Tõrva municipality special plan I

Strategic Environmental Assessment

FIRST STAGE REPORT

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Title:	**Tõrva Municipality Special Plan I [1] Strategic Environmental Assessment First Stage Report**
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[1] Two special plans for wind energy have been initiated in Tõrva Parish. To distinguish between them, the special plan discussed in this SEA report is also referred to as "special plan I."

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Summary of the report

The strategic planning document that is the subject of this strategic environmental assessment is **the special plan of Tõrva municipality for finding a suitable location for wind farms in the southwestern part of Tõrva municipality**. This is the preliminary selection stage of the special plan ([2]), but the planning solution has been prepared with a degree of accuracy that determines the basic location of the wind turbines and associated infrastructure.

The preparation of the special plan for Tõrva municipality and the strategic environmental assessment was initiated by Tõrva Municipal Council on 25 October 2022 with decision no. 1-3/2022/24 "Initiation of a special plan for local government and strategic environmental assessment."

The purpose of the special plan is to identify suitable locations for wind farms and the infrastructure necessary for their operation in the special planning area located in the southwestern part of Tõrva Municipality. The special plan covers an area of approximately 115 km^{2}and the location is being sought for a wind farm of at least 150 ha.

The maximum permitted height and number of wind turbines in the wind farm area will be determined during the preliminary selection of the location, based on the size of the suitable location, the effective placement of the wind turbines, the location of objects causing restrictions, and the height restrictions specified by the Ministry of Defense.

The need to establish a wind farm stems from Estonia's climate and energy policy, the framework for which is set out in the document Climate Policy Fundamentals until 2050[3] . Estonia's long-term goal is to balance greenhouse gas emissions and sequestration by 2050 at the latest, i.e. to reduce net greenhouse gas emissions to zero by that time. In the shorter term, Estonia has set a target of producing as much renewable electricity in 2030 as our total annual consumption[4] . In terms of onshore wind energy, these targets mean that by 2030, new wind farms with a capacity of at least 1GW must be built onshore[5] .

The special plan being drawn up is in line with Estonia's climate and energy policy objectives, including the Estonian Energy Sector Development Plan 2030+ and the Estonian Climate Change Adaptation Development Plan until 2030. The wind farm planned in the plan will have a significant positive impact on the achievement of climate goals. The impact on the climate and climate security has been assessed in section4.1.10 .

When compiling the SEA program, a preliminary simplified map analysis of the Tõrva municipality special plan area was carried out. It was found that there are two potential pre-selection areas within the special plan area that have no direct exclusionary factors for the further selection of the location of the object covered by the special plan and that have sufficient territory (Figure2). The description of the areas and the objects potentially located in the impact area is presented in the SEA program and will not be repeated here. The SEA report also presents relevant information on the current state of the environment in the assessment of the impact of the respective impact area.

In this SEA, the impact assessment takes into account the maximum possible height of wind turbines over a five-year period, which is estimated to be up to 300 m. The height of wind turbines is particularly important from the point of view of visual impact. At the time of compiling this SEA report, there are no known wind turbines with a tip height of 300 m in series production. The highest models in series production from leading wind turbine manufacturers are known to have a tip height of approximately 270 m at the time of compiling this SEA report. In accordance with the impact assessment methodology,

[2] Preliminary site selection According to the Planning Act, the most suitable location or area for the planned construction is selected by considering various possible locations.
[3] https://kliimaministeerium.ee/kliimapoliitika-pohialused-aastani-2050
[4] Energy Economy Organization Act § 32(1) https://www.riigiteataja.ee/akt/110102024005?leiaKehtiv
[5] State Chancellery. 2022. Audit on accelerating the development of renewable energy.

the assessment is based on the worst-case scenario, i.e. the maximum wind turbine parameters that can be expected in the near future are used.

When making the preliminary selection of the location for the special plan, the location of areas belonging to the Natura 2000 network was taken into account in order to ensure the favorable status of the areas and their conservation objectives. Natura 2000 areas were excluded as potentially suitable areas in the initial map analysis. Further analysis found that, by not planning the wind farm in the potentially suitable area to the north and planning to connect it to the electricity grid with an underground cable, there would be no significant adverse impact on any Natura bird or nature areas based on the available information. The Natura assessment is presented in section . 4.1.1

The impact assessment on protected sites revealed that by ensuring a 2 km wind turbine-free buffer zone around the permanent habitats of the lesser spotted eagle found in the KSH bird survey and established on that basis, applying a 1 km buffer zone around the permanent habitat of the capercaillie in Lasa, the permanent habitat of the corncrake and the habitat of the capercaillie in the Tündre Nature Reserve, and maintaining a buffer zone of at least 2 km around micro-reserves 2185 and 2609 in accordance with the position of the Republic of Latvia, it is possible to avoid significant adverse effects on all protected areas (see section4.1.7).

In both potentially suitable areas, there is little overlap with high-value plant communities, and wind turbines and related infrastructure can be constructed without causing significant adverse effects on vegetation. The impact assessment on vegetation is presented in section4.1.2 .

During the SEA, data on the areas identified in the initial map analysis was compiled from databases and previous studies on the region. As the data on bats, a species group threatened by wind turbines, was very incomplete and the data on birds was insufficient, field studies were also conducted during the first stage of the SEA to assess the suitability of the habitats of these species groups.

The bird survey concluded that it would be possible to establish a wind farm with service roads and facilities in the southern potentially suitable area outside the habitats of Category II protected species and important movement corridors. In the northern potentially suitable area, the construction of a wind farm would have a significant adverse impact on birdlife, and therefore the construction of a wind farm there should be avoided. The impact assessment on birdlife is presented in section4.1.3 . In order to avoid significant adverse effects on birdlife, mitigation measures have been developed and a follow-up monitoring obligation has been established in the SEA report.

As a result of the bat survey, priority habitats and feeding areas for bats were mapped in potentially suitable areas. No wind turbine positions are planned in priority habitats and feeding areas as a mitigation measure. The impact assessment on bats is presented in section4.1.4 . In addition, mitigation measures have been developed to avoid significant adverse effects on bats.

As the planning area largely overlaps with green network areas, a green network survey was carried out in potentially suitable areas. The survey mapped habitats important for mammals and amphibians, the avoidance of which will ensure the functionality of the green network when establishing the wind farm. A proposal for the expansion of the green network as compensation was also presented. The impact assessment on the green network is presented in section . 4.1.5

To assess the social and human health aspects of wind turbines, modeling of wind turbine noise, including low-frequency noise (see section4.4.1), and shadow modeling (see section4.4.2) was carried out. All modeling was based on the worst-case scenario (21 wind turbines with maximum parameters). The impact assessment showed that it is possible to locate wind turbines in the potentially suitable area to the south in a way that ensures compliance with noise limits and recommended shadowing levels in all residential areas. In terms of noise, there is one residential area where the target value for industrial noise applicable to residential areas (40 dBA) may not be met, but the interested party has agreed to tolerate noise up to the noise limit value for this particular residential building. The nighttime target value for industrial noise is guaranteed in all other residential areas. Mitigation measures must be implemented in two residential areas to ensure the recommended level of shading (8 h/a, taking into account climatic conditions).

Wind turbines are large objects and therefore remain visible from open areas, whereby the openness of the view is important, rather than the distance from the wind turbine (a wind turbine may not be visible even from a point very close to the wind turbine if there is a forest in front of the view, , while in open areas, wind turbines can be clearly visible from a distance of several tens of kilometers in clear weather conditions). To assess the visual impact of the wind farm, a visibility analysis with visualizations was prepared (see section4.5). It was found that the wind farm does not dominate visually from any significant viewing corridor or location with a significant view.

The SEA also analyzed the impact on water bodies (section4.1.8), the impact on soil, including valuable agricultural land (4.1.9), the impact on cultural heritage (section4.5), and the impact on social needs and property (section4.4.4). Waste generation (section4.3) and infrastructure and land use restrictions (section4.2) were also discussed. On these issues, it was found that the construction of a wind farm in the potentially suitable area in the south is not expected to have a significant adverse impact on these environmental elements, or that this impact can be mitigated by the mitigation measures presented in the SEA report.

In summary, it is possible to establish a wind farm in the potentially suitable area in the south without significant adverse environmental impact if the mitigation measures presented in the SEA report are implemented. By excluding the undesirable areas presented in the SEA report, it is possible to establish a wind farm in the area, the positive environmental impact of which outweighs the associated adverse effects.

1 General section

1.1 Objective of the planned activity

The strategic planning document subject to this strategic environmental assessment is **the Tõrva municipality special plan for finding a suitable location for wind farms in the southwestern part of Tõrva municipality**. This is the preliminary selection stage of the special plan location[6] .

The SEA is an assessment carried out with the participation of the public and relevant authorities to identify the significant environmental impact associated with the implementation of the strategic planning document, to identify alternative options and to find measures to mitigate adverse effects. The results of the assessment will be taken into account in the preparation of the strategic planning document and a report will be prepared in accordance with the requirements. **The purpose of the SEA** is to take environmental considerations into account in the preparation and adoption of the strategic planning document in accordance with the Environmental Impact Assessment and Environmental Management System Act (hereinafter referred to *as the KeHJS)*, to ensure a high level of environmental protection and to promote sustainable development. This SEA report is a strategic environmental assessment of the preliminary selection of the location for the special plan**,** i.e.**, the first stage of the SEA.** As a basic solution for the wind farm has been prepared during the preparation of the plan, the impacts have been assessed with a degree of accuracy corresponding to the accuracy of the plan. It has been taken into account that no additional strategic environmental assessment will be carried out for the planning of this wind farm, i.e. the SEA is at the level of detail of the SEA for the detailed solution/detailed plan of the wind farm.

Pursuant to § 95 (1) of the Planning Act (hereinafter *PlanS*) , a local government (hereinafter *LG*) shall prepare a special plan for the construction of a building with a significant spatial impact if the location of the building with a significant spatial impact is not specified in the comprehensive plan. According to the Government of the Republic Regulation No. 102 of 01.10.2015 "List of buildings with significant spatial impact" p-le 4, a wind farm consisting of wind turbines more than 30 meters high is considered a building with significant spatial impact.

The purpose of the construction of wind farms (hereinafter referred to *as wind farms*) (planned activity) is to generate electricity from wind and feed it into the main grid. The need to establish wind farms stems from the agreement between the Member States of the European Union on long-term climate goals, whereby each country, including Estonia, has committed itself to moving towards a cleaner and carbon-neutral future. Estonia has set a target that, in order to meet its climate goals and ensure energy security, it will produce as much renewable electricity in 2030 as our total annual consumption[7] . To achieve this, new wind farms with a capacity of at least 1 GW must be built on land[8] .

1.2 Parties

The parties involved in the preparation of the special plan and SEA are as follows:

- The initiator and establisher of the special plan and SEA is the Tõrva Municipal Council, and the compiler and organizer of the special plan is the Tõrva Municipal Government (Valga County, Tõrva Municipality, Tõrva City, Kevade tn 1, 68605);

[6] According to the Planning Act, the preliminary selection of a location involves choosing the most suitable location or area for the planned construction by considering various possible locations.
[7] Energy Economy Organization Act § 32(1) https://www.riigiteataja.ee/akt/110102024005?leiaKehtiv
[8] State Chancellery. 2022. Audit on accelerating the development of renewable energy.

- The consultant for the preparation of the special plan is AB Artes Terrae OÜ (Tartu County, Tartu City, Tartu City, Küütri tn 14, 51007; e-mail:heiki@artes.ee ; tel: +372 509 1874; contact person: Heiki Kalberg);
- The SEA is being prepared by LEMMA OÜ (Harju County, Tallinn, Kristiine District, Värvi tn 5, 10621;
  e-mail:info@lemma.ee ; tel: +372 505 9914);
- The party interested in the special plan is Evecon OÜ (Saare County, Saaremaa Municipality, Kuressaare City, Lossi tn 3, 93819, e-mail addressinfo@evecon.ee).

The SEA working group includes:

- Piret Toonpere – SEA lead expert/EIA expert (KMH0153) – socio-economic impacts, shadowing, noise, visualizations, Natura assessment, comparison of alternatives; The lead expert has the right to manage SEA in accordance with § 34(4) of the Environmental Impact Assessment and Environmental Management System Act;
- Heli Aun – environmental consultant – compilation of environmental description, deposits, impacts on the natural environment, issues related to hydrogeological conditions and cartography;
- Andrus Veskioja – environmental consultant – impact on climate change;
- Mihkel Vaarik – environmental consultant – impact on soil, water regime and aquatic environment;
- Astrid Koplimäe – environmental consultant – visual impacts, including fieldwork necessary for the preparation of photomontages;
- Laura Elina Tuovinen (participated until 08.2024) – environmental consultant – impacts on the natural environment, including green networks and protected areas; compilation of WindPro models;
- Liis Promvalds – environmental consultant – impact on climate change and climate resilience.

The bird survey and guidelines for taking bird impacts into account were provided by a Xenus OÜ working group consisting of Hannes Pehlak (MSc), Jaan Grosberg (MSc, bird of prey specialist), Uku Paal, and Art Villem Adojaan (BSc).

The analysis of the functioning of the green network and the study of bat habitats, as well as guidelines for the development of a wind farm in the Tõrva municipality wind energy planning area, were carried out by a working group from OÜ Rewild, which included Piret Remm (PhD), Jaanus Remm (PhD), Jaan Grosberg (MSc), Kertu Jaik (MSc), Art-Villem Adojaan (BSc), Kauri Remm, and Rando Remm.

The work also drew on previously compiled expert opinions, studies and other relevant work on the region, including the database compiled as part of the ELME project[9] . In addition, the assessment of the impact of wind turbines was based on scientific literature and studies conducted on wind farms elsewhere in the world.

1.3 Overview of the SEA process and public participation

The preparation of the Tõrva municipality special plan and strategic environmental assessment was initiated by the Tõrva Municipal Council on 25 October 2022 with decision no. 1-3/2022/24 "Initiation of a local government special plan and strategic environmental assessment."

The reason for initiating the special plan was the application submitted by Evecon OÜ (registry code 10340286) to the Tõrva Municipal Government on 8 August 2022 No. 7-7/2022/1476-1 submitted to the Tõrva Municipal Government. Evecon OÜ specified the location and size of the planning area in its letter dated 28.09.2022. According to the application, the planning area covers approximately 115 km² of land in the southwestern part of Tõrva Municipality.

[9] https://loodusveeb.ee/et/themes/uleriigiline-hindamine-ja-kaardistamine/maismaaokosusteemid

Report on the first stage of the strategic environmental assessment of the special plan for Tõrva municipality

The purpose of the special plan is to identify suitable locations for wind farms and the infrastructure necessary for their operation in the special planning area located in the southwestern part of Tõrva Municipality. The special plan covers an area of approximately 115 km².

The maximum permitted height and number of wind turbines in the wind farm area will be determined during the preliminary selection of locations, based on the size of the suitable location, the effective placement of the wind turbines, the locations of objects causing restrictions, and the height restrictions specified by the Ministry of Defense.

In accordance with the special plan and the technical description of public procurement 255426 organized for the preparation of the SEA location selection stage, a suitable location for the wind farm(s) is being sought. Following the procurement procedure, the starting points for the special plans and the SEA program began to be prepared.

From July 10, 2023, to August 11, 2023, the starting points for the preliminary selection of the location for the special plan for Tõrva municipality and the strategic environmental assessment program were publicly displayed. Written opinions on the document were also requested by letter. During the public display, 11 letters were received, nine of which were from legal entities and two from natural persons. Public discussions on the results of the public display of the special plan took place on September 19, 2023, at the Mulgi Experience Center and on September 20, 2023, at the Tõrva Cultural Center.

Based on the positions of the relevant authorities, the public display, and the results of the public discussions, the initial planning positions and the strategic environmental assessment program were adjusted. Information on whether opinions and proposals were taken into account or not was compiled in a table, which was published on the local government's website and sent to the person or institution that had submitted the letter for review.

Subsequently, the SEA report was prepared and, upon completion of its preliminary draft, the planning solution. The planning solution was prepared and refined during the first half of 2024. In order to refine the solution, the developer also carried out yield forecasts for different wind farm layout solutions to achieve the highest possible wind farm efficiency. In the second half of 2024, the planning solution and SEA were reviewed by the local government and the materials were supplemented based on the feedback received.

After supplementing the materials in accordance with the proposals of the interested parties and the local government, the materials were submitted for coordination to the cooperation partners and to the parties involved for their opinion. Based on the proposals of the cooperation partners, the SEA report was then supplemented, including the preparation of additional Annexes 5-7 to the SEA report. Based on the proposals submitted by the Environmental Board, it became apparent that there was a need to specify the mitigation measures and, consequently, the planning solution. In addition, based on the proposals of the Environmental Board, an additional summer bird survey was carried out.

The specified planning solution, together with the supplemented SEA report, was then resubmitted to the National Heritage Board and the Environmental Board for coordination. The local government will prepare its positions on the opinions expressed by the respondents, which will be published on the local government's website.

Everything related to the special plan, including the proposals received, the municipality's positions on them, and the additional considerations raised in public discussions and the municipality's positions on them, are publicly available on the Tõrva municipality website at https://kov.torva.ee/eriplaneering.

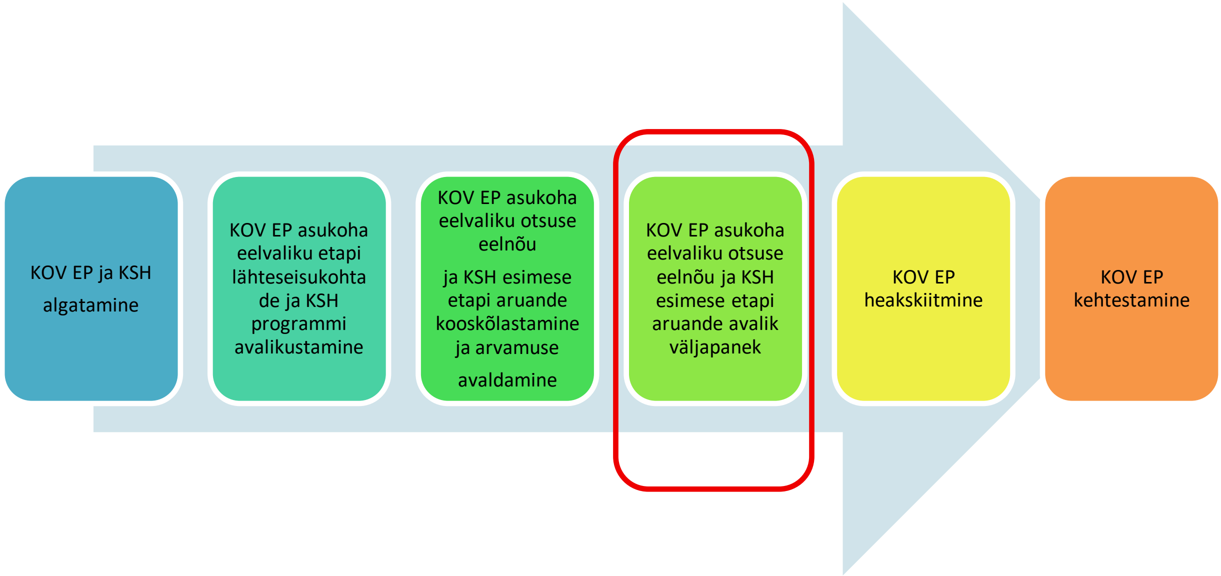

Figure1 . Local government special plan and its SEA procedure scheme. The red box indicates the current stage of the procedure. The scheme is based on the version of the Planning Act that entered into force on July 18, 2025.

This chapter will be updated on an ongoing basis in accordance with the progress of the SEA procedure.

1.4 Methodology

The strategic environmental assessment was carried out on the basis of the Environmental Impact Assessment and Environmental Management System Act (KeHJS) and the Planning Act (PlanS). The SEA report was prepared in accordance with the requirements of the relevant legislation in force in Estonia and the European Union. The SEA report was prepared in accordance with the requirements set out in § 40 of the KeHJS, taking into account, among other things, the objectives of the strategic planning document. Pursuant to § 40(3)(2) of the KeHJS, the SEA report must take into account the content and level of establishment of the strategic planning document.

Similar to the special plan itself, the SEA report for special plans is also prepared in two stages in accordance with the Planning Act. Together with the preliminary selection of the location of the special plan, an SEA Stage I report is prepared, which deals with the identification and comparison of suitable locations based on environmental impacts. The SEA Stage I report also sets out the conditions that need to be taken into account and identifies and determines the need for additional studies for the object at the selected location. A SEA report will be prepared together with the detailed solution of the special plan, which will assess the impacts of specific wind farm solutions and identify mitigation measures. Both the planning solution and the SEA preparation process are public and involve the public.

When preparing a special plan for a wind farm, the local government unit may waive the preparation of a detailed solution and establish the location of the plan on the basis of a preliminary selection decision if there are no factors that would preclude the further planning of the wind farm with design conditions and the preliminary selection decision. In preparing this special plan, the local government has provided guidelines for areas where it is possible to waive the preparation of a detailed solution in order to reduce the administrative burden. Therefore, in places where there is certainty about the absence of exclusionary factors (including certainty about the absence of significant adverse effects on Natura areas), conditions for issuing design conditions will be set when compiling the location selection, including the approximate locations of wind turbines, service roads, and connection lines.

Neither PlanS nor KeHJS provide guidance on how to resolve the preparation of the SEA report in such a situation. The SEA report on the location selection should, in essence, address the suitability of the location and the impacts resulting from the location selection, rather than being an assessment of the impacts of the detailed solution for the wind farm. The Environmental Board (hereinafter *KeA)* has expressed the view that if a detailed solution is not adopted, the SEA Stage I report should be more accurate, including more detailed baseline studies. This SEA report is based on an approach whereby recommendations are made for the preventive exclusion of known and potential high-value natural communities from the location selection process if a detailed solution is to be abandoned. This approach minimizes the risk that additional nature studies conducted during the design phase would result in the need to significantly change the wind farm solution.

The assessment was based on relevant methodological guidelines, the most important of which were:

- Peterson, K., Kutsar, R., Metspalu, P., Vahtrus, S., and Kalle, H. 2017. Handbook for Strategic Environmental Assessment;
- Põder, T. 2017. Environmental Impact Assessment Handbook;
- Kutsar, R.; Eschbaum, K. and Aunapuu, A. 2019. Guidelines for conducting Natura assessments in the implementation of Article 6(3) of the Habitats Directive in Estonia;
- European Commission. Commission Communication on the assessment of plans and projects in relation to Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. ET Brussels, 28.9.2021 C(2021) 6913 final.

In addition, the environmental impact assessment takes into account the knowledge of the lead expert and the working group in the field of environmental impact assessment, as well as information presented in professional scientific literature. References to literature sources are provided as footnotes when presenting the relevant claims.

During the SEA, environmental status studies were carried out in areas where the SEA program had identified that the area had not been sufficiently studied to carry out the assessment. If the assessment of the presence of impacts has been carried out through additional studies, the methodology for assessing the impacts in the relevant impact area is described in the corresponding assessment in section4 . A description of the knowledge gaps is also provided in the impact assessment chapters, where, based on the SEA program, there was a need to conduct studies to describe the existing environmental status and components, as the research was insufficient.

According to the KeHJS, the first stage report of the strategic environmental assessment must contain source data for the preparation of the strategic environmental assessment report for the local government's special plan. This report takes the approach that, if a detailed solution is not adopted, the need for additional assessment as provided for in the design conditions will be described in the Stage I SEA report. The corresponding additional activities (impact assessments and studies to be carried out during the further design of the wind farm and conditions to be followed) are presented at the end of each impact assessment in section4 on a colored background.

1.5 Source materials

The following source materials were used in the preparation of the SEA:

- Tõrva Municipal Council Decision No. 1-3/2022/24 of 25 October 2022 "Initiation of a local government special plan and strategic environmental impact assessment".
- AB Artes Terrae OÜ and LEMMA OÜ. 2023. Starting points for the preliminary selection of the location of the Tõrva municipality special plan and the strategic environmental assessment program.

1.6 Overview of difficulties encountered in preparing the SEA report

No significant procedural difficulties worth mentioning arose during the preparation of the SEA Stage I report for this special plan. To a certain extent, the lengthy planning process is a difficulty, as there is a considerable time lag between the basic studies and the coordination of the planning solution.

However, this sometimes causes the baseline studies to become outdated in terms of time and methodology in relation to the preparation of newer guidelines. In this case, this occurred in the case of the bird survey, where the issues related to the possible obsolescence of the survey were resolved by conducting additional spot observations in the summer.

The uncertainty of the estimates (gaps in knowledge) is described in the relevant impact assessment when necessary. Throughout the preparation of the SEA report, the impact forecasts are based on the maximum dimensions of the wind turbines (including the construction base area) and number in order to minimize the risks associated with uncertainty in the estimates.

2 Planned activity and alternatives considered

2.1 Planned activity

In accordance with Tõrva Municipal Council Decision No. 1-3/2022/24 of 25 October 2022 "Initiation of a local government special plan and strategic environmental assessment" and the starting points of the special plan**, a suitable location for wind farms will be sought** in accordance with **the special plan,** taking into account the following aspects:

- A location is sought for wind farms **with an area of at least 150 ha**. Therefore, locations for individual wind turbines are not being sought. A wind farm may also consist of several separate groups of wind turbines in the same pre-selected area, each with a separate connection point, electricity and communications network and, if necessary, a road network.
- A wind farm consists of wind generators (wind turbines), roads serving the wind farm and wind turbines, an internal electricity network, substations, and other infrastructure.
- The maximum permitted height and number of wind turbines on the wind farm site shall be determined during the preliminary selection process, based on the size of the suitable location and the effective placement of the wind turbines. The height of the masts of the wind turbines planned by the developer shall be up to 200 m and the length of the blades up to 100 m. The building right area for one wind turbine, including the wind turbine foundation and service road, is approximately 1 ha;
- The maximum permitted height of the wind turbines will be determined in cooperation with the Ministry of Defense. The Ministry of Defense has clarified that the properties of interest in Tõrva Parish are among the areas to be opened up by compensation measures in mainland Estonia, and after the full implementation of these measures, it will be possible to waive the height restrictions, presumably in 2025. Based on the position of the Ministry of Defense, it is therefore not foreseeable that national defense restrictions on the erection of wind turbines in Tõrva Parish will remain in place after 2025. During the planning process, the Ministry of Defense may, if necessary, grant conditional approval, and the Ministry of Defense would approve the future building permit after the height restrictions have been changed (EhS § 120).
- Existing and planned high-voltage substations are preferred for connecting wind farms to the electricity grid. whereby the location(s) of the connection point(s) between the wind farm and the electricity grid should be determined on the basis of existing overhead lines and the routes of lines provided for in the applicable plans; the location and approximate length of additional new overhead lines between the wind farm and the electricity grid connection point shall be determined during the preliminary selection of the location;
- The wind farm must take into account economic, social, national defense, and environmental protection restrictions, including the protection objectives of protected objects, and cause as little disturbance as possible to the population and environment (milieu) of the area where it is located, including views of the landscape. In cooperation with the authorities and local residents involved, the important economic and social aspects affected by the wind farm that require further investigation must be identified, and suitable research methods found. Studies of the natural environment must be carried out in full during stage I. The contractor must identify relevant mitigation and prevention measures;
- When selecting the location of the wind farm, both public interests and the state's tasks and obligations to reduce greenhouse gas emissions and mitigate the effects of climate change, as well as developments in wind energy production technology, must be taken into account.
- The principles for the development of wind energy set out in the Valga County Plan must be taken into account when drawing up the special plan.

2.2 Location alternatives

The special plan area covers part of the territory of Tõrva municipality. Within the special plan area, there are two potentially suitable areas for the development of wind farms, which are of interest to the person interested in the plan and whose suitability as wind farm areas will be assessed in accordance with the SEA program when preparing the SEA.

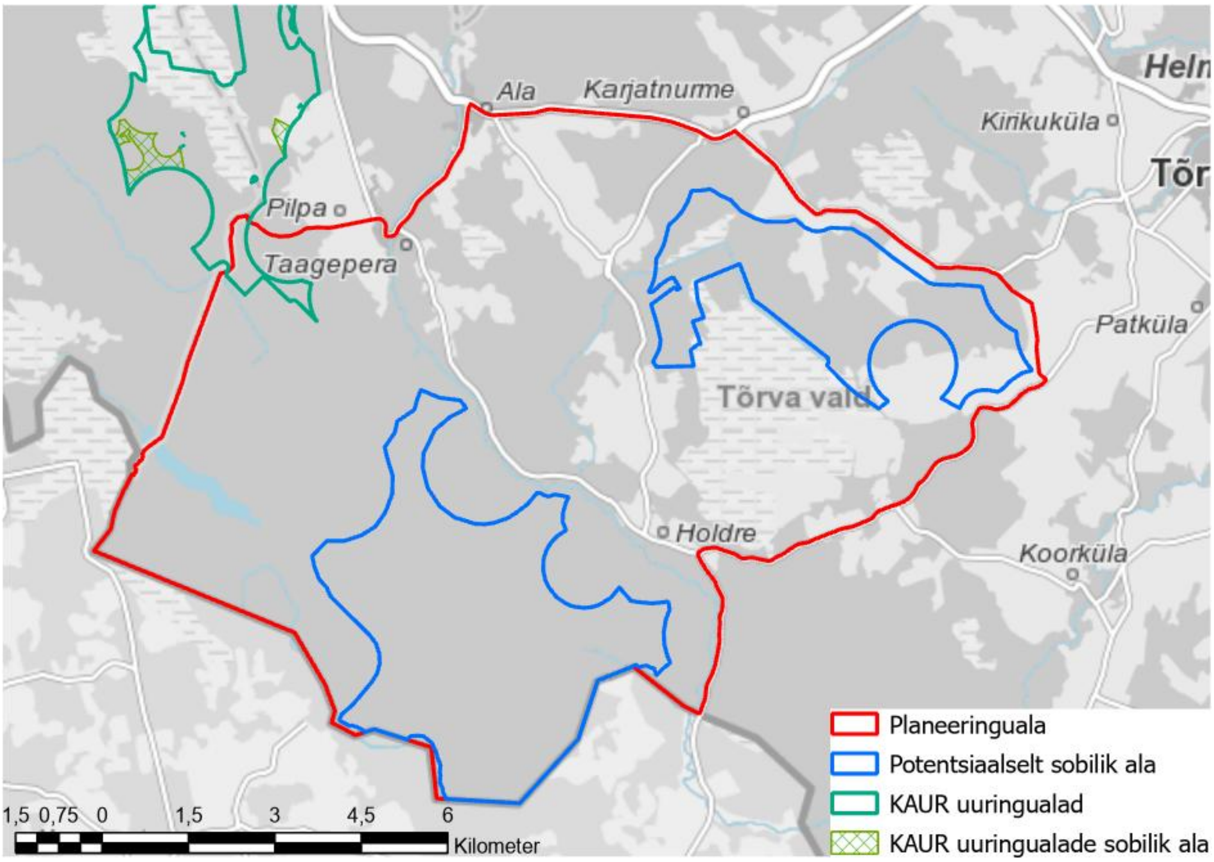

Figure2 . Areas potentially suitable for wind farms identified in the initial map analysis.

During the preparation of the SEA program, a preliminary simplified map analysis of the Tõrva municipality special plan territory was carried out. It was found that there are two potential pre-selection areas in the special plan area that have no direct exclusion factors for the further selection of the location of the object covered by the special plan and that have sufficient territory. The description of the areas and the objects potentially located in the impact area is presented in the SEA program and will not be repeated here. The SEA report also presents relevant information on the current state of the environment in the assessment of the impact of the respective impact area.

Table1 . Potentially suitable areas in the Tõrva municipality special plan area.

Designation	Settlements located in the area	Area, ha
Northern area	Holdre village, Kähu village, Karjatnurme village, Kirikuküla and Koorküla	1069
Southern area	Holdre village, Pilpa village	2023
Total		**3092**

In addition to the map analysis carried out during the preparation of the SEA program for this special plan, the Environmental Agency carried out a project *to map additional areas for wind energy development* in the period 2022-2024. As part of the project, nature studies were analyzed and conducted in 23 areas across Estonia. One of the areas (the so-called Tõrva areaFigure2) remained within the area of this special plan. The studies and analyses showed that the part of the study area within the special plan area is unsuitable for wind energy development[10] .

2.3 Alternatives for wind turbine height

In this SEA, the impact assessment takes into account the maximum possible wind turbine height over a five-year period, which is estimated to be up to 300 m. The height of wind turbines is particularly important in terms of visual impact and shadowing. At the time of compiling this SEA report, there are no known wind turbines with a tip height of 300 m in series production. The highest models in series production from leading wind turbine manufacturers are known to have a tip height of approximately 270 m at the time of compiling this SEA report. In accordance with the impact assessment methodology, the assessment is based on the worst-case scenario, i.e. the maximum wind turbine parameters that can be expected in the near future are used. This approach helps to minimize the risks associated with the uncertainty of estimates. If a significant adverse impact is identified, the SEA report considers reducing the height of the wind turbines as a mitigation measure (if the impact is related to the size of the wind turbines).

2.4 Wind turbine layout and technical solution and alternatives

The preliminary selection stage of the special plan does not generally determine the location of the wind turbines or the internal infrastructure of the wind farm associated with them. However, if a special plan is to be established after the preliminary selection stage, it is necessary to determine the basic locations of the wind turbines and the indicative solution for the accompanying infrastructure. In addition to identifying areas suitable for initial location selection, this special plan also includes a basic solution for the wind farm in the location selection area, including the approximate layout of the wind turbines. The location of the wind turbines, including their number, has been determined taking into account the location of natural values mapped during the SEA (areas of higher natural value have been avoided). The wind turbine layout solution has also been developed in cooperation with the interested party, taking into account the wind farm's productivity[11] . The layout of the wind turbines takes into account the main wind direction and ensures sufficient distance between the wind turbines to guarantee optimal productivity.

At the preliminary selection stage of the wind farm location, the technical solution for the wind turbines is not known. However, in order to assess the impacts appropriately, it is necessary to have an idea of the technical solution for the wind farm, primarily in order to assess the land requirements and the associated impacts. Therefore, the following subsections provide a basic description of the wind farm components, which has been used as a basis for assessing the impacts. The specific technical solution will be determined during the detailed planning stage. **The following data is indicative.**

2.4.1 Wind turbines and their layout

Wind farms today mainly use three-bladed horizontal axis wind turbines. This SEA report assumes that such wind turbines will be used in the wind farm.

Wind turbines are usually painted in natural colors (white, gray) with matte paint. To ensure flight safety, the nacelles of wind turbines are equipped with red warning lights.

The maximum capacity of mass-produced onshore wind turbines is currently almost 7 MW[12] . To date, the capacity of wind turbines has been steadily increasing in line with technological developments. When assessing environmental impacts, the capacity of a wind turbine is not a factor that directly

[10] Environmental Agency. 2024. Mapping of additional areas for wind energy development.

[11] Yield forecasts are based on a special plan commissioned by an interested party and its SEA, and their detailed results are not presented in the SEA report.

[12] https://www.vestas.com/en/products/enventus-platform/v162-6-8-mw

determines its environmental impact. However, capacity does determine the energy yield of wind turbines, and in order to achieve renewable energy targets, it is appropriate to install wind turbines with the highest possible yield, which reduces the number of turbines required.

Wind turbines generate energy at wind speeds ranging from 3 to 25 m/s.

This SEA report assumes that the maximum height of the wind turbines to be built in the area will be up to 300 m and the rotor diameter up to 200 m.

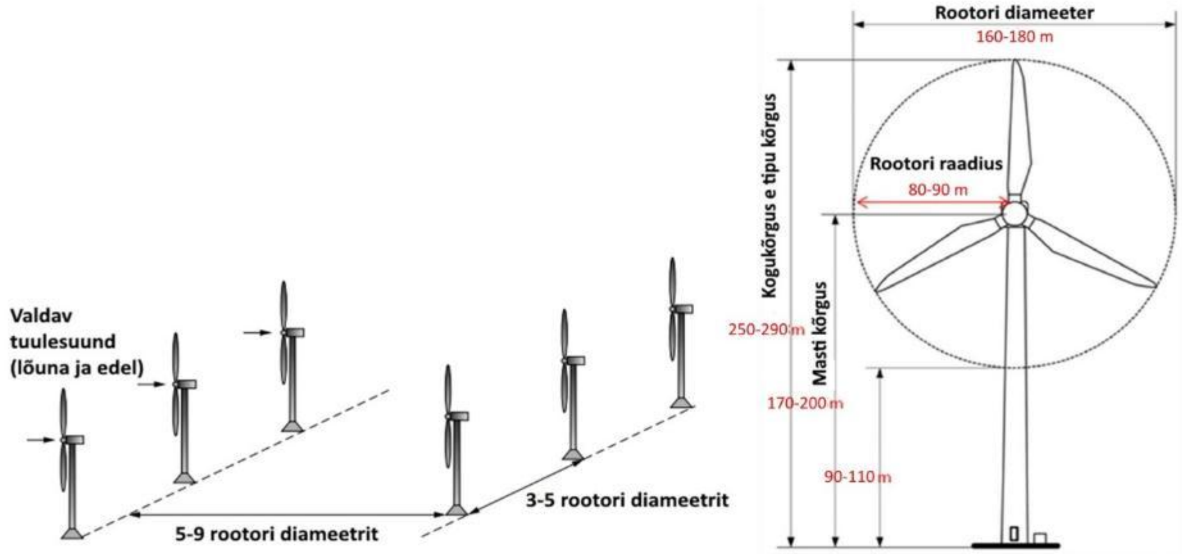

Figure3 . Wind turbine dimensions and typical wind turbine layout in a wind farm. This is an illustrative diagram.

Wind turbines are placed in a wind farm in the prevailing wind direction at a distance of approximately 5–9 rotor diameters from each other (minimum 800 m for a 160 m rotor) and in other wind directions at a distance of approximately 3–5 rotor diameters (minimum 480 m for a 160 m rotor). The required distance is determined by the person interested in the plan based on yield forecasts.

In this special plan, it is recommended that, where possible (in the absence of any obstacles), the procedure permitted by the Planning Act be used for as many areas suitable for wind farms as possible, whereby the selection of the location is followed by the issuance of design conditions. Based on this, in addition to excluding areas unsuitable for wind farms due to natural environment restrictions, the special plan also includes basic solutions for wind turbines and roads.

2.4.2 Foundation

The type of wind turbine foundation is not specified in the special plan. The type of wind turbine foundation and technical solution will be selected according to the engineering geological properties of the soil when preparing the construction project. For onshore wind turbines, the most common type of foundation is a gravity foundation – a reinforced concrete foundation that keeps the wind turbine upright by means of gravity. A gravity foundation is also the type of foundation that requires the most land.

The foundations of modern wind turbines are generally up to 25 m in diameter, which makes the construction area of the foundation approximately 490 m^2. The depth of the foundation also depends on the geological conditions. The depth can be approximately 2–6 m. The volume of soil excavated for the construction of a single wind turbine is 1000–2000 m([3] .Some of the excavated soil is used to cover the foundation. This SEA report assumes that, when using a gravity foundation, its diameter will be a maximum of 31 m and its depth up to 6 m.

When constructing wind turbines in swampy areas and on soil with low bearing capacity, pile foundations or a combination of piles/anchors and gravity foundations are often used instead of gravity foundations. When using piles, the amount of excavated material and concrete used is significantly smaller, while piles can be constructed to a depth of 10–20 m. In this area, the need to use pile foundations is unlikely. If the need to use them arises, the corresponding effects and necessary groundwater protection measures must be addressed in the construction project with the involvement of a hydrogeologist.

Figure4 . Types of wind turbine foundations[13] . From left: gravity foundation, single pile foundation or monopile foundation, slab foundation with combined piles, slab foundation with combined anchors.

2.4.3 Assembly sites

An assembly site is established for the erection of each wind turbine, where a crane and other necessary equipment can be set up for the construction period. The assembly site can also be used to store wind turbine components prior to erection. Each wind turbine manufacturer has standard assembly site solutions developed for each wind turbine model, which are modified as necessary based on the specific characteristics of the location. The assembly site is built directly next to the wind turbine to allow the crane to lift the wind turbine components into place. The site must be level and have sufficient load-bearing capacity. The site is not usually dismantled after construction work is completed, as it may also be needed for wind turbine maintenance work.

The larger the wind turbine to be erected, the larger the assembly site, as the dimensions of the components to be erected and the size of the crane used increase. The shape of the assembly sites depends on the technical requirements of the specific wind turbine manufacturer (Figure5 - example of an assembly site). This SEA report assumes that the area of hard-packed ground required for the assembly site is up to 10,100 m$^{(2)}$.

[13] Annan, D. 2019. Getting Your Wind Farm On The Right Footing. https://www.golder.com/insights/getting-your-wind-farm-on-the-right-footing/

Figure5 . Possible wind turbine foundation area with assembly sites. Source: Land Board aerial photograph – Tootsi/Sopi wind farm. The exact shape and area of the assembly site depends on the specifications of the wind turbine manufacturer.

2.4.4 Roads

Access roads must be built for all wind turbines to enable their construction (including the transport of wind turbine components) and subsequent maintenance. Roads in operating wind farms must be kept accessible all year round. The roads to be built must have sufficient load-bearing capacity and be wide enough. The width of the road surface in a wind farm is usually around 5 m and the width of the road corridor around 10 m. The SEA report takes into account a wind farm road corridor width of up to 10 m.

In the case of road bends and slopes, the transport requirements of particularly large items must be taken into account, and it may be necessary to remove obstacles (including trees) from bends in order to increase the turning radius.

Where roads intersect with ditches or larger water bodies, culverts/bridges must be designed. To ensure the stability of the roads, it may be necessary to design storm water ditches adjacent to the roads (the need for this will be specified on the basis of engineering geological surveys during the design phase).

2.4.5 Internal electrical connections in the wind farm

The wind turbines will be connected to the wind farm substation by underground cables. The underground cables will be laid in a trench up to a few meters wide and up to 1 m deep.

2.4.6 Wind farm substation

A substation must be built in order to connect the wind farm to the grid. The size of the substation depends on the size of the wind farm, and its location depends on the technical conditions of the grid operator (the substation may be located either near the main grid or, in some cases, within the wind farm area). Based on the example of the Jäneda substation, the land requirement for a 110 kV substation is 50× 70 m, or approximately 3500 m^2(Figure6). The substation territory is generally a hard-surfaced area, which is usually enclosed by a fence. In this SEA report, the impact assessment takes into account the hard-surfaced area required for the substation, with a surface area of up to 10,700 m(2) .

Figure6 . Illustration of a 110 kV substation – Jäneda substation. Source: Land Board aerial photograph.

2.4.7 Connection to the main grid

To connect the substation to the main grid, an electrical connection is planned with a 110 kV overhead line or underground cable to an existing substation in the electricity grid or to a new substation to be built on the high-voltage line. As the connection conditions for the wind farm will be determined on the basis of the technical conditions issued by the network operator after the plan has been approved, the connection points for the wind farm are not known at the time of preparing the special plan. Taking into account the recommendations for measures presented in the impact assessment during the preparation of the special plan for Tõrva municipality**, no overhead power lines are planned in the plan. The SEA report is based on the assumption that all electrical connections to the grid will be planned with underground cables**.

3 Links to relevant strategic development documents

An analysis of links to relevant strategic development documents is presented in the SEA program[14] . The analysis will not be repeated in full here.

Document "Climate Policy Basics until 2050[15] ." 08.02.2023. The "Climate Policy Basics until 2050" updated by the Riigikogu stipulates that Estonia's long-term goal is to balance greenhouse gas emissions and sequestration by 2050 at the latest, i.e. to reduce net greenhouse gas emissions to zero by that time. On May 12, 2021, the Riigikogu approved the long-term development strategy "Estonia 2035," which agreed on Estonia's national climate neutrality goal for 2050. The "Estonia 2035" action plan sets a target of 8 million tons of CO_2 equivalent for net greenhouse gas emissions by 2035.

In the shorter term, Estonia has set a target of producing as much renewable electricity in 2030 as our total annual consumption[16] . To achieve this, new wind farms with a capacity of at least 1 GW must be built on land[17] . The Energy Economy Organization Act, which entered into force on November 1, 2022, stipulates that by 2030, renewable energy will account for at least 65% of the country's total final energy consumption. Renewable energy will account for at least 100% of total final electricity consumption.

The special plan being prepared is in line with Estonia's climate and energy policy objectives, including the Estonian Energy Sector Development Plan 2030+ and the Estonian Climate Change Adaptation Development Plan until 2030.

The need to prepare a special plan arises from the fact that the comprehensive plans and county plans in force in the territory of Tõrva municipality have not designated areas for the development of wind farms in the special plan area, but there is interest in establishing wind farms in the area, and both national and local renewable energy targets provide for an increase in the share of renewable energy.

The Valga County Plan does not designate any preferred areas for the establishment of wind farms, but section 4.2.5 of the explanatory memorandum to the Valga County Plan sets out the principles for the development of renewable energy. The county plan stipulates that Valga County is not a nationally important area for the development of wind energy. It is noted that, based on wind resources, small wind turbines may be developed for local small-scale consumption. Due to the increased demand for renewable energy, technological developments, and expected changes in national defense restrictions, the planning of wind farms in Valga County has become a pressing issue.

The county plan does not specify specific areas for the development of renewable energy in the county; development will take place based on development interest and the availability of resources, and subject to the following conditions. The Valga County Plan sets the following conditions for the planning of wind turbines and wind farms:

- All plans and design conditions for wind generators and wind farms of any height must be coordinated with the Ministry of Defense, or, in the absence of an obligation to do so, draft building permits or construction notices. In order to ensure national defense interests, it is necessary to start cooperation with the Ministry of Defense already at the initial stage of planning a wind generator or wind farm.
- When planning wind turbines, the minimum distance of the wind turbine from the state road must be equal to the total height of the wind turbine (mast and blade height), and the planning of wind turbines must be based on measures to mitigate the risk of accidents.

[14] https://kov.torva.ee/documents/179495/37966748/Torva+EP+LS+ja+programm.pdf/efa13753-4cbb-4dbe-9bce-9c3c6c0fdb45?version=1.0
[15] https://kliimaministeerium.ee/kliimapoliitika-pohialused-aastani-2050
[16] https://valitsus.ee/valitsuse-eesmargid-ja-tegevused/rohepoliitika/taastuvenergia-arendamine
[17] State Chancellery. 2022. Audit on accelerating the development of renewable energy.

- When designing wind turbines, the minimum distance of the wind turbine from the boundary of the railway protection zone must be equal to the total height of the wind turbine (mast and blade height), and the design of wind turbines must be based on measures to mitigate the risk of accidents.
- When designing wind farms, attention must be paid to avoiding noise pollution and, if necessary, developing mitigation measures. When planning new wind farms, the goal should be to ensure compliance with the strictest equivalent industrial noise level standards set out in legislation, i.e. 50 dB during the day and 40 dB at night for Category II residential areas.
- When planning wind turbines and wind farms as dominant features in the landscape, the preservation of landscape values must be taken into account.

When drawing up a special plan, the conditions for the development of wind farms set out in the county plan shall be followed. When drawing up a special plan, the need to amend or clarify the county plan shall be decided in cooperation with the Land and Environment Board and the Ministry of Economic Affairs and Communications.

4 Analysis of the environmental impact expected to accompany wind turbines and the internal infrastructure of wind farms

The SEA program has carried out a preliminary mapping of the impacts and identified the areas of significant impact. **Areas of impact that were identified as insignificant during the preparation of the program are not addressed** in **the SEA report.** In addition, the SEA process assesses relevant social and cultural impacts, including impacts on human health, **in accordance with the scope of assessment specified in the SEA program.** In the case of this SEA, the assessment of impacts pursuant to § 40(4) of the KeHJS and § 4(2) of the PlanS has therefore been combined. Within the scope of assessment specified in the SEA program.

A description of the environmental conditions of the special planning area, particularly potentially suitable areas, is provided in the same chapter as the impact assessments. At the end of each subsection, a description of the environmental measures and additional assessments necessary for the preparation of the construction project is provided.

Based on the nature of the special plan, the impact assessment has been carried out with the degree of accuracy that is possible and appropriate at the location selection stage of the special plan. According to PlanS, the task of the first stage of the special plan is to find the most suitable location for the planned object from among the potentially suitable locations. According to the initial task of this special plan, all suitable locations must be found. Neither the initial task nor the SEA program stipulates the need to rank the potential suitable areas.

According to PlanS, it is possible that the selection of a location will be followed by the preparation of a detailed solution and its SEA report or, alternatively, the issuance of design conditions (if necessary, together with the submission of an application for a building permit and the performance of an EIA). A solution is possible if, during the preliminary selection of the location, it becomes clear that there is an area in the special planning areas where there are no factors preventing the further development of the wind farm, including the conviction that there will be no adverse impact on Natura areas. The decision on the preliminary selection of the location, including the design conditions or the choice of a detailed solution, can be made by the council, based, among other things, on the results of the SEA and the opinions of the relevant authorities.

4.1 Impacts on the natural environment

4.1.1 Natura assessment

Natura 2000 is a Europe-wide network of protected areas, the purpose of which is to ensure the protection of rare or endangered birds, animals and plants and their habitats and growing sites, or, if necessary, to restore the favorable status of species and habitats that are endangered across Europe. The purpose and content of the Natura 2000 network is set out in the European Union's Habitats Directive (92/43/EEC), adopted in 1992. The same directive also established the bird areas selected on the basis of the Birds Directive (2009/147/EC), which entered into force in 1979, as part of the Natura network. The Natura assessment is an assessment of the impact that the implementation of the planned activity is expected to have on the Natura 2000 network sites.

The Natura 2000 assessment is based on the relevant guidelines[18,19] . Natura areas located in the territory of the Republic of Latvia have also been taken into account.

[18] Kutsar, R.; Eschbaum, K. and Aunapuu, A. 2019. Guidelines for conducting Natura assessments in the implementation of Article 6(3) of the Habitats Directive in Estonia. Commissioned by: Environmental Board.

[19] European Commission. Commission Communication on the assessment of plans and projects in relation to Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC. ET Brussels, 28.9.2021 C(2021) 6913 final.

In the case of plans and more general planning (such as the location selection stage of special plans) , the Natura assessment is carried out with the necessary degree of precision, based on the degree of precision of the strategic planning document, which must allow for the identification of sensitive/threatened areas and conflicts/risks that need to be taken into account in further planning stages.

When compiling the starting points for the special plan, the map analysis excluded Natura sites whose conservation objective is not birds or bats with a 100 m buffer zone, and Natura sites whose conservation objective is bats with a 600 m buffer zone. A 600 m buffer zone was applied to the entire bird area.

4.1.1.1 Natura preliminary assessment

A Natura preliminary assessment was carried out during the preparation of the SEA program. Both Natura nature areas and bird areas are located in and around the special planning area (Figure7 ,Table2). The construction of wind farms involves the construction of sites, roads and, if necessary, embankments or drainage ditches to ensure the stability of the roads/sites. In the case of Natura nature areas, the impact area of wind turbines and infrastructure is generally estimated to be 100 m from the nature area[20] . In the case of communities that are sensitive to changes in the water regime, the possible significant impact area can be estimated at up to 250 m[21] . In the case of particularly sensitive communities (transitional mires), the impact of drainage structures that may accompany the construction of a wind farm is limited to 400 meters[22] . The extent of the impact area in terms of plant species habitats and plant communities does not depend directly on the dimensions of the wind turbine tower and blades, but on the location of the construction areas associated with the construction of the foundation and infrastructure and the possible extent of changes in the soil water regime.

There are no Natura nature areas within the distances indicated. The nearest nature area is the Tündre nature area (EE0080415), located approximately 0.6 km away, which is outside the area of impact and therefore does not require a preliminary assessment.

For nature areas where the conservation objective is bats, the impact area may be 1000 m[23] , which is the distance of the area actively used by the bat colony (the possible extent of this impact area is related to the habitat use of bats, not the dimensions of the wind turbine). There are no nature reserves with conservation objectives for bats within a 1000 m radius of potentially suitable areas.

According to the analysis of the EOÜ terrestrial bird fauna[24] , the most sensitive species in terms of bird fauna are the black stork and the golden eagle, for which the potential impact area (zone 3 area) can extend up to 14 kilometers. The only urban area within the impact area is the Rubina urban area (EE0080572).

Natura areas located in the territory of the Republic of Latvia have also been taken into account. The visual impact area of the wind farm may be significantly larger, but no visual impact of the wind farm

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[20] The impact of onshore wind farms on wildlife and the recommendations of the Environmental Board regarding their planning in local government comprehensive plans (as of November 10, 2021).

[21] Helm, A., Kull, A., Veromann, E., Remm, L., Villoslada, M., Kikas, T., Aosaar, J., Tullus, T., Prangel, E., Linder, M., Otsus, M., Külm, S., Sepp, K., 2020 (updated 2021). Final report on the nationwide assessment and mapping of the status of forest, bog, meadow and agricultural ecosystems and the baseline levels of ecosystem services. ELME project. Commissioned by: Environmental Agency (public procurement no. 198846).

[22] University of Tartu. 2023. Guidelines for the implementation of mitigation and compensation measures for the negative impacts of land improvement systems. Updated version.

[23] Impact of onshore wind farms on biota and recommendations of the Environmental Board for their planning in local government comprehensive plans (as of 10 November 2021).

[24] https://kliimaministeerium.ee/elurikkus-keskkonnakaitse/looduskaitse/uuringud-projektid-ja-analuusid#analuus-ja-lisad

on animal or plant habitats has been observed. The nearest nature area on Latvian territory is more than 8 km away from potentially suitable areas and more than 17 km away from the bird area.

After the SEA program was drawn up, the boundaries and conservation objectives of the Rubina urban area were changed. Based on this, the preliminary assessment of the Rubina urban area has been refined compared to the preliminary assessment carried out in the SEA program. The Rubina urban area has been expanded to include the permanent habitat of the Holdre golden eagle. The expansion of the urban area has been carried out on the basis of the Natura assessment compensation measures plan for the special national plan for the central training area of the Defense Forces and the order of the Government of the Republic No. 173 of 16.06.2022 "Establishment of the special national plan for the central training area of the Defense Forces and granting of consent for the application of the Natura derogation" (Figure7 **).** Based on the analysis of the EOÜ mainland bird population, the golden eagle is classified as zone 1, where wind turbines will not be built within 2 km of the nesting site + habitat polygon, and zone 3, which is worthy of attention, up to 14 km from the nesting site . The golden eagle conservation action plan stipulates that the construction of industrial wind turbines in the core area of the nesting territory will lead to the abandonment of the nesting territory by the golden eagle.

Table2 . Natura preliminary assessment.

Name	Distance	Conservation objective	Potential impact
Tündre nature reserve (EE0080415)	The southernmost potentially suitable area (nearest area) is located approximately 600 m away.	The protected habitat types listed in Annex I are naturally nutrient-rich lakes (3150), species-rich grasslands on calcareous soils (*6270), old natural forests (*9010), old broad-leaved forests (*9020), spruce forests rich in herbs (9050), swamp and bog forests (*9080) and transition mire forests (*91D0).	Considering the large distance, there is no impact on the communities that are the conservation objectives of the nature reserve. Even the most sensitive plant communities are not affected by the changes in the water regime and light conditions associated with the construction and operation of the wind farm at a distance of 600 m.
Lasa nature reserve (EE0080416)	The southernmost potentially suitable area (the nearest area) is located approximately 750 m away.	The protected habitat types listed in Annex I are humus-rich lakes and ponds (3160), old natural forests (*9010), spruce forests rich in herbs (9050), swamp and bog forests (*9080) and transition mire and bog forests (*91D0).	The nearest potentially suitable area is at least 750 m away from the nature reserve. Considering the distance and conservation objectives, no impact is expected. The activity is not expected to have any direct or indirect impact (changes in water regime or light conditions) on the conservation objectives of the nature reserve.
Rubina bird area (EE0080572)	Rubina bird area The area overlapping with the permanent habitat of the golden eagle is located between the northern and southern potentially suitable areas.	The species whose habitats are protected are the whooper swan (*Cygnus cygnus*), the merlin (*Falco columbarius*), the osprey (*Pandion haliaetus*) and golden eagle (*Aquila chrysaetos*).	Based on the SEA analysis, an adverse impact on the merlin can be ruled out if a 1000 m buffer zone is maintained around its habitat. Therefore, an impact on the merlin can be ruled out. In the case of the whooper swan and osprey, the potentially suitable wind areas overlap with zone 3 areas in the SEA analysis. The habitat of the golden eagle lies between the northern and southern potentially suitable areas, and the northern area overlaps

Name	Distance	Conservation objective	Potential impact
			with zone 1 of the EIA analysis for the golden eagle habitat. Zone 3 extends to both potentially suitable areas. **Therefore, an impact on the conservation objectives of the bird area cannot be ruled out.**

The preliminary assessment concluded that the possibility of a negative impact cannot be ruled out in the Rubina bird area (EE0080572) and therefore a Natura assessment will be carried out for this area. The preliminary assessment ruled out a negative impact on the Tündre nature reserve (EE0080415) and the Lasa nature reserve (EE0080416). No new circumstances emerged during the preparation of the SEA report that would have necessitated a repeat of the preliminary assessment for these nature reserves.

The planned activity is not necessary for achieving the conservation objectives of the aforementioned bird and nature areas.

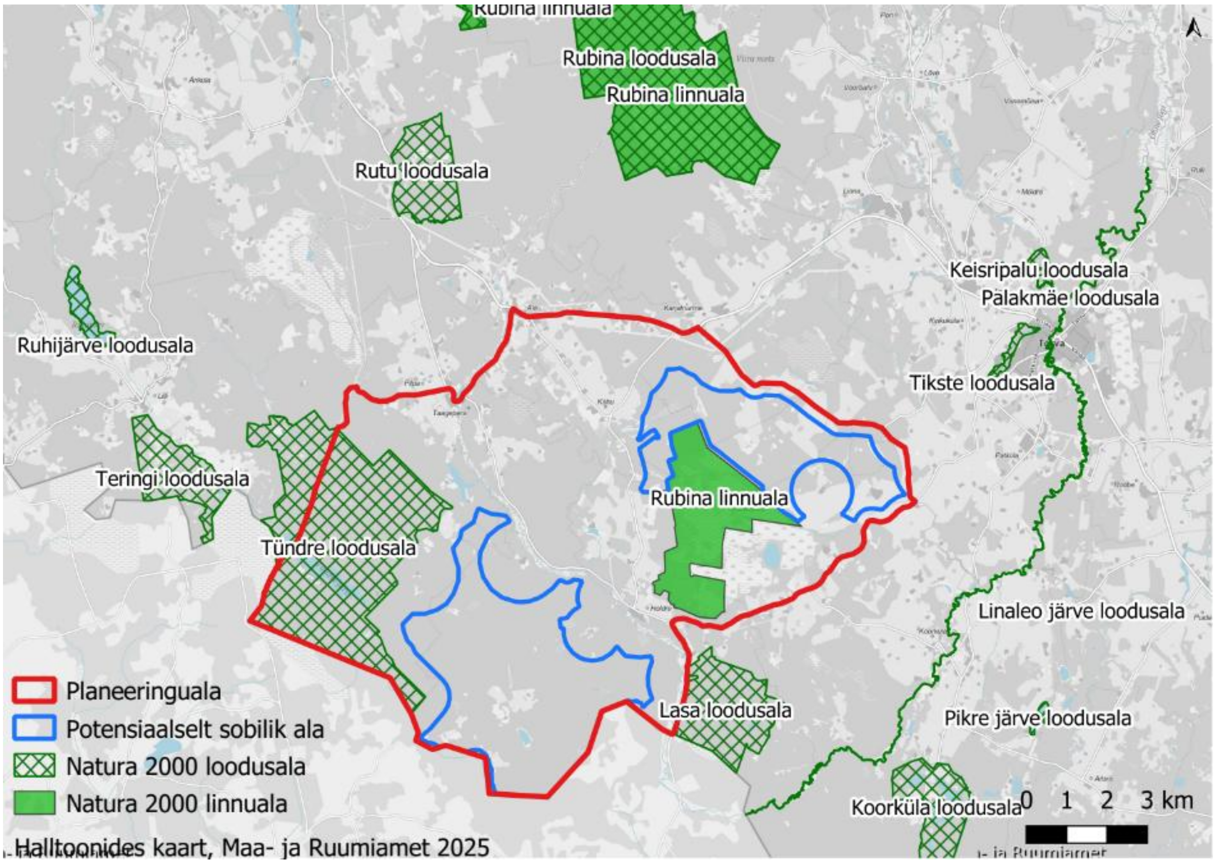

Figure7 . Location of Natura nature and bird areas in relation to potentially suitable areas. Natura area data: EELIS (Estonian Nature Information System), Environmental Agency, 17 April 2025.

4.1.1.2 Relevant assessment of Natura

4.1.1.2.1 Characteristics of Natura areas

The Rubina bird area (EE0080572) is located in the immediate vicinity of the northern potentially suitable area and is approximately 1.3 km from the southern potentially suitable area (Figure7). The species whose habitats are protected in the Rubina bird area are the whooper swan (*Cygnus cygnus)*, the merlin (*Falco columbarius)*, the osprey (*Pandion haliaetus)* and the golden eagle (*Aquila chrysaetos)*.

The Rubina urban area (which overlaps with the Rubina nature reserve) is located in the southeastern part of the Sakala Uplands. Most of the bird area is covered by the Rubina bog, which is located in a vast depression in the undulating moraine plain. After the retreat of the continental ice sheet, small lakes remained in the depressions, as indicated by scattered 30–40 cm thick layers of lake mud under the peat. Rubina bog is an old and well-developed bog with a thick peat layer (up to 9.7 m), which in terms of its vegetation is transitional from the East Estonian type to the West Estonian type. Veisjärv, located in the bird area, is relatively large (area 481 ha) and is the only remnant of a larger glacial lake that has survived in this basin. The lake has a maximum depth of 4 m and an average depth of only 1.3 m, with a layer of mud up to 4.5 m thick at the bottom. Veisjärv is one of the nutrient-rich lakes of Upper Estonia, with water of medium hardness and no stratification. The Rubina urban area is located entirely in a natural landscape, with no human settlements or agricultural land in the nature reserve. The diverse landscape is a good habitat for many protected species.

The Rubina bird area is one of the five best habitats for the osprey (*Pandion haliaetus*). Other important bird species in the area include the whooper swan (*Cygnus cygnus)*, merlin (*Falco columbarius)* and golden eagle (*Aquila chrysaetos)*. These are species whose numbers in the area constitute at least 1% of the minimum population in Estonia.

Table3 . Rubina bird area Natura standard data form (2017) on the abundance (2016) and status of species in the area (EELIS (Estonian Nature Information System), Environmental Agency 17.04.2025).

Species	Type[25]	Size		Unit	Condition assessment			
		Min	Max		Pop.	Protection	Isolation	Overall
gray heron	c				C	C	C	C
black stork	p				C	C	C	C
songbird	r	1	1	p	B	B	B	B
small bird	r	1	1	p	B	B	B	B
viupart	c				C	C	C	C
Osprey	r	2	2	p	B	B	C	A
metsis	p				C	C	C	C
heletilder	c				C	C	C	C
golden eagle	p				C	B	B	B

The potential impact on birdlife in general is described in section4.1.3 . The planned wind farm may affect the conservation objectives of the Rubina bird area if the wind turbines or related infrastructure are planned too close to the habitats of species that are the conservation objectives of the bird areas. To clarify the possible impact, the location of the habitat of the species designated as a conservation target has been determined based on data from EELIS (Estonian Nature Information System) and the Environmental Agency. If data on the location of the habitat is not available in the EELIS (Estonian Nature Information System) database of the Environmental Agency, the location of the habitat has been determined based on the habitat preferences of the species. The appropriate distance, or buffer zone, has been determined based on scientific literature (mainly[26]) and guidelines provided by the Environmental Board[27] . The main threat to the Rubina bird area is drainage, and restoration takes time when ditches are removed.

The following is an overview of the location of the habitats of species protected in the bird area, their habitat preferences, and the buffers recommended for species protection in relation to wind turbines.

[25] p – permanent, stationary, r – nesting, c – stopping.

[26] Busch, M., Trautmann, S., Gerlach, B. 2017. Overlap between breeding season distribution and wind farm risks: a spatial approach. VOGELWELT 137: 169–180.

[27] The impact of onshore wind farms on wildlife and the recommendations of the Environmental Board for their planning in local government comprehensive plans (as of 10.11.2021).

Taking these aspects into account, the potential impact on the habitats of species protected in the relevant bird area has been determined (Table4).

In principle, accidental collisions with wind turbines during migration or accidental overflights cannot be ruled out for any bird species, but in the context of the Natura assessment, this cannot be considered an impact on the conservation objectives of the bird area.

4.1.1.2.2 Impact on conservation objectives

Table4 . Registered habitats of species protected in the Rubina bird area according to EELIS (Estonian Nature Information System) and the Environmental Agency (as of 15 December 2023) and possible impact on them. Where relevant, the overlap with the bird zones according to the EOÜ analysis[28] is indicated.

Species	Location of habitat in nature reserve EELIS (Estonian Nature Information System), according to data from the Environmental Agency	Description of habitat use and risk factors	Possible impact	Potential negative impact
Osprey (I)	According to the EELIS (Estonian Nature Information System) database of the Environmental Agency, the habitat is located approximately 5.8 km north of a potentially suitable area. The last confirmed observation was in 2022, when the nest was occupied but breeding was unsuccessful.	The osprey population is fluctuating and its habitats are threatened. Threatening factors include disturbance, the disappearance of old coniferous forests, eutrophication of water bodies, and air pollution (Draft Osprey Conservation Action Plan 2011–2015; Eagle Club, 2011)[29] . The osprey originally nests in bogs, bog edges, and bog islands. It prefers a nesting tree that is as high as possible above the rest of the forest and offers good visibility; this may also be a single tree. Larger standing water bodies are more suitable for feeding than flowing water bodies, as they must contain a sufficient amount of fish of a suitable size. The osprey is a typical species that needs to fly actively between its nesting site and feeding grounds. Feeding grounds are located up to 25 km away.	In the case of the osprey, the northern potentially suitable wind area partially overlaps with the osprey habitat zone 3 in the Rubina bird area according to the MLA. The main threat to the species is the risk of collision. The actual collision risk during feeding flights is low, as the potentially suitable areas are not located between the habitat and the main potential feeding waters (Lake Tündre, Lake Asu, River Õhne). There may be a certain risk in the case of the potentially suitable area to the north, if ospreys also use Lake Märdi to a certain extent for feeding. During the	There is no significant adverse impact on known bird habitats.

[28] Estonian Ornithological Society, Eagle Club. 2022. Analysis of terrestrial bird species across Estonia. Public procurement no. 239156. Report.

[29] Action plan for the protection of the osprey (*Pandion haliaetus)*. Approved by order no. 1-1/19/208 of the Director General of the Environmental Board on 12 November 2019.

Species	Location of habitat in nature reserve EELIS (Estonian Nature Information System), according to data from the Environmental Agency	Description of habitat use and risk factors	Possible impact	Potential negative impact
			bird survey, no ospreys were encountered in the potentially suitable areas of , so their presence in the area can be considered rather random.	
Whooper swan (II)	According to the EELIS (Estonian Nature Information System) and the Environmental Agency database, the habitat is located approximately 5.0 km north of the potentially suitable area. The last confirmed observation was in 2020, when there were two pairs of birds.	The song thrush mainly stays in Estonia during migration, but the number of nesting pairs has increased steadily in recent decades and the former migrant has become a significant nesting bird. The species is under protection category II in Estonia.	The main threat is the risk of collision during flights between roosting areas and feeding areas. In addition to collisions, it must be taken into account that artificial structures may also cause birds to abandon feeding areas and create a barrier effect in bird flight corridors. [30] Based on the MLA, there is no overlap with the little grebe/song thrush zone 1 or 2. In the northern area, there is a slight overlap with zone 3, which is related to the Veisjärve migratory bird stopover site. During the	There is no significant adverse impact on known bird migration stopover sites.

[30] Action plan for the protection of the *Bewick's* swan (*Cygnus columbianus bewickii Yarr.)*. APPROVED by order no. 1-1/18/161 of the Director General of the Environmental Board on 18 April 2018.

Species	Location of habitat in nature reserve EELIS (Estonian Nature Information System), according to data from the Environmental Agency	Description of habitat use and risk factors	Possible impact	Potential negative impact
			bird survey conducted in the planning area, no active or regular movement of the song thrush ( ) was detected in potentially suitable areas across the survey areas. There are also no significant landscape conditions for this.	
Merlin (I)	According to the EELIS (Estonian Nature Information System) and the Environmental Agency database, there are no habitats.	A breeding bird with a strong downward trend and sporadic distribution, which is classified as vulnerable according to the Estonian Red List and is considered a rare and endangered species under the Nature Conservation Act, falling under Category I protected species. The species' nesting sites are mostly not permanent, and the species uses different (magpie) nests for nesting each year.	The buffer zone recommended in scientific literature is 1000 m. Considering the distance of the wind farms from the bird area and the species' habitat use, the impact is ruled out.	No
Golden eagle (I)	According to the EELIS (Estonian Nature Information System) and the Environmental Agency database, the habitat KLO9127415 is located in the immediate vicinity of a potentially suitable area to the north.	Despite a slight negative productivity trend, the species' population has grown moderately in recent decades, reaching 60 pairs today. According to the Estonian Red List, the golden eagle is vulnerable and is classified as a rare and endangered species under the Nature Conservation Act, falling under Category I of protected species. The Estonian golden eagle population is most affected by the decline in the abundance of forest birds and open-country birds due to the destruction and deterioration of their feeding areas –	According to the EOÜ analysis, the northern potentially suitable area remains in zone 3 for golden eagles, and the southern potentially suitable area remains mostly in zone 3 for golden eagles and, to a lesser extent (in the northeastern corner), also in zone 1 for golden eagles. Based on the EOÜ's analysis of land birds,	Yes (more detailed impact assessment in the table below)

Species	Location of habitat in nature reserve EELIS (Estonian Nature Information System), according to data from the Environmental Agency	Description of habitat use and risk factors	Possible impact	Potential negative impact
		open bogs and bog-edge forests. Disturbance is becoming an increasingly significant threat factor[31] .	zone 1 for golden eagles is an area where wind turbines are not built within 2 km of the nesting site + habitat polygon, and zone 3 is an area up to 14 km from the nesting site, which is worthy of attention ( ). The zones have been determined based on data from scientific literature.	

[31]; Eagle Club, 2012 Draft conservation action plan for the golden eagle.

During the bird survey, no golden eagles were recorded in either of the potentially suitable areas, but as the area has been placed under protection as a compensation area, the aim of the compensation area is to restore the golden eagle population there. The golden eagle habitat KLO9127415 was last inhabited in 2014, and there was no breeding (no eggs laid) in 2014 or 2013. In recent years, the former golden eagle nest has been used by white-tailed eagles.

Based on the relationship between the habitat of Finnish golden eagles and wind turbines, it is known that the average home range of an individual is 297 $^{km^2}$, flying up to 14 km from the nest, preferring steep slopes in the immediate vicinity of the nest (favorable air currents, which are also suitable for buzzards) and old forests, but avoiding settlements and the territories of neighboring pairs. According to GPS data, golden eagles fly 2.2 hours per day, 30% of that time at an altitude of 50–200 meters above ground level, i.e., in the so-called wind turbine safety zone32 . Telemetry data from Swedish golden eagles show that their nesting territory is 5–30 km2, with the birds preferring clear-cut areas and coniferous forests[33] . Telemetry studies of golden eagles conducted in Estonia show that the territory of female golden eagles covers 150–160 km^2 [34] ,[35] .

Studies conducted in other countries on the habitat use of golden eagles in the vicinity of wind farms show that golden eagles avoid wind farm areas. A study conducted in Scotland using GPS-tagged non-breeding golden eagles in the vicinity of two wind farms showed that the average distance of birds with transmitters from the nearest wind turbine nacelle was 679 ± 233 m (293–990 m), and golden eagles flew very rarely within the wind farms[36] . Due to this behavior, the risk of golden eagles dying in collisions with wind turbines is rather low, but at the same time, the loss of habitat (e.g., feeding grounds) within the wind farm area and within a radius of approximately 1 km means that the species avoids the area. Studies show that golden eagles do not get used to wind turbines over time[37] .

Golden eagles use different parts of their home range to varying degrees, preferring open landscapes for hunting, where it is easier to spot prey[38] . The home ranges of golden eagles are generally not circular, but often "elongated" towards feeding areas, which is why tracking is the best method for assessing the impact of wind farms. As the Holdre bog is not inhabited by golden eagles, it is not possible to carry out tracking in this area.

The golden eagle conservation action plan states the following about wind turbines: "*The construction of industrial wind turbines in the core area of the nesting territory will cause the golden eagle to abandon its nesting territory. Outside the core area, the golden eagle selectively uses different*

[32] Tikkanen H, Rytkönen S, Karlin O-P, Ollila T, Pakanen V-M, Tuohimaa H, Orell M. 2018. Modelling golden eagle habitat selection and flight activity in their home ranges for safer wind farm planning. Environmental Impact Assessment Review 71: 120-131, https://doi.org/10.1016/j.eiar.2018.04.006

[33] Singh NJ, Moss E, Hipkiss T, Ecke F, Dettki H, Sandström P, Bloom P, Kidd J, Thomas S, Hörnfeldt B. 2016. Habitat selection by adult Golden Eagles Aquila chrysaetos during the breeding season and implications for wind farm establishment. Bird Study 63: 233-240, DOI: 10.1080/00063657.2016.1183110

[34] Sein, G. 2023. Preliminary habitat use analysis. KIK project no. 18694 "Installation of transmitters for golden eagles and search for new nesting territories." Manuscript at KIK and Kotkaklubi, 8 pp.

[35] MTÜ Kotkaklubi. 2025. Expert assessment of the impact of wind farms in Kehtna and Türi municipalities on golden eagles in Keava bog.

[36] Fielding AH, Anderson D, Benn S, Dennis R, Geary M, Weston E, et al. 2021. Non-territorial GPS-tagged golden eagles Aquila chrysaetos at two Scottish wind farms: Avoidance influenced by preferred habitat distribution, wind speed, and blade motion status. PLoS ONE 16(8): e0254159. https://doi.org/10.1371/journal.pone.0254159

[37] Fielding AH, Anderson D, Benn S, Dennis R, Geary M, Weston E, Whitfield DP. 2022. Responses of dispersing GPS-tagged Golden Eagles (Aquila chrysaetos) to multiple wind farms across Scotland. Ibis, 164: 102-117. https://doi.org/10.1111/ibi.12996

[38] Marzluff J M, Knick S T, Vekasy M S, Schueck L S & Zarriello TJ. 1997. Spatial use and habitat selection of Golden Eagles in southwestern Idaho. Auk 114: 673–687.

landscapes, and in its home range, the construction of wind turbines can only be considered on land that is not used as habitat. The construction of wind turbines should also be avoided in large natural marsh areas and their surroundings."[39] .

Based on the above, the construction of the wind farm will have no direct impact on the habitat of the golden eagle in Holdre lagesoos. The possible impact may manifest itself, on the one hand, in the risk of collision and, on the other hand, in a reduction in the feeding area due to the creation of an avoidance zone around the wind turbines. To assess both impacts, a landscape analysis of the feeding areas associated with the habitat was carried out. As previously noted, it is not possible to conduct telemetry studies or specify habitat use through aerial observations for this habitat, as it has not been inhabited by golden eagles in recent years.

The main (primary) feeding area of the golden eagle is bogs (especially fens). The feeding area is mainly located within a radius of up to 5 km (home range) from the nesting site and consists of open (semi-)natural biotopes (suitable meadows, permanent grasslands, and to a lesser extent also fields). Feeding areas may be up to 14 km away from the nest, with more distant areas being used mainly when the feeding area is very good and mainly outside the nesting period.

The data on habitat types in the Estonian and Latvian Habitats Directive was used to analyze feeding areas. The areas where habitat type 7110 (bogs) occurs were designated as priority feeding areas, and all areas where the meadow habitat type occurs (habitat types with codes beginning with 6) that are located within 14 km of the Rubina urban area, which covers the Holdre lowland. In addition, all grasslands within a 5 km radius, according to data from the Estonian Topographic Database (ETAK), were designated as potentially insignificant feeding areas. No similar database was found for Latvia, but based on orthophotos, there are no large grasslands within a 5 km radius on Latvian territory, and the open areas are mainly arable land. The analysis is presented atFigure8 . The analysis showed that the northern potentially suitable area is largely located in the core habitat and also in the possible flight path of other nearby priority feeding areas (Ridasoo and Rubina bog). The construction of wind turbines in this area would also overlap with the potential avoidance area of the habitat. Therefore, the northern area could have a significant adverse impact on the habitat of the golden eagle in the Rubina urban area, both in terms of collision risk and reduction of feeding areas and habitat.

The overlap of the southern area with the core habitat is minimal. The northern part of the southern area would potentially fall within the possible flight path of the Teringe bog and the nearby bog area in Latvia.

In the case of the conceptual solution for the wind farm developed for the southern area, the possible avoidance area of the wind turbines (1 km from the wind turbines) does not overlap with any priority or important feeding areas. All bog areas and floodplains along the Õhne River in both Estonia and Latvia remain outside the avoidance area. Similarly, the potential avoidance area does not create a barrier to any priority or important feeding areas. The area of insignificant feeding areas within the wind farm's avoidance area is small and consists mainly of overgrown grasslands surrounding former farmsteads, which are of little importance as feeding areas.

Therefore, in the southern area, the Rubina urban area has a low risk of collision with the golden eagle habitat and a low risk of adverse effects in terms of reduction of feeding areas and habitat, and these effects are likely to occur primarily in the northern parts of the area, where no wind turbines are planned in the developed wind farm solution.

[39] https://www.kotkas.ee/files/kaljukotka_ktk_2018-2022.pdf

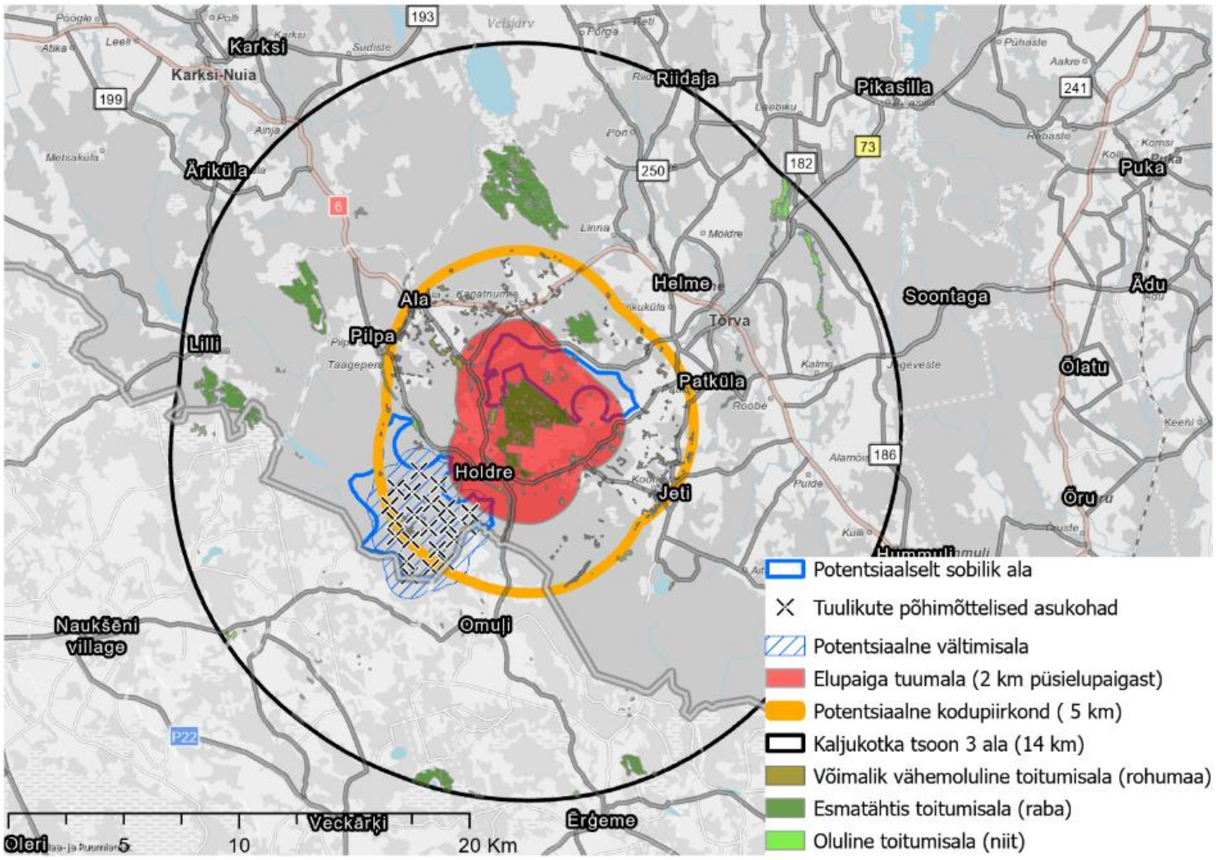

Figure8 . Rubina urban area Holdre bog for the protection of the golden eagle habitat, its 2 km buffer zone and suitable feeding areas.

4.1.1.2.3 Impact on the integrity of Natura areas

Table5 . Questionnaire on the integrity of Natura areas.

Rubina urban area	Northern area	Southern area
Could the project or plan:		
Reduce the area of habitat types or the abundance of species for which the site was established?	No	No
Cause disturbance that could affect the size of populations or the balance between species or population density?	YES (with regard to the golden eagle)	No
Cause species displacement and thus reduce the range of these species in the area?	No	No
Cause fragmentation of habitats or species listed in Annex I?	No	No
Cause a reduction or loss of key features (e.g., tree cover, openness to the sea, annual flooding, etc.)?	No	No
Disturb the balance, distribution, and population density of key species used as indicators of the favorable status of the area?	YES (in relation to the golden eagle)	No
Slow down or prevent the achievement of the conservation objectives of the area?	YES (in relation to	No

Rubina urban area	Northern area	Southern area
	the golden eagle)	
Cause changes in critical aspects that determine the nature of the area (e.g., nutrient balance), on which the favorable functioning of the area as a habitat or ecosystem depends?	No	No

4.1.1.2.4 Planning of mitigation measures and conditions

The first stage of the KOV EP is generally appropriate to be treated as a higher-level strategic planning document and also as a "plan" within the meaning of Article 6(3) of the Habitats Directive. The European Commission has stated in its guidance 'Management of Natura 2000 sites. Provisions of Article 6 of Directive 92/43/EEC on habitats' (2019/C 33/01), the European Commission has clarified in section 4.6.1 that an appropriate Natura assessment must be carried out before the plan is approved. In section 4.7.3 of the same guidance, the European Commission has in turn stated that "The approval decision may only be taken after they are satisfied that the plan or project will not adversely affect the integrity of the site concerned." Among other things, mitigation measures may prevent such an impact (section 4.6.6 of the guidelines). The Natura assessment does not need to go into more detail or use more resources at the strategic planning document level than is necessary to achieve the conservation objectives of Natura sites, and it would be inappropriate and impractical to assess the impact in the level of detail normally required for a project-level assessment. Consequently, the level of detail of the higher-level strategic planning document itself determines the possible scope of the Natura assessment, i.e. the level of detail of the strategic planning document must be taken into account. If the level of detail of the strategic planning document does not allow for a final assessment of the effects of the planned activity, e.g. the construction and use phase (specific in terms of volume, location, etc.), as a result of the Natura assessment, measures and conditions must nevertheless be provided for to exclude adverse effects on the Natura site and to allow the conclusion that there will be no adverse effects. To this end, measures or conditions must be proposed for the next planning or permit stage for each planned activity or strategic planning document guideline that may have an impact on the conservation objectives and integrity of the Natura site.

At the preliminary site selection stage, there must be a fundamental conviction that, given the level of detail of the planning, it is possible, based on the available information, to carry out the planned activity at the selected site in such a way that any adverse impact on Natura sites and conservation objectives is ruled out. Final certainty that the implementation of the plan will not have an adverse impact on the integrity of the Natura 2000 network area and conservation objectives must be established by the time the plan is adopted. This also means that if, after the location has been selected, the design conditions procedure is to be continued, any adverse effects on Natura areas must be ruled out in the Natura assessment of the SEA report on the location selection.

In this case, it is necessary to implement mitigation measures to exclude significant adverse effects on the planned bird area. The measures are presented atTable6 .

Table6 . Mitigating measures and their effectiveness.

Measure/condition	Effectiveness
A 2 km buffer zone must be ensured around the current permanent habitat/bird area of the golden eagle in Holdre lagesoo (Figure8). As the golden eagle does not currently inhabit the permanent habitat, it is not appropriate to apply the buffer to the former nesting tree, but rather to take into account the boundary of the permanent habitat. Based on this, a large part of the potentially suitable area in the	Effective

Measure/condition	Effectiveness
north must be excluded as a wind farm area, as well as the area in the south with the core habitat area shown inFigure8 .	
An undisturbed connection must be ensured between Holdre bog and other bogs in the area (especially Ridassooga, which is closest to Holdre and may have a positive impact on the functionality of the habitat) and other important feeding areas. Based on this, the northern protruding part of the potentially suitable area in the south (Figure8 the area between Holdre bog and Teringe bog) should also be excluded, as it remains in the flight corridor between potentially priority feeding areas.	Effective
Avoid planning overhead power lines when connecting the wind farm to the power grid. Considering that the most likely connection is to the Helme substation, the overhead line would run directly alongside the prospective urban area. To avoid the risk of collision and death associated with power lines, the connection should be planned with an underground cable.	Effective

4.1.1.3 Results and conclusion of the Natura assessment

When making the preliminary selection of the location for the special plan, the location of areas belonging to the Natura 2000 network was taken into account in order to ensure the favorable status of the areas and their conservation objectives. Natura 2000 areas were excluded as potentially suitable areas in the initial map analysis. Further analysis found that by not planning the wind farm in the potentially suitable area to the north, reducing the southern potential area in its northern part and abandoning the planning of overhead power lines, there would be no negative impact on the conservation objectives of all Natura bird and nature areas based on the available information.

The wind farm solution developed as part of the planning process will not have an adverse impact on the integrity and conservation objectives of the Natura bird and nature areas. The solution takes into account the mitigation measures presented inTable6 .

4.1.2 Impact on vegetation

In the case of wind farms, **the impact on vegetation** may occur during the construction phase through the removal of vegetation from the construction sites and damage to vegetation caused by construction activities (trampling by machinery in the immediate vicinity of the construction sites).

The extent of the direct impact area is limited to the actual construction site area of the wind turbines and related infrastructure. Clearing (in forested areas) and soil work will be carried out in the wind turbine assembly areas, areas used by construction machinery, areas at the base of new connection corridors, and areas with underground cables within the wind farm (underground cables are subject to a 1 m protective zone on both sides of the line from the outermost cables[40] .

Clearing is carried out if the above-mentioned areas overlap with forest land. It is not necessary to clear the entire area covered by the wind turbine blades, as the blades are significantly higher than the trees. The forest community in the cleared area will be destroyed. Clearing also causes a edge effect (changes in light and moisture conditions) in the forest area adjacent to the cleared area. The edge effect may extend for several tens of meters.

The activity that causes the greatest removal of vegetation is the construction of roads in the wind farm. The size of the road construction area depends largely on the existing roads in the area and their

[40] Regulation No. 73 of the Minister of Economic Affairs and Infrastructure of 25.06.2015 "Extent of the protective zone of a building, procedure for operating in the protective zone and requirements for marking the protective zone" § 10 lg 3.

potential use, as well as the planned location of the wind turbines (which will become clear during the detailed planning of the wind farm). At the preliminary selection stage of the wind farm location, the assessment of the road area is subject to a high degree of uncertainty.

The need to remove vegetation depends greatly on the exact location of the wind farm. It can be roughly estimated that the area directly related to the construction of wind turbines is approximately 1 ha, to which 1–2 ha of construction areas related to roads and routes can be added.

Indirectly, the construction of a wind farm may affect plant communities through changes in the water regime or light conditions. The extent of indirect impacts depends on the type of community and the nature of the construction activities . In the case of dry communities, the impact may extend a few meters from the construction areas. In the case of wetlands, the impact may extend to several hundred meters from the construction areas.

There is little data in scientific literature on the impact of wind farms on vegetation during their operational life. Scientific studies have observed possible changes in vegetation characteristics in connection with microclimatic changes caused by wind farms[41] . No significant impact on vegetation during the operational life of wind farms has been identified to date.

4.1.2.1 Assessment methodology

The impact on vegetation was assessed in potentially suitable areas mapped in special planning areas. To this end, existing data on protected plant species, forest habitats of high conservation value (VEP), habitats under the Habitats Directive (LD), and areas of ecosystems in good condition were analyzed in the EELIS (Estonian Nature Information System) database, the Environmental Agency database, and the Environmental Agency ELME map layer catalog (2021). **The aim of the assessment was to identify known and potential high-value plant communities in potentially suitable areas, the avoidance of which as construction sites would prevent significant adverse effects on vegetation.** No additional vegetation inventories were carried out within the framework of this SEA. However, by excluding potentially higher-value habitat types from the wind farm location, the likelihood of finding high-value plant communities through additional surveys is also significantly reduced.

4.1.2.2 Protected plant species

Species under nature conservation in Estonia are divided into three categories. Category I includes species that are predominantly declining in number and critically endangered, with habitats in a critical condition, and whose continued survival in the Estonian natural environment is doubtful if the risk factors continue to exist. Category II protected species in Estonia are species that occur in a very limited area or in few habitats, and whose numbers are declining and range is shrinking. Category III protected species in Estonia are species that are relatively common, but whose numbers may decline critically. The overlap of potentially suitable areas with the habitats of protected plant species is presented atTable7 . No protected plant species have been recorded in the northern area, and no representative habitats of protected plant species were recorded during the KSH fieldwork.

Table7 . Overlap of locations of protected plant species with potentially suitable areas. Source: EELIS (Estonian Nature Information System), Environmental Agency 23.02.2023 and Rewald fieldwork data.

Code	Name in Estonian	Name in Latin	Protection category	Area covered by the site (ha) and additional information
		Southern area		
KLO9401908	Wulf's peat moss	*Sphagnum wulfianum*	III	Point object, observation in 2020

[41] Diffendorfer et al. 2022. Wind turbine wakes can impact down-wind vegetation greenness. DOI 10.1088/1748 9326/ac8da9.

KLO9343674	common clubmoss	*Huperzia selago*	III	Point object, observation in 2020.
KLO9401907	feather moss	*Neckera pennata*	III	point object, observation in 2020
–	feather moss	*Neckera pennata*	III	Point observation, 2023 Rewild fieldwork (eastern edge of potentially suitable area in the south X=6421299.8; Y=601310.3)

The analysis showed that only the southern potentially suitable area contains locations of plant species in protection category III. There are no locations of plant species registered in protection categories I and II. However, the vegetation survey of the areas can be considered rather limited. In most cases, it is appropriate to exclude the locations of protected species known at the site selection stage from the wind farm construction areas in order to avoid significant adverse effects on vegetation. At the site selection stage, in order to avoid significant adverse effects , the locations of protected plant, fungus, moss, and lichen species according to the EELIS (Estonian Nature Information System) and the Environmental Agency database should be excluded as wind farm sites. [42]Such data can be considered to be continuously up to date. **In order to preserve the light and moisture regime in the growing areas, do not designate possible construction sites closer than 20 m from the location of protected species.**

4.1.2.3 Forest communities, including valuable habitats

Potentially suitable wind farm areas in Tõrva municipality are located near the Estonian-Latvian border in a relatively sparsely populated area. The areas are predominantly managed dry forests and, to a lesser extent, cultivated landscapes. Both potentially suitable areas are predominantly forest land. The establishment of a wind farm requires the clearing of forest from the areas where the wind turbines will be built and from the areas where the infrastructure related to the wind farm will be located[43] . The northernmost potentially suitable wind farm area also includes arable land. (Table8)

Based on data available in Latvian registers[44] , the southernmost potentially suitable area is located approximately 1.2 km from *Pyrus sp*. approximately 1.1 km from *Quercus robur*, and approximately 0.7 km from *Salix alba* and *Salix caprea.*

During fieldwork conducted in the summer of 2023 as part of a study of the green network in the Tõrva wind farm area, it was found that the forests in the wind farm areas have generally been heavily logged. Logging sites, scrub, and young forests are widespread. There are young coniferous stands in many places. There are relatively few older stands and aspen forests. Within the planned wind farm areas, valuable habitats have only been recorded in the southern part. Of the Natura habitat types, old deciduous forests 9010* remain in the western part of the northern area. It is therefore predominantly a commercial forest area with relatively few forest communities of higher ecological value.

There are no valuable registered grasslands in the areas potentially suitable for wind farms. In the buffer zone of the potential wind farm area in the southern part, near the Õhne River, there are floodplain meadows and Natura habitat type 6450. There are smaller meadow patches around former farmsteads, but most of them are unmaintained and are becoming overgrown. Field observations identified a species-rich meadow on the Raupa property (20301:001:0170). The northern potentially suitable area contains cultivated grasslands associated with cattle grazing.

[42] The surface area of the blade projection on the ground is considered to be the construction base of the wind turbine. In terms of the impact on vegetation, the location of actual construction areas, i.e., potential construction sites, is important. Therefore, the KSH report uses the term "construction site," which refers to the area actually affected by construction activities (the area where soil work is carried out).

[43] Clearing is logging that is carried out to enable the use of land for purposes other than forest management.

[44] https://www.lvmgeo.lv/en/data

The overlap of potentially suitable areas with forest land, wetlands, open areas, and arable land is presented atTable8 . In terms of land use, the construction of wind farms on arable land and open areas can be considered to have a smaller environmental impact. In the case of wetlands and forests, the change in environmental conditions associated with the construction of a wind farm is greater and, as a rule, the environmental impact is also greater.

Table8 . Overlap of potentially suitable areas with forest land, wetlands, open areas and arable land (ETAK land use data as of 01.04.2024).

Area no.	Area, ha	Forest land area, ha (% of total area)	Area of wetlands, ha (% of total area)	Open land area, ha (% of total area)	Area of arable land, ha (% of total area)
Northern area	1069.30	772.17 (72%)	43.01 (4%)	38.38 (4%)	210.21 (20%)
Southern area	2021.01	1880.05 (93%)	29.47 (1%)	55.32 (3%)	49.05

In addition to the reduction in forest area, the ecological value of the affected forest communities is also important in assessing the significance of the environmental impact. Ecologically valuable parts of the forest are designated as valuable forest habitats. According to the Forest Act, a valuable forest habitat (VEP) is an area where there is a high probability of finding species that are narrowly adapted, endangered, vulnerable, or rare. Habitats may be negatively affected if direct construction activities or related activities (e.g., logging) are planned in or in the immediate vicinity of their locations. The overlap of areas with habitats is presented atTable9 .

Table9 . Overlap of potentially suitable areas with valuable habitats. Source: EELIS (Estonian Nature Information System), Environmental Agency, 11 January 2024.

VEP code	VEP type	Area overlapping with the site, ha
	Southern area	
VEP210151	Spruce forests and mixed spruce forests	2.87
VEP209758	Other deciduous forests	1.59
VEPE01302	Other deciduous forests	0.21
VEPE01301	Spruce forests and mixed spruce forests in wetlands	0.18
VEPE01304	Spruce forests and mixed spruce forests in wetlands	2.06
VEPE01306	Spruce forests and mixed spruce forests in wetlands	1.1
VEPE01305	Marsh pine forests and birch forests	0.19
VEP209757	Other deciduous forests	1.9
VEP209756	Wetland broadleaf forests	1.86
VEP205427	Other deciduous forests	1.37
VEP210076	Aspen forests	1.41
VEP211713	Other deciduous forests	0.08
VEP209755	Other deciduous forests	1.93
VEP211714	Other deciduous forests	1.63
VEP207423	Spruce forests and mixed spruce forests	0.35
VEP112030	Other deciduous forests	1.64
VEP211715	Other deciduous forests	1.59
VEP212614	Other deciduous forests	1.43
VEP212612	Wetland pine forests and birch forests	1.18
VEP212611	Wetland pine forests and birch forests	1.16

VEP code	VEP type	Area overlapping with the site, ha
VEP212272	Alder forests	2.39
VEP212271	Other deciduous forests	1.66
VEP212270	Alder forests	1.09
VEP212269	Haavikud	0.67
VEP212268	Woodlands	1.29
VEP212267	Other deciduous forests	9.00
	Overlap of valuable habitats with the southern area, ha	**41.85**
	Percentage of valuable habitats overlapping with the southern area, %	**2.07**

The potentially suitable wind farm area to the north does not overlap with any valuable habitats. The area to the south overlaps with several valuable habitats (Table9).

In the case of the potentially suitable area in the south, the proportion of valuable habitats is particularly high in the northern part of the area. Considering the importance of valuable habitats in preserving biodiversity, wind turbines and related buildings, platforms, and roads must be placed in such a way that they do not overlap with valuable habitats. In the immediate vicinity of valuable habitats, the construction of drainage ditches and other structures that alter the water regime and significantly change the light regime should be avoided. Considering the relatively small proportion of valuable habitats in the total area of potentially suitable sites, it is possible to establish a wind farm in both areas without significantly affecting valuable habitats.

4.1.2.4 Habitats outside protected areas under the Habitats Directive

The legislative act governing nature conservation activities in the European Union is Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, adopted in 1992, or the Habitats Directive (hereinafter also referred to as *HD*). The aim of the Habitats Directive is to protect biotopes not only as habitats/growing sites for certain animal and plant species, but also as phenomena with their own intrinsic value. Habitats are defined in the directive as natural or semi-natural terrestrial or aquatic areas that are distinguishable from others by their geographical, abiotic or biotic characteristics. Areas with high-value habitat types under the Habitats Directive are protected as nature areas belonging to the Natura 2000 network. At the same time, habitats under the Habitats Directive have also been inventoried outside protected areas. Habitats under the Habitats Directive occur in both potentially suitable areas (seeTable10).

Table10 . Overlap of habitat types designated under the Habitats Directive with potentially suitable areas. Source: EELIS (Estonian Nature Information System), Environmental Agency, 11 January 2024.

id	Habitat code	Habitat name	Area covered by the site, ha	Representativeness (and other important information about the value)
		Northern area		
493545083	7110	Rabad	7.21	Representativeness: C[45] Structural preservation: III[46]
150945083	9010	Old natural forests	6.37	Representativeness: B Structure preservation: III
Overlap with northern area			**13.58**	

[45] Representativeness: A – very good; B – good; C – considerable; D – low representativeness; p – potential habitat.

[46]Structure preservation: I – very good; II – good; III – average.

Southern area				
1009045083	314	Low to medium nutrient lakes	5.35	Representativeness: D Structure preservation: III
240445083	9010	Old natural forests	1.99	Representativeness: B Structure preservation: II
Overlap with southern area			**7.34**	

The analysis revealed that LD habitats are located in the northernmost potentially suitable wind area on the edges of Lakesoo. There are two LD habitats in the southern potentially suitable area – one in the northwestern part and the other in the southern part of Holdre village in the Mäsajärve area (Figure9 andFigure10). When establishing a wind farm, the overlap of wind turbines and related buildings, sites, and roads with the areas where the habitat types specified in the Habitats Directive occur must be avoided. In the immediate vicinity of habitat types listed in the Habitats Directive, the construction of drainage ditches and other structures that alter the water regime and significantly change the light regime must be avoided.

4.1.2.5 Assessment results

There are no direct exclusions arising from vegetation in the northern potentially suitable area. There is little overlap with the habitat types listed in the Habitats Directive in the northern area (Figure9) and with both forest habitats and the habitat types listed in the Habitats Directive in the southern area (Figure10).

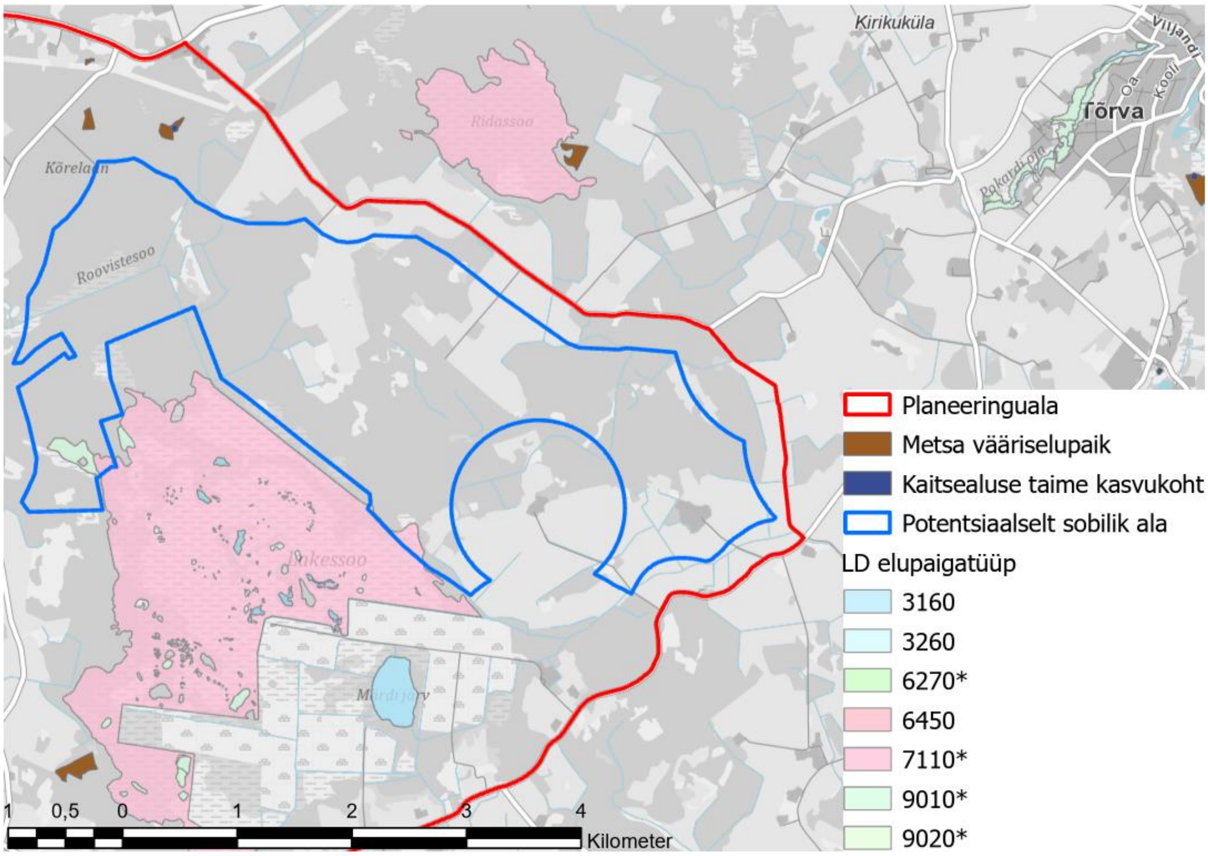

Figure9 . Overlap of the potentially suitable area in the north with valuable forest habitats and habitats listed in the Habitats Directive. Source: EELIS (Estonian Nature Information System), Environmental Agency, 22.03.2024.

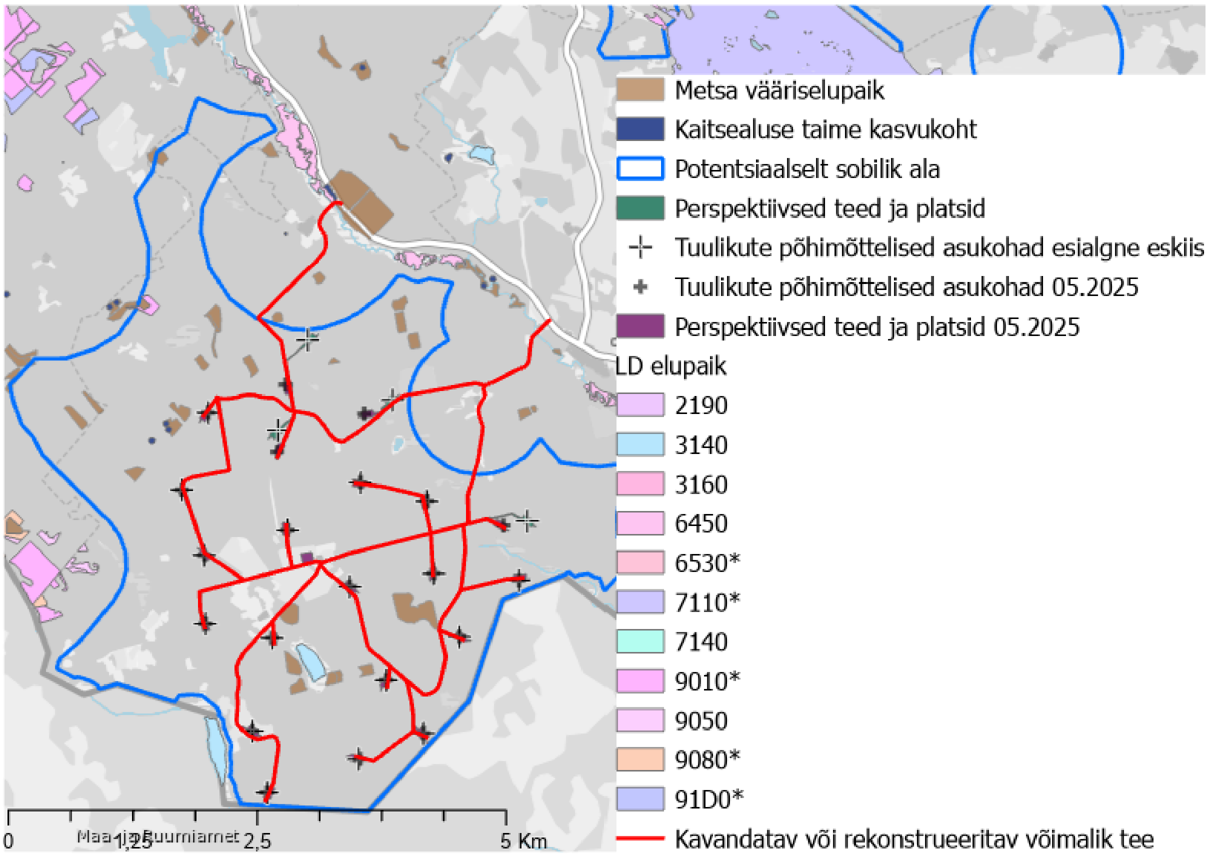

Figure10 . Overlap of the potentially suitable area in the south with valuable forest habitats, habitats under the Habitats Directive, and locations of plant species, fungi, and lichens in protection category III. Source: EELIS (Estonian Nature Information System), Environmental Agency, 22 March 2024.

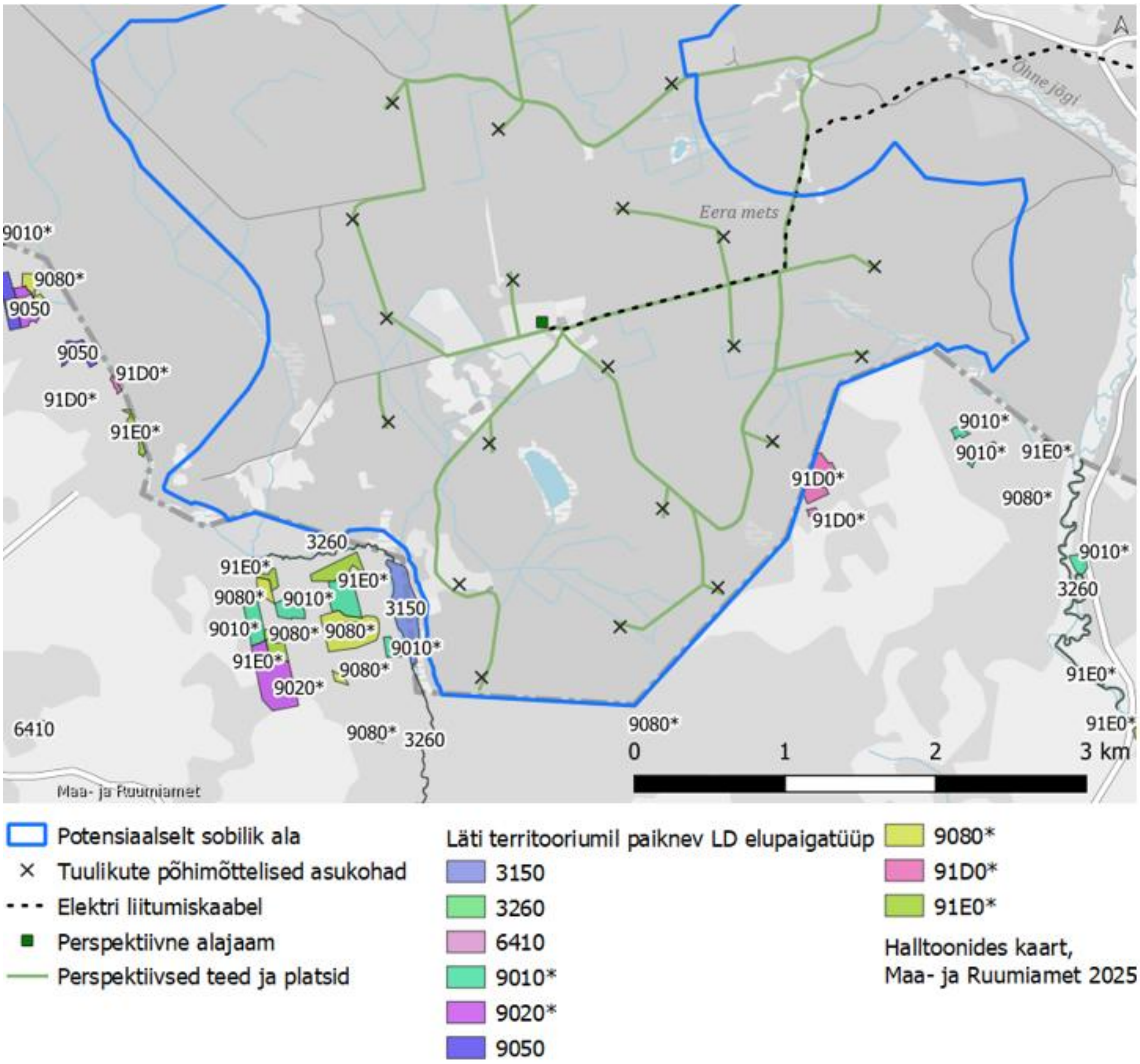

Figure11 . The closest Habitats Directive habitat types located in Latvian territory to the southern potentially suitable area[47] .

In both potentially suitable areas, there is little overlap with high-value plant communities, and wind turbines and related infrastructure can be built without causing significant adverse effects on vegetation. The area covered by roads, platforms and foundations in the preliminary design of the wind farm is 69 ha, and 42 ha in the revised design of 05.2025. The construction of the wind farm in the initial draft solution will involve the clearing of approximately 38 ha of forest, and in the revised solution as of May 2025, approximately 37 ha[48] .

This estimate is approximate, considering the possible locations of prospective assembly sites and road corridors overlapping with forest land. Therefore, the establishment of the wind farm will be accompanied by a reduction in vegetation, including forest area, but this will be a relatively small area. The climate impact of the change in land use and the need to compensate for clearing are discussed in section4.1.10 .

In the case of the wind farm planning solution developed during the planning process, all known high-value plant communities (forest habitats, habitat types under the Habitats Directive, and growth sites

[47] https://ozols.gov.lv/pub

[48] Calculated overlap of possible roads, sites and substations with the ETAK tree cover map layer.

of protected plant species) have been excluded as locations for wind turbines and infrastructure. Therefore, no significant adverse impact on vegetation is expected when implementing the planning solution . The recommended distances specified in section4.1.2.6 have been taken into account in determining the locations of the wind turbines, and it is possible to place the construction sites at least 50 m away from valuable forest habitats, habitat types specified in the Habitats Directive, and the locations of protected plant species.In such situations, further design work must ensure that the impact of drainage on valuable habitats does not increase. The possible locations of wind turbine access roads have been planned using existing forest roads. In some places, the roads run alongside areas of valuable forest habitats. In such situations, further design work must ensure that the impact of drainage on the valuable habitat is not increased. There are no situations within the wind farm area where the existing road would be surrounded on both sides by valuable habitats (or other vegetation-sensitive communities), so it is possible to plan the wind farm infrastructure without significantly affecting valuable habitats. It is necessary to take into account the measures set out in section4.1.2.6 in further design work.

The developed planning solution ensures sufficient distances from the habitat types specified in the Habitats Directive and the known locations of protected plant species in order to avoid any significant adverse impact on them.

The nearest habitats listed in the Habitats Directive located on Latvian territory are approximately 190 m away from the planned roads and sites (Figure11), which means that there will be no impact on the habitats listed in the Habitats Directive located in Latvia.

The plan provides for two possible alternative solutions for the access road to the wind farm. The nearest public road is the 23194 Helme-Kirikuküla-Holdre-Taagepera road, from which possible exits are limited by the fact that the Õhne River lies between the potentially suitable area to the south and this road. To cross the river, it is appropriate to use the locations of the existing bridges/culverts. Possible crossing points are along the Holdre-Läti road L2 or along the road running through the Koorküla forest district 32. When using the Holdre-Läti road, there is no contact with valuable plant communities. Therefore, this access road is the preferred solution in terms of its impact on vegetation. At the same time, it should be noted that this is a narrow road running between two residential buildings, with a small right-of-way. The use of this connecting road may prove technically complicated, and it is appropriate to provide for an alternative access road in the plan in case the use of the Holdre-Latvia road is not possible. In the case of the road passing through Koorküla forest district 32, it is possible to turn off at a point surrounded by valuable forest habitats (Figure12).

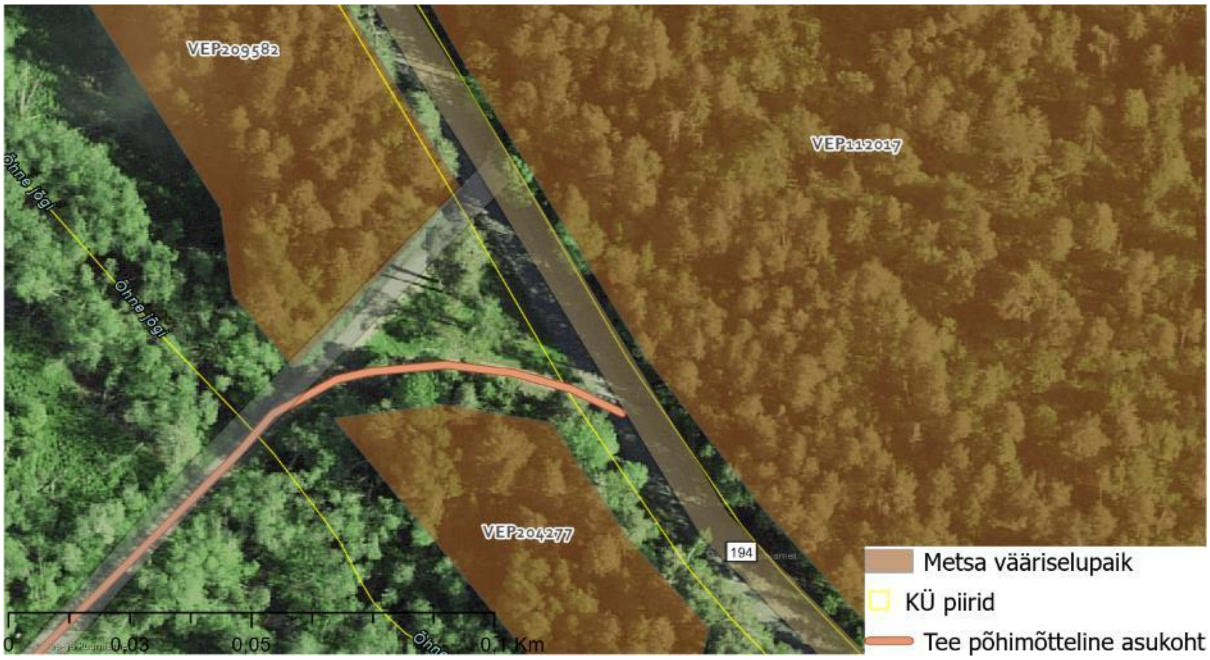

Figure12 . Location of valuable forest habitats in the vicinity of the possible western access road.

When transporting wind turbine blades through this location in the normal position, it is necessary to clear the forest at the edges of valuable habitats to ensure the required turning radius. It is estimated that the felling requirement may range from to 0.5 ha (the exact volume depends on the wind turbine model and the exact method of transporting its components). This is a felling requirement, not a clearing requirement. As the value of the forest habitat lies in the old-growth forest community, this part of the community will be destroyed as a result of logging. As logging would affect small areas on the outskirts of the VEP, there would be no wider significant impact on the coherence and integrity of the VEP communities. The edge effect is minor considering the total area of the VEP. The edge of the forest to be opened is small considering the total perimeter of the VEP, and therefore the change in wind exposure and light regime is insignificant for the VEP. The impact of changes in the water regime depends to some extent on the need for road reconstruction, but considering that the soil map indicates that this is a parched area, no significant changes in the water regime are expected for the VEPs. Therefore, the reduction in the area of the VEP due to the need for logging to ensure the turning radius will have a significant impact.

Pursuant to § 23(3) of the Forest Act, the protection of VEPs in state forests is organized by the State Forest Management Centre (RMK) in accordance with the regulation of the Minister of the Environment[49] . Section 26[(1)] (2) of the regulation stipulates that logging is prohibited in forests owned by public legal entities and in VEPs entered in the environmental register located in state forests, except for exceptional logging and selective logging with the consent of the Environmental Board. According to the explanatory memorandum to the Regulation, such logging includes, for example, maintenance work on road protection zones, land improvement systems and power lines, the construction of light traffic roads and activities related to national defense objects. Exceptional felling may also include the removal of dangerous trees or felling organised to improve the survival of VEPs. According to § 26[(1)]of the regulation, the Environmental Board has discretionary power when deciding on VEPs (felling, liquidation). When making a discretionary decision, the Environmental Board must weigh the public interest, the outcome of the felling, and the possible impact on the VEP, and decide which (public) interest prevails. The construction of a wind farm can be considered a project of public

[49] Regulation No. 34 of the Minister of the Environment of 04.01.2007 Classification of valuable habitats, selection guidelines, organization of protection, conclusion of agreements for the protection of valuable habitats, and specified bases for calculating usage fees.

interest, which can be taken into account when deciding on the preservation of VEPs. In order to prevent a reduction in the area of VEPs in the register, the logging of existing VEPs must be compensated for with equivalent VEPs in the surrounding area (within a 20 km radius of the destroyed VEPs).

Knowledge gaps: During the SEA of the preliminary selection stage of this special plan, no separate vegetation inventory was carried out in potentially suitable areas. During the green network survey, the locations of protected plants were mapped, but no separate vegetation inventory was carried out. As the potentially suitable areas were very extensive, such a large-scale vegetation inventory without knowing the locations of the wind turbines would be disproportionately resource-intensive. Therefore, when designing the wind farm, an inventory of vegetation must be carried out in the construction areas of the wind turbines and routes and their 50 m buffer zone, during which the presence of potentially protected species will be inventoried (see section4.1.2.6 for more details).

4.1.2.6 Measures and need for further research and assessment

At the site selection stage:

Valuable forest **habitats** within the areas **must be preserved**. In the immediate vicinity (50 m) of valuable habitats, the construction of drainage ditches and other structures that alter the water regime and significantly change the light regime must be avoided. In the case of VEP areas, **a buffer zone of at least 50 m** must be taken into account for wind turbine construction sites.

Habitat types listed in the Habitats Directive that are in at least good condition (representativeness A and B) must be preserved. In the immediate vicinity of LD habitat types, the construction of drainage ditches and other structures that alter the water regime and significant changes to the light regime must be avoided.

The habitats of known protected plant and fungus species must be preserved. During the site selection phase, in order to avoid significant impact, wind farm sites should be excluded from **areas where protected plant, fungus, moss, and lichen species are found,** according to the EELIS (Estonian Nature Information System) and Environmental Agency databases**.** In order to preserve the light and moisture regime in the habitats, construction sites should not be located closer than **20 m from the location of protected species.** A smaller buffer zone is acceptable in situations where the habitat of the protected species is already adjacent to a road, a route corridor, a logging site, or other open landscape, i.e., the establishment of a construction site does not change the growing conditions.

The exclusion of higher-value natural communities has significantly reduced the likelihood of protected plant, fungus, moss, and lichen species occurring in potential wind farm construction areas. Therefore, from the point of view of vegetation, a significant adverse impact on high-value plant communities can be considered excluded, and the construction of a wind farm outside the excluded areas can be assessed as feasible from the point of view of vegetation impacts.

During further design and operation:

When designing the wind farm, an inventory of vegetation shall be carried out in the construction areas of the wind turbines and routes and their 50 m buffer zone, during which the presence of possible protected species shall be inventoried. The inventory does not need to be carried out on cultivated land and artificial areas where the probability of finding protected species is very low. When protected species are found during the inventory, either the preservation of the site or appropriate relocation shall be planned, depending on the representativeness of the site and the protection category of the species. It should be noted that specimens of protected species may only be removed from the wild for relocation if this does not adversely affect the favorable status of the species[50] . The

[50] Nature Conservation Act § 58(5)

relocation of protected species shall be carried out in accordance with the procedure established by the Government of the Republic[51] .

During the construction of wind farms, care must be taken to ensure that construction materials, construction waste and soil are not stored in the habitats of protected plant species, in valuable forest habitats or in areas where habitat types listed in the Habitats Directive are in good condition (representativeness A and B).

In the case of structures that significantly alter the water regime, apply a 250 m buffer zone to valuable forest habitats and habitat types of the Habitats Directive that are sensitive to the effects of drainage (mapped for planning purposes as communities sensitive to the effects of drainage) a 250 m buffer zone or provide for construction measures in the project (e.g., retaining walls, ditches with embankments, etc.) to avoid significant drainage effects on communities sensitive to drainage. A smaller buffer zone is also acceptable in situations where the sensitive community is already adjacent to a road, ditch, route corridor, logging area, or other open landscape, i.e., the construction of the project area does not increase the risk of windbreak or change the water regime in the sensitive community area.

When further specifying the locations of wind turbines and routes during the design phase, it must be ensured that changing the locations does not cause a greater adverse impact on vegetation and plant communities than the assessed solution.

If it proves unavoidable to use the western access road, the following measures must be taken:

- When designing the access road, attention must be paid to the need to minimize logging in areas of valuable forest habitats.
- In order to prevent a decrease in the area of valuable habitats in the register, the felling of existing VEPs must be compensated for with equivalent VEPs in the surrounding area (within a 20 km radius of the destroyed VEPs). Compensation may be considered to be the conclusion of a VEP protection agreement in a private forest, both for VEPs that do not currently have a protection agreement and for newly mapped VEPs. The selection of VEPs to be used as replacements shall be organized by the developer. The selection shall be coordinated with the Environmental Board.

4.1.3 Impact on birdlife

Wind farms can affect birds in three main ways:

1. birds may be killed by collision with wind turbine blades or masts[52] ;
2. disturbance may cause a reduction in habitat use or the relocation of birds from the wind farm area[53] ;
3. habitat destruction and alteration causes changes in bird populations[54] .

The impact of wind turbines on bird populations is most evident in collision mortality – flying birds may collide with wind turbines (primarily with the blades, but there are also examples of birds flying into the mast) and associated infrastructure, resulting in death or injury. In addition to wind turbines,

[51] Regulation No. 248 of the Government of the Republic of 15.07.2004 "Procedure for the relocation of protected species"
[52] Thelander, C. G. & Smallwood, K. S. 2007. The Altamont Pass Wind Resource Area's effects on birds: a case history. Birds and Wind Farms (eds M. de Lucas, G. Janss & M. Ferrer): 25–45. Quercus Editions, Madrid.
[53] Drewitt, A. L. & Langston, R. H. W. 2006. Assessing the impacts of wind farms on birds. Ibis 148: 29–42.
[54] Gove, B., Langston, R. H. W., McCluskie, A., Pullan, J. D. & Scrase, I. 2013. Wind farms and Birds: an updated analysis of the effects of wind farms on birds, and best practice guidance on integrated planning and impact assessment. Report prepared by BirdLife International on behalf of the Bern Convention, RSPB/BirdLife in the UK, Sandy, UK. 89 pp.

wind measurement masts erected in wind farm areas for wind research purposes may also pose a certain risk of collision, especially if the mast uses guy wires. Guy wires are not easily visible to birds and may pose a collision risk. However, the collision risk posed by wind measurement masts is no different from that posed by guy wires. Compared to the collision risk posed by wind turbines themselves, the probability of collisions with wind measurement masts is low and limited in time (wind measurements are usually carried out for 1-2 years, after the wind turbines have been erected, there is no need for a separate mast, as the measuring equipment can be installed on the wind turbine mast). Therefore, the use of wind measurement masts does not have a significant impact and is not assessed in detail in the SEA.

Bird collisions with wind turbines are not particularly frequent, but there are several known examples of wind farms causing the death of large numbers of birds or protected species. The risk depends primarily on the location of the wind farm, the terrain, and the behavioral characteristics of the bird species. Gliders, including storks and cranes, and especially birds of prey[54] , which often do not avoid wind farms[55] , collide with wind turbines relatively frequently.

The risk of collision is also linked to the barrier effect – in order to avoid wind farms, birds must fly past or above them, which reduces the usability of certain habitats or increases the energy expenditure of birds. The barrier effect has a more significant impact in the case of larger wind farms or when a wind farm is built on a regular bird migration route (e.g., a migration route or daily flight path between nesting and feeding areas). Considering the size and location of potentially suitable areas in the Tõrva municipality special plan, which are located inland away from the main migration corridors, no significant barrier effect on bird populations is expected in the case of this special plan.

The construction of wind farms is also accompanied by a direct loss of bird habitat and a decline in habitat quality due to disturbances. The direct loss of habitat resulting from the construction of wind turbines is usually relatively minor, but the construction of access roads and electrical connections must also be taken into account at the wind turbine construction sites. Disturbances caused by wind farms that affect habitat quality occur during the construction phase, during the operation of the wind turbines, and during the dismantling phase. The sources of disturbance may be the wind turbines themselves (including noise, light flicker, and vibration) and/or other infrastructure associated with them, or increased human traffic associated with the wind farm.[55] (both wind farm maintenance and other traffic using the access roads). The extent and significance of the disturbance varies depending on the species and species group and possible habituation to wind turbines[55] . Bird groups that are considered to be more sensitive to wind farm-related disturbances (and therefore more likely to avoid wind farms) include swans, geese, cranes, waders, and some species of passerines. Studies have confirmed that forest birds (e.g., capercaillies)[56 (,) 57] also avoid wind farm areas. As a result of disturbances, birds may no longer use a potentially suitable habitat in or near the area, or may use it less frequently, resulting in a reduction in the area of habitat available to the population.

The primary task in reducing the impact on birdlife is therefore to carefully select the location of the wind farm. The primary task in selecting the location is to avoid planning wind turbines in areas that are most sensitive from the point of view of birdlife and near the habitats of endangered species that are sensitive to disturbance or collision.

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[55] Hötker, H., 2017. Birds: displacement. In: Martin R. Perrow (ed): Wildlife and Wind Farms, Conflicts and Solutions. Volume 1 Onshore: Potential Effects.

[56] Coppes, J., Braunisch, V., Bollmann, K., Storch, I., Mollet, P., Grünschachner-Berger, V., Taubmann, J., Suchant, R., Nopp-Mayr, U., 2020. The impact of wind energy facilities on grouse: a systematic review. Journal of Ornithology (2020) 161:1–15.

[57] Taubmann, J., Kämmerle, J-L., Andrén, H., Braunisch, V., Storch, I,, Fiedler, W., Suchant, R. and Coppes, J., 2021. Wind energy facilities affect resource selection of capercaillie Tetrao urogallus. Wildlife Biology 2021 (1). https://doi.org/10.2981/wlb.00737.

4.1.3.1 Assessment methodology

An inventory of protected breeding bird species was carried out as a general census using a mapping method across the study areas. The census methodology is based on the guidelines for the inventory and monitoring of birds in protected areas[58] . The unit to be mapped is a breeding pair – usually an adult bird singing or otherwise behaving territorially in a habitat suitable for nesting, or individual birds in the case of black grouse and capercaillie.

The mapping of the territories of corvids took place in the northern area on March 19, 2023, and April 6, 2023, and in the southern area on March 19, 2023, March 20, 2023, March 29, 2023, April 6, 2023, April 7, 2023, and April 8, 2023. The song of the woodcock or common snipe was used for luring between 0 and 3 hours after sunset or 3 and 0 hours before sunrise. The entire forest landscape of the study area was covered with luring points at a distance of approximately 400 m, no more than 500 m away. Luring was not used in the vicinity of already singing woodpeckers. Luring was performed with a JBL Charge 4 speaker (sound pressure level at a distance of 1 m approximately 80 dB).

The territories of woodpeckers and hazel grouse were mapped in the northern area on March 10, 2023, March 19, 2023, March 20, 2023, April 1, 2023, April 6, 2023, and April 7, 2023, and in the southern area on March 19, 2023, March 20, 2023, April 6, 2023, 07.04.2023, 08.04.2023, 09.04.2023, 10.04.2023 and 11.04.2023. The survey was conducted in forest landscapes using lures with the drumming of the white-backed woodpecker (2 min), the song of the gray-headed woodpecker (1 min) and the call of the woodcock (2 min) 0.5 h before sunrise until 3–4 hours after sunrise. The entire study area was covered with decoy points at intervals of 150 m, with no more than 250 m between points. Decoying was not used in the vicinity of woodpeckers that were already drumming or vocalizing (including great spotted woodpeckers). The same devices were used as for luring woodpeckers.

Playing tetras were mapped in the northern study area in open landscapes and nearby during woodpecker counts. In addition, the area was visited on May 9, 2023, from 0.5 hours before sunrise to 3 hours after sunrise.

To map the territories of the corncrake, the open areas of the study area were visited on June 8, 2023, June 22, 2023, June 23, 2023, and July 5, 2023, between sunset and sunrise.

To map the territories of the nightjar, the southern forests suitable for the species were visited on 10.06.2023, 22.06.2023, 23.06.2023, and 05.07.2023 between sunset and sunrise.

All other protected species (e.g., waders, birds of prey, crane, corncrake, bittern, meadow pipit, red-backed shrike, lesser spotted flycatcher) and species important for conservation management (e.g., corncrake, moorhen) were mapped by conducting a census 0.5 hours before sunrise until 4 hours after sunrise throughout the entire study area. As a rule, the area was covered in forest terrain at intervals of approximately 300 m, no more than 400 m apart (quarterly), and in open terrain, preferably from existing roads and tracks, using a spotting scope with a range of no more than 500 m. The counts took place on 25.05.2023, 31.05.2023, 02.06.2023, 03.06.2023, June 5–8, 2023, June 10, 2023, and June 13, 2023.

During fieldwork, the territories of non-protected species and other observations were also selectively recorded and entered into the PlutoF database.

The location of the state border was not taken into account when conducting the inventories (if the 500 m buffer zone extended into Latvian territory, the species present there were also recorded). In addition to the database, the data on the locations of protected species in Latvia was used: https://ozols.gov.lv/pub. Consultations were also held with Latvian ornithologist Gaidis Grandāns, an expert on birdlife.

[58] Renno Nellis and EOÜ Monitoring Committee 2008.

More detailed data on **bird stopover sites and migration routes** was collected in 2023 in a potentially suitable area in the northern part of the study area, targeting cranes and swans. The study was planned based on the knowledge that Lakesoo bog is a known gathering place for cranes, where up to 500 cranes have been recorded in different years (EELIS registered habitat KLO9132180). Fieldwork for aerial observations took place on 09.05.2023, 14.05.2023, 14.07.2023, 04.09.2023, and 21.09.2023 at various times during daylight hours. The location and flight altitude of the birds were determined using laser binoculars. As the development area proved to be highly unsuitable for wind farm development (due to the presence of habitats of Category I protected species), the study was not completed to the extent originally planned, and more thorough monitoring of the autumn habitat use and movements of the crane population was omitted.

Due to the landscape of the potentially suitable area in the south, there are no prerequisites for the presence of spring and autumn migration corridors for cranes and swans. The absence of important migration corridors for cranes, swans, and geese is also confirmed by map data from an analysis of land birds across Estonia. This is also confirmed by data on the movement routes of small swans coordinated by German researchers[59] . The absence of important spring and autumn migration corridors throughout the region is also confirmed by bird surveys conducted as part of the KAUR Repower project in the Mulgi-Tõrva[60] study area. Based on this, the southern area focused on breeding bird surveys. The use of permanent observation points (point observation) was not considered appropriate by bird experts for assessing the impact at the preliminary selection stage of planning. The reason for this was that the area consists mainly of forest landscape (which significantly limits the field of view and thus makes it difficult to carry out point observations). Furthermore, there are no known permanent waterfowl resting places or good feeding areas for birds of prey in or near the area that would create the conditions for regular flight paths through the area. Therefore, the risk of factors preventing the establishment of a wind farm due to airspace use was assessed as low. The experts considered it appropriate to conduct airspace observations during the inventories and other visits to the area instead of point observations. During the fieldwork, the fieldworkers observed the use of airspace by birds, paying particular attention to the possible presence of birds of prey, which could indicate possible nesting in the area. During the fieldwork carried out in March and April, flights of geese and swans were recorded. An overview of the fieldwork carried out in the southern area, including dates and duration of observations, is presented in Annex 5. In the southern area, a bird expert carried out a total of 188.5 hours of fieldwork in 2023 (overlapping times of several experts were not added together), of which approximately 160 hours were during daylight hours.

The fieldwork was carried out by Jaan Grosberg, Uku Paal, Hannes Pehlak, and Art Villem Adojaan.

As Jaan Grosberg, who participated in the bird survey working group, also participated in the green network survey (presented in Annex 4), the fieldwork for the green network survey and the bird survey was partially combined.

Based on the 2023 bird inventories and observations, a zoning of potentially suitable areas was compiled based on the expert assessment of bird experts. Areas where the construction of wind turbines is expected to have a significant adverse impact were zoned. The zoning took into account, first and foremost, the protection category of species, i.e., the habitats and movement corridors of species in protection categories I and II were zoned as requiring preservation free of wind turbines ( ). The zoning was used as a basis for the preparation of the draft plan.

In order to minimize the risk of failing to identify important feeding areas or habitats of birds of prey during breeding bird surveys and other bird inventories and observations, additional bird spot observations were carried out in June and July 2025 in the pre-selected location for 24 hours (report

[59] https://zwergschwan.de/karte-senderschwaene?

[60] Loodustaju OÜ. 2024. Public procurement "Bird survey to identify priority areas for wind energy development for the Environmental Agency" Public procurement reference number 260767 Part 12 Mulgi-Tõrva Final report

in Annex 7). The observation methodology was based on the guidelines prepared by the Environmental Board, "Methodology for wind farm biodiversity surveys and minimum requirements for follow-up monitoring." As visibility in the airspace in this area is limited due to forest cover, observations were made at a total of nine sub-points (covering 3-4 points per observation) to cover the airspace in the area, and the 18-hour observation period required by the methodology was increased to 24 hours. The observations were carried out by Hannes Pehlak, Jaan Grosberg, and Anni Miller.

The methodology and results of the 2023 bird survey are presented in the KSH report; no separate survey report was prepared. Drawings intended for internal use (due to restrictions under the Nature Conservation Act) and background data on the methodology and results of the bird survey in the southern area (locations of decoy points and observation points, drawings of observation results for protected breeding birds, observation table for geese and swans) are presented in Annex 5 to the SEA report.

The materials from the 2025 summer spot observations are presented in Annex 7.

4.1.3.2 Assessment results

4.1.3.2.1 Impact on nesting species

Bird assessments are presented for the initial areas of the special plan according to their potential suitability for the construction of a wind farm from a bird protection perspective. The bird assessment does not directly exclude any potentially suitable areas as possible wind farm areas, but the so-called red areas are likely to have a significant adverse impact on birdlife, and extensive mitigation and compensation measures would need to be developed for the construction of wind turbines there. From a procedural point of view, there is no certainty regarding the feasibility of the plan in the red areas, and it is not possible to abandon this minimally detailed solution. The construction of wind turbines in the red areas would require additional studies and the implementation of compensation measures.

During fieldwork related to birdlife in 2023, two nests of **the lesser spotted eagle** (*Clanga pomarina*, protection category I, near threatened according to the Estonian Red Book) were identified in a potentially suitable area in the north, which had not previously been recorded in the EELIS database. These are currently registered as habitats KLO9132095 and KLO9132137. Considering the usual size of the species' home range (based on the species' conservation action plan), **the construction of wind turbines closer than 2 km should only be possible on the basis of an expert assessment of habitat use. Within a 2 km radius, there is an increased risk of collision with wind turbines and therefore a possibility of significant adverse effects on species in protection category I.** Habitat use studies have shown that the flight path of small eagles equipped with transmitters mostly remained within a 6 km radius of the nest, but most of the species' activities took place within 3 km of the nest[61] . Studies conducted in Estonia have shown that the landscape surrounding the nest consists of the following feeding areas: grasslands 31.2%, fallow fields and unmanaged grasslands 41.6%, and arable land 27.2%[62] . The lesser spotted eagle spends most of its hunting time on grasslands (85.7%), less on arable land (9.3%) and significantly less time in other habitats such as water bodies and their banks (3.3%), roadside areas (1.5%) and forests (including clearings) (0.3%).

The lesser spotted eagle is one of the most abundant eagles in Europe. Despite this, the species is considered endangered, as its range and abundance have declined compared to the previous century. The current abundance of the lesser spotted eagle can be estimated at 600–700 pairs. According to

[61] Environmental Board. 2018. Lesser Spotted Eagle conservation action plan for the years.

[62] Väli, Ü., Tuvi, J., Sein, Gunnar. 2017. Agricultural land use shapes habitat selection, foraging and reproductive success of the Lesser Spotted Eagle Clanga pomarina. Journal of Ornithology.

the Estonian Red List ( ), the species is near threatened and, under the Nature Conservation Act, is classified as a rare and endangered species in protection category I. The lesser spotted eagle inhabits a mosaic landscape where forests alternate with meadows, pastures, fields, river valleys, and bogs. The lesser spotted eagle avoids areas with little forest cover and intensive land use, as well as large, contiguous forest areas. The main threats to the species are the decline in the quality of nesting sites and hunting grounds and disturbance during the nesting season[63] . In the case of wind farms, the main threat is the risk of collision.

The open landscapes of the northern potentially suitable area were also found to be actively used by cranes as a resting place (in some places over 100 birds). The area is also located in the immediate vicinity of the permanent habitat of the corncrake (a buffer zone of 1000 m between wind turbines and nests is recommended for corncrakes) and the permanent habitat of the golden eagle (discussed in the Natura assessment section4.1.1).

Therefore, the entire northern part of the potentially suitable area is zoned as undesirable from the perspective of birdlife. The planning of wind turbines in this area may have a significant adverse impact on birdlife, particularly the lesser spotted eagle. Considering the location of the lesser spotted eagle's nests, the wind turbine location solution developed in the plan will not have an adverse impact on the lesser spotted eagle. The nearest wind turbines are more than 6 km away from the lesser spotted eagle nests, which can be considered a significant distance for the lesser spotted eagle. Similarly, there are no significant feeding areas suitable for the lesser spotted eagle in the potentially suitable area to the south.

In the southern potentially suitable area, bird experts identified 22 unsuitable areas (Figure13 , full version of the figure is presented in Annex 5).

Unsuitable area 1 (consisting of three parts) was zoned red mainly in order to preserve the connectivity between the habitats of the capercaillie (*Tetrao urogallus*, protection category II, vulnerable according to the Estonian Red List) outside the potentially suitable area.

The capercaillie is evenly distributed in the boreal forests of Eurasia from Scandinavia to Eastern Siberia. In the southwestern part of its range in Western and Central Europe, its distribution is fragmented mainly due to the sporadic distribution of old-growth forests in the mountains, but also due to habitat loss. A significant decline in numbers in Western and Central Europe has led to the local extinction of the capercaillie, and most of the remaining populations are small (<200 individuals) and likely isolated. The capercaillie is a sedentary species that spends most of its life within a 3 km radius of its lek. Young birds usually disperse up to 10 km from their birthplace. The capercaillie prefers to use forests consisting solely of pine trees, where the trees are most often at least 80 years old. The size of the mating area in Estonia is estimated to be 12–67 ha. The nest can be located in all types of forests, and the brood may later move to a suitable feeding site hundreds of meters away. Female birds with broods prefer to feed in old, moist forests where blueberries dominate the undergrowth. In winter, capercaillies prefer old pine forests that are over 100 years old. In Estonia, the number of capercaillie cocks has fallen from around 2,000–3,000 in the early 1980s from 2000–3000 individuals to approximately 1100–1200 individuals. In Europe, the breeding population is estimated (2012) at 0.76–1 million pairs (25–49% of the global population), and the overall trend is considered to be declining. In the European Union member states, the population is estimated at 300,000–430,000 pairs, with a moderate decline (10–50%). In boreal forests, higher species richness among forest birds and mammals has been found in capercaillie lekking areas, and therefore the capercaillie acts as an umbrella species for other species. The main threats to the capercaillie are habitat fragmentation and loss, decline in habitat quality due to drainage, and

[63] Conservation Action Plan for the Lesser Spotted Eagle (*Aquila pomarina)* 2009–2013. Approved by order no. 1-1/18/138 of the Director General of the Environmental Board on 26 March 2018.

predation. Studies have shown that the habitat use of capercaillies is affected (i.e., reduced) by wind farms at distances of 650 meters[64] to 865 meters[65] from wind turbines.

Based on data from the terrestrial bird analysis (MLA)[66] completed by the Estonian Ornithological Society and the Eagle Club at the end of 2022, it is likely that there is a movement corridor along the Õhne River green corridor. This is the most direct connection between the capercaillie breeding grounds in the Lasa permanent habitat (capercaillie habitat KLO9101746) and the capercaillie breeding grounds in the Tündre Nature Reserve (capercaillie habitat KLO9134331) (see Figure 5 in the Annex). It is also a forest community suitable for capercaillie movement, with no significant disturbances or infrastructure fragmenting the corridor. There are two sand quarries in the corridor, but these are small-scale quarries, the operation of which is not expected to significantly fragment the capercaillie movement corridor. There are also applications for geological exploration permits in the corridor. Geological surveys do not affect the habitat and movement of capercaillies, but when considering mineral resources, attention must be paid to the impact on the connectivity between capercaillie habitats in mining permit applications and, if necessary, mitigation measures must be planned. It can be assumed that the need to open new quarries will arise primarily when existing ones are depleted, i.e., when new ones are opened, it can be assumed that existing ones will be reorganized at the same time.

No extensive traces of capercaillie activity were found in the southern study area during fieldwork, and encounters with capercaillie during fieldwork were random. Considering that the southern potentially suitable area is a large forest landscape, capercaillies may use the entire area, but there are no forest areas suitable for breeding grounds. The exact movement of capercaillies can only be mapped using telemetry, which is complex and time-consuming. Based on this, the possible movement corridor of capercaillies has been determined on the basis of land use analysis, using data from the capercaillie habitat model.

It is known that capercaillies avoid the vicinity of wind turbines, but dead capercaillies have also been found in wind farms[67] , where they are more likely to be killed by collision with the turbine tower (rather than the blades). **In order to avoid disturbance in capercaillie habitats, a 1 km buffer zone around capercaillie habitats registered in EELIS must be excluded.** The buffer zone has been determined based on the MLA recommendation, which is based on the avoidance zone estimate presented in scientific literature (based on the conservative assumption that the planned wind turbines are larger and may have a greater impact than the wind turbines discussed in the studies).

In addition to protecting capercaillie habitats, it is also necessary to ensure connectivity between capercaillie habitats. To ensure connectivity between habitats, it is recommended to leave as wide and natural a connection corridor as possible. As a relatively large wind farm area is planned, the minimum width of the corridor must be over 1 km (the extent of the possible avoidance area) to ensure connectivity. The new draft capercaillie protection action plan currently being prepared provides for corridors at least 2 km wide to connect habitats. **In the case of this area, it is appropriate to ensure a corridor at least 1.5 km wide on the banks of the Õhne River.** It is also necessary to preserve old-growth forest areas and wetlands between the Tündre and Lasa habitats free of wind

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[64] Coppes, J., Kämmerle, J. L., Grünschachner-Berger, V., Braunisch, V., Bollmann, K., Mollet, P., … Nopp-Mayr, U. (2020). Consistent effects of wind turbines on habitat selection of capercaillie across Europe. Biological Conservation, 244(February), 108529. https://doi.org/10.1016/j.biocon.2020.108529.

[65] Taubmann, J., Kämmerle, J. L., Andrén, H., Braunisch, V., Storch, I., Fiedler, W., … Coppes, J. (2021). Wind energy facilities affect resource selection of capercaillie Tetrao urogallus. Wildlife Biology, 2021(1). https://doi.org/10.2981/wlb.00737

[66] https://kliimaministeerium.ee/elurikkus-keskkonnakaitse/looduskaitse/uuringud-projektid-ja-analuusid#analuus-ja-lisad

[67] FCG. 2018. Kalajoki-Pyhäjoki wind farms. Monitoring of bird impacts 2017. https://pohjoispohjanmaa.fi/wp-content/uploads/2020/08/6168.pdf

turbines. A 1.5 km buffer zone can be considered sufficient in this case, as there are no other significant sources of disturbance on the northern bank of the Õhne River. The northern banks of the Õhne River also consist of forest land and extensive land use, which do not cause disturbances equivalent to those caused by wind farms or other large-scale infrastructure. In addition, it is important to preserve the alternative connection between capercaillie habitats from the Koorküla area across the western edge of Lakesoo towards the Rubina urban area, where there are also suitable step-board habitats in between ( ). The preservation of this connection is supported by the proposal to supplement the green network in the area presented in section4.1.5.3 of the SEA and the inclusion of Lakesoo in the Rubina urban area. In addition, it is highly likely that the connectivity between habitats will be preserved in this area through Latvia. As far as is known, there are no planned developments in the area bordering the planning area on the territory of the Republic of Latvia that could significantly impair the connectivity of the forest areas there.

In the case of the preliminary design of the wind farm, three wind turbine positions (positions 2, 4, and 11 in the plan) remain in the potential movement corridor between the habitats of forest birds, according to the analysis of the terrestrial bird population. The establishment of these positions may cause some disturbance to the connectivity between capercaillie habitats. **To reduce this, positions 2, 4 and 11 should be moved outside the 1.5 km buffer zone of the Õhne River bank area. The proximity of existing roads and logging areas/forest clearings should be preferred as locations for the positions.** In addition, forest management that takes into account the habitat preferences of capercaillies, as proposed in section4.1.3.3 , will help to avoid adverse effects on habitat connectivity. By implementing these measures, it is possible to avoid significant adverse effects on habitat connectivity. In order to maintain the viability of the capercaillie population in the region, attention must be paid to the problems identified in the national monitoring of the hunting grounds and their solutions, which are not covered by the SEA assessment of the special plan.

The unsuitable area 4 was zoned red due to the presence of goshawks (*Accipiter gentilis*, protection category II, near threatened according to the Estonian Red List) found during fieldwork (two nests found).

The northern goshawk is one of the most widespread birds of prey in the world, occurring in both Eurasia and the coniferous forest belt of North America. However, from 2023, the northern goshawk found in North America will be treated as a separate species (*Accipiter atricapillus)*[68] . In Estonia, the northern goshawk is mainly a resident species, with only a small proportion of birds (mainly young) flying to southern areas.

In Estonia, the northern goshawk breeds in both natural landscapes and cultivated landscapes interspersed with patches of forest, but individual pairs have also been recorded in larger urban forests. The northern goshawk stays near its nest as early as late winter, when the pair begins to build and tidy up the nest and the male birds bring their prey to their mate at the nesting site. The size of the nesting stand is positively correlated with nest occupancy. The nest is built on average in coniferous stands that are over 80 years old and located 350 m from the forest edge and young forest. Egg laying begins in the first half of April. The landscape of the home range consists of an average of 51% forest, 29% open landscape, and 11% transitional forest areas. The size of the home range can range from 10 to 25 km$^{(2)}$,but this may be an underestimate.

In Estonia, the number of corncrakes has declined sharply since the early 1990s (>50%) and is estimated at 400-600 breeding pairs [69] . In Europe, the breeding population is estimated at 160,000–210,000 pairs, and the overall population trend is estimated to be moderately increasing

68 Gill, F., Donsker, D., Rasmussen, P., et al. (2023). Species Updates – IOC World Bird List. 20.08.2024, https://www.worldbirdnames.org/new/updates/species-updates/

69 Action plan for the protection of the corncrake, Environmental Board, 2022.

(10–50%). In the European Union member states, the population size is estimated (2004) at 46,000–70,000 pairs and the abundance is moderately declining (10–50%).

The main threats to the capercaillie are the destruction of nesting sites, the decline in the quality of feeding areas, and disturbance during the nesting season. To protect nesting sites, a special protection zone should be established around the nest or nests, covering at least 5 ha of forest that is at least 60 years old. If the older forest area is larger, it should be included in the special protection zone for at least 300 m, following forest divisions or natural boundaries. To avoid disturbance during the nesting period, younger forest adjacent to a suitable nesting stand should be included in the restricted zone for a distance of *approximately* 300 m, following forest divisions or natural boundaries.

In some literary sources, the barn owl has also been considered a species with a higher than average risk of collision with wind turbines[70] . However, only a few cases of barn owl deaths due to wind turbines are known[71] . This may be related to the species' feeding strategy – the vast majority of the species' food sources (primarily gray wagtails, yellow wagtails, chaffinch, magpie, house sparrow, collared dove, and tree sparrow[72]) can be found on the ground or at lower flight altitudes, and the species prefers to hunt at flight altitudes that are below the height range of modern wind turbine rotors.

According to the species conservation action plan, the protection of additional permanent habitats in accordance with the action plan ensures sufficient protection of the habitats of the Eurasian curlew ([73]). At the same time, the species conservation action plan states that the goal is to achieve a favorable conservation status for the species and that the protection of representative nesting sites must be continued. The species is classified as vulnerable on the basis of the Red List. Currently, only forestry restrictions apply to the corncrake habitat in the area, i.e. for corncrake habitats located outside the protected area, temporary restrictions on logging are set for the coordination of forest notifications on the basis of the provisions of the Nature Conservation Act on the protection of individual species, i.e. logging is prohibited from March 1 to July 31. This measure ensures protection during the nesting season, but does not guarantee the sustainability of the habitat. In order to preserve this habitat, it is advisable to consider establishing a permanent habitat for the capercaillie. The sustainability of this habitat depends largely on forest felling (rather than the establishment of wind farms). Based on the species protection action plan, some pairs may remain loyal to their nesting sites even after winter felling in the vicinity of their nests. It seems to be important for the hazel grouse that the forest structure characteristic of old-growth forests is preserved even after selective logging.

In the case of the northern location, it was probably a one-time nesting attempt by a young bird. Forest areas suitable for nesting by the black woodpecker have been preserved in this region. Therefore, the implementation of a more extensive buffer zone at this location is not necessarily necessary to preserve the species' habitat. In August 2024, the nest was checked and found to have collapsed.

[70] Volke, V., Kuus, A., Leivits, M., Luigujõe, L., Mägi, M., Ojaste, I., Sellis, U., Tammekänd, I., Väli, Ü. & Võhandu, K. 2022. Analysis of the terrestrial bird fauna of Estonia. Estonian Ornithological Society and Eagle Club, Tartu.
[71] Rydell, J.; Ottvall, R.; Pettersson, S.; Green, M. The Effects of Wind Power on Birds and Bats - an Updated Synthesis Report 2017; Swedish Environmental Protection Agency (Naturvårdsverket): Stockholm, 2017; p. 132.
[72] Väli, Ü., Grosberg, J., Mellov, P., Melsas, R., & Nellis, R. (2024). The composition of the corncrake's prey and changes therein in Estonia. Hirundo, 37(1), 1-16.
[73] On March 25, 2023, 41 new permanent habitats of the corncrake were placed under protection in Harju, Hiiu, Ida-Viru, Jõgeva, Järva, Lääne, Põlva, Pärnu, Rapla, Saare, Tartu, Viljandi, and Võru counties. Thus, 56% of the total number of corncrake habitats and 65% of the total area (as of 01.01.2022) have been placed under protection in Estonia as part of protected areas or conservation areas or as permanent habitats, and the requirement of § 48(2) of the Nature Conservation Act has been fulfilled, which requires that at least 50% of the known habitats of species in protection category II registered in the environmental register be protected by establishing protected areas or conservation areas or by designating permanent habitats based on the representativeness of the areas.

However, the forest area suitable for the black woodpecker as a habitat has been preserved, so it is possible that a new nest has been built in the vicinity, but its location is unknown.

In the case of the southern location (listed in EELIS as habitat KLO9134698), the nest has probably been in use for several years, but clear-cutting has recently been carried out in the vicinity of the nest, making the future sustainability of this nest use questionable. According to the corncrake conservation action plan, nests are generally abandoned due to clear-cutting. During the 2023 observation, it was not possible to determine whether the nest was inhabited, but during the 2024 follow-up inspection, there were signs of corncrake nesting. During the 2025 follow-up inspection, the nest was uninhabited. The analysis of the terrestrial bird population recommends a 1 km buffer zone for wind farms in the case of the corncrake. This can also be recommended here, but as it is likely that both nests have already found new nesting sites due to the changes that have already taken place, it may not be appropriate to create a strict extensive restricted area. The area within a 500 m radius of the corncrake nests has therefore been zoned as undesirable in order to preserve a forest area free from disturbance by development activities[74] . The zoning takes into account that these are not habitats located in a protected area and that the establishment of permanent habitats for their protection is questionable (given the collapse of the southern nest and the extensive logging carried out in the northern nesting forest). In order to reduce the impact on the habitat of the capercaillie in the developed planning solution, the position of wind turbine 11 should be moved as close as possible to the existing forest road in the area of the young forest.

Unsuitable areas 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, and 23 were zoned red due to the presence of the white-backed woodpecker (*Dendrocopos leucotos,* protection category II, not endangered according to the Estonian Red Book) found during fieldwork. In addition, the following species listed in protection category II were found in the unsuitable areas: Tengmalm's owl (*Aegolius funereus,* unsuitable area 5, endangered according to the Estonian Red Book) and the three-toed woodpecker (*Picoides tridactylus,* unsuitable area 23, not endangered according to the Estonian Red Book).

The white-backed woodpecker prefers older deciduous forests. The main threats are forest management, which reduces the age of forests and the area of suitable habitats for woodpeckers. There is no significant risk of collision with wind turbines, but it is necessary to preserve the direct habitat.

The hairy-legged woodpecker is a typical old-growth forest bird that nests in larger forest stands, mostly in mixed spruce and pine forests, and needs a hollow for nesting. The main threat to the species is the deterioration of suitable habitats. In order to preserve its habitat, it is undesirable to zone forest areas suitable for the hairy-legged woodpecker in wind farms.

The hazel grouse is a small breeding bird. The hazel grouse lives in larger natural forest areas. The hazel grouse prefers older forests with plenty of dead trees, preferably spruce. The species is widespread throughout Estonia. Every winter, woodpeckers migrate from the north to Estonia, increasing the local population of the species two to three times. The woodpecker is threatened by forest management, which reduces the age of forests and the area of habitats suitable for the woodpecker.[75] There is no significant risk of collision with wind turbines, but it is necessary to preserve its direct habitat.

Unsuitable areas 6 and 7 were zoned red due to the presence of common buzzards (*Buteo buteo*, protection category III, not endangered according to the Estonian Red Book) found during fieldwork. Although this is a category III species, unlike other undesirable areas, the immediate vicinity of the

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[74] Morkūnė R, Marčiukaitis M, Jurkin V, Gecevičius G, Morkūnas J, Raudonikis L. et al. (2020). Wind energy development and wildlife conservation in Lithuania: A mapping tool for conflict assessment. PLoS ONE 15: e0227735. https://doi.org/10.1371/journal.pone.0227735

[75] Draft species action plan 2012, T. Evestus and A. Nurmla.

nest must be excluded from construction activities in order to preserve the species' nesting opportunities.

As part of the bird survey, several Category III protected species were inventoried in both areas. As the northern area has already been zoned as undesirable for various bird protection reasons, the SEA report does not provide separate recommendations for the placement of wind turbines in the northern area with regard to Category III protected species.

According to information entered in **the Latvian nature data management system Ozols**, there is a micro-reserve for the protection of the corncrake (micro-reserve code: 2609) and the capercaillie (micro-reserve code: 2185) in the territory adjacent to the Latvian planning area. Based on the position of the Republic of Latvia at the SEA program stage, it is necessary to observe a buffer zone of at least 2 km around these micro-reserves when planning wind farm development areas. For both micro-reserves, the distance buffer is already ensured when mapping potentially suitable areas. No adverse impact on the habitats of species protected by micro-reserves is expected.

In Latvia, there is a former black stork nesting site located approximately 1 km from the Estonian border and approximately 3 km from the nearest planned wind turbine. The nest has since collapsed and extensive logging has taken place in the area. Due to the logging, it is unlikely that the nesting site will be repopulated. No micro-reserve has been established to protect the area. No other nesting sites of Category I protected species are known to exist in the cross-border area (within a 5 km radius)[76] .

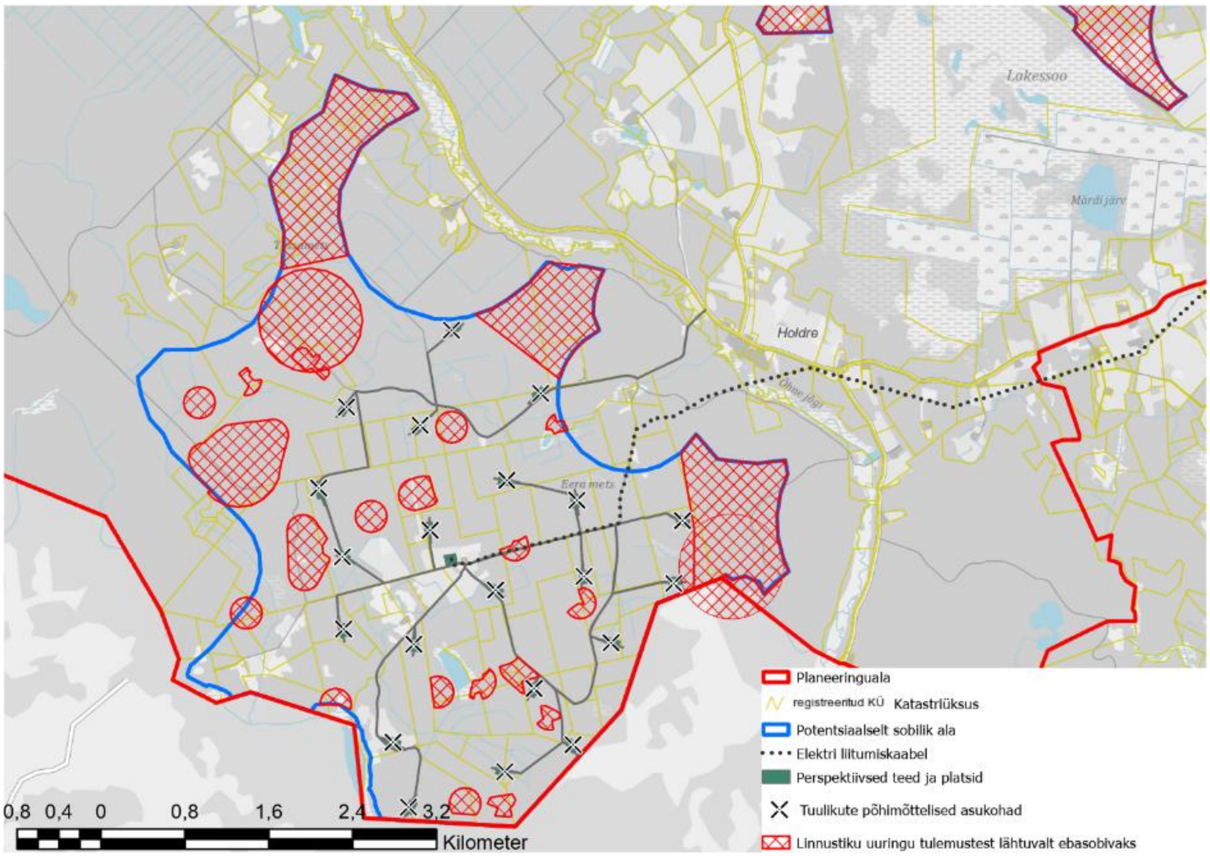

Figure13 . Areas zoned as unsuitable based on the results of the bird survey in the southern potentially suitable area. The public version of the report does not show the numbers of areas zoned as unsuitable so that the locations of species I and II cannot be identified. The figure intended for internal use is presented in Annex 5.

[76] Data from Gaidis Grandāns.

In the wind farm planning solution developed during the preparation of the plan, all areas zoned as unsuitable from the point of view of birdlife have been excluded as locations for wind turbines and infrastructure. Therefore, no significant adverse impact on birdlife is expected when implementing the planning solution, provided that the measures presented in the following chapter are also implemented to mitigate the impacts during construction.

In addition to the identified locations of bird species in protection categories I and II described above, the bird inventory also identified numerous locations of bird species in protection category III. If, based on the bird survey, the northern potentially suitable area is excluded as a wind farm development area due to the need to protect bird species in protection categories I and II, then attention must also be paid to Category III protected bird species in the southern area. Therefore, an impact assessment was also carried out for Category III protected bird species in the southern potentially suitable area, the presence of which was identified in the breeding bird inventory.

As the potentially suitable area in the south is a large forest massif, it is expected that there are numerous forest species in the area, including the hazel grouse, the woodcock, several species of woodpecker (the gray-headed woodpecker, the black woodpecker), the nightjar, and the buzzard (Table11). The habitats of these species depend on the structure of the forest and change over time depending on changes in the forest (including the impact of logging). The significance of the impact on species in protection category III was assessed based on the assessment of the status of the species (the latest national red list category assessment based on EELIS). No significant adverse impact on species in protection category III in a favorable condition is expected from the establishment of the wind farm, given that the area affected is clearly too small to impact the populations of species in a favorable condition.

Table11 . Bird species in protection category III identified in the potentially suitable area in the south, their habitat preferences and population status.

Species name	Description	EELIS-compliant forest management restrictions and recommendations	National Red List category	Birds Directive[77]
Grey-headed woodpecker	The grey-headed woodpecker prefers to nest in light-rich mixed and coniferous forests, alder swamps, wooded meadows and riverbanks. It avoids large forest areas, preferring to nest in smaller patches of forest, often near water. There are 2,000-3,000 pairs living in Estonia.	In a designated habitat or within 100 m of a point object, a temporary restriction on logging is set from April 1 to July 15 (LKS § 55 lg 6). Leave at least 20 m³/ha of living and dead deciduous trees with a diameter of more than 10 cm as retention trees in regeneration felling, giving preference to thicker aspens.	In favorable condition	Annex I Stable Rising
Buzzard	The abundance of the common buzzard varies between 5,000 and 6,000 pairs. Although the common buzzard is a migratory bird in Estonia, some individuals remain in Estonia for the winter if suitable habitats and good feeding opportunities are available. The common buzzard prefers coniferous and mixed forests as its habitat.	It is prohibited to cut down nesting trees (LKS § 55 lg 6¹ p 1), and in designated habitats or within 300 m of nesting trees, logging is restricted from March 15 to July 31 (LKS § 55 lg 6). The area around the nest (within a radius of 15 m) must be kept natural, i.e. no felling. No clear-cutting may be	Favorable condition	Stable Stable

[77] Population trends according to: https://kliimaministeerium.ee/sites/default/files/documents/2021-07/Linnudirektiivi%20liikide%20nimekiri.pdf

Species name	Description	EELIS-compliant forest management restrictions and recommendations	National Red List category	Birds Directive[77]
		carried out closer than 25 m to the nest.		
Hoburästas	The Eurasian jay nests in various pine forests and pine-spruce coniferous forests, preferring older heath, bog, swamp, transition bog and bog pine forests. In western Estonia, due to the scarcity of coniferous forests, the species also occurs in sparse deciduous forests and wooded meadows. There are 30,000-50,000 pairs living in Estonia. The population is stable.	Clear-cutting of more than 0.5 ha may be prohibited. In a designated habitat or up to 50 m from a point object, a temporal restriction on logging is set from April 15 to July 15 (LKS § 55 lg 6).	Favorable status	Annex II, Part B Stable Improving
Woodcock	The woodcock is currently a widespread breeding bird across mainland Estonia. Its distribution is clearly denser and more uniform in areas with large forest areas. The woodcock breeds in a wide variety of older forests, preferring spruce-dominated forests. Its population varies between 2,000 and 3,000 pairs. The woodcock prefers open areas or mosaic forests bordering clearings as its habitat.	Clear-cutting of more than 0.5 ha may be prohibited. Dead and hollow trees should be preserved as retention trees in the first row of clear-cuts. In a designated habitat or within 100 m of a nesting tree, a temporary restriction on logging is imposed from February 15 to June 30 (LKS § 55 lg 6). Dead and hollow trees should be preserved as retention trees in the first row. If possible, avoid clear-cutting closer than 25 m to the nesting site. Leave old trees that are suitable as ambush trees as retention trees in the cutting area.	Vulnerable	Annex I Stable Stable
Eurasian woodcock	The hazel grouse is a member of the grouse family. It is a resident bird in Estonia, found mainly in the forest areas of the mainland, where it is a common breeding bird, but rarely found on the islands. It is estimated that its population has declined by >50% between 2006 and 2017. However, according to distance census data for forest birds from 2011 to 2018, the decline in the hazel grouse population is smaller. According to point count data, the long-term trend (1983-2018) in the population of the woodcock is strongly declining. At the same time, based on point counts, the trend over three generations (12 years) is unclear.	Regeneration felling may be prohibited in the habitat. A time limit is set for felling in a defined habitat or within 50 m of a point object from April 1 to June 30 (LKS § 55 lg 6). Recommendation to preserve unthinned areas and deciduous trees, especially alders, in spruce thinning operations. During thinning and selective felling, leave at least two uncut areas of at least 0.05 ha per 1 ha, where the undergrowth and second layer are also preserved. Store logging residues in such a way that they do not cover a significant part of the forest floor, so as not to significantly reduce the area of undergrowth necessary for feeding and accessibility to chicks.	Vulnerable	Annex II, Part A, Annex I Falling Falling

Species name	Description	EELIS-compliant forest management restrictions and recommendations	National Red List category	Birds Directive[77]
Lõopistrik	The Eurasian sparrowhawk is a small breeding bird found throughout Estonia. It prefers tall, light-filled pine forests as its nesting grounds. It inhabits both natural and cultivated landscapes, nesting most often near water bodies, bogs, clearings or meadows. It nests in old crows' or rooks' nests, often on top of seed trees in clearings.	Clear-cutting may be prohibited within a 20 m radius of a known nest. Leave retention trees in groups, giving preference to pine trees. In a designated habitat or within 300 m of a nesting tree, a temporary restriction on logging is imposed from May 1 to August 15 (LKS § 55 lg 6). Felling of nesting trees is prohibited (LKS § 55 lg 6¹ p 1). If possible, avoid clear-cutting closer than 20 m to the nest. It is recommended to leave at least two tall (first-class) pine trees in a forest area of at least 0.5 ha, one of which should be a known nesting tree.	Favorable condition	Stable Stable
Black woodpecker	The black woodpecker is a bird with a stable population. It prefers large coniferous forests, mixed pine forests, tall, sparse pine forests, clearings, and burnt areas as its habitat. The black woodpecker is threatened by the reduction in the area of suitable habitats. The black woodpecker builds a new nest cavity every year, thus providing nesting sites for other forest dwellers.	Leave retention trees in groups, give preference to pine trees and dead trees, and preserve trees with hollows. In a designated habitat or within 50 m of a point object, a temporary restriction on logging is set from March 15 to June 30 (LKS § 55 lg 6).	In favorable condition	Annex I Stable Improving
Meadow pipit	The woodlark nests in moors, moor forests, sandy clearings and deciduous forests. The main threats are habitat destruction as a result of forest management and changes in land use. The woodlark is unevenly distributed across Estonia. It is more common in southern Estonia south of the Virtsu–Pärnu–Nuia–Rõngu–Räpina line, in northern Estonia north of the Haapsalu–Rapla–Mustvee line, and in the western parts of Saaremaa and Hiiumaa. In the period 2008-2012, the population size was estimated at 10,000-20,000 pairs, and the trend in 2001-2012 was stable. The 2017 estimate was 3,000–6,000 pairs, and the trend from 2006 to 2017 was moderately declining. The population has declined by 70% over three generations.	In a defined habitat or within 50 m of a point object, a time restriction on logging is set from April 1 to July 15 (LKS § 55 lg 6).	Threatened with extinction	Annex I Declining Declining
Red-backed shrike	The red-backed shrike is a common breeding bird in Estonia, nesting in semi-open landscapes: shrubby meadows and bogs, scrubland, thickets, clearings, forest edges, and parks. After a period of decline, the species' population has rebounded in recent years. In 1998–2002, its population was estimated at 20,000–35,000 breeding pairs, and in 2003–2008, it was already 40,000–60,000 breeding pairs. The species is threatened by the large number of small predators. According to the Estonian Red List, the red-backed shrike is not endangered and is classified as a Category III protected species under the Nature Conservation Act.		Favorable status	Annex I Declining Declining

Species name	Description	EELIS-compliant forest management restrictions and recommendations	National Red List category	Birds Directive[77]
Raven	The black grouse is a common breeding bird in Estonia. The typical nesting site of the black grouse is a young dense spruce forest or a mixed spruce and deciduous forest with dense undergrowth, often of the boggy type. It builds a new nest every year, almost always in a spruce tree. The black woodpecker is content with even very small areas of habitat that meet its requirements and tolerates human presence well.	Reforestation on areas larger than 0.5 ha may be prohibited. In a designated habitat or within 100 m of a nesting tree, logging is restricted from April 1 to July 31 (LKS § 55 lg 6). Recommendation: preserve approximately 0.1 ha of unthinned areas per 1 ha when thinning spruce stands.	Favorable condition	Stable Stable
Corn crake	The corn crake is a widespread breeding bird. The corn crake inhabits various open landscapes. The abundance of the corn crake can be considered relatively stable over the last 40 years, with no clear long-term trend. There are strong short-term fluctuations in abundance. However, the population of corn crakes has been steadily declining over the last decade, especially in Western Europe. Therefore, Estonia, with its relatively healthy corn crake population, plays an important role in preserving the species' habitats. The main reason for the decline in corn crake numbers is intensive agriculture (the destruction of nests on cultivated land).		Favorable status	Annex I Declining Declining
Crane	The crane is a widespread species in the temperate zone of Eurasia, but its range, abundance, and overall status have been constantly changing. In Estonia, its breeding range has expanded significantly over the last 30 years and its population has increased at least 3-4 times. The crane inhabits various wetland habitats. Its preferred nesting sites are coastal water bodies and inland lakes. It may also nest in sparse wet forests.	In a designated habitat or within 300 m of a nesting site, logging is restricted from April 1 to July 15 (LKS § 55 lg 6).	Favorable status	Annex I Stable Increasing
Little flycatcher	Nowadays, it inhabits the whole of Estonia, with the majority of the population nesting in the forested areas of Central and Northern Estonia. It prefers to nest in natural semi-open cavities, inhabiting denser forests such as spruce forests and mixed spruce forests. It is estimated that only 40,000-60,000 pairs of lesser spotted woodpeckers nest in Estonia.	Clear-cutting of areas larger than 0.5 ha may be prohibited. Standing dead trees must be preserved during logging. In designated habitats or within 100 m of a point object, a temporal restriction on logging is set from May 1 to July 15 (LKS § 55 lg 6). If possible, avoid clear-cutting areas larger than 0.5 ha ( ). During logging, preserve standing dead trees.	In favorable condition	Annex I Stable improving
nightjar	Widespread across Estonia. Distribution uneven due to habitat preferences. The nightjar has specific habitat requirements: it prefers sparse bog and heath forests, but can also live in sparse forests, clearings, clear-cuts and heaths. The number of nightjars is declining, and their habitats are threatened by forest management and drainage.	Clear-cutting of more than 0.5 ha may be prohibited in the habitat. In a designated habitat or within 50 m of a point object, a temporary restriction on logging is set from May 1 to July 15 (LKS § 55 lg 6).	Favorable condition	Annex I Stable Declining

Of the protected bird species found in the area, the population of the corncrake and the woodcock is in a vulnerable state, and the meadow pipit is considered to be at risk of extinction due to a significant decline in numbers.

The corncrake was observed during the inventory in the Variku sand quarry and on farmland in the central and southwestern parts of the area. According to EELIS, the habitat area of the corncrake in Estonia has been reduced by the afforestation of dunes and heaths and the decline of extensive agriculture, but the status of the species depends primarily on the population status in the core area of its range south of us. The risk of collision with wind turbines is considered to be low (it is necessary to take into account the migration corridors of birds, which, however, remain on the coast)[78] . Of the six habitats identified in the inventory, the proposed wind farm solution will have an impact (loss of habitat due to construction) on two habitats, one of which is a logging area (not a sustainable habitat for the species) and the other is arable land (species-specific use depends on the choice of crop). Considering that more than half of the habitats in the area will remain unaffected by the construction of the wind farm and that in two cases most of the area suitable for habitat will remain intact, no significant adverse impact on the status of the species is expected.

The corncrake was scattered across the entire southern area during the inventory. The corncrake was more prevalent in the part of the Tündre Nature Reserve where the impact of forest management has been less significant. According to EELIS, the main causes of death for adult woodcocks in Estonia are roadkill and predation by golden eagles. The sustainability of the population as a whole is mainly threatened by habitat loss or a decline in habitat quality. As old (natural) forests decline, suitable nesting trees and hollow trees are disappearing. On the other hand, the addition of a moderate amount of clear-cut or thinning areas may even improve the species' food base. An analysis of the terrestrial bird population considers the reduction of nesting sites to be the main threat to the capercaillie and recommends that these sites be preserved. In order to preserve the habitats of the corncrake to the maximum extent possible and to avoid significant adverse effects on them, at least 90% of the area outside the areas zoned red in the bird assessment must be preserved in its natural state (i.e., no construction areas should be planned). The parts of the Tündre Nature Reserve where the corncrake population is high should be excluded from the pre-selection area. No significant adverse impact on the status of the species is expected from the implementation of the measures.

The hazel grouse was scattered across the entire southern area during the inventory. The hazel grouse was more prevalent in the part of the Tündre Nature Reserve where the impact of forest management has been less significant and in the area adjacent to the Õhne River. The analysis of terrestrial birds considers wind turbines to be a threat to the hazel grouse in terms of both collision mortality (the risk of collision with the turbine tower, not the blades) and habitat loss, both directly and through disturbance, and recommends maintaining a 500 m buffer zone around habitats. As the woodcock population in the area is high and it is known that wind turbines cause both disturbance and collision risk for the species, it is necessary to implement mitigation measures to avoid significant adverse effects. In order to preserve the woodcock habitat as much as possible and avoid significant adverse effects on it, at least 90% of the area outside the areas zoned red in the bird assessment must be preserved in its natural state (i.e., no construction areas planned). In addition, measures must be implemented to minimize the risk of collision with the hazel grouse. The implementation of these measures is not expected to have a significant adverse impact on the status of the species.

There are still relatively few studies on the impact of wind farm construction on the overall abundance of birdlife in forest landscapes (as the history of wind farms in forest landscapes is short). From an environmental impact perspective, it is important that commercial forest areas with lower ecological value are preferred for the construction of wind farms in forest areas. In this case, the entire area is commercial forest, and the previously presented zoning excludes all areas of higher value for bird populations. Previous studies of wind farms located in forest landscapes have shown that bird communities in commercial forests are strongly related to forest structure, season, and to a certain

[78] Volke, V., Kuus, A., Leivits, M., Luigujõe, L., Mägi, M., Ojaste, I., Sellis, U., Tammekänd, I., Väli, Ü. & Võhandu, K. 2022. Analysis of the terrestrial bird fauna of Estonia. Estonian Ornithological Society and Eagle Club, Tartu.

extent also to the diameter of the wind turbine rotor, but were not related to the distance of the wind turbine. For example, bird abundance decreased in structurally poor (−38%) and monocultural (−41%) forests where wind turbines were located, and in young (−36%) deciduous forests where there were more and larger wind turbines (−24%). Wind turbines in managed forests partially repel common forest birds. At the same time, forest bird communities are locally more sensitive to forest quality than to the presence of wind turbines[79] . Based on the above, the establishment of a wind farm in the area may be accompanied by a decline in the abundance of forest birds. Section4.1.3.3 provides recommendations on how forest management practices can help prevent a decline in abundance, both in terms of protected bird species and forest bird communities in general.

In order to preserve habitats suitable for forest species as much as possible, the locations of existing roads should be used to the maximum extent possible for the location of wind turbines and infrastructure, and the wind farm should be designed to be as compact as possible. The wind farm location solution developed during the planning process will preserve sufficient natural landscape in the area surrounding the wind farm for species to relocate.

4.1.3.2.2 Impact on species using airspace

The use of airspace by birds was monitored during all fieldwork carried out during daylight hours. The main purpose of the airspace use study is to identify the regular migration routes of large flocks of birds (cranes, swans, geese) in the spring and/or autumn and the possible use of feeding areas by birds of prey in the summer. The aim of the airspace observations is also to identify the flight paths and feeding areas of birds of prey, which may indicate nesting in the area.

Based on the landscape and previous information, it was reasonable to assume that spring and autumn **flocks of cranes** would gather in Lakesoose and fly in and out of the surrounding open areas from the bog. The observations carried out confirmed this assumption. Cranes move across the northern part of the potentially suitable area, including using fields and grasslands located in the northern part of the area and fields and grasslands located to the north of the area for resting. The use of fields and grasslands as feeding areas may vary from year to year, as their suitability for feeding depends on the choice of crops. The main (most energy-efficient) feeding fields, for which it is appropriate to talk about arrival and departure corridors, are located within a radius of up to 5 km from the roosting area (Figure14). Such open landscapes are located mainly to the east, southeast, and north of the roosting area. Thus, the northern part of the potential suitable area would remain on the migration route of cranes. There is no potential suitable area in the southern part of the flight corridor.

[79] Rehling, I., Delius, A., Ellerbrok, J., Farwig, N., Peter, F. 2023. Wind turbines in managed forests partially displace common birds, Journal of Environmental Management, Volume 328, https://doi.org/10.1016/j.jenvman.2022.116968

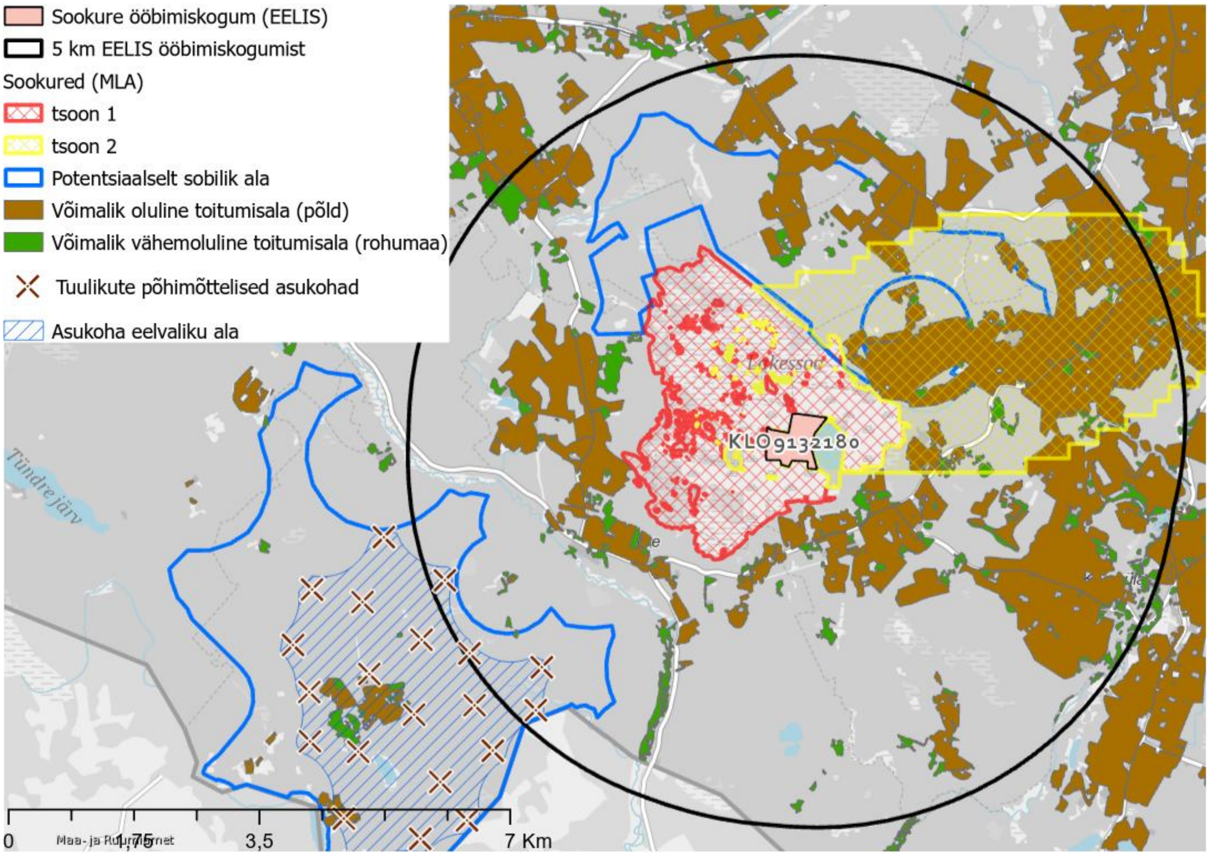

Figure14 . Lakesoo crane roosting area and associated potential feeding areas.

The occurrence of roosting flocks of cranes (hundreds of birds moving twice a day between feeding and roosting sites) and observations of nesting cranes made during bird surveys in development areas should not be confused with each other. The abundance of nesting cranes in one place is usually one nesting pair, which does not fly far to feed. Although the crane is a Category III species, it is also very common (7,000-8,000 pairs) and a widespread breeding bird throughout Estonia. Individual nesting pairs of cranes do not need to be taken into account when planning wind farms (as they are found almost everywhere). A moderate decrease in their nesting sites is not expected to have a significant adverse impact. However, it is important to take crane flocks into account, as the construction of a wind farm in the feeding area of crane flocks is likely to have a significant adverse impact on the species, including a significant risk of death and a barrier effect.

The southern part of the potentially suitable area is almost entirely covered by forest. As there are no feeding areas suitable for cranes in this area and the open landscapes in Latvia are already so far from Lakesoo (outside the energetically reasonable range of feeding flights), regular feeding flights over this forest area are unlikely and have not been observed during observations.

The construction of a wind farm in the southern area will not have a significant adverse impact on cranes, including the risk of death and the barrier effect.

The nearest known migration stopover site for **little** grebes is Lake Ikeperä (approximately 9 km from the northern area and 7.5 km from the southern area). The arrival and departure of small swans in relation to Lake Ikeperä was studied during the Mulgi-Tõrva wind energy priority development area study, and the lake is used by small swans as a stopover site. The directions of arrival and departure are mainly westward from the lake, but there is also northward and southward movement. Considering the distance of potentially suitable areas from the stopover site and the nature of the landscape, regular flights of birds stopping at this stopover site over potentially suitable areas are unlikely. The analysis of terrestrial birds considers an area of 10 km from the stopover site to be noteworthy for the little grebe, and although both potentially suitable areas fall within this distance buffer, the part covered by the buffer is a forest area. There are no suitable feeding areas for little grebes, and there are extensive open landscapes suitable for feeding between the potentially suitable areas and the stopover site. However, on April 7, 2023, a flight of little grebes (17 individuals) was observed in the southern area. This was a small flock, probably flying over by chance.

The German environmental organization NABU is implementing the "Little Grebe Project," which aims to study the use of little grebe habitats, feeding areas, and night roosting sites, as well as to clarify conflicts between little grebes and wind turbines, power lines, and hunting. In their study, they have equipped 40-58 little bitterns with GPS transmitters to track their migration and habitat use over a period of six years (2020-2026). They have published an online version of the migration map for 66 little bitterns on the project website, which is available at https://zwergschwan.de/karte-senderschwaene.

The map shows the birds' roosting sites and some feeding sites, but it is difficult to identify the movement corridors between roosting sites and feeding areas. This is because the time difference between GPS data from a single transmitter on the migration map is large (5-6 hours), and birds often fly hundreds of kilometers during this time. On the migration map, these long distances are connected by straight lines, but the birds have probably landed in between. These movements are probably not straight lines between the two migration points. Nevertheless, the migration map provides a fairly accurate indication of possible important movement corridors and overnight stops.

From the migration map (Figure15), it can be concluded that small ducks equipped with transmitters have migrated through the northern area or its vicinity up to five times (in the period 2021-2024) and through the southern area up to four times. There is no regular movement of small ducks across either of the potentially suitable areas.

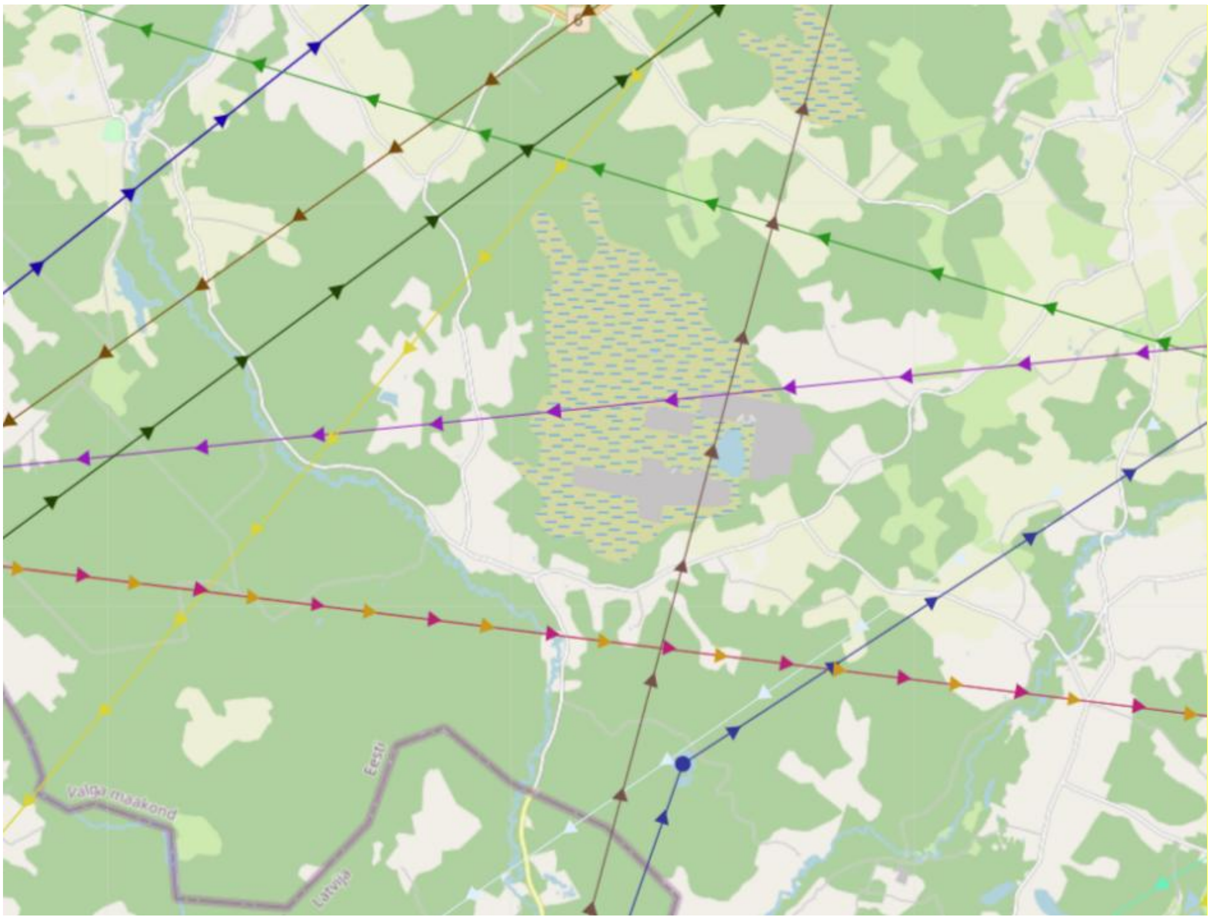

Figure15 . Excerpt from the migration map of small birds equipped with transmitters https://zwergschwan.de/karte-senderschwaene .

In summary, the construction of wind turbines will not significantly affect small birds in either the northern or southern areas. There is no significant movement through the areas. No regular movement corridors between resting places and feeding grounds were identified in the study or based on existing transmitter data.

In the case of greater white-fronted geese and bean geese, similar to small ducks and cranes, the regular movements of spring and autumn migration flocks are particularly important from the perspective of wind farm construction. Migration is generally more active in Estonia during the spring period. Geese generally stop at bodies of water. The mapping of greater white-fronted goose stopover sites and flight corridors was carried out during the compilation of a nationwide analysis of land birds, using 86 GPS-tagged greater white-fronted goose locations covering the spring periods of 2014-2020 as source data. Based on the data, there are no goose migration stopover sites in the planning area. The nearest one is located in Veisjärve, which is about 10 km from the northern area and 14 km from the southern area. Based on the analysis of land birds, both the northern and southern areas overlap to a small extent with the so-called zone 3 area of large geese, i.e. the migration corridor, where the flight intensity was 6-20 flight paths/km($^{2)}$based on the marked birds. To a certain extent, there is migration of geese across both the northern and southern areas. However, neither area is a regular or very intensive migration corridor for geese that would affect the possibility of establishing a wind farm in the area. The impact of mortality on the population can be considered significant if the activity is expected to result in the death of more than 0.0075% of the breeding population of the species in Estonia per year[80] . In the case of geese, the population is very large (at least one million individuals), so the threshold for a significant impact of mortality is also very high, and there is no possibility of exceeding it in the Tõrva area. Geese also have a high collision avoidance rate with wind turbines (99.9%)[81] . During the spring fieldwork, the highest number of geese flying over (Figure16) was recorded on 07.04.2023, with a total of 566 individuals (14 flights). In April (the most active month for spring migration of geese), a total of 1502 geese were recorded flying over.

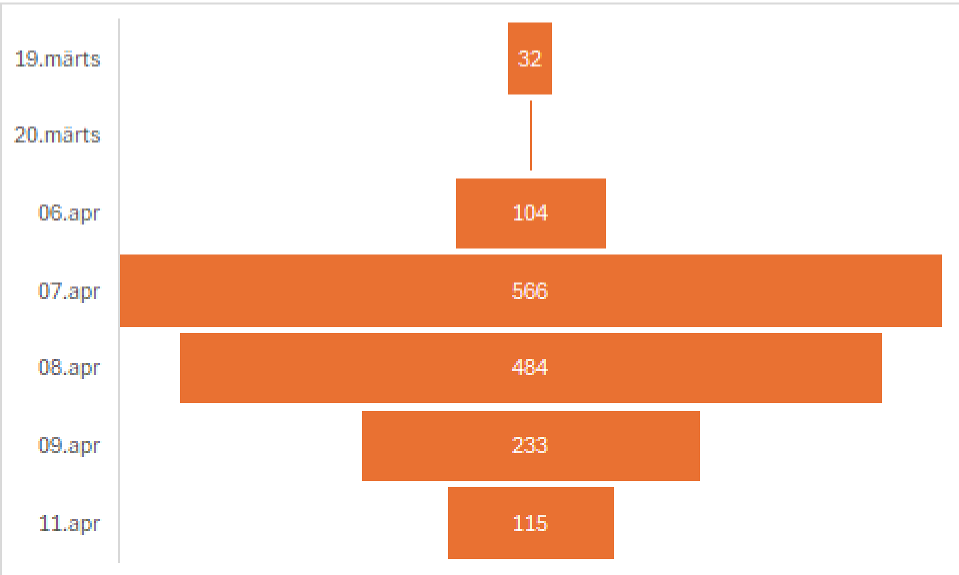

Figure16 . Number of geese observed during spring fieldwork in 2023 in the southern study area.

When compiling the KSH, the point observation methodology used in the 2023 spring bird survey commissioned by the Environmental Agency was not followed in the priority development areas of

[80] Estonian Ornithological Society. 2024. Public procurement (reference number 265181) "Bird survey to identify priority areas for wind energy development (Environmental Agency)" part 13 (Väike-Maarja - Vinni survey area) (contract no. 4-5/23/22) final report

[81] Zehtindjiev, P., & Whitfield, P. (2013). Monitoring of wintering geese in the AES Geo Energy Wind Farm "Sveti Nikola" territory and the Kaliakra region in winter.

state land (the so-called Repower survey areas), but as a general principle, the observation results were consistent with the results of the Repower survey areas. [82]In the Repower Mulgi-Tõrva survey area, 414 geese were observed in point observations in April 2024 , 3058 geese were observed in the Tõrva survey area [83] , and 8186 geese were observed in the Tõrva-Valga survey area [84] . Spot observations made in the vicinity of Ridasoo in the spring of 2025 confirm the previous results (according to preliminary data, 1325 geese were observed)[85] . Observations in the surrounding areas thus show that, in the case of Tõrva municipality, the most active movements of geese during migration are in areas closer to Lake Võrtsjärv. The special planning area is not a major migration route for geese. However, it is appropriate to provide for follow-up monitoring after the construction of the wind farm. If undesirable environmental impacts (significant bird mortality during the migration period) become apparent, measures to reduce the risk of mortality must be developed.

During observations in 2023, lesser spotted eagles were repeatedly spotted in the open areas of the northern part of the area, which is **a Category I protected species of birds of prey**. As two lesser spotted eagle nests were also found in the area, it is clear that the open landscapes of the northern area are actively used by lesser spotted eagles as feeding grounds and that the construction of wind turbines in the northern area would pose a significant risk of death to lesser spotted eagles.

In addition to cormorants, white-tailed eagles were observed once in the northern area and twice in the southern area. It is known that white-tailed eagles successfully nest in the former golden eagle nest in Lakesoo, and these may have been the same individuals (no other nests are known in the area). The most important feeding area for this pair of white-tailed eagles is probably the floodplains of the Õhne River. According to the white-tailed eagle conservation action plan, wind farms may not be built closer than 2 km to eagle nests and closer than 1 km to important feeding areas (coasts, wetlands, lakes). This condition is met in the case of potentially suitable areas. Considering that both potentially suitable areas are located outside the white-tailed eagle's usual home range (2 km) and that there are no feeding areas suitable for white-tailed eagles in these areas, no significant risk of death or barrier effect for white-tailed eagles is expected. However, it would be undesirable to leave the white-tailed eagle's habitat between two wind farm areas (which would cumulatively reduce its feeding areas). Therefore, the wind farm should be planned compactly in one potentially suitable area (taking into account the habitat use of white-tailed eagles, preferably in the southern area).

There has historically been an osprey nest in the vicinity of the southern area. The habitat was archived in EELIS 10 years ago. The nest was built by eagles in 2011 and was inhabited for only one year. By 2015, the nest had fallen apart. The nesting site was located in an area with high human disturbance, on a logging site between three roads, and the quality of the nesting tree and habitat was poor. Re-colonization of the habitat was considered unlikely. No ospreys were encountered in the area during fieldwork. The nearest known osprey nest inhabited in recent years is located in the Rubina Nature Reserve. Lake Tündre is a suitable feeding area for ospreys in the region. There are no potentially suitable areas between the osprey habitats in the Rubina Nature Reserve and Lake Tündre.

No other Category I protected species were encountered during the bird survey conducted in the area. The PlutoF database also lacks observation data on other Category I protected species in potentially suitable areas.

[82] Midges OÜ. 2024. Public procurement "Bird survey to identify priority areas for wind energy development for the Environmental Agency" Public procurement reference number 265181 Part 11 Tõrva Final report

[83] Loodustaju OÜ. 2024. Public procurement “Bird survey to identify priority areas for wind energy development for the Environmental Agency” Public procurement reference number 260767 Part 12 Mulgi-Tõrva. Final report

[84] Loodustaju OÜ. 2024. Public procurement "Bird survey to identify priority areas for wind energy development for the Environmental Agency" Public procurement reference number 260767. Part 13 Valga-Tõrva. Final report

[85] Verbal information from Ants Tull

The Tõrva special planning area is located deep inland, far from large inland water bodies. Based on this, it is unlikely that there are other important bird migration corridors in the area.

In June and July 2025, additional spot observations were carried out over a 24-hour period in the area designated as the preliminary location in the draft plan (as of May 2025). The purpose of the observations was primarily to check for possible regular use of the airspace by birds of prey, which could indicate nesting or regular feeding flights. **During the point observations, no observations were made that would indicate the nesting or regular feeding of Category I protected bird species in the preliminary selection area .** During the observations, a young white-tailed eagle (presumably a second-year juvenile) was spotted on one occasion. The observation does not indicate nesting or regular feeding. No species belonging to protection category II were recorded during the spot checks. As expected, common buzzards were observed during all observations. As several inhabited nests are known to exist in the area, this is entirely expected use of airspace. A black kite was also seen on one occasion and a honey buzzard on two occasions. Of the species in protection category III, a pair of cranes was observed on one occasion, and a total of four white storks were also seen. Of the non-protected species that are important for conservation, a flock of 11 cormorants was observed on one occasion.

The spot observations did not reveal any circumstances that would require additional environmental measures to be implemented when establishing the wind farm in the area.

Knowledge gaps: Thorough studies of breeding birds have been conducted in the preliminary selection area under assessment, and considering the time spent by ornithologists on various fieldwork in the area during the spring and summer periods and the additional spot observations carried out in the summer of 2025, sufficiently thorough knowledge of the breeding bird population, spring and summer use of airspace, and migration intensity in the spring period has been established for the assessment. However, as no autumn point observations have been carried out in the location selection area, it is appropriate to plan point observations in the autumn period before applying for a building permit (see section4.1.3.3 for more details). It should also be taken into account that the wind farm may change the behavior patterns of birds in the area, and therefore it is important and necessary to conduct bird monitoring during operation.

4.1.3.3 Measures, need for further studies and assessment

At the site selection stage:

- Areas zoned red in the bird assessment should be avoided as locations for wind turbines (including the rotor range).
- To prevent bird deaths from collisions with overhead lines, underground cables should be used instead of overhead lines.
- Outside areas classified as red zones in the bird assessment, at least 90% of the area must be preserved in its natural state (i.e., no construction areas planned). This measure reduces the impact on the habitats of bird species in protection category III and those not under protection.

During further design and operation:

- To protect forest breeding birds, clearing, felling related to the construction of the wind farm, and major soil works must be scheduled between July 21 and February 28.
- Significant changes to the water regime and other impacts that are not essential for the development should be avoided.
- When further specifying the locations of wind turbines and routes during design, it must be ensured that changing the locations does not cause a greater adverse impact on birdlife than the assessed solution.

- The area has a high abundance of woodcocks. In woodcock habitats, the most effective measure known to prevent the death of individuals in collisions with wind turbine towers is to paint the lower part of the tower (up to 10 m above ground level) in dark or striped colors[86], as this reduces the risk of collision with birds by up to 48%[87]. This measure also helps to prevent possible collisions between forest birds and wind turbine towers. The measure must be implemented for all wind turbines to be erected on forest land.
- In order to avoid a significant decline in bird populations, forest management practices that support population abundance and species diversity must be implemented in the pre-selected area (at least 70% of the forest land in the pre-selected area).

  Logging must be avoided during the peak nesting period from May 1 to July 15. Standing dead trees must be preserved during logging. During thinning and selective felling, leave at least two uncut areas of at least 0.1 ha per hectare, where the undergrowth and second-growth trees are also preserved[88(,)89].

  To ensure connectivity between capercaillie habitats, carry out regeneration felling in areas of up to 2 ha. Preserve large scattered pine trees and keep as much of the ground covered with blueberry bushes as possible free of logging debris. In habitats suitable for pine trees, preserve pine as the main tree species in logging areas and, if possible, aspen in the first layer, and give preference to pine as the main tree species when regenerating the forest.

  The forest management conditions of the pre-selected area must be entered in the Forest Register when the plan is established.
- In order to reduce the impact on the habitat of the corncrake and the connectivity between capercaillie habitats, the positions of wind turbines 2, 4 and 11 must be moved so that they are at least 1.5 km away from the Õhne River to ensure a free corridor for the connectivity of capercaillie habitats.
- Point observations of birdlife should be carried out in the preliminary selection area in the autumn before applying for a building permit. The methodology set out in section 1.7 of the guidelines "Methodology for biodiversity studies and minimum requirements for follow-up monitoring of wind farms" prepared by the Environmental Board must be followed. If significant use of airspace by birds of prey or geese is identified, additional measures to prevent significant mortality risk must be submitted in cooperation with an ornithologist. Possible measures that may need to be implemented include:
  - If there is a large number of geese moving through the area in autumn and a high risk of collision as a result, the risk of collision must be mitigated by imposing restrictions on the operation of wind turbines or their control systems.

Environmental monitoring condition:

Search for dead birds, including tests of search effectiveness and predation load, must be carried out for two years after the construction of the wind farm in accordance with the methodology. The methodology is described in section 5.3 of the analysis of land birds. Searches for dead birds shall be carried out twice a month during snow-free periods. Monitoring is carried out under all wind turbines in the wind farm (in the case of wind farms with more than ten wind turbines, the number of wind turbines to be monitored may be specified in cooperation with the Environmental Board) within a radius equal to the length of

[86] The exact color scheme should be developed in cooperation with forestry experts, following the latest knowledge available at the time of the wind farm construction.

[87] Stokke B. G., Nygård T., Falkdalen U., Pedersen H. C., May R. 2020. Effect of tower base painting on willow ptarmigan collision rates with wind turbines.

[88] Mägi, M. 2019. The potential impact of spring-summer logging on forest birds and measures to mitigate it.https://www.eoy.ee/pics/1154_kevadsuviste_raiete_voimalik_moju_metsalindudele_ja_seda_leevendavad_meetmed.pdf

[89] EELIS forest management restrictions and recommendations

the wind turbine blade, measured from the tower of the wind turbine (the search area may be reduced depending on the search conditions). The monitoring scheme may be specified based on the analysis of the monitoring results. If the monitoring reveals an undesirable environmental impact on birdlife, the experts conducting the monitoring must propose a suitable set of measures to prevent, minimize, or compensate for the environmental impact.

4.1.4 Impact on bats[90]

The impact of wind farms on bats can be divided into two categories based on the mechanism of impact: loss and alteration of habitats, and bat mortality. The occurrence and extent of both impacts depend on the location of the wind turbines in the landscape, which is why it is important to assess the suitability of the planning area as a habitat for bats prior to the construction of wind turbines. In addition to the location of the wind turbines, the extent of the impact may also vary depending on the season. In terms of impact, two periods are mainly distinguished: the migration period and the summer period, with the risk of death being higher during the autumn migration period ( ). In general, the potential impacts of habitat change are considered to be minor (often small), while the impacts of mortality are considered to be large to very large, depending on the location[91] . However, recent studies[92] have shown that, in the case of modern wind turbines built in forest landscapes, bat species avoid the vicinity of wind turbines (the impact extends to several hundred meters), which is presumably due to the decline in habitat quality associated with the construction of wind turbines. The way to mitigate both the risk of bat mortality and habitat loss is the same: when planning wind farms, good bat habitats must be avoided.

The main cause of bat mortality is direct contact with moving wind turbine blades, but under specific conditions, mortality due to barotrauma is also possible[93,94] . Bat fatalities have been recorded mainly in onshore wind farms in Europe and North America, but there is also some data from other regions[95(,)96(,)97] . The available data on fatalities is also largely related to whether and how bat fatalities have been monitored.

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90 OÜ Rewald. 2024. The green network of wind areas in Tõrva municipality and bats. Work no. 2023-3.

91 Rodrigues, Luisa, Lothar Bach, M.-J Dubourg-Savage, B Karapandža, D Kovać, T Kervyn, Jasja Dekker, et al., eds. 2014. Guidelines for Consideration of Bats in Wind Farm Projects. EUROBATS Publication Series 6. Bonn: UNEP/EUROBATS.

92 Ellerbrok, J.S., Delius, A., Peter, F., Farwig, N. and Voigt, C.C., 2022. Activity of forest specialist bats decreases towards wind turbines at forest sites. Journal of Applied Ecology 59(2); Gaultier, S.P., Lilley, T.M., Vesterinen, E..J. and Brommer, J. E., 2023. The presence of wind turbines repels bats in boreal forests. Landscape and Urban Planning 231 (2023) 104636).

93 Baerwald, Erin F., Genevieve H. D'Amours, Brandon J. Klug, and Robert M. R. Barclay. 2008. "Barotrauma Is a Significant Cause of Bat Fatalities at Wind Turbines." Current Biology 18 (16): R695–96. https://doi.org/10.1016/j.cub.2008.06.029.

94 Lawson, Michael, Dale Jenne, Robert Thresher, Daniel Houck, Jeffrey Wimsatt, and Bethany Straw. 2020. "An Investigation into the Potential for Wind Turbines to Cause Barotrauma in Bats." PLOS ONE 15 (12): e0242485. https://doi.org/10.1371/journal.pone.0242485.

95 Rydell, Jens, Lothar Bach, Marie-Jo Dubourg-Savage, Martin Green, Luisa Rodrigues, and Anders Hedenström. 2010. "Bat Mortality at Wind Turbines in Northwestern Europe." Acta Chiropterologica 12 (2): 261–74. https://doi.org/10.3161/150811010X537846.

96 Voigt, C.C., A.G. Popa-Lisseanu, I. Niermann, and S. Kramer-Schadt. 2012a. "The Catchment Area of Wind Farms for European Bats: A Plea for International Regulations." Biological Conservation 153: 80–86. https://doi.org/10.1016/j.biocon.2012.04.027.

97 Gaultier, Simon P., Anna S. Blomberg, Asko Ijäs, Ville Vasko, Eero J. Vesterinen, Jon E. Brommer, and Thomas M. Lilley. 2020. "Bats and Wind Farms: The Role and Importance of the Baltic Sea Countries in the European Context of Power Transition and Biodiversity Conservation." Environmental Science & Technology 54 (17): 10385–98. https://doi.org/10.1021/acs.est.0c00070.

The problem of bat mortality is widespread and significant in some areas, but the extent of its impact varies greatly from place to place. According to a summary published in 2016, the number of bats killed in wind farms varies greatly across mainland Europe, ranging from 0 to 11 bats per MW[98] . However, a 2010 study[95] puts the range at 0–23 bats killed per MW. The risk of death is generally higher in locations where wind turbines are located in or near habitats suitable for bats, such as forests and water bodies, the home range of some bat colonies, or in areas where bats congregate during migration[95,98] . Thus, both resident populations, where the impact may be greater on females and young animals[99] , and migratory populations[96] are affected. In addition, it should be noted that many bat species are habitat-specific, and a wind farm located in the home range of a breeding colony is likely to affect the population over a long period of time.

The risk of coming into contact with wind turbine blades and dying as a result also varies between species. Wind turbines mainly threaten species that fly high and use open biotopes, while species that fly low and close to trees rarely die as a result of wind turbines. In northwestern Europe, where the bat fauna is largely similar to that of our region, the majority (98%) of bats killed in wind farms belong to the families *Nyctalus, Pipistrellus, Vespertilio*, and *Eptesicus*[95] . All of these families are also represented in the Estonian bat fauna. Species belonging to *the Myotis* and *Plecotus* families have a low risk of death according to the same source, as they usually hunt closer to the ground and tend to stay away from open areas. The distribution of bat species found in Estonia into species with high and low collision risk is presented atTable12 . At the same time, the parameters of wind turbines and their possible impact must also be taken into account in the near future. The studies on whichTable12 is based have been conducted mainly in the vicinity of wind turbines with a mast height of approximately 90–100 m, located in open areas or on the edges of forests and on the coast. However, as wind turbines become taller, it is likely that they will also be located above forests, where much less is known about bat habitat use.

Table12 . Distribution of bat species found in Estonia based on the risk of death in onshore wind farms[91,95] .

Species name	Species name in Latin	Risk class[95]	Risk class[91]
pond bat	*Myotis dasycneme*	low risk	medium risk
water bat	*Myotis daubentonii*	low risk	low risk
Daubenton's bat	*Myotis brandtii*	low risk	low risk
long-eared bat	*Myotis mystacinus*	low risk	low risk
Natterer's bat	*Myotis nattereri*	low risk	low risk
brown long-eared bat	*Plecotus auritus*	low risk	low risk
park bat	*Pipistrellus nathusii*	**high risk**	**high risk**
Pipistrellus pipistrellus	*Pipistrellus pipistrellus*	**high risk**	**high risk**
pygmy bat	*Pipistrellus pygmaeus*	**high risk**	**high risk**
northern bat	*Eptesicus nilssonii*	**high risk**	medium risk
silver bat	*Vespertilio murinus*	**high risk**	**high risk**
great spotted bat	*Nyctalus noctula*	**high risk**	**high risk**
small noctule	*Nyctalus leisleri*	**high risk**	**high risk**

98 Arnett, Edward B., Erin F. Baerwald, Fiona Mathews, Luisa Rodrigues, Armando Rodríguez-Durán, Jens Rydell, Rafael Villegas-Patraca, and Christian C. Voigt. 2016. "Impacts of Wind Energy Development on Bats: A Global Perspective." Bats in the Anthropocene: Conservation of Bats in a Changing World, edited by Christian C. Voigt and Tigga Kingston, 295–323. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-25220-9_11.

99 Kruszynski, Cecilia, Liam D. Bailey, Lothar Bach, Petra Bach, Marcus Fritze, Oliver Lindecke, Tobias Teige, and Christian C. Voigt. 2021. "High Vulnerability of Juvenile Nathusius' Pipistrelle Bats (Pipistrellus Nathusii) at Wind Turbines." Ecological Applications n/a (n/a). https://doi.org/10.1002/eap.2513.

European long-eared bat	*Barbastella barbastellus*	low risk	<u>medium risk</u>

Bat mortality in wind farms can be seasonal, with the number of animals killed often peaking during the autumn migration period, which is why wind turbines located along migration routes increase the risk of bat mortality. Therefore, bat mortality in wind farms is a problem with cross-border implications. For example, some of the bats killed in wind farms in Germany are very likely to originate from the Baltic States[96(,)99] .

The European bat conservation agreement EUROBATS has compiled guidelines for taking bats into account in wind energy planning[91] . The guidelines state that wind turbines should not be installed in forests or less than 200 meters from their edges, as this increases the risk of bat mortality. Particular attention should be paid to broadleaf forests. In the Estonian context, it is also appropriate to consider mixed forests as an important forest type, as they are known to be important habitats for bats. When planning wind farms, the immediate vicinity of colonies and important bat habitats/feeding areas should also be avoided. At the same time, EUROBATS points out that in the densely forested Nordic countries, it may be unavoidable to build wind turbines in forest areas. In such cases, specialists should be involved in the site selection process and, based on the best available knowledge and, if necessary, data collected during fieldwork, areas should be selected where there are likely to be few bats and the risk of mortality is as low as possible.

4.1.4.1 Assessment methodology

<u>Bat census transects</u>

Acoustic monitoring of bats was carried out in the special planning area of Tõrva municipality using stationary automatic recorders. *Titley Scientific Chorus*[100] devices with omnidirectional ultrasonic microphones were used. The recorders were set as follows:

- *sampling rate*: 320 ksps;
- frequency range (*high/low pass filter*): 15–150 kHz. The manufacturer claims that the microphone can actually detect sounds up to 140 kHz;
- sensitivity (*trigger level*): 16/20. To avoid recording a large number of noise files, the sensitivity was set slightly lower than the maximum possible;
- trigger duration (*trigger window*): 2 ms;
- minimum recording length: 2 s;
- Maximum recording length: 10 s;
- recording format: WAV (*full spectrum*);
- start of operating mode: sunset;
- End of working hours: sunrise.

Detectors were installed on masts above the treetops (up to 3.5 m above the treetops) to detect the level of bat activity where the impact of wind turbines on bats is expected to be greatest. Bats use ultrasonic echolocation to navigate and catch prey. The propagation of ultrasound in the air is limited (the higher the frequency, the less it propagates), which means that the sounds made by bats moving in the tree canopy and above the treetops cannot be heard on the ground. The propagation of ultrasound is also hindered by dense foliage. In selected locations, ultrasonic signals were also recorded at the base of trees, approximately 2 m above the ground. This makes it possible to identify species that prefer to move close to the ground and feed in the shade of tree canopies, and which may be affected by the wind farm through habitat change and disturbance.

In potentially suitable areas in Tõrva, 20 points scattered across the landscape were initially selected as potentially suitable for bats, of which 16 remained due to various restrictions. Within the

[100] https://www.titley-scientific.com/eu/chorus.html

boundaries of the properties, locations were selected that were expected to be most suitable for bats and where there were taller trees for installing the detectors. Sounds were recorded at four points at a time, and every 19–34 nights, the detectors were moved to the next points. At the same time, the batteries and memory cards in the devices were replaced. Recording took place from June 12, 2023, to September 23, 2023. In total, there were 334 nights of recordings from the treetops and 77 nights from the tree base, totaling 3,312 hours. Due to technical difficulties, some observation periods were shorter than planned.

4.1.4.2 Assessment results

Data from databases

Analysis of databases revealed that there are no bat habitats registered in the Tõrva wind farm area in the EELIS (Estonian Nature Information System) or the Environmental Agency's database. Near the southern tip of the southern area, in a 500 m buffer zone on Lake Asu, the northern bat and the pond bat are registered in the EELIS (Estonian Nature Information System) and the Environmental Agency database. The following species have been registered in the wider area:

- Daubenton's bat on Lake Tündre;
- In Taagepera, the common pipistrelle, northern bat, park bat, pond bat, and brown long-eared bat;
- Northern bat, pond bat, pond bat and brown long-eared bat in Koorküla on the banks of the Õhne River.

Analysis of detector data

During the 2023 fieldwork, bat species were identified by listening to recordings and analyzing sonograms manually using the *Anabat Insight* program *(Titley Scientific)*. The [following] handbooks were used to identify [species101,102] , and bat expert Oliver Kaldaga was consulted. The following information was recorded:

- species or species group;
- number of individuals;
- feeding calls;
- social calls.

In order to assess the impact of wind turbines, accuracy at the species group level is generally sufficient, and therefore, for the sake of efficiency, species that are difficult to distinguish were not usually identified as species. Species were divided into groups based on sonograms and ecological similarity. Risk assessments are based on EUROBATS 2015[103] and a review from 2021[104] .

1. NEV species group – typically emit long 20–30 kHz calls, often feed in open areas and may fly high above tree tops, medium to very high risk of collision with wind turbines (in the case of migratory noctule bats):
    - common noctule (*Nyctalus noctula*);

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[101] Russ, J. (ed; 2021). Bat Calls of Britain and Europe: A Guide to Species Identification. Pelagic publishing.

[102] Marckmann, U. (2020). Analysis of Bat Call Recordings and Criteria for the Evaluation of Acoustic Identification of Species. Part 1 – Genera Nyctalus, Eptesicus, Vespertilio, Pipistrellus (nyctaloid and pipistrelloid Species), Barbastelle, Long-eared Bats and Horseshoe Bats in Bavaria. Bayerisches Landesamt füür Umwelt

[103] Rodrigues, L., Bach, L., Dubourg-Savage, M.-J., Karapandža, B., Kovač, D., Kervyn, T., Dekker, J., Kepel, A., Bach, P., Collins, J., Harbusch, C., Park, K., Micevski, B., Minderman, J. (2015). Guidelines for consideration of bats in wind farm projects - Revision 2014. EUROBATS Publication Series No. 6 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany.

[104] Voigt, C., Russo, D., Runkel, V., Goerlitz, H. (2021). Limitations of acoustic monitoring at wind turbines to evaluate fatality risk of bats. Mammal Review. 51. 10.1111/mam.12248.

   - northern bat (*Eptesicus nilssonii*);
   - common bat (*Vespertilio murinus*).
2. *Pipistrellus* family – typical calls 35–55 kHz, feed in edge habitats, may also move in open areas, medium to high risk of collision with wind turbines (especially during migration, depending on the height of the wind turbine):
   - Park bat (*Pipistrellus nathusii*);
   - common pipistrelle (*Pipistrellus pipistrellus*);
   - Pygmy bat (*Pipistrellus pygmaeus*).
3. Flying squirrels and brown long-eared bats – typically emit short, high-frequency (fm) calls, feed above water bodies or around and inside tree crowns, avoid open and illuminated areas, generally no risk of collision with tall wind turbines, but avoid proximity to wind turbines due to disturbance, may be sensitive to habitat changes:
   - pond bat (*Myotis dasycneme*);
   - Daubenton's bat (*Myotis daubentonii)*;
   - Brandt's bat (*Myotis brantii*);
   - long-eared bat (*Myotis mystacinus*);
   - Natterer's bat (*Myotis nattereri)*;
   - brown long-eared bat (*Plecotus auritus*).

The analysis deals with the most numerous species of northern bats at the species level, as it is generally clearly distinguishable from other species. In part, the northern bat is definitely also among the NEV species group. Of the bats, *Natterer's* bat was identified as a species where possible, as it has a characteristic relatively low-pitched call. Other bat species cannot be distinguished by their calls in a forest environment. The brown long-eared bat is treated together with bats because it is ecologically similar (feeds in tree crowns, hibernates in Estonia). Migratory species include the greater mouse-eared bat, the silver bat, and the *Pipistrellus* family. Some northern bats also migrate south in winter.

Based on the collected data, *generalized add*itive *models* (GAM) were used to determine the activity period of bats and to link it to weather data[105] . The explanatory environmental variables and/or covariates taken into account were the operating time of the detectors, their location, date, time, air temperature (adjusted to the average nighttime temperature for the previous week), wind speed (10-minute average), and precipitation (per hour) were taken into account as explanatory environmental variables and/or covariates. Weather data was obtained from the Environmental Agency. Wind data was obtained from the Valga meteorological station (approx. 25 km from the Tõrva wind farms) and precipitation and air temperature data from the Tõrva hydrometric station (approx. 7 km from the northern wind farm and approx. 15 km from the southern wind farm).

During external monitoring, a total of 5,076 bat flights were recorded in the Tõrva wind farms (4,690 above the treetops and 386 at the base). A total of 4,633 bats were identified with species-level accuracy (4,290 of them were northern bats) and 442 bats were identified with species group accuracy. Only in one case was the bat species undetermined. Overall, bat activity in the wind farms was moderate, with an average of 1.71 bats per hour (standard deviation 2.65). Only at locations 12 and 4 (Figure17) were there significantly more bats, with 10.74 and 6.76 flybys per hour, respectively. An average of 1.5 times more flyovers were recorded in the northern wind area than in the southern wind area. In the southern wind area, there were a few isolated locations where the abundance was higher than average – 10, 12, and 18 (Figure17).

All bat species found in Estonia were probably represented, except for the pygmy bat. It is not possible to identify the species in the forest landscape solely by their calls in the case of the common pipistrelle and the silver-washed bat, which is why it is not possible to be completely certain about the presence

[105] Wood, S. N. (2011). Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models. Journal of the Royal Statistical Society (B) 73: 3-36.

of all species. The numbers of recorded species/species groups flying by location are presented atTable13 andTable14 .

The most common species was the northern bat, which typically accounted for more than three-quarters of the sightings (84% in total). This was followed in frequency by the NEV species group with 7%, bats with 5% and the *Pipistrellus* family with 3%. The NEV species group (i.e., the greater mouse-eared bat and the silver-washed bat) was relatively abundant at site 10 on June 6 and at sites 6 and 21 (Figure17) at the end of the observation period. It is worth noting that the greater mouse-eared bat, as the species most threatened by wind turbines, had a higher proportion of flyovers in the northern area.

A relatively large number of park bats were recorded in the vicinity of Lake Mäsäjärv, although the overall bat abundance there was surprisingly low considering the proximity of the water body and the presence of old forests in the landscape. It is possible that water bats and pond bats associated with water bodies mainly move close to the surface of the water and did not reach the hearing range of the detector installed in the treetops. Therefore, their risk of collision with wind turbines is low. There were also relatively many park bats at location 21 (Figure17) during the autumn migration period. On one occasion, a pipistrelle bat was recorded flying past in the northern area at location 4 (Figure17). No pygmy bats were detected in the Tõrva wind farm area during this study.

In general, few bats were recorded, with relatively more in the southern area at locations 10, 16, and 18 (Figure17 , and also at the foot of location 4 (Figure17) in the northern area. Flying insects prefer to stay in the shade of the canopy, which is why there were on average five times more of them flying around the base of the trees than above the canopy. Of the flying insects, the most likely to be found in forest landscapes is the brown hawk moth. The Natterer's hawk moth, which is rare in Estonia, was recorded at locations 4, 12, and 15 (Figure17) as single flyovers.

Feeding calls accounted for an average of 16% of flyovers. Over 20% of flyovers were recorded at feeding sites 4, 6, 18, and 20 (Figure17). A very small proportion of feeding calls were recorded at sites 9 and 21 (Figure17). Overall, the northern Tõrva wind farm is a more important feeding area for bats than the southern wind farm.

Bats use various social calls to communicate with each other. These are most common around colonies and during mating behavior. Social calls were detected in 9 of the 16 locations studied . The highest number of social calls was recorded at sites 4 and 12 (Figure17), which also had the highest number of flyovers. It is likely that bat colonies were located near these sites. At site 15 (Figure17), the social call of *Natterer's* bat was detected.

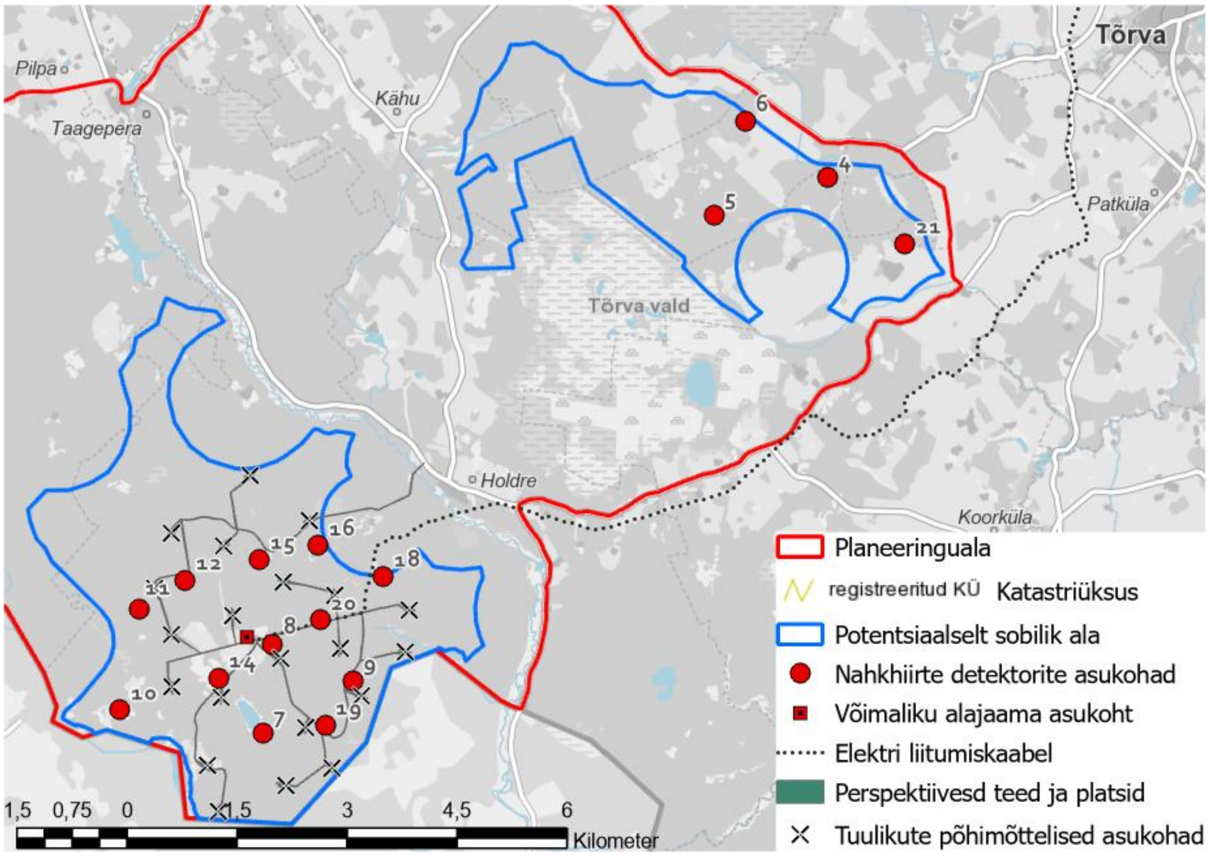

Figure17 . Locations of automatic detectors during the bat observation period.

Table13 . Relative abundances of bat species using automatic detectors (fixed to trees) in the northern study area.

Species	5	4	6	2	Total
Northern bat (*Eptesicus nilssonii*)	89	1352	604	35	2080
Silver-washed bat (*Vespertilio murinus*)	7		14	2	2
bat (*Myotis sp.*)	1	81	5		87
common noctule (*Nyctalus noctula*)	4	5	26	20	55
Park bat (*Pipistrellus nathusii*)		1	24	12	37
common pipistrelle (*Pipistrellus pipistrellus*)		1			1
Natterer's bat *(Myotis* nattereri)		1			1
Nyctalus noctula/Eptesicus nilssonii/Vespertilio murinus		7	26	6	39

Table14 . Relative abundances of bat species using an automatic detector (fixed to a tree) in the southern study area.

Species	7	10	20	9	18	14	8	12	16	15	11	19	Total
Northern bat (*Eptesicus nilssonii*)	67	177	34	34	335	54	156	1012	15.6	58.5	49	77	2069.1
Daubenton's bat (*Myotis daubentonii*)		50											50
brown long-eared bat (*Plecotus auritus*)		4								1		2	7
silver-eared bat (*Vespertilio murinus*)	1	5	1				19.5	43	2			1	72.5
bat (*Myotis sp.*)	5		3		36	4	1	5	58	1		5	118

Species	7	10	20	9	18	14	8	12	16	15	11	19	Total
common noctule (*Nyctalus noctula*)	1	1		1			2	9	4	2	3		23
Park bat (*Pipistrellus nathusii*)	34	9	2	3	12	12	4	4	10	12.5	1	8	111.5
Natterer's bat *(Myotis* nattereri)								6		3			9
Pond bat (*Myotis dasyctneme*)									1				1
Noctule (*Nyctalus noctula*)											2		2
Nyctalus noctula/Eptesicus nilssonii/Vespertilio murinus	11	94	6	1		1	3.5	8	14	2	5	4	149.5

Bats are generally more active on warm, windless nights when there are more insects in the air. There was a weak negative correlation between wind and bat activity, i.e., bat activity was slightly lower when the wind was stronger (Figure18). No clear threshold value was identified at which bats were absent, but there were too few observations on windy nights to draw conclusions. There were several windy nights when bat activity was relatively high. The average wind speed data came from the Valga weather station, located 25 km from the study area. Therefore, it is possible that the actual wind speed in the study area was slightly different. However, since the average wind speed was taken into account rather than gusts, it can be assumed that the weather in the study area did not differ greatly from that recorded at the weather station. Wind speed also depends greatly on height above ground level. At the height of a wind turbine rotor, the wind is generally much stronger than at ground level.

There was a clear positive correlation between bat activity and nighttime air temperature (Figure18). The warmer the night, the more bats there were. The absolute temperatures at which bats are active depend on the season. In spring and autumn, bats can feed and drink even at temperatures of 0°C (or even lower). In July, however, bat activity decreased significantly when the temperature fell below +10°C.

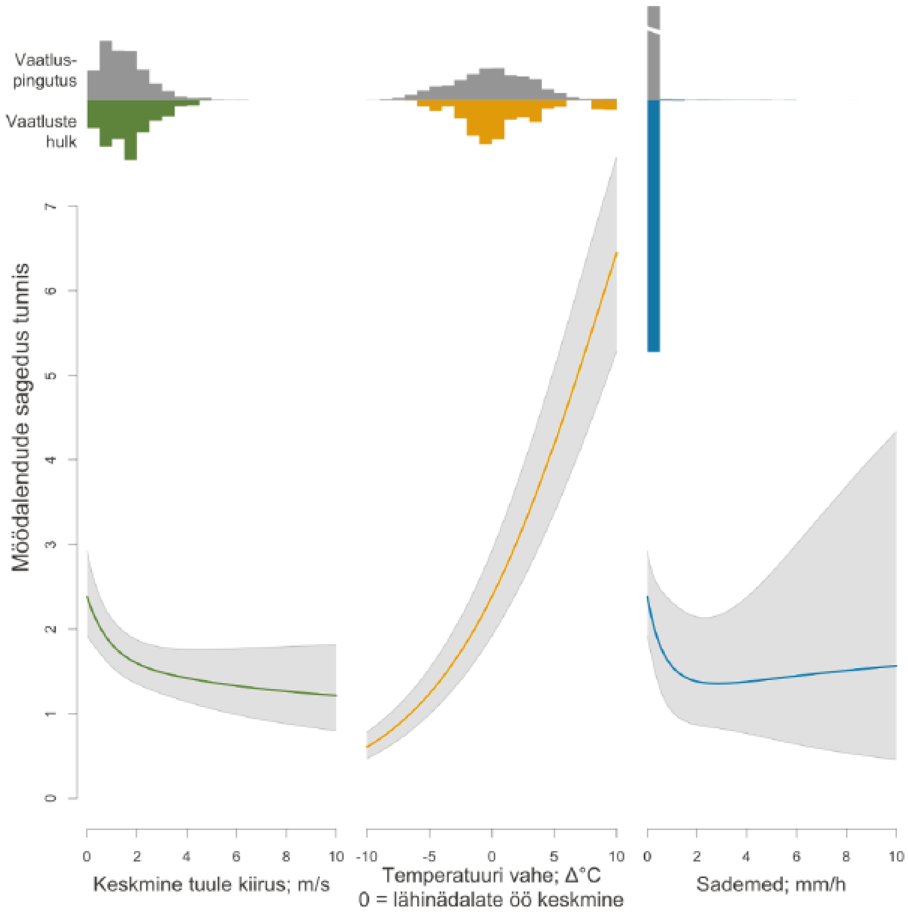

Figure18 . The relative abundance of bats as a function of wind, air temperature, and precipitation.[106]

No correlation was found between precipitation and bat activity. In some cases, bats came out to feed earlier than usual on warm, rainy evenings. It is likely that it is darker under thick clouds and they dare to come out earlier. It may also be that higher humidity means more insects are flying around, thus providing more favorable feeding conditions for bats.

<u>Map analysis</u>

The wind farms in Tõrva municipality are located near the Estonian-Latvian border in a relatively sparsely populated area. The study areas are predominantly managed dry forests and, to a lesser extent, cultivated landscapes.

In summary, it is possible to establish wind farms in the Tõrva wind areas from the perspective of bats.Figure19 shows the zones suitable (green), less suitable (yellow), and unsuitable (red) for the establishment of wind turbines in the planned wind areas of Tõrva municipality. The construction of wind turbines in less suitable (yellow) areas should be avoided if possible, but is not ruled out. Zoning directly affects the location restrictions for wind turbines (including the entire range of the blades, i.e. calculated as the vertical projection of the tip of the wind turbine blade on the ground). To a lesser extent, zoning also determines the construction of roads and other support infrastructure. Specific valuable habitats must also be avoided when constructing infrastructure, but routes may be built through yellow areas and red areas caused by large green corridors.

[106] The mean value of the model and its 95% confidence interval are shown. The upper part of the graph shows the frequency distributions of detector operating time and recorded flyovers according to weather conditions.

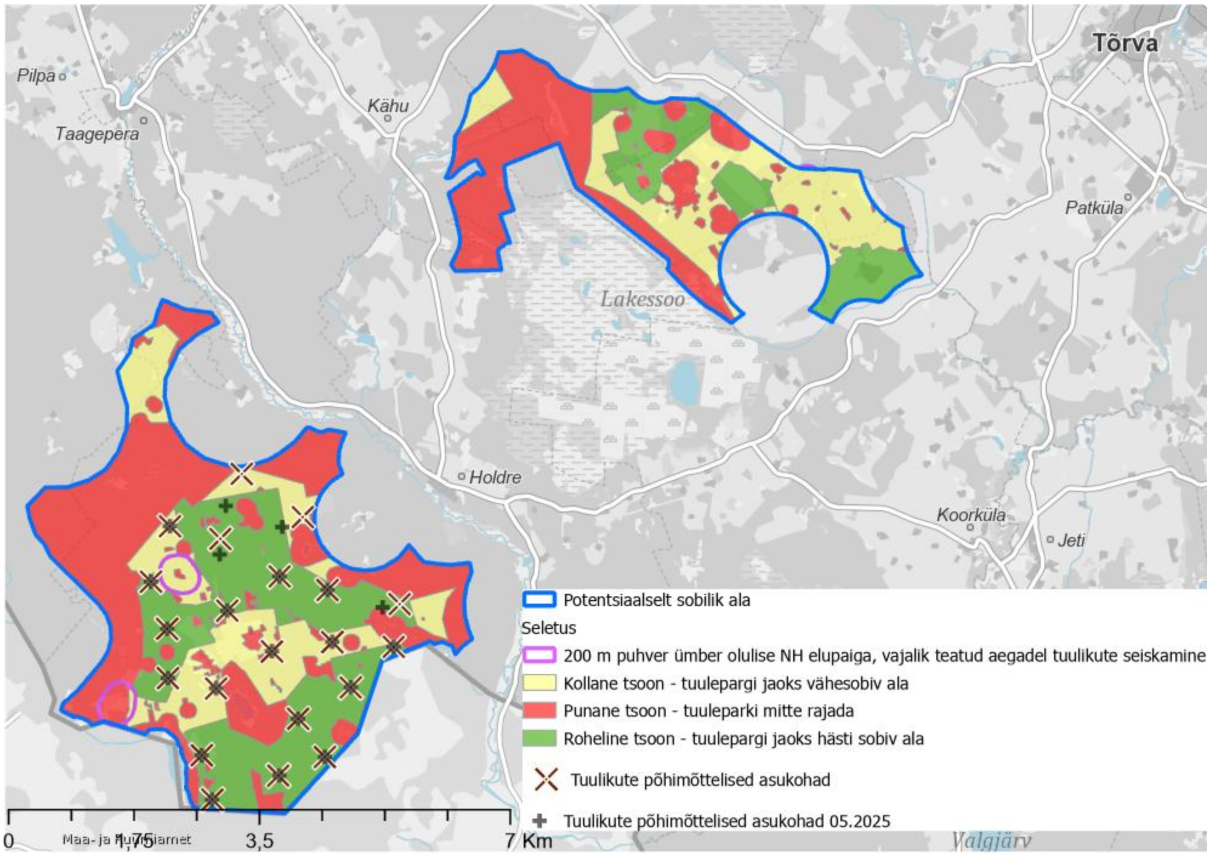

Figure19 . Potentially suitable areas for wind turbine construction in the special planning area from the perspective of bats.

Bats may be killed by collision with wind turbine blades or by barotrauma caused by a sudden drop in air pressure near a moving blade. Bat mortality is higher in late summer and autumn when young animals discover the world and autumn migration takes place. The blades of the large wind turbines planned for the Tõrva wind farm will remain above the forest canopy and higher than the flight altitude of most bat species, which reduces the risk of collision. The risk of death is high during migration periods for the greater mouse-eared bat, the silver-washed bat, and species of the *Pipistrellus* genus. On average, the greater mouse-eared bat is at risk throughout its entire period of activity, and to a lesser extent, the silver-washed bat and the northern bat. The common pipistrelle and the brown long-eared bat fly below the wind turbine rotors and are therefore not at significant risk of death. Bat mortality can be significantly reduced by carefully planning the location of wind turbines so that they are at least 200 m away from important bat habitats[103(,) 107] .

Figure19 , the indicative locations of the wind turbines are mainly in the green zone, but seven wind turbines are also located in the yellow zone. At the same time, no preliminary selection of locations is planned, and therefore the wind farm will not be built in the potentially suitable northern area, thus preserving the bat habitats there. Areas where bats congregate have been avoided as locations for wind turbines.

Knowledge gaps: A thorough bat survey has been conducted in the preliminary selection area using the best available knowledge and research capabilities. Prior to the construction of wind farms, it is not possible to assess the flight activity of bats at the height of the wind turbine blades, taking into

[107] Lotman, K., Viilma, K., Öövel, M., Pärn, M., Šavrak, A.-L., Kalda, R., Kalda, O., Lutsar, L. (in preparation). Guidelines for assessing the impact of wind farms on bats in Estonia. Appendix to point 6.5 of the bat conservation action plan. Environmental Board (draft as of 08.02.2023).

account both the repellent and attractive effects of wind turbines on bats. Based on the above, it is important and necessary to carry out bat monitoring during operation (see section4.1.4.3).

4.1.4.3 Measures, need for further research and assessment

At the site selection stage:

Avoid building wind turbines in mapped bat roosting sites. According to the pan-European EUROBATS guidelines, wind turbines must not be located closer than 200 m from good bat habitats. Therefore, wind turbines should not be located closer than 200 m to water bodies mapped as suitable for bat feeding, which serve as feeding areas and movement corridors for bats (mappedFigure17 as red areas). Wind turbines should also not be located within a 200 m buffer zone around bat colonies (Figure19 purple areas).

In further design and operation:

Do not plan logging in areas that are potentially suitable for bats as important habitats in mapped forests in order to avoid the destruction of potentially good habitats for bats. If, however, it is necessary to clear forests that are important as habitats, this should be done outside the summer activity period of bats (May 1–September 30) to avoid disturbing protected animals.

If logging is carried out during the bats' active period (April–October), bats sheltering in tree hollows may be killed. Young animals that are unable to fly are particularly at risk. In forests and farmsteads where there may be large hollow trees that bats can use as shelters, logging must not be carried out during the bats' active period, April 15–October 15. The most critical period is the breeding season, from May 20 to July 15.

Environmental monitoring:

- Bat monitoring must be carried out for at least two years: 1–2 years after the completion of the wind turbines and 5–6 years after the completion of the wind farm in order to identify long-term effects.
  The first monitoring should provide answers to the following questions.

  How great is the risk of bats being killed by wind turbines?

  Determine when and at what height bats move near wind turbines, including: near the ground, above tree crowns, at the height of the blades, at the height of the nacelle; at the same time, record weather data. Conduct observations for at least 14 nights in each of the three periods: spring migration period 01.05–31.05, breeding period 01.06–10.07, autumn migration period 01.08–15.09.
  Determine the risk/frequency of bat mortality at least at the three wind turbine sites with the highest risk of bat mortality.
  Based on the data obtained, decisions will be made regarding restrictions on wind turbine operation during periods of high bat activity (e.g., in the event of high bat mortality, wind turbines will be switched on in stronger winds and/or lower air temperatures).

  Are there any previously undetected breeding colonies near the wind turbines?

  Identify bat activity during the breeding season from June 1 to July 10 on at least three nights using transect counts. Focus on potential roosting sites (old wounds and other trees, buildings). If a colony is found near a wind turbine (up to 200 m away, measured from the vertical projection of the tip of the wind turbine blade on the ground), operating restrictions must be applied to the relevant wind turbine at night during the breeding period (to be determined more precisely on the basis of monitoring results).
- During the second monitoring period, it is sufficient to carry out monitoring point 2.

- Observations made at different times and locations must be comparable. Preferably, a similar methodology and the same equipment and software should be used.

4.1.5 Impact on the green network , including the connectivity of animal habitats

4.1.5.1 Assessment methodology

Map analysis

The analysis used the Land Board's basic map data on standing and flowing water bodies. Habitats important for bats and other animal species were mapped in the planned wind farm areas and up to 500 m away from them. The following sources were used for mapping:

- Estonian Topographic Database (ETAK; Land Board);
- Base map with relief shading (Land Board);
- Up-to-date orthophoto (Land Board);
- Estonian vegetation height model (CHM; Land Board, spring 2021);
- Forest Register (Environmental Agency, 21.04.2023);
- EELIS (Estonian Nature Information System), Environmental Agency (November 30, 2023);
- ELME (Environmental Agency)[108] .

The following information was entered into the habitat drawings:

- Protected areas, including permanent habitats (EELIS (Estonian Nature Information System), Environmental Agency);
- Habitats of protected species (EELIS (Estonian Nature Information System), Environmental Agency);
- Larger standing and flowing water bodies, including natural-looking streams and ditches with a 200 m buffer zone (ETAK). Important feeding areas and drinking places for bats, habitats of semi-aquatic mammals and amphibians;
- Wetlands (bogs, fens, marshes, etc.) and smaller standing water bodies with a 100 m buffer zone (ETAK). Important feeding areas and drinking places for bats, habitats of amphibians, edges of wetlands are important for various species, including reptiles;
- Natural bogs (ELME);
- Forests that are 100 years old or older (Forest Register), destroyed (cleared) stands have been excluded using orthophotos and CHM. Old forests are likely to provide shelter for bats, other small mammals and birds, and multi-layered stands favor the presence and abundance of various invertebrates.
- Stands where the proportion of aspen in the first layer is 10% or more and the age of the aspen is at least 55 years (Forest Register). Cleared stands have been excluded, and forest patches with large aspens have been added based on field observations and orthophotos. There is a high probability of tree hollows suitable for bats, and the hollows provide a habitat for a wide variety of species;
- Highly valuable forests (ELME);
- Habitats of special conservation interest (EELIS (Estonian Nature Information System), Environmental Agency);
- Natura habitats (EELIS (Estonian Nature Information System), Environmental Agency);

[108] Environmental Agency, ELME project: Helm, A., Kull, A., Veromann, E., Remm, L., Villoslada, M., Kikas, T., Aosaar, J., Tullus, T., Prangel, E., Linder, M., Otsus, M., Külm, S., Sepp, K., 2020 (supplement 2021). Final report on the nationwide assessment and mapping of the status of forest, bog, meadow, and agricultural ecosystems and the baseline levels of ecosystem services. ELME project. Commissioned by: Environmental Agency (public procurement no. 198846).

- Farmsteads (base map with relief shading, orthophoto) – both farmsteads in use and old abandoned farmsteads. As an exception, farmsteads that do not stand out from the surrounding landscape (e.g., farmsteads located on clear-cut areas or in forests where there are no conspicuous old trees, meadows, etc.) have been omitted. However, the ruins/foundations in these locations are still marked. Both buildings and large trees in yards may provide shelter for bats and birds;
- Ruins or foundations, stone fences, piles of stones (ETAK). Foundations, stone fences, and piles of stones provide habitats for reptiles, amphibians, and small and micro-mammals. Earth cellars may be suitable hiding places for bats.
- Field islands and natural strip structures (ditches, tree rows, wider grass strips) in agricultural landscapes (orthophoto, base map). Important habitats and movement corridors for various species, including bats.

The results of the analysis are summarized in zoning drawings and map layers, which delineate areas suitable, less suitable, and unsuitable for wind turbine construction based on the functioning of the green network and bat habitats.

4.1.5.2 Assessment results

A green network (hereinafter *GN*) is a system of natural and semi-natural communities that ensures the preservation of different types of ecosystems and landscapes and balances the impacts of settlement and economic activity. It consists of core areas and green corridors connecting them[109] .

The main objectives of the green network are[110] :

- to protect and preserve biodiversity;
- mitigating and adapting to climate change;
- promoting the green economy, including the tourism industry.

Support areas are mostly areas valued for their nature or environmental protection (protected areas, conservation areas, valuable habitats, habitats under the Habitats Directive, etc.) and/or areas with high biodiversity and/or areas that provide ecosystem services important from the perspective of the RV.

(Green) corridors, or strip structures, are elements of the RV that connect core areas with the aim of ensuring the connectivity of the RV, contributing to the preservation of high biodiversity in core areas, and reducing the impact of habitat destruction and fragmentation on biota. Corridors are less massive and compact than core areas and change or are changed more quickly over time.

In order for the RV to fulfill its functions, its structures must be planned in a coherent manner so that the core areas are connected to the corridors to form a unified whole. Even more important is to ensure ecological coherence so that the structures of the green network function as a coherent network of habitats and movement routes for species and populations.

The green network is divided into hierarchical levels or value classes – national, county, and local support areas. Planning activities that affect the green network in a support area of national importance requires more thorough consideration than activities located in a support area of local importance.

The basis for the planning of the green network is the comprehensive plan of Tõrva Municipality (established by Tõrva Municipal Council Decision No. 1-3/2024/6 of 21 March 2024). The western part of the planned northern potentially suitable area overlaps with the green network corridor. Most of the wind farm area remains outside the green network. The southern part of the potentially suitable area overlaps entirely with the green network support area (Figure20).

[109] Planning Act https://www.riigiteataja.ee/akt/119032019104

[110] OÜ Hendrikson & Ko. 2018. Green network planning guide.

In Estonia, the green network mainly includes forests and bogs, with significantly fewer meadows and other open landscapes. At the same time, open landscapes are important for many protected species (e.g., lesser spotted eagle, corncrake, bumblebees). Often, the area surrounding wetlands is also excluded from the green network, even though it is even more important for biodiversity than the bog itself. There are many species that avoid open bogs but are happy to move around in the edge forests of wetlands.

As the wind turbines are located at relatively large distances from each other (the distance between the planned large wind turbines is expected to be at least 500 m) and the gaps created by the construction of roads and wind turbine assembly sites are relatively small in the forest landscape, the compactness of the natural landscape will be preserved on a large scale. The construction of the wind farm will not create any significant barriers to the movement or spread of species. Unlike solar parks, wind farms are not fenced off (except for substations).

However, wind farms cause fragmentation of the green network (e.g., migration barriers for birds and bats and habitat changes for large mammals) and therefore have a negative impact on the preservation and functioning of the green network. The extent and significance of the impact largely depends on the specific design of the wind farm, i.e. the location of the wind turbines and related infrastructure, including the fragmentation of green areas.

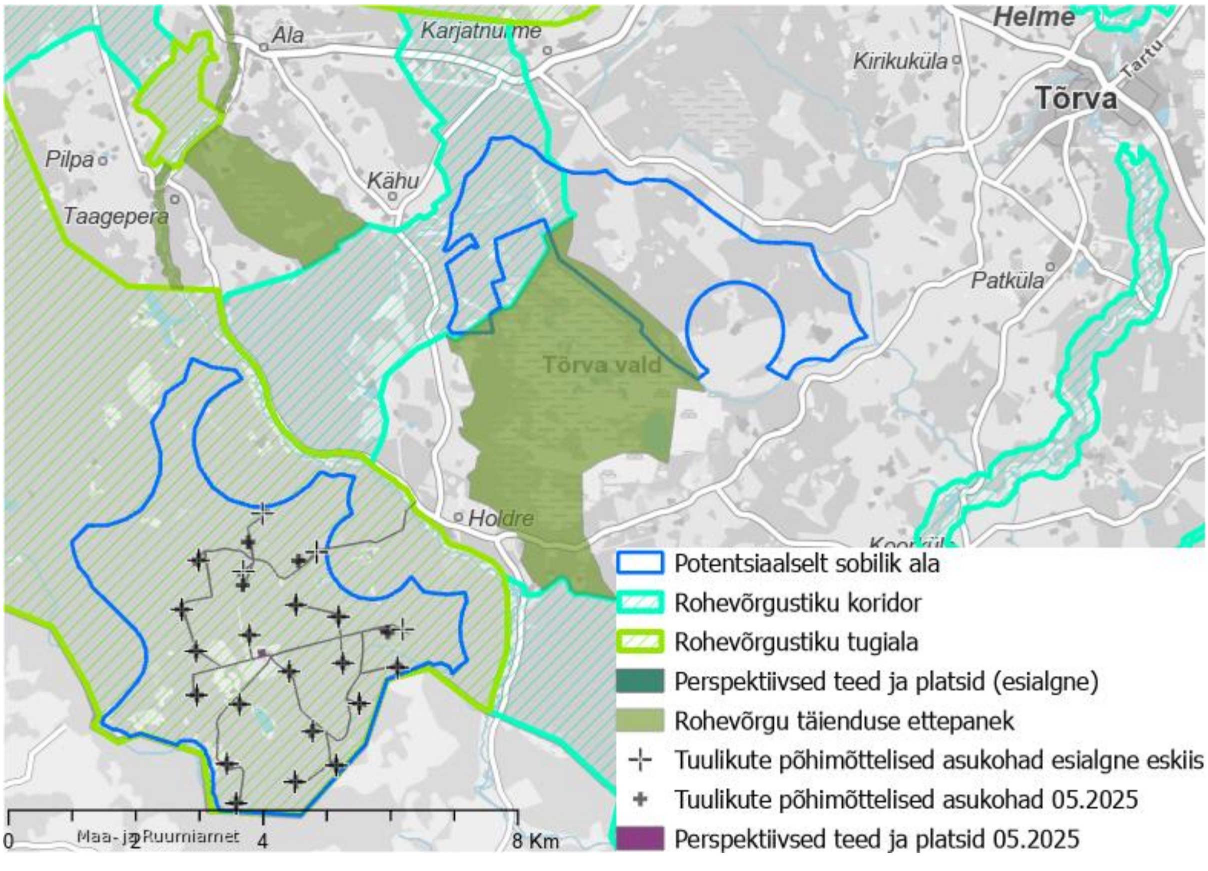

Figure20 . Location of potentially suitable areas for special planning in relation to the green network according to the comprehensive plan of Tõrva municipality and proposals for additions to the green network.

In order to mitigate the impacts of the wind farm, it is reasonable to add sections of the Õhne River that are not yet part of the green network to the green network. The river is predominantly in its natural state, and this would also connect Taagepera Castle Park to the green network. A total of 1465 ha would be added to the green network.

It is important to preserve a functional wide (approx. 1 km) green corridor along the Õhne River, which connects the Tündre nature reserve with the Lasa nature reserve. When planning mining activities in this corridor, it is necessary to ensure that a passage at least 400 m wide is maintained between obstacles (quarries, wind turbines, buildings, etc.). When the mineral resources are exhausted, the quarry areas should be restored to their natural state and, if possible, small water bodies should be created.

If a wind farm cannot be built in the potentially suitable area in the north due to nature conservation restrictions, it is worth considering creating a larger green network support area, covering not only Lakessoo but also Ridassoo and the areas between them. This is an uninhabited area of approximately 2,500 ha, which fully meets the criteria for a green network support area.

In the potentially suitable area in the north, wind turbines should not be placed in the western part of the green corridor and on the edge of Lakessoo. The most suitable area for wind turbines is the eastern part, where there are open fields. The advantage of this location is its proximity to the main grid, which means that the impact of transmission lines is expected to be minimal.

In the big picture, the most important watercourse in the area is the Õhne River, which flows between two potentially suitable areas, followed by smaller streams. Field observations confirmed that the northern part of the Saksniidu stream and the southern part of the Kiviste and Lavine streams are worth preserving from the point of view of amphibians, semi-aquatic species ( ) and bats. Lake Pupsi, Lake Mäsäjärv, Lake Paganajärv and, to some extent, Lake Asu are located within the potentially suitable area in the south and the buffer zone. Smaller water bodies in potentially suitable areas include farm ponds and firefighting water intake points. The largest wetland is Lakessoo, which lies between two potentially suitable areas. There are small salt marshes in some places, mostly associated with streams or lakes. In the northern part of the southern potentially suitable area is Tüssaalune bog, which is a small wooded bog.

In the southern potentially suitable area, it is important to ensure a wide functional green corridor from the banks of the Õhne River towards the Tündre nature reserve. Preferably, a narrower corridor should also be preserved from Lake Pupsi across Lake Mäsäjärve to the Kiviste stream. The construction of wind turbines should be avoided near water bodies. In both potentially suitable areas, it is important to preserve older stands, farmsteads, and old trees.

The forests in the wind areas are generally heavily logged. Logging sites, scrub and young forests are widespread. There are young coniferous stands in many places. Older stands and aspen forests are relatively rare. Within the planned wind farm area, valuable habitats have only been registered in the southern part of the potentially suitable area. Of the Natura habitat types, old deciduous forests 9010* remain in the western part of the northern potentially suitable area, northwest of Lakessoost.

According to the comprehensive plan of Tõrva municipality, for the green network to function, **the proportion of areas with natural land cover (areas not covered by artificial surfaces) must not fall below 90% in the support area.**

The special plan is based on the conditions set out in the comprehensive plan regarding the green network, valuable landscapes, and valuable farmland. The sufficient preservation of areas in their natural state is critical for the coherent functioning of the green network. Therefore, the green network must also be taken into account when planning wind farms so that the proportion of natural areas remains at least 90%.

In order to analyze the possible limitations of construction areas, the green network established in accordance with the comprehensive plan of Tõrva municipality was used as a basis, and the proportion of natural areas and, consequently, the area of possible construction areas for the wind farm were analyzed. The analysis was carried out within the boundaries of the Tõrva municipality, as the SEA object is the local government's special plan. The local government cannot control changes to the green network outside its administrative territory, and the special plan cannot set conditions outside the area covered by the special plan. The results of the analysis are presented atTable15 .

Table15 . Overlap of wind areas with the green network and the naturalness of the green network.

Wind area	Designation and hierarchy of the overlapping green network area	Area of green network, ha	[111] Area of natural and semi-natural areas in the green network area, ha	Proportion of natural and semi-natural areas in the green network area, %	Permissible maximum additional area of artificial areas, ha
Northern area, partial overlap	County corridor K3, Karjatnurme – Holdre corridor	306.06	306.06	100	30.61
Southern area, complete coverage	Large support area T3, Taagepera - Tündre support area	2022.64	2022.63	100	202.26

At the time of compiling the SEA report, all support areas have a high proportion of natural areas. Therefore, it is possible to ensure that 90% of natural areas are preserved when establishing the wind farm.

According to the green network planning guidelines[112] , planning changes in land use in areas of national importance requires thorough consideration. According to the guidelines prepared by the Environmental Board[113] , the planning of a large number of wind farms in core areas of national importance in the green network should be avoided, where wind farms may, in addition to their adverse impact on the wind farm area and its immediate surroundings, also damage the connectivity of various protected areas and habitats of endangered species. In the case of the Tõrva EP, there is no overlap with areas of national importance.

In the developed planning solution, the proportion of natural areas in the green network support area (considering arable land as non-natural) is conservatively estimated at 98.91%. After the establishment of the park, the proportion of natural areas would be 98.16%. The decrease would therefore be 0.75%, which can be considered an insignificant change**.**

When placing wind turbines and related infrastructure, minimal fragmentation of the green network must be ensured. Based on this, the preferred solution is to plan the park as compactly as possible.

In terms of the impact on forest animals, there may be positive effects for some species (the creation of new "edge areas," which are usually richer in biodiversity), but also negative effects (new roads and other infrastructure fragment habitats, and the use of infrastructure causes disturbance to more human-shy species). During the construction period, wild animals will avoid the construction areas[114] , which cannot be considered a specific impact of wind turbine construction. Any construction activity

[111] Natural areas are treated as ETAK land types E_306_margala_a, E_305_puittaimestik_a, E_304_lage_a, E_303_haritav_maa_a, E_202_seisuveekogu_a and E_203_vooluveekogu_a as of 06.10.2023. There are different opinions on whether arable land should be included in natural areas. In this case, arable land has been included in natural areas because it does not hinder the movement of game and a significant portion of the fields are used as permanent grassland.
[112] OÜ Hendrikson & Ko. 2018. Green network planning guide.
[113] The impact of onshore wind farms on wildlife and the Environmental Board's recommendations for their planning in local government comprehensive plans (as of 10.11.2021).
[114] Helldin, J.O., Jung, J., Neumann, W., Olsson, M., Skarin, A., Widemo, F. 2012. The impacts of wind power on terrestrial mammals. Swedish Environmental Protection Agency Report 6510.

is inherently disruptive, and when construction takes place in previously natural areas, it is often accompanied by the avoidance of the construction area by the fauna present in the area.

Bats and birds are considered to be the animal groups most affected by wind turbines. A significant negative impact has been observed in relation to these species, and therefore these species groups must be assessed in more detail when planning wind turbines (see sections4.1.3 and4.1.4).

No lasting or significant changes in animal behavior have been observed in mammals as a result of the noise and shadow effects associated with wind turbine operation[114] . However, it should be noted that this topic has been relatively little researched. According to data from specialist literature, studies have been conducted, for example, on the impact of audible noise from wind turbines on squirrels, and it has been found that individuals are able to cope with the noise generated by wind turbines by changing their behavior.[115]

No studies have been conducted on the impact of wind turbine operation on small mammals. For example, shrews and rodents have been studied in Poland both in wind farm areas and in control areas, and no significant differences in species composition, abundance, or intrapopulation parameters have been found[116] .

The movement of larger mammals in wind farm areas and nearby open landscapes has been studied, and it has been found that **some mammals (especially herbivores) may use areas close to wind turbines less intensively**. For example, the use of movement routes by roe deer and gray hares within wind farms has been found to be less intensive than in the areas surrounding wind farms. In the case of foxes, the study did not find any effect [117] . The study linked the decrease in the intensity of use in the vicinity of wind turbines primarily to the hypothesis that it is more difficult for prey animals to hear predators approaching in the vicinity of wind turbines. Therefore, it is likely that the impact is smaller in the case of predators and in forest landscapes. At the same time, the study, which was conducted during both the construction and operation of the wind farm, did not show any measurable change in the behavior of red deer, for example, as measured by radio transmitters[118] .

In summary, it can be said that, based on the scientific literature, it is not possible to draw a single conclusion about the impact of wind turbines on the habitats of terrestrial mammals and their connectivity.[119] **The impact on wild animals can be considered primarily negative and significant in cases where the facilities are located in an area that is considered important for a particular population and whose loss would limit the abundance of the species. The same applies if a wind farm would affect critical movement corridors. It is therefore very important to avoid significant fragmentation of green network corridors, and it may also be necessary to study the main gathering places of game animals in green network areas.**

In addition to directly inventoried high-value communities, environmental protection is increasingly focusing on the preservation of ecosystems and the benefits they provide, i.e., ecosystem services. The more functioning and biodiverse ecosystems there are, the better equipped we are with food, natural resources, clean water and air, and the better we are able to withstand and mitigate environmental pollution and adapt to climate change.

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[115] The Wildlife Society. 2007. Impacts of Wind Energy Facilities on Wildlife and Wildlife Habitat. The Wildlife Society Technical Review 07-2.

[116] Lopucki, R., Mroz, I. 2016. An assessment of non-volant terrestrial vertebrates response to wind farms – a study of small mammals. Environmental Monitoring and Assessment- 2016; 188: 122.

[117]Lopucki, R., Klich, D., Gielarek, S. 2017. Do terrestrial animals avoid areas close to turbines in functioning wind farms in agricultural landscapes? Environmental Monitoring and Assessment. 2017; 189(7): 343.

[118] Walter WD, Leslie Jr DM, and Jenks JA. 2006. Response of Rocky Mountain elk (Cervus elaphus) to windpower development. The American Midland Naturalist 156:363-375.

[119] American Wind Wildlife Institute (AWWI). 2021. Wind Turbine Interactions with Wildlife and Their Habitats: A Summary of Research Results and Priority Questions. Washington, DC. Available at www.awwi.org

The land needed for the development of wind farms and related facilities comes at the expense of existing ecosystems. Therefore, the construction of wind farms has an adverse impact on ecosystems in their natural state and, consequently, on biodiversity. When planning wind farms, the primary measure to avoid significant adverse effects is to select locations for wind farms where the condition of ecosystems is already poor and to avoid building wind farms in locations where their construction would damage ecosystems and biodiversity in good condition.

The assessment of ecosystem status and biodiversity was based on the ecosystem mapping compiled within the framework of the ELME project as of March 2024. The analysis used the nationwide ecosystem services base map compiled as part of the ELME project (www.keskkonnaagentuur.ee/elme), which classified different ecosystems (meadows, forests, fields, bogs) into condition classes. The aim of the assessment was to identify known ecosystems in good condition in potentially suitable areas that are necessary for the preservation of biodiversity. By avoiding such areas as construction sites, it is possible to prevent significant adverse effects on ecosystems and biodiversity.

During the field observations in the summer of 2023, i.e., the Tõrva wind farm green network and bat survey and habitat mapping, protected birds, invertebrates, and plants that caught the eye were also noted. Field observations for habitat mapping took place on March 3, 2023, March 10, 2023, June 8, 2023, July 6, 2023, and August 1, 2023. The routes were planned in advance based on map analysis so that potentially suitable wind areas would be evenly covered and as many potentially valuable habitats as possible would be covered. The transects in the study area were traversed on foot and the locations of amphibians, reptiles and terrestrial mammals, as well as traces of animal activity (footprints, droppings, feeding traces, etc.), were marked on the map using a GPS device.

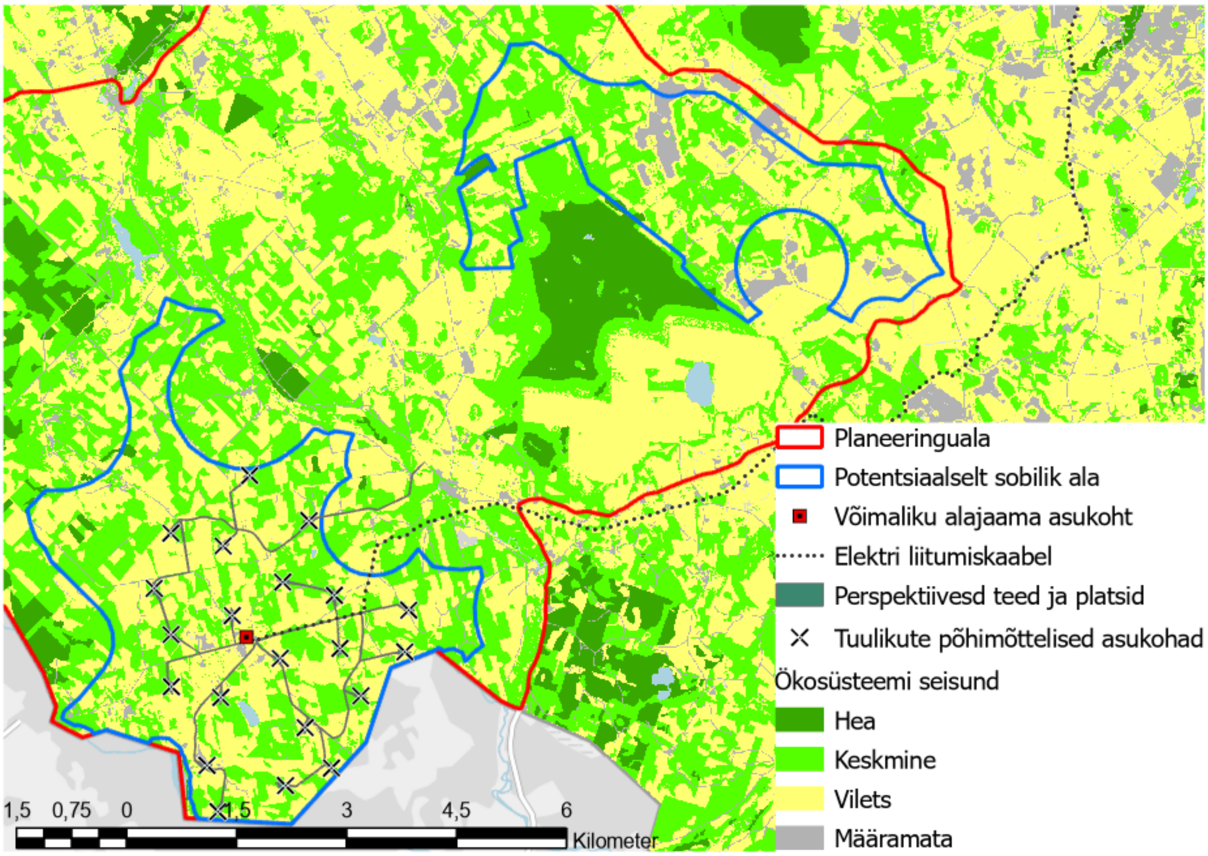

Figure21 . Status of ecosystems in the special planning area in potential pre-selection areas. Source: Environmental Agency ELME project.

To simplify the use of the ecosystem status map compiled as part of the ELME project, the results were generalized into four status classes: "good" (meadow A, bog A1 and A2, forest A, field A), "average" (meadow B and C, bog B1 and B2, forest B, A–B, C, A–C, field B), "poor" (meadow D1–D3, bog C1, C2, D and E, forest D, E, F, field D) and "undetermined". According to this map, only 11% of Estonia's terrestrial ecosystems are in good condition, 33% are in average condition, 47% are in poor condition, and 9% are undetermined. The location of potentially suitable areas in relation to the ecosystem status map compiled as part of the ELME project is shown atFigure21 . Ecosystems in good condition are predominantly those with less human impact, which therefore provide habitats for rarer species.

The overlap between potentially suitable areas and ecosystems in good condition is small. At the same time, it must be taken into account that there are few ecosystems in good condition in Estonia. Small communities in good condition are found on the western edge of the southern area and on the southern edge of the northern area. Given the scattered location of these communities, it is possible **to avoid planning wind turbines and related infrastructure in areas with ecosystems in good condition** by planning **wind turbines** more precisely**.** In the immediate vicinity of ecosystems in good condition, the construction of drainage ditches and other structures that alter the water regime and significantly change the light regime should be avoided.

Table16 . Number of locations of protected species identified during field surveys in the summer of 2023 (bird data not presented).

Name Estonian	Name in Latin	Number of locations
Northern potentially suitable area		
Native	*Anura*	2
bumblebee	*Bombus*	7
kuklane	*Formica*	3
saarmas	*Lutra lutra*	4
water vole	*Pelophylax*	2
grass frog	*Rana temporaria*	8
arctic fox	*Zootoca vivipara*	5
Southern area		
vaskuss	*Anguis fragilis*	1
true frogs	*Anura*	3
toad	*Bufo bufo*	15
crested newt	*Formica*	17
beaver	*Lutra lutra*	1
badger, town	*Meles meles, town*	1
nastik	*Natrix natrix*	3
water snake	*Pelophylax*	1
pond frog	*Pelophylax lessonae*	7
marsh frog	*Rana arvalis*	4
common frog/moor frog	*Rana arvalis/Rana temporaria*	4
common frog	*Rana temporaria*	1
common lizard	*Zootoca vivipara*	3
feather moss	*Neckera pennata*	1

There are five species of reptiles in Estonia, all of which are protected. Reptiles are cold-blooded animals that can be found in a wide variety of habitats, but they are more common in humid areas and near bodies of water. In addition to high-quality feeding and wintering grounds, reptiles need sunny, wind-protected basking spots (e.g., forest edges, slopes open to the afternoon sun, stone fences and piles, stumps, fallen tree trunks). Reptiles hibernate underground (e.g., in rodent burrows, under stumps and rocks), often forming hibernation groups. In potentially suitable areas, there are favorable hibernation sites for reptiles in stone piles on field islands and around old farmsteads. Of the reptiles, the most frequently observed in potentially suitable areas in Tõrva was the *viviparous* lizard (*Zootoca vivipara)*, with the slow worm (*Anguis fragilis)* and grass snake (*Natrix natrix)* also observed in some places in the Eera village area.

All amphibians are protected in Estonia. Amphibians are small, cold-blooded animals that need different habitats at different stages of their life cycle: breeding sites, feeding areas, and wintering sites. Amphibians need shallow, fast-warming water bodies for breeding. In the study area, lakes, ponds, stream pools, ditches, and temporary pools are suitable for amphibian reproduction. Metamorphosed frogs mainly move on land and feed on various invertebrates (insects, mollusks, etc.). Amphibians need both sun and shade for feeding. Green frogs (*Pelophylax lessonae, P. kl. esculentus*) and common frogs (*Rana temporaria)* need oxygen-rich water bodies that do not freeze to the bottom for hibernation. There are springs in the study area that are well suited for this purpose. Moor frogs (*Rana arvalis)*, toads (*Bufo bufo)* and newts (*Lissotriton vulgaris)* hibernate on land, burrowing into the ground, under stumps, in rodent burrows or in caves (including cellars). Older forests with fallen trees, rock piles, and farmsteads are well suited for hibernation.

Important amphibian habitats in the southern part of the potentially suitable area are Lake Paganajärv and the surrounding marshland, and Kiviste Stream with its floodplain and springs. During fieldwork, amphibian breeding was also observed in various ponds, ditches, and pools that had formed in clearings. In general, the entire study area is a suitable habitat for amphibians. The species represented were the common frog, moor frog, natterjack toad, and green frogs (pond frog or water frog).

In the potentially suitable area in the south, wind turbines will not be located around Lake Paganajärv or in the surrounding marshland, so there will be no impact on important amphibian habitats.

By adapting to climate change, we mean mitigating the risks caused by climate change and establishing a framework for action to increase the preparedness and resilience of both society and ecosystems to climate change. Many of the phenomena associated with climate change – more frequent storms, floods, increased precipitation, extreme temperatures, and other extreme weather events – can be mitigated, at least in part, through green space planning[112] . At the same time, it should be noted that wind farms are planned to reduce $CO_{(2)}$emissions from the burning of fossil fuels and thus slow down climate change. The impact of the planned activity on climate change, including the impact of land use change, is assessed in section4.8 .

The recreational function of the green network is particularly important in urban areas, in their immediate vicinity, and in traditional natural recreational areas with established recreational infrastructure.

Based on expert assessments created within the framework of the ELME project's nationwide assessment and mapping of the status of terrestrial ecosystems and baseline levels of natural benefits, the recreational values of different types and naturalness of ecosystems (on a scale of -2 to 8) based on the raster layer[120] , none of the potentially suitable areas have a high or very high recreational value as a whole (Figure22).

[120]www.keskkonnaagentuur.ee/elme

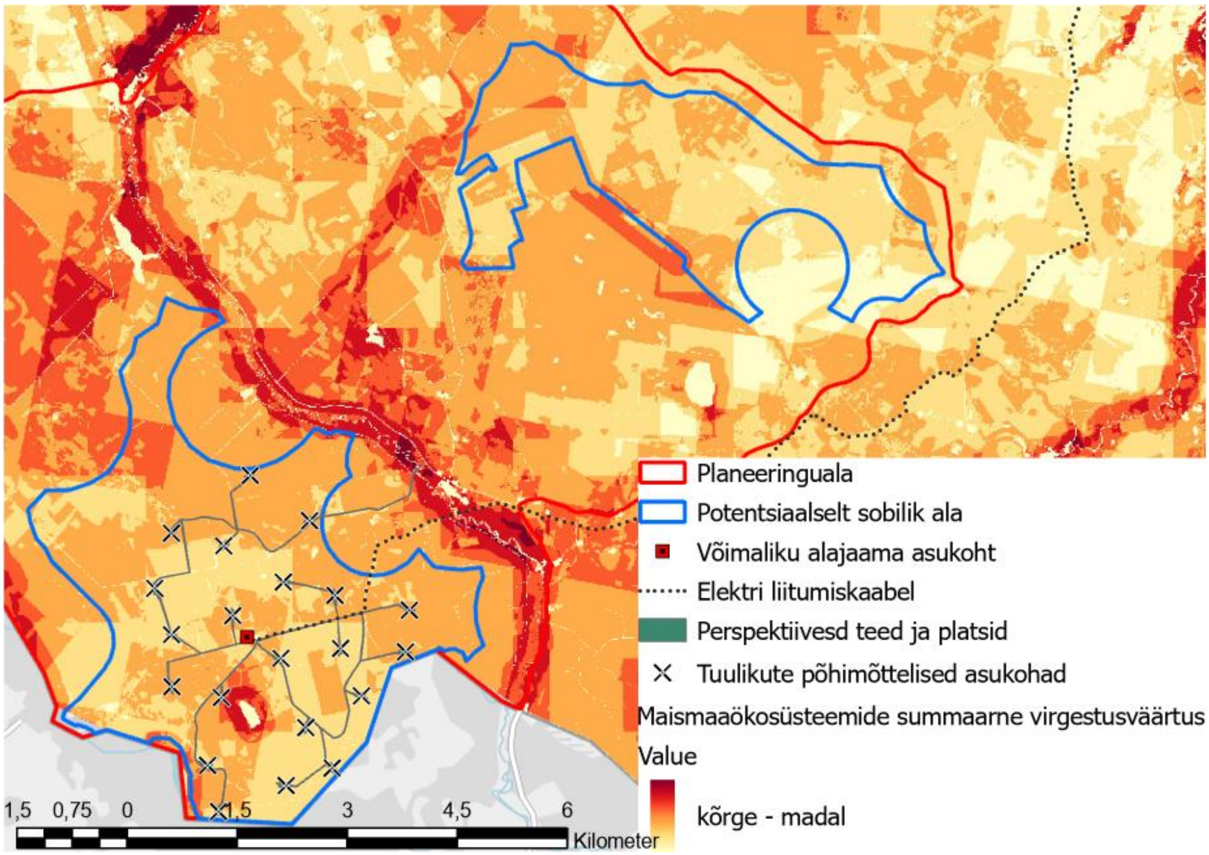

Figure22 . Overlap of potentially suitable areas in the special planning area with recreational values. Map base: Environmental Agency ELME project recreational value map.

No green network areas have been designated in the currently valid plans for the territory of Latvia. Similarly, as no infrastructure or similar facilities related to the wind farm are planned on Latvian territory, the establishment of the wind farm will have no significant impact on the natural areas of Latvian territory, including possible animal migration routes and habitats.

4.1.5.3 Measures and need for further studies and assessment

At the site selection stage:

When planning wind farm construction areas, the proportion of natural areas in any element of the green network must not fall below 90% when considering the combined impact of different wind farms. In addition, when placing wind turbines and related infrastructure in the green network, minimal fragmentation of the green network must be ensured.

To compensate for the decline in the quality of the green network in the wind farm area, the green network in the region must be supplemented. Based on the analysis of the green network, it is proposed to plan changes (additional areas) to the green network of Tõrva municipality in the planning area in connection with the establishment of the wind farm (Figure20). Additional green network areas must be included in the comprehensive plan. With regard to the proposal to supplement the green corridor of the Õhne River, the SEA and the planning process have concluded that the green corridor is already protected under the Nature Conservation Act within the scope of the construction prohibition and restriction zone on the banks, and there is no immediate need to include it in the comprehensive plan.

According to the county plan, the clearing of forest land should generally be avoided in green network areas. As this is not possible when establishing wind farms, the extent of the forest area to be cleared must be minimized. In green network areas, underground cables should be used instead of overhead lines, which will significantly reduce the area of forest to be cleared. Existing roads should be used as access roads to the maximum extent possible.

In further design and operation:

When designing a wind farm, the destruction or significant impact on amphibian breeding sites must be avoided. If this is unavoidable, it is necessary to create suitable replacement water bodies for amphibian breeding. If water bodies (e.g., ditches or fire water reservoirs) are planned as part of the wind farm, they should be designed in such a way that they can also function as amphibian breeding sites[121] . If it is unavoidable to affect amphibian breeding water bodies, this must be done at a time when the specimens are not associated with specific water bodies (i.e., avoid the breeding and hibernation periods).

In the green network support area, additional drainage of forest areas that have not yet been drained or have been drained to a lesser extent must be avoided, as this would reduce the biodiversity of the area and the ecological and climate change mitigation value of the support area. Drainage may be carried out to the extent necessary for the construction of a wind farm, and mitigation measures must be integrated into the drainage facilities during the course of the activity in order to increase biodiversity and prevent water pollution[122] .

In the further design of the wind farm, preference should be given to layout solutions for assembly sites, roads, and cable corridors that utilize existing infrastructure and minimize the area of forest to be cleared. If clearing is necessary, give preference to clear-cut areas and young forests over older forests.

4.1.6 Impact on domestic animals

There is no scientific literature indicating that wind turbines could have a significant impact on domestic animals (including animals used in agriculture). At the same time, there are only a few scientific articles dealing with the impact of wind turbines on domestic animals.

Historically, there were two villages in the northern part of the Tõrva EP that were potentially suitable for wind turbines – Laugaste or Metsaküla and Kannu or Koive, both with more than ten families[123] . Today, people still live in the southern part of Kannu village at the Soosaare farm and the Tõntso cattle farm. In the southern part of the potentially suitable area is the village of Eera (including a cattle farm), which was surrounded by the forests of the Taagepera forest district.

In general, it is relatively common in global practice to combine agricultural production (including sheep and goat farming) with wind farms. In the case of cows, it has been observed that when a wind turbine is erected on pasture land, it initially causes stress in the animals and milk production declines slightly, but within five weeks the initial condition is restored and the cows become accustomed to the wind turbines([68]) ·A study conducted in Poland on the impact of wind turbines on the stress parameters and weight gain of young geese found that geese aged five weeks placed in close proximity to a wind turbine (50 m) from the wind turbines gained less weight over a 12-week period and had higher levels of stress hormones in their blood compared to another group of geese that were placed 500 m away from the wind turbines[124] . A similar study has also been conducted with pigs. It was found that raising pigs in the immediate vicinity of a wind turbine (50 m) caused a decrease in muscle pH,

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[121] Vaikre, M., Rannap, R., Remm, L., Soomets, E. 2019. Establishment of mitigation water bodies in forest areas to mitigate the effects of ditching (KIK project 13227).

[122] Timmusk, T., Ots, H., D. 2024. Technical guidelines for the design of environmental protection structures in land improvement systems. Commissioned by: Environmental Board.

[123] https://xgis.maaamet.ee/xgis2/page/app/parandkultuur

[124] Mikołajczak, J., Borowski, S., Marć-Pieńkowska, J., Odrowąż-Sypniewska, G., Bernacki, Z., Siódmiak, J., Szterk, P., 2013. Preliminary studies on the reaction of growing geese (Anser anser f. domestica) to the proximity of wind turbines. Polish Journal of Veterinary Sciences Vol. 16, No. 4 (2013), 679–686.

heme pigments and heme iron, and a decrease in C18:3n-3 fatty acid content in the rumen.[125] Therefore, based on the available data, it cannot be ruled out that being in the immediate vicinity of a wind turbine causes stress, which may affect their growth and thus the quality of agricultural production.

In the case of this planning solution, there are no livestock buildings in or near the wind farm area, and there is no known grazing of livestock in the wind farm area. The area is predominantly forest land, and the arable land within the area is cultivable. Based on this, no significant impact on farm animals or other domestic animals is expected.

4.1.7 Impact on protected areas

4.1.7.1 Assessment methodology

The assessment of the impact on areas protected under the Nature Conservation Act is based on the conservation objective of the area, which is specified in the conservation rules (or other conservation document) for the area. If there is a protection management plan for the area, the protection objective is also based on the protection management plan, which specifies the protection objective. The principle is that the planned activity must not harm the protection objectives of the area.

4.1.7.2 Assessment results

The initial map analysis has excluded areas that are protected areas, conservation areas and permanent habitats under the Nature Conservation Act as potentially suitable areas. Based on this, the planned activity is not expected to have a direct significant adverse impact on protected areas, conservation areas, permanent habitats, or their conservation objectives.

There may be an indirect impact on protected areas, conservation areas and permanent habitats whose protection objectives are the protection of birds and bats. Bird feeding areas usually extend beyond the protected area, and if an important feeding area overlaps with the wind farm area, there may be an impact through a reduction in the feeding area and through the risk of death due to the risk of collision with wind turbines. According to specialist literature, a buffer zone of 0.5–3 km between the habitat and the wind turbine can be considered sufficient for most bird species. Based on this, areas with bird protection objectives located within a 3 km radius have been considered for protected areas. The possible impact on birds, including permanent habitats established for the protection of bird species, is discussed separately in section4.1.3 .

Figure23 on , which does not include data on permanent habitats of Category I and II species under the Nature Conservation Act.

There are no protected areas or conservation areas in the potential pre-selection areas.

The larger protected areas in the region are located to the west of the potentially suitable areas: Pilpa Nature Reserve (KLO1000728) and Tündre Nature Reserve (KLO1000193), and Lasa Lake Conservation Area (KLO2000101) in the southeast. Of the areas listed, only the Tündre Nature Reserve (Figure23 ,Table17) remains in the special planning area.

Of the permanent habitats, the Kähu corncrake permanent habitat (KLO3000713) and the Holdre golden eagle permanent habitat (KLO3002815) are located in the immediate vicinity of the potentially suitable area in the north. In addition, the Lasa capercaillie permanent habitat KLO3000065 is located 760 m from the southern potentially suitable area. During fieldwork for the bird survey, two lesser spotted eagle nesting sites were identified in the northern area, for the protection of which the Karjatnurme and Koorküla lesser spotted eagle permanent habitats were established.

[125] Karwowska, M., Mikołajczak, J., Dolatowski, Z.J., Borowski, S., 2015. The effect of varying distances from the wind turbine on meat quality of growing-finishing pigs. Ann. Anim. Sci., Vol. 15, No. 4 (2015) 1043–1054.

The impact of the Holdre golden eagle permanent conservation area has been thoroughly discussed in the Natura assessment section of4.1.1 and will not be repeated here.

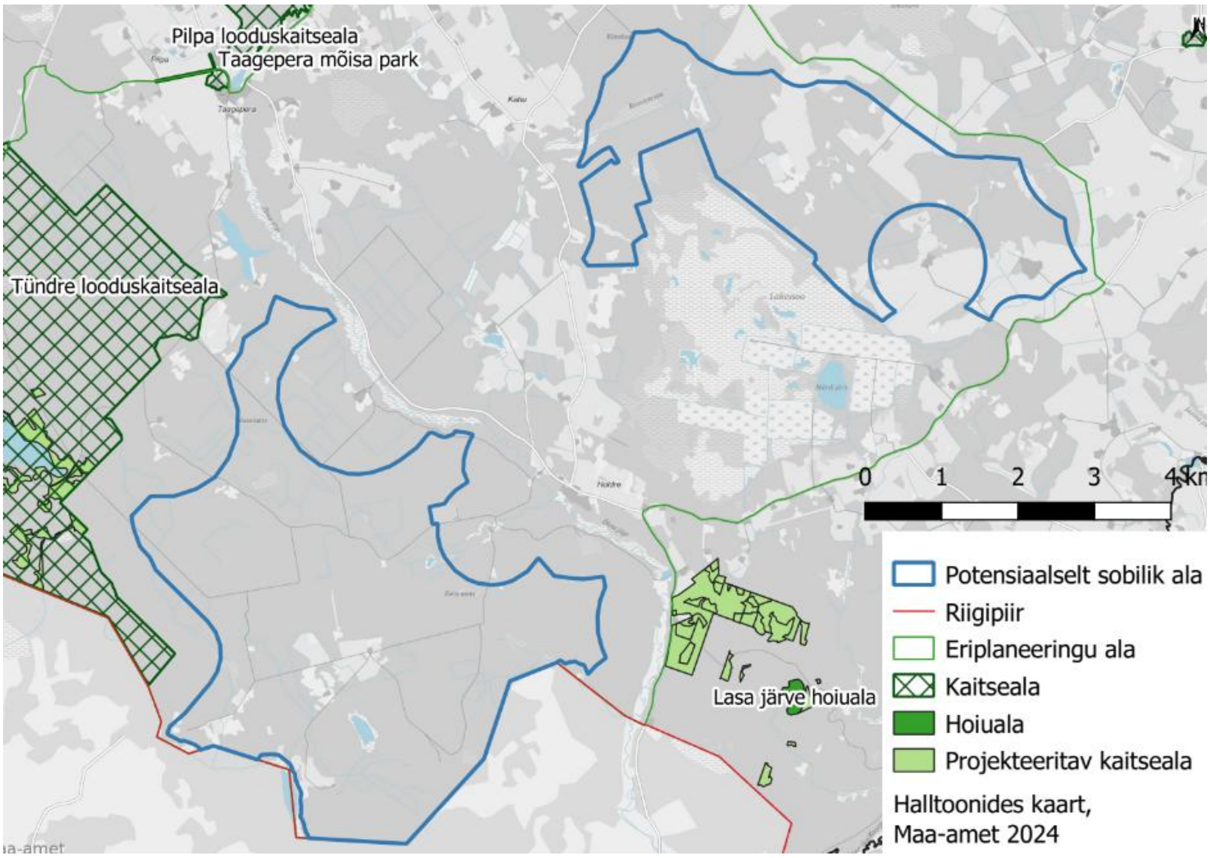

Figure23 . Protected areas within the potentially suitable areas (permanent habitats are not shown). EELIS (Estonian Nature Information System), Environmental Agency data as of 22 March 2024.

Table17 . Impact on the closest (planned) protected areas to potentially suitable areas within the special planning area.

Protected area	Distance from the potential pre-selection area	Conservation objective of the protected area	Impact on the protected area and its conservation objectives	Measures
Tündre Nature Reserve (KLO1000193)	600 m from the southern area	The conservation objective of the Tündre Nature Reserve is to protect and preserve: 1) the forest ecosystem, biodiversity, endangered and protected species; 2) habitat types listed in Annex I to Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (OJ L 206,	Considering the distance of the potentially suitable area from the protected area and the habitat types that are the conservation objectives of the protected area, it is unlikely that there will be a	A recommended 1 km buffer zone should be implemented around the capercaillie habitat within the protected area to avoid significant adverse

Protected area	Distance from the potential pre-selection area	Conservation objective of the protected area	Impact on the protected area and its conservation objectives	Measures
		22.07.1992, pp. 7–50): naturally nutrient-rich lakes (3150)3, species-rich calcareous fens on calcareous soils (6270*), old natural forests (9010*), old broad-leaved forests (9020*), spruce forests rich in herbs (9050), swamp and bog forests (9080*) and transition mire and bog forests (91D0*); 3) Protected species and their habitats: capercaillie (*Tetrao urogallus*) and limatünnik (*Sarcosoma globosum*).	significant impact on the habitat types and species habitats that are the conservation objectives of the protected area, except for the capercaillie habitat. In the case of capercaillie and other grouse, it has been found that the impact of wind turbines extends up to 1 km away[126,127,128].	effects on the habitat.
Lasa capercaillie permanent habitat (KLO3000065)	745 m from the southern area	Habitat and breeding area of the capercaillie	In the case of capercaillies and other game birds, it has been found that the impact of wind turbines extends up to 1 km.	Implement the recommended 1 km buffer zone around the capercaillie habitat to avoid significant adverse effects on the habitat.

[126] Kämmerle, J.-L., Taubmann, J., Andrén, H., Fiedler, W., Coppes, J. (2021). Environmental and seasonal correlates of capercaillie movement traits in a Swedish wind farm. Ecology and Evolution, 11: 11762–11773. doi: 10.1002/ece3.7922.

[127] Taubmann, J., Kämmerle, J.-L., Andrén, H., Braunisch, V., Storch, I., Fiedler, W., Suchant, R., Coppes, J. (2021). Wind energy facilities affect resource selection of capercaillie Tetrao urogallus. Wildlife Biology. doi: 10.2981/wlb.00737.

[128] The impact of onshore wind farms on wildlife and the Environmental Board's recommendations for their planning in local government comprehensive plans (as of 10.11.2021). Environmental Board.

Protected area	Distance from the potential pre-selection area	Conservation objective of the protected area	Impact on the protected area and its conservation objectives	Measures
Permanent habitat of the corncrake (KLO3000713)	Adjacent to the northern area	Habitat of the corncrake	According to the MLA, adverse effects on the corncrake may occur up to 1 km away.	Implement a 1 km buffer zone around the nesting site of the corncrake, which is protected as a permanent habitat, to avoid significant adverse effects on the habitat.

The entire Latvian territory bordering Tõrva municipality belongs to the North Vidzeme Biosphere Reserve. The North Vidzeme Biosphere Reserve is the only biosphere reserve in Latvia. The reserve covers an area of 4576 km$^{(2)}$ ·The biosphere reserve protection regime specifies areas where wind turbines over 30 m in height may be erected. The part of the biosphere reserve adjacent to the planning area has not been designated as a suitable area for wind turbines[129] .

The national and international objective of the biosphere reserve is to achieve a balance between the protection of natural diversity, the promotion of economic development, and the preservation of cultural values. The biosphere reserve represents the internationally recognized terrestrial and Baltic Sea coastal ecosystems of the temperate forest zone. In order to ensure the preservation of the landscape, ecosystems, species and genetic diversity of the territory and to promote sustainable economic development, the biosphere reserve territory is divided into functional zones (landscape protection zones and neutral zones)[130] . The landscape protection zone of the biosphere reserve (zone 9) is adjacent to the special planning area.

Under the current protection regime, the following is prohibited in the landscape protection zone of the biosphere reserve:

- In areas of landscape value (if these are defined in the local government's spatial plan) activities that significantly alter the landscape and its elements, change the character of the cultural-historical environment and landscape elements specific to the area, or reduce biological diversity and the ecological quality of the landscape;
- Driving off-road and traveling with motor vehicles, trikes, quad bikes, and mopeds on forest and agricultural land, except for movement on routes specially constructed for visitors or movement related to the management, supervision or national defense tasks of these lands;

129 https://likumi.lv/doc.php?id=229252&from=off#piel2
130 https://www.daba.gov.lv/en/north-vidzeme-biosphere-reserve

- Burning dry grass, heather, reeds, and forest undergrowth. The prohibition does not apply to habitat restoration measures for which written permission has been obtained from the Nature Conservation Agency and which have been notified in writing to the authority responsible for fire safety and firefighting;
- Erection of buildings or establishment of plantations and afforestation in a manner that may obscure the view of elements and values characteristic of the landscape from publicly accessible viewpoints and landscape roads (if such are defined in the local government's spatial plan);
- Without the written permission of the Nature Conservation Agency:
    - Establishing publicly accessible nature tourism and nature education infrastructure facilities (e.g., hiking trails, routes, observation towers, campsites, parking lots, visitor centers, and information centers);
    - Changing the location of the road corridor when reconstructing landscape roads (if such roads are defined in the local government's spatial plan).
- The felling of forests affected by clear-cutting along landscape roads is permitted only ten years after clear-cutting in coniferous forests and five years after clear-cutting in deciduous forests, provided that the clear-cut area has been declared regenerated and the average height of the regenerated forest is at least one meter for coniferous trees and at least two meters for deciduous trees.
- Trees left standing after clear-cutting should, where possible, be left in groups, preserving the undergrowth or scrub, except where the area of managed forest in a single cadastral unit is less than one hectare.
- Local governments may establish additional requirements in their regulations to preserve the character and value of the existing landscape.

According to the current spatial plan of the Valka municipality, the dominant land use in the border area is forest land (M). According to the current spatial plan of the Naukšēni municipality, the main designated uses are forest land (M), agricultural land (L) and water bodies (Ū), including residential construction in areas designated for agricultural use. No areas of landscape value or viewpoints have been designated in the areas adjacent to the planning area.

The territory of the Republic of Latvia adjacent to the special planning area also includes micro-reserves (permanent reserves in Estonian terms) 2185 and 2609, which have been established for the protection of bird species, and micro-reserve 1857 for the protection of plant communities (habitat type 91E0*). The border area also includes areas where habitat types listed in the Habitats Directive are present (Figure24). According to the position of the Republic of Latvia, a buffer zone of at least 2 km with wind turbines must be maintained around micro-reserves 2185 and 2609. No wind turbines are planned for the buffer zone under the special plan, and therefore no adverse impact on the micro-reserves is expected. Micro-reserve 1857 was created to protect the forest community. Considering the location of the reserve on the other side of Lake Pupsi from the wind farm. The establishment of the wind farm will not have an adverse impact on the forest communities protected in micro-reserve 1857.

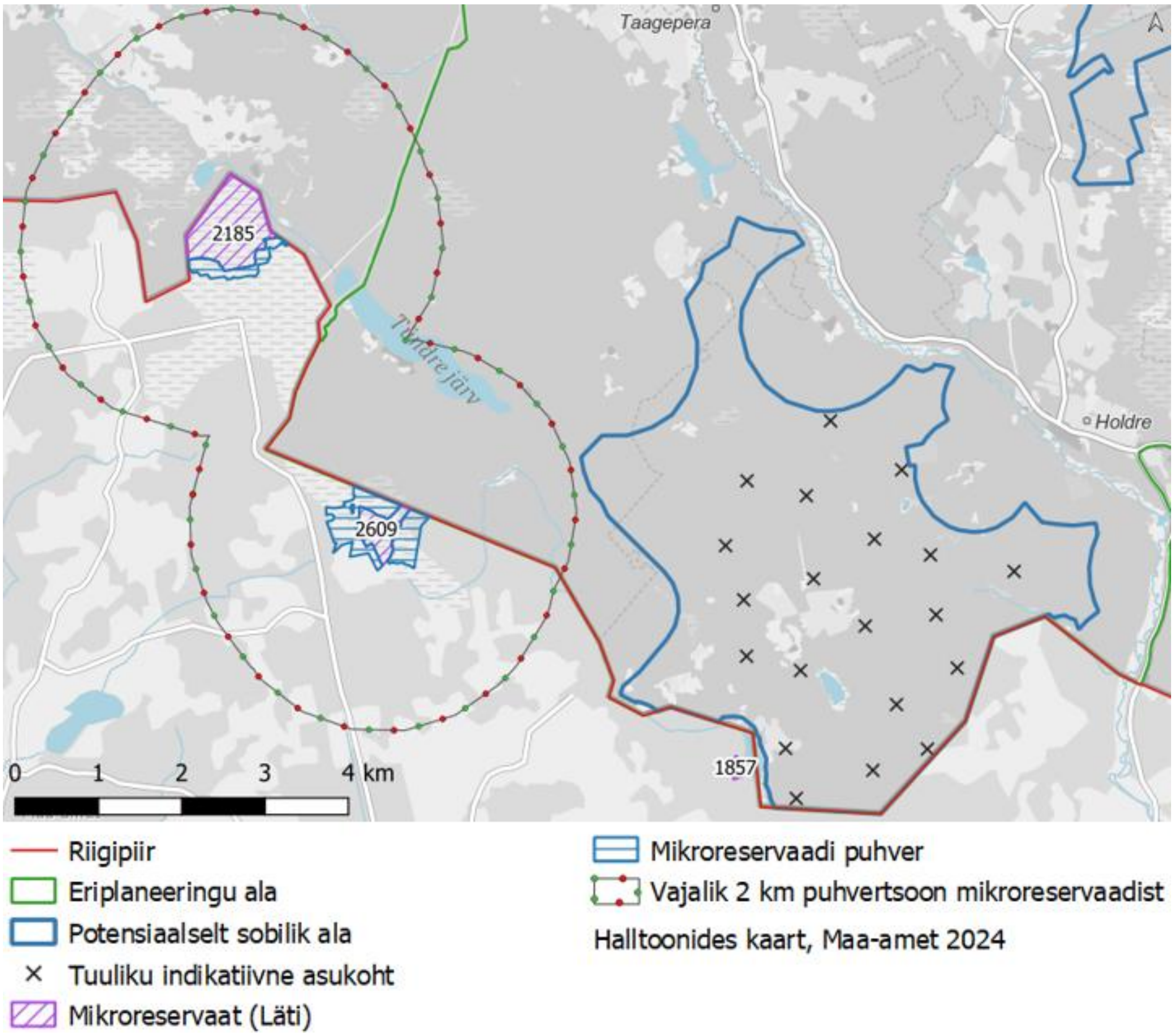

Figure24 . Micro-reserves and their buffer zones located on Latvian territory.

4.1.7.3 Measures, need for further research and assessment

Location selection stage:

During fieldwork in 2023, two habitats of lesser spotted eagles were found in a potentially suitable area in the north. In the case of established permanent habitats, buffer zones free of wind turbines must be maintained within a radius of 2 km to avoid adverse effects on the conservation objectives of the permanent habitats.

In addition, wind turbines should not be planned within 1 km of the permanent habitat of the capercaillie in Lasa, the permanent habitat of the black grouse in Kähu, and the capercaillie habitat in the Tündre nature reserve.

4.1.8 Impact on the water body of the Lasa River (istik)

4.1.8.1 Assessment methodology

The impact on water bodies was assessed in potentially suitable areas mapped in the special plan. To this end, existing data on surface water bodies, land improvement systems, wetlands and groundwater protection were analyzed. The aim of the assessment was to identify areas of potential importance for water protection in potentially suitable areas, the avoidance of which as construction areas would prevent significant adverse impacts on water bodies. Based on the database-driven assessment, potential adverse impacts and restrictions necessary to ensure the protection of surface water and groundwater were mapped. This assessment served as the basis for determining the preliminary selection area for the plan and for preparing the initial draft solution.

The draft solution was then subjected to an additional expert assessment of surface and groundwater by a hydrogeologist (presented in Annex 8) to assess the potential adverse effects and, if necessary, to recommend additional environmental measures to prevent or mitigate adverse effects.

4.1.8.2 Impact on surface water

The construction of wind farms may potentially have an impact on water bodies during the construction phase if construction activities are planned on water bodies (e.g., access road bridges or culverts) or their shore areas. The main risk during construction is the entry of sediment and petroleum products into water bodies. If necessary, detailed surface water monitoring requirements will be determined during the SEA process. During the operational phase of a wind farm, potential impacts on water bodies may mainly occur in emergency situations (e.g., oil spills).

It should be noted that construction restriction zones apply to water bodies under the Nature Conservation Act. As the area is predominantly forest land, it must be taken into account that, within the meaning of § 3(2) of the Forest Act, the construction restriction zone on forest land on the banks of a river extends to the boundary of the beach or shore restriction zone. When planning infrastructure related to the wind farm, the restrictions applicable to water body shore areas under the Nature Conservation Act must also be taken into account.

According to the EELIS (Estonian Nature Information System) database of the Environmental Agency, there are standing water bodies in potentially suitable areas (Figure25). According to ETAK data, there are several standing water bodies in potentially suitable areas that are not linked to the EELIS (Estonian Nature Information System) database of the Environmental Agency. In addition, there is overlap with flowing water bodies (Figure25), for which data is presented atTable18 .

Table18 . Overlap of watercourses with potentially suitable areas. Source: EELIS (Estonian Nature Information System), Environmental Agency, 11.06.2024.

Code	Name	Extent of construction restriction zone, m	Length of water body within the area, km
Northern part of the area			
VEE1014000	Saksniidu stream	50	1.74
VEE1014400	Jaoma main ditch	0	0.57
VEE1014500	Lagesoo main ditch	0	0.55
		TOTAL	**2.86**
Southern area			
VEE1154100	Rocky ditch	0	2.34
VEE1014200	Kiviste stream	25	1.16
		TOTAL	**3.5**

Potentially suitable areas in the south include Lake Mäsäjärv (VEE2115300), Lake Paganajärv (VEE2115310) and Lake Pupsi (VEE2115400), which is located approximately 50 m from the area. There are no standing water bodies in the potentially suitable northern area.

The Õhne River (VEE1013700) flows through the potentially suitable areas, accompanied by smaller streams. The northern potentially suitable area is crossed by the Saksniidu Stream (VEE1014000) with a 50 m construction restriction zone. The southern potentially suitable area is adjacent to Lake Pupsi (VEE2115400) and includes Lake Mäsäjärv (VEE2115300) and Lake Paganajärv (VEE2115310), whose construction restriction zone extends 25 m from the lake.

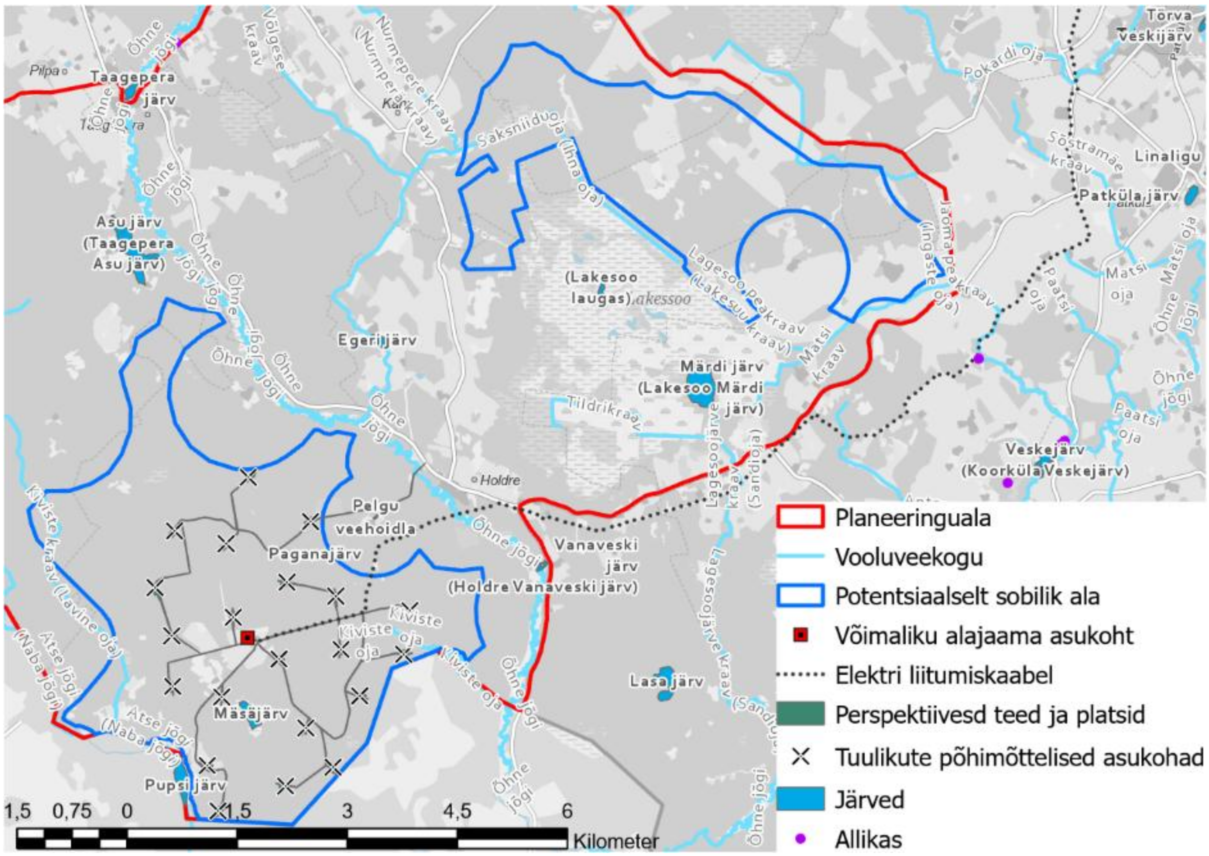

Figure25 . Location of watercourses and standing water bodies in relation to potentially suitable areas. Data as of 05.08.2024.

In order to avoid significant adverse effects on surface water bodies, the extent of the construction restriction zones for water bodies should therefore be observed on the basis of the above, which will help to ensure the protection of water bodies.

In the developed planning solution, the construction restriction zones of all water bodies will remain untouched by construction activities. No reduction of the construction restriction zone is planned for any water body. A more detailed description of the hydrology of the preliminary site selection area, together with an assessment of the possible impact on surface water quality and regime, is provided in Annex 8.

Access to the wind farm requires crossing the Õhne River. The location of the road and the design solution will be specified during the design phase, but in order to avoid adverse effects, it is appropriate to use the location of an existing bridge to cross the river. It may be necessary to increase the load-bearing capacity of the bridge and widen it. When constructing a new bridge or reconstructing an existing one, the measures set out in section4.1.8.7 must be followed to avoid significant adverse effects on the river.

Groundwater pumped out of foundation pits flows naturally into the same streams and rivers (Õhne and Atse rivers), which means that the water regime in the area remains largely unchanged. Only the ratio of the flow rates of specific ditches may change. The inflow of groundwater into one excavation is usually ~6.4 l/s, and up to ~8.4 l/s during the spring flood period. If all excavations in one catchment area are drained at the same time, 70–92 l/s will be added to the Õhne River and 64–84 l/s to the Atse River. This represents approximately 9% and 42% of the average flow of the rivers, respectively. The impact on the Õhne River is negligible, while it is more significant in the case of the Atse River, but the construction work will be carried out in stages, which will reduce the load.

The additional drainage water may even improve the ecological status of water bodies by increasing the flow and reducing the risk of oxygen deficiency. However, the ditches must have sufficient capacity to prevent flooding.

The construction work does not use materials that would significantly pollute the water. The pH change associated with the use of concrete is small and temporary. The main risk is sediment that enters the ditches due to construction work and erosion, increasing water turbidity and damaging biota. Most of the sediment settles on site, but during high water it can be carried into rivers. Measures must be taken to reduce sedimentation.

Another risk is oil spills from heavy machinery. This can be prevented through maintenance, refueling stations, and the use of absorbents. Contaminated soil must be removed if necessary.

The construction of the wind farm will not cause significant or permanent changes to the surface water regime or quality in the area. The impacts are mainly temporary during the construction period and can be mitigated by proper planning and construction protection measures.

4.1.8.3 Impact on land improvement systems

Land improvement involves draining and irrigating land and regulating the water regime on both sides in order to increase the cultivation value of land intended for agricultural use (hereinafter referred to *as agricultural land*) and to protect the environment. Potentially suitable areas overlap significantly with existing land improvement structures (Figure26) – these are areas where the water regime has already been altered.

The proportion of the land improvement system (based on the spatial data of the Land Board as of July 1, 2023) in potentially suitable areas is as follows:

- northern area 30% (323.00 ha);
- southern area 42% (453.57 ha).

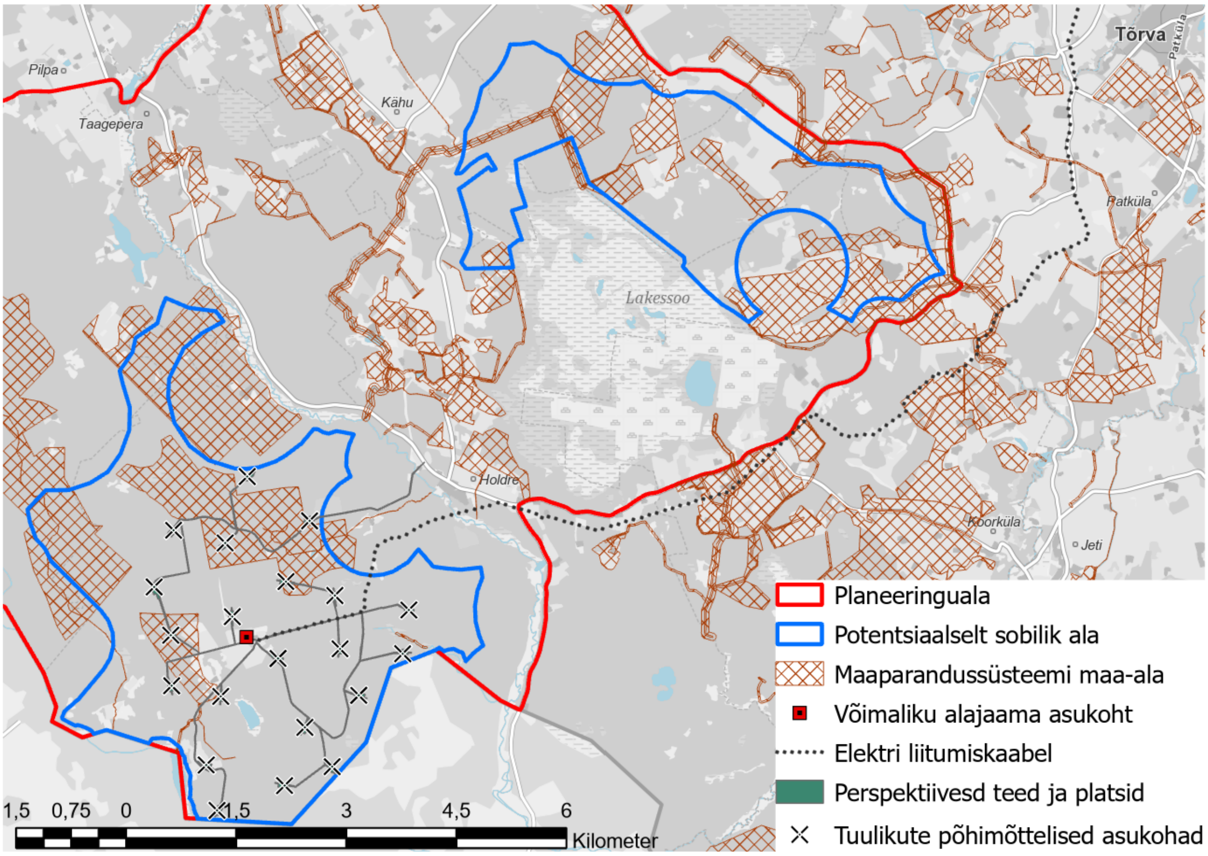

Figure26 . Land improvement systems in potentially suitable areas of the special planning area. Source: Land Board spatial data (land improvement system impact areas) as of April 1, 2024.

The planned activity must not impair the functioning of existing land improvement structures. Damage to land improvement structures may cause flooding in areas associated with the relevant land improvement object. This, in turn, may cause damage to people's property or the natural environment. The functioning of land improvement structures can also be ensured from a construction engineering perspective by building in their area of occurrence, but it is necessary to take land improvement structures into account in the design, including, if necessary, planning their relocation, supplementation, etc. **Construction projects located in the planning and land improvement network area must be coordinated with the Agricultural and Food Board in accordance with § 47 (1) of the Land Improvement Act.**

It is undesirable to construct new land improvement structures in connection with the establishment of wind farms in areas where there are currently no drainage systems. The construction of land improvement systems reduces the naturalness of areas and is known to have a negative impact on carbon sequestration. Therefore, areas already covered by land improvement systems should be preferred as locations for wind farms. This applies in particular to areas where the land improvement system is still functioning.

When establishing a wind farm, the location of the wind turbines, the access roads built for them, and the drainage associated with them will affect the water regime. New ditches may slightly increase the amount of water drained from the area and thus also increase the flow into the Atse and Õhne rivers. To a certain extent, this may affect the water level of the rivers during the spring flood and change the moisture conditions in the areas downstream of the wind farm, e.g. by prolonging the flood recession period. At the same time, the wind farm area is already relatively densely ditched, so the water regime is unlikely to change significantly.

To some extent, the flow paths and loads of individual ditches will change, so the system of ditches constructed for wind turbines and their access roads must be coordinated with the land improvement system manager. The design must ensure the continued functioning of the land improvement system and prevent flooding and excessive moisture in forest areas and deterioration of land use.

4.1.8.4 Impact on wetlands

The overlap with wetlands was analyzed using EELIS (Estonian Nature Information System), the Environmental Agency's database layer "sood" (wetlands). EELIS (Estonian Nature Information System), the Environmental Agency's "sood" layer, was used because it contains inventoried natural bogs, while the ETAK "wetlands" layer has a somewhat broader scope.

The following bogs are located in the northern potentially suitable area: Roovistesoo, Laugaste Juksi bog, Helme Metsaküla - Laugaste bog, Laugaste Undi bog 1 , Laugaste Undi bog 2, Helme Metsaküla (Kannu) Tepatsi bog, Helme Metsaküla (Kannu) Tupe - Tepatsi bog, Helme Metsaküla (Kannu) Värgi bog, Helme Metsaküla (Kannu) Roiu bog, Helme Metsaküla (Kannu) Söödi bog, Helme Metsaküla Lõhmusmäe bog, Marjasoo (Helme Marjasoo) southwestern edge remnants, Lakessoo (Holdre Lagesoo) northeastern part transition bog, Lakessoo (Holdre Lagesoo) eastern edge bog, Lakessoo (Holdre Lagesoo) eastern part transition bog, Lakessoo (Holdre Lagesoo) eastern part alder swamp, Lakessoo (Holdre Lagesoo) northern part transition bog 2 and Lakessoo (Holdre Lagesoo) northwestern edge transition bog (Figure27).

The following bogs are located in the southern part of the potentially suitable area: Eera northern fen, Eera northern transitional bog, Eera Pelgu fen, Eera northeastern bog, Eera northeastern transitional bog, Eera Raupa fen, Eera Ojaniidu fen, Eera Tilga(li) (Nabina) fen, Pupsi järve põhjakalda bog, Eera Tamme fen, Mäsajärve transition bog, Eera southeastern transition bog 2, Eera southeastern fen, Eera southeastern transition bog 1, and Eera southeastern bog (Figure27).

Wetlands are ecologically valuable and highly sensitive to changes in water regime. Wetlands play an important role in preserving biodiversity and regulating climate change. When establishing wind farms in their vicinity, damage to wetlands must be avoided. In Estonia, there are no specific recommendations for planning wind farms (or other large-scale construction projects) near wetlands. The relevant guidance material in Ireland recommends planning wind farms at a distance of 250 m from important wetlands [131] to avoid changes in the water regime in wetlands. In Canada, a 100 m buffer zone is used for all wetlands[132] . This SEA recommends that wetlands (EELIS bog layer) covering at least 0.5 ha be kept free of wind turbines and wind farm infrastructure. Wetlands are important both from the perspective of preserving biodiversity and from the perspective of climate impact. As the wetlands that overlap with potentially suitable areas are predominantly of lesser importance in terms of nature conservation (in some cases already affected by drainage, very small, predominantly with a low status assessment), it is appropriate to focus primarily on the preservation of larger (at least 0.5 ha) and better-preserved wetlands (representativeness or nature conservation status A or B). To this end, a 100 m buffer zone should be implemented for such communities. In order to avoid changes in the water regime, it is not advisable to establish a wind farm in the buffer zone of the wetland, as the impact on the wetland could be highly negative. Construction activity in or in the immediate vicinity of a wetland will damage the water regime of the wetland, which is likely to lead to the destruction of the wetland.

In the wind turbine layout developed during the planning process, there are three positions where the potential installation sites overlap with small wetland areas. All three wetlands are very small habitat areas with a representativeness rating of D. All wetlands with a representativeness rating of at least C

[131] Northern Ireland Environmental Agency. 2015. Wind farms and groundwater impacts. A guide to EIA and Planning considerations. Version 1.1/April 2015.

[132] Wildlife Directive for Alberta Wind Energy Projects: https://open.alberta.ca/dataset/2d992aec-2437-4269-9545-cd433ee0d19a/resource/11d33fdc-5971-42e7-8cb4-947d2f226804/download/wildlifewindenergydirective-apr07-2017.pdf

will be preserved in the planning solution. Therefore, the implementation of the plan will not have a significant adverse impact on the wetlands.

In general, the roads within the wind farm are at least 5 m wide gravel roads with ditches along the edges to drain water and ensure the stability of the road. Road embankments can cause excessive moisture in some areas, while roadside ditches can cause excessive drainage of valuable wetlands. In general, the digging of new ditches should be avoided unless absolutely necessary. When constructing new roads, the banks of existing ditches should be preferred. Valuable wetland communities must be preserved. When constructing new roads, culverts should be designed for existing watercourses (including ditches) to prevent the formation of new waterlogged or dry areas.

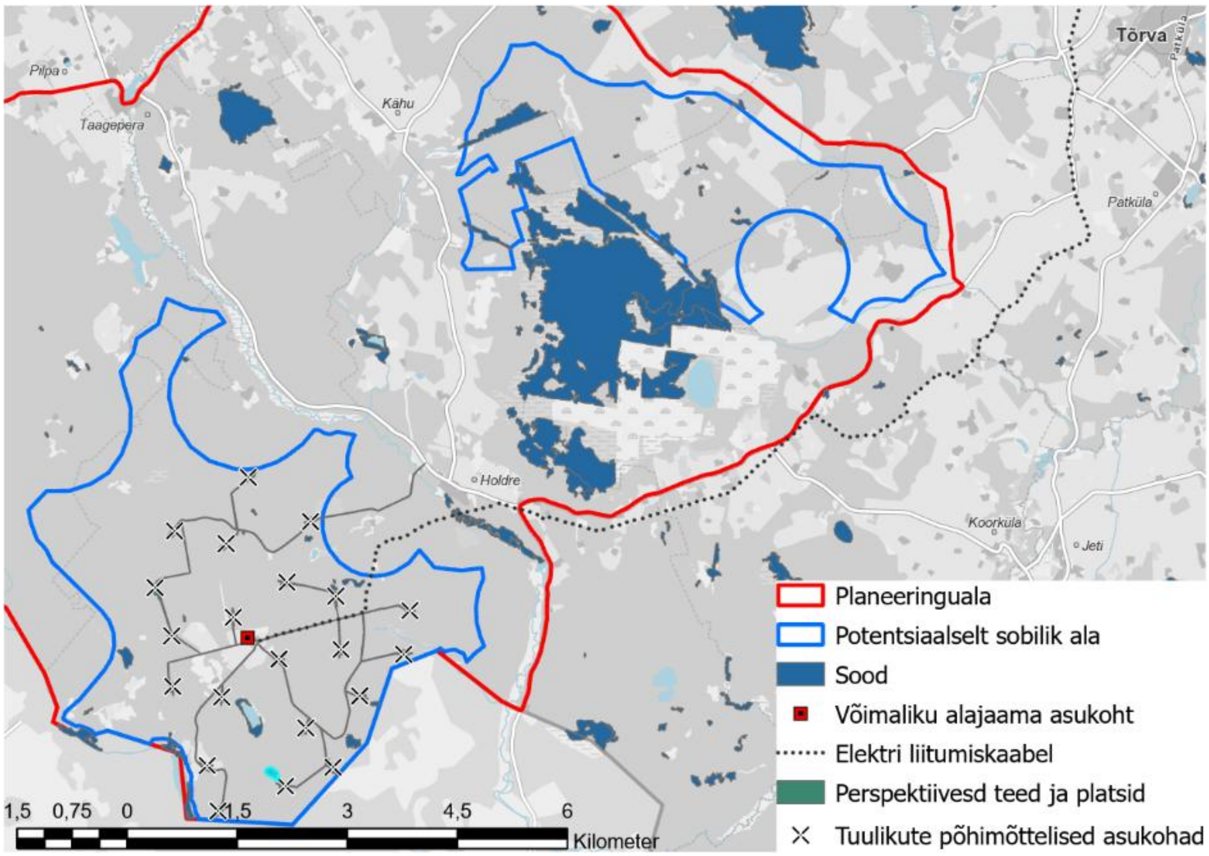

Figure27 . Potentially suitable areas in the bog special planning area. Based on EELIS data from 05.08.2024.

4.1.8.5 Impact on groundwater

The special planning area includes the Middle Lower Devonian groundwater body in the West Estonian river basin, the Middle Lower Devonian groundwater body in the East Estonian river basin, the Middle Devonian groundwater body in the West Estonian river basin, and the Middle Devonian groundwater body in the East Estonian river basin. According to Annex 7 of the water management plans for the period 2022–2027, approved on October 7, 2022, the Middle Devonian groundwater body in the East Estonian river basin is in poor overall condition.

Groundwater in the special planning area is mainly relatively well protected, and there are areas where groundwater is moderately protected (Figure28).

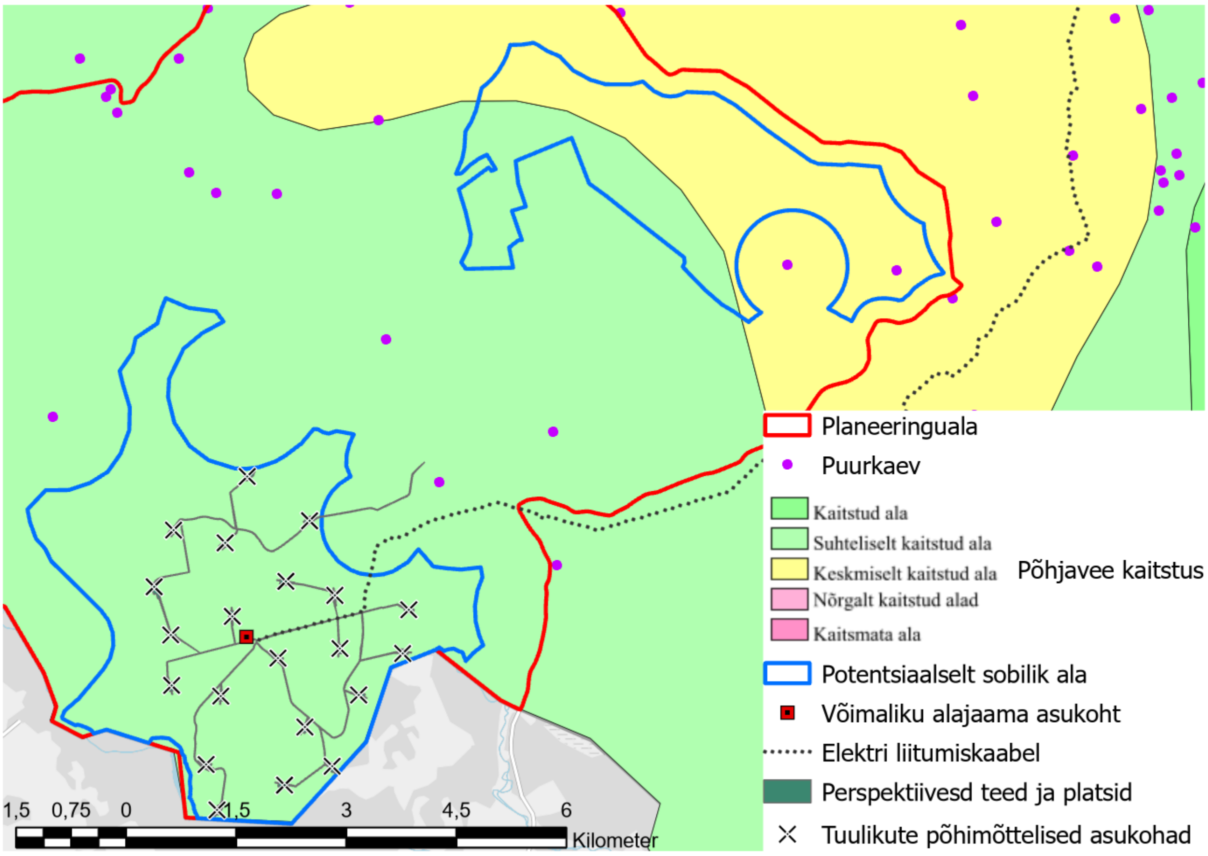

Figure28 . Groundwater protection and location of boreholes in potentially suitable areas in the special planning area. Source: Land Board groundwater protection map 1:400,000.

Considering groundwater protection, the main risk associated with the construction of wind turbines is possible accidental pollution during the construction or operation of the turbines. Considering the modern construction solutions used in wind turbines, their construction will not have a significant impact on the distribution of groundwater or groundwater resources.

Wind turbine foundations are essentially large structures, the specific design of which depends on the geological conditions. The foundation must ensure the stability of the wind turbine and is therefore designed for each wind turbine model based on the parameters of the wind turbine and the properties of the soil. Technical solutions for foundations are discussed in section2.4.2 . Depending on the choice of wind turbine foundation design, pile foundations can reach depths of up to 30 m in soft soil. Considering the depth and location of the boreholes in relation to potentially suitable areas, it is unlikely that they will have a significant negative impact. One borehole remains in the northern potentially suitable area. No permanent lowering of the groundwater level is necessary for the construction of the wind turbine. The foundation will not significantly affect groundwater movement or quality. The construction of the foundations must comply with the requirements of the Water Act, which prohibits the mixing of different groundwater layers. The mixing of groundwater layers must be prevented by means of construction measures.

The main source of danger to groundwater and surface water associated with wind turbines is the oil used in the gearbox located in the nacelle (up to 600 liters per wind turbine), which, in the event of a nacelle breakage or incorrect oil change procedure, may enter the soil and, in the worst case, surface water or groundwater. Wind turbine technology has been developed in such a way that oil changes are rarely necessary. Modern wind turbine technology also takes into account the minimization of the risk of leakage. Oil changes are generally carried out using a special tanker truck. The old oil is pumped into the vehicle using hoses and replaced with new oil. Oil changes are carried out by specialized companies and qualified specialists. In the event of an accident, the main measure is the rapid response of the rescue service and their ability to resolve the situation ( ). Modern wind turbines are under constant digital control, which provides operational information on the status of the turbine and thus reduces the risk of accidents.

Potential groundwater pollution in connection with the construction or operation of wind turbines may have a significant impact, especially if it threatens the quality of drinking water. Existing dug and drilled wells are mainly located in populated areas. As the terms of reference for this special plan stipulate that wind turbines shall not generally be built closer than 1 km to residential areas, most of the region's dug wells and boreholes will remain more than 1 km away from the potential wind farm area. There are no direct recommendations in Estonia for planning wind farms near wells. The relevant guidance material in Ireland[133] **recommends planning wind farms at a distance of 250 m from wells used as drinking water sources and at least 50 m from other wells.** Table19 lists boreholes located closer than 1 km to potential pre-selection areas. There is one known borehole located in the northern potentially suitable area. If the well is to be preserved and used as a drinking water source or is necessary for hydrogeological studies in the area, a buffer zone of 250 m should be ensured as a precautionary measure. Alternatively, the borehole should be properly decommissioned (especially if it is no longer in use). Based on the results of the bird survey, the northern potentially suitable area will not be used as a wind farm area, so there will be no impact on the borehole located in the potentially suitable area.

Table19 . Drilled wells located closer than 1 km to potentially suitable areas. (Borehole data – EELIS (Estonian Nature Information System), Environmental Agency as of 22 January 2023 and Veka EELIS[134] as of 12 January 2024). In addition to the boreholes listed in the register, it is very likely that there are unregistered dug or boreholes in the yards of all residential areas located in sparsely populated areas.

Drilled well code	Groundwater body associated with the borehole	Water table depth of the borehole, m	Distance from potential pre-selection area, m	Additional
Northern area				
PRK0012224	Middle Devonian aquifer in the East Estonian basin	85	3	Operating borehole for domestic water supply.
PRK0022489	Middle Devonian aquifer in the East Estonian basin	80	Overlaps with the northern area	Operational borehole for domestic water supply.
PRK0052398	Middle Devonian aquifer in the East Estonian basin	61	985	Operational borehole for domestic water supply.
PRK0053380	Middle Devonian aquifer in the East Estonian basin	52	978	Operational borehole for domestic water supply.

[133] Northern Ireland Environmental Agency. 2015. Wind farms and groundwater impacts. A guide to EIA and Planning considerations. Version 1.1/April 2015.
[134] https://veka.eelis.ee/veka.aspx?type=artikkel&id=757660072

Drilled well code	Groundwater body associated with the borehole	Water table depth of the borehole, m	Distance from potential pre-selection area, m	Additional
PRK0053657	Middle Devonian aquifer in the East Estonian basin	80	689	Operational borehole for domestic water supply.
PRK0058822	Middle Devonian aquifer in the East Estonian basin	50	987	Operational borehole for domestic water supply.
Southern area				
PRK0012276	Middle Devonian aquifer in the East Estonian basin	85	960	Operating borehole for domestic water supply.

A more detailed description of the hydrogeological environment of the preliminary selection area, together with an assessment of the possible impact on groundwater, is provided in Annex 8. When constructing gravity foundations, it is necessary to drain the excavation pits, which causes groundwater to flow into the pits and creates a depression. The water level drops most significantly next to the excavation and decreases rapidly with increasing distance. The impact is temporary – the groundwater level will recover after construction. The water will be directed through ditches into the Õhne and Atse rivers.

Conservative assumptions were used to assess the water regime: maximum excavation dimensions (6.5 m deep, 32 m in diameter), the highest measured filtration module (18 m/day), and simultaneous drainage of all excavations. Based on the model, the theoretical impact radius is over 1 km, but a groundwater level decrease of 0.5 m was taken as the threshold for significant impact. This extends to a distance of ~357 m from the excavation.

Based on this, the nearest households (Pelgu, Viitaku) remain outside the significant impact limit. The impact also does not extend to protected areas (e.g., Tündre Nature Reserve).

As the drainage of the dredging areas is temporary and the formation of a depression cone takes time, the actual impact is smaller than the model results.

It should also be noted that the impact of groundwater lowering during construction does not accumulate in the case of different dredging sites – the lowering basins overlap but do not deepen. The impact is also limited by:

- the smaller actual dimensions of the excavations or the use of pile foundations,
- the local relief and the locality of the groundwater cycle,
- the presence of watercourses between the excavations and households.

As the nearest dug and drilled wells are located >1000 m away, the construction-related lowering of the water level does not affect their water supply. The deeper Middle Devonian groundwater complex, which feeds the drilled wells, also remains unaffected.

The lowering of the groundwater level during the construction of the wind turbines is temporary, extends to a limited distance, and does not affect the water supply of households in the area or deeper groundwater complexes. The impact may be noticeable only in the immediate vicinity of the excavations, but in practice it is smaller than conservative model calculations indicate.

In the case of wind turbines with gravity foundations, the foundation pits are filled with concrete. In the case of pile foundations, the piles are also created by injecting concrete into drilled holes. After construction is complete, no water is removed from the excavations, so the original water regime is restored and the resulting groundwater level depressions disappear. Concrete foundations do not impede further groundwater flow, as the foundations are built on porous surface layers where water spreads diffusely through interconnected pores throughout the soil, rather than through specific underground flow channels (as can occur on a local scale in karstified carbonate rocks). Thus, groundwater finds a flow path around the foundation and the movement of groundwater is not impeded.

4.1.8.6 Risk of surface and groundwater pollution

The impact on groundwater and surface water quality during long-term wind farm operation depends mainly on maintenance equipment failures, which can be prevented by the same safety measures as during construction. No sediment will be generated after the completion of construction work, except in cases where ditches or roads are maintained.

The main source of pollution risk is the oil used in the gearbox located in the nacelle of the wind turbine (up to 600 l in total), which may enter the soil and, in the worst case, surface water or groundwater if the nacelle breaks. In general, wind turbines do not have their oil changed every year. In the case of existing wind turbines in Estonia, oil changes are carried out approximately once every five years, depending on the type of wind turbine, and even less frequently in the case of newer wind turbines. Precautionary measures (e.g., a collar installed around the wind turbine tower) are always taken during oil changes to prevent oil from entering the environment. Groundwater in the special planning area is mainly relatively protected, and there are areas where groundwater is moderately protected. For the special planning area, a groundwater protection map with a scale of 1:400,000 has been used (due to the large scale, the map is not very accurate, so it should be viewed with a critical eye).

The accident is similar in nature to, for example, a fuel truck accident on a highway, and the main remedy is the rapid response of the rescue service and the wind turbine maintenance team and their ability to resolve the situation. To prevent accidents, the wind farm owner must ensure continuous monitoring of the condition of the wind turbines and maintenance in accordance with the technical specifications of the specific wind turbines installed.

4.1.8.7 Measures, need for further research and assessment

At the site selection stage:

In order to avoid significant adverse effects on surface water bodies, the extent of the construction prohibition zones of water bodies must be observed and areas within the construction prohibition zone of water bodies must be excluded from the location selection areas. Considering the extent of potentially suitable areas, reducing construction restriction zones and diverting watercourses (except for land improvement ditches) for the construction of a wind farm is not justified.

Wetlands of at least 0.5 ha (EELIS bog layer) should be kept free of wind turbines and wind farm infrastructure. Wetlands are important both from the point of view of preserving biodiversity and from the point of view of climate impact. As wetlands that overlap with potentially suitable areas are predominantly of lesser importance in terms of nature conservation (in some places already affected by drainage, very small, predominantly with a low status assessment), it is appropriate to focus primarily on the preservation of larger (at least 0.5 ha) and better-preserved wetlands (representativeness or nature conservation status A or B). To this end, a 100 m buffer zone should be applied to such communities.

During further design and operation:

During construction work, especially when crossing water bodies and carrying out work in the construction restriction zone, damage to the banks of water bodies, the risk of erosion, and the entry of soil and pollution into water bodies must be avoided. Construction machinery and vehicles are not allowed to drive in water bodies.
Water drainage during construction must be addressed in the relevant construction project. The flow of sediment and larger particles into the receiving water body can be prevented and reduced by means of specially constructed sedimentation basins or directly in drainage ditches, using dams or extensions built there. Design must be based on applicable design standards and the best available technology, using practical experience and solutions available in this field.
If additional drainage ditches or significant reconstruction of existing drainage ditches and water diversion during construction are planned in wind farm areas, flow stabilizers (settling ponds or purification beds) must be provided to reduce sediment input[135] . Measures must be taken to prevent sediment from being carried further in the ditches and reaching the streams/rivers in the area and/or to reduce the resulting negative impacts. Various methods can be used for this purpose:

- dimension ditches taking into account the possible sediment load and, if necessary, carry out regular cleaning of ditches;
- create temporary sediment basins in new or deepened ditches to stop the further spread of soil particles carried along the sides of the ditch;
- plant new or deepened ditches as quickly as possible to reduce sediment erosion;
- Install sediment traps at the wind turbine foundation excavation sites to clean the pumped water before it is discharged into the receiving water body.

Construction activities must not impair the functioning of existing land improvement systems (drainage). If it is unavoidable to affect the drainage, the drainage system must be reconstructed if necessary to ensure the continued functioning of the land improvement system.

When designing a wind farm, a construction geological survey must be carried out to determine suitable foundation and infrastructure solutions. Where possible, wind turbines should be located in areas with more suitable construction geological conditions, which reduce the need for drainage and soil work.

During construction, construction machinery must be parked, refueled, and maintained on designated hard-surfaced areas. In order to minimize the risk of possible fuel leaks associated with construction sites, measures must be taken to protect groundwater and surface water when establishing temporary fuel and oil storage areas, e.g., for the duration of construction work, parking areas and material and soil storage areas must be secured with a geomembrane or similar base to prevent leaks into surface and groundwater.

Temporary storage areas and parking areas for construction machinery during construction must be located more than 50 m away from drinking water wells and flowing and standing water bodies according to the Estonian Nature Information System EELIS.

Refrain from digging new ditches unless absolutely necessary. When constructing new roads, give preference to areas with existing ditches or other areas where the water regime has already been altered. When constructing new roads, design culverts with sufficient capacity for existing watercourses and ditches to prevent the formation of new areas that are too wet or too dry.

[135] Timmusk, T., Ots, H., D. 2024. Technical guide for the design of environmental protection facilities for land improvement systems. Commissioned by: Environmental Board.

In the case of structures that significantly alter the water regime, implement a 250 m buffer zone in good condition for wetlands (mapped for planning purposes as communities sensitive to the effects of drainage) or provide for construction measures in the project (e.g., retaining walls, embanked ditches, etc.) to avoid significant drainage effects on communities sensitive to drainage. A smaller buffer zone is also acceptable in situations where the sensitive community is already adjacent to a road, ditch, route corridor, logging area, or other open landscape, i.e., the construction of the building area does not increase the change in the water regime in the sensitive community area.

When reconstructing the bridge over the Õhne River or building a new bridge, it must be taken into account that the consent of the Environmental Board is required for the felling of trees and shrubs in the river's water protection zone (in accordance with § 119 of the Water Act, see section 4.3 for more details). During and after the construction of the bridge, the structure must allow the natural flow of the water body and must not cause any damming. The bottom of the water body must remain uniform under the bridge compared to the bottom of the water body upstream and downstream. Work in the water body must not be carried out during the active spawning and migration period of fish.

When reconstructing the bridge over the Õhne River or building a new bridge, the need to register the activity or obtain a water permit must be taken into account due to the risk to the aquatic environment (Water Act § 196(2), § 187). The need for a preliminary environmental impact assessment (EIA) must also be taken into account when constructing a bridge that will change the cross-sectional area of the water body or when dredging a water body with a volume of 100 cubic meters or more[136] .

4.1.9 Impact on soil, including valuable agricultural land

4.1.9.1 Assessment methodology

The impact on soil was assessed primarily from the perspective of soil fertility. The overlap between arable land and valuable agricultural land mapped in potentially suitable areas of the special plan area was assessed. The aim of the assessment was to identify known agriculturally important areas in potentially suitable areas, the preservation of which would prevent significant adverse effects on valuable agricultural land.

4.1.9.2 Impact on soil

The impact on soil occurs during both the construction and operational phases. The impact is more extensive during the construction phase, when large-scale soil works are carried out. During the operational phase, the impact may occur primarily in connection with possible accidents/incidents, which are discussed in section0 .

The construction of wind farms has an impact on soil primarily in connection with the removal of soil from construction sites. Direct soil works (removal of soil and replacement with fill material) are to be expected within the construction areas. The greater the number of wind turbines to be built, the greater the amount of soil to be removed. The impact on the soil is local and limited to the direct construction areas. At the same time, construction activities have a strong and partially irreversible impact on the soil – the humus-rich layer necessary for vegetation growth is removed and the natural structure of the soil is disturbed. Soil that is converted into a foundation for buildings or remains in their immediate vicinity loses its original function and can no longer be restored or used for its previous purpose.

The area under roads, squares, and foundations in the preliminary design of the wind farm is 69 ha, and in the revised design of 05.2025, it is 42 ha. In addition, the location of the roads has been chosen to make maximum use of existing roads, forest roads, and other areas affected by human activity. The

[136] Government of the Republic Regulation No. 224 of 29 August 2005, "Detailed list of areas of activity for which a preliminary assessment of the need for an environmental impact assessment must be provided," § 11, points 5 and 6.

estimated volume of soil to be excavated for 21 wind turbines (assuming a foundation depth of up to 6 m and a diameter of up to 31 m) is up to 21 x 4,527 m³ = 95,067 m(3).

The area under roads, squares, and foundations in the 05.2025 planning solution for the wind farm is 42 ha. In reality, the area partially overlaps with existing roads, which can be used for construction activities. Part of the construction area also consists of the foundation area for the assembly site, for which the material requirements have already been described. To assess the worst-case scenario, it is estimated that 50% of the construction area will require additional roads and sites. The roads and areas will be constructed mainly from gravel, and the road structure will typically be 40 cm thick. To this extent, it is usually necessary to remove the subsoil. When excavating an area of 42*50% hectares to a depth of 40 cm, the volume of soil to be excavated is 84,000 m³.

In total, the construction of the wind farm is expected to generate approximately 180,000 m³of soil. This is a large amount of soil.

The movement of vehicles and machinery involved in construction work exerts strong mechanical pressure on naturally loose soil, causing it to compact and settle. The extent of subsidence depends on the properties of the soil, the load on the surface, and changes in the groundwater level. Compaction reduces the volume of soil pores, which in turn slows down water infiltration and movement in the soil and limits gas exchange. As a result, the upper layers of the soil become oxygen-deficient, or anaerobic. In compacted soil, plant root development is impeded because the availability of water, air, and nutrients is significantly reduced.

To minimize soil damage, the area covered by construction work should be limited and activities outside the construction site should be avoided. This applies to the storage of construction materials and waste, the movement, maintenance, and storage of machinery, as well as the placement of auxiliary equipment and temporary structures. If temporary storage areas outside the construction site are absolutely necessary, areas with hard surfaces or already disturbed soil should be preferred.

In areas where the soil has been disturbed by construction activities but which are not directly within the construction area (e.g., roadside areas), the natural structure can be restored over time, usually within a few vegetation periods . In contrast, in areas that will be covered by buildings, the natural functions of the soil will be irreversibly lost.

The soil is therefore significantly negatively affected during the construction phase, but this is limited in scope. The impact is mainly limited to the land under the construction and its immediate surroundings and can be mitigated by environmental measures (section4.1.9.4).

4.1.9.3 Impact on valuable agricultural land

Based on ETAK data (as of 01.04.2024), the overlap of arable land with potential pre-selection areas is presented inTable8 . The proportion of arable land in the northernmost potentially suitable area is 20%. The proportion of the southernmost potentially suitable area is 2%.

The comprehensive plan for Tõrva Municipality was adopted by Tõrva Municipal Council on March 21, 2024, with decision no. 1-3/2024/6. The comprehensive plan states that the initial map layer of valuable agricultural land was specified, taking into account changes in existing land use and the built environment. Areas smaller than 2 ha, areas covered by detailed plans, farmyards, forest areas, areas designated for specific land use in the comprehensive plan, and areas proposed for afforestation by the State Forest Management Centre (RMK) were excluded. However, the VPM layer is missing from the layers established in the comprehensive plan (presented as a base data layer, but this layer also includes agricultural land smaller than 2 ha). Valuable agricultural land in the base data layer in relation to potentially suitable areas is presented atFigure29 .

The comprehensive plan sets the following protection and use conditions for valuable agricultural land:

- valuable agricultural land shall be kept in agricultural use. Afforestation is not permitted, but landscape elements such as rows of trees or hedges, stone fences or groves of trees may be established or allowed to develop naturally on valuable agricultural land in order to protect the soil, mitigate climate damage or diversify the spatial form of the agricultural land mass. Valuable agricultural land may also be used as a plant nursery, tree nursery or for growing trees and shrubs with a rotation period of up to five years.

- new buildings for various purposes (residential buildings with outbuildings, public buildings, commercial and industrial buildings, livestock buildings or other agricultural buildings, recreational buildings, roads, renewable energy production facilities that generate electricity using wind power, or other buildings) and/or existing buildings may be expanded, but:
    - buildings must be located primarily along existing roads and field boundaries, avoiding the fragmentation of agricultural land;
    - the construction of new roads must be avoided where possible, and access to the building must be provided primarily using existing roads. If the construction of a road to valuable agricultural land is unavoidable, the road must be constructed in a way that causes as little damage as possible to the use of the agricultural land. If the construction of a road results in the division of a valuable agricultural land mass into several parts, the size of the agricultural land mass formed as a result of the division must be at least two hectares;
- A new building may be constructed on valuable agricultural land or an existing building may be extended if, prior to the designation of the valuable agricultural land in the comprehensive plan, a detailed plan has been established for the land or design conditions, building permits, and building notices have been issued.
- valuable agricultural land does not prevent the application for and issuance of a mining permit in accordance with the procedure established by law.

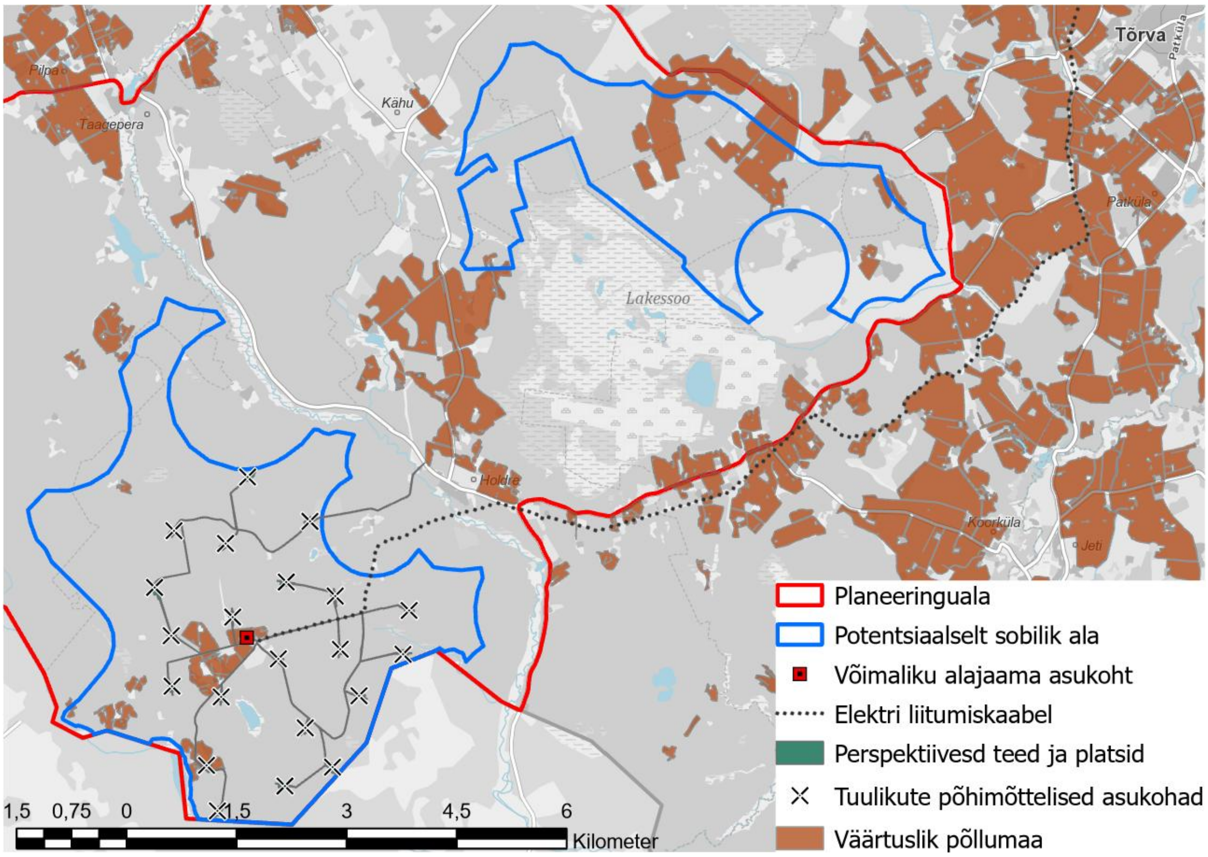

Figure29 . Location of valuable agricultural land in relation to potentially suitable areas. Source: Tõrva municipality comprehensive plan base data from the planning database.

In the case of the wind farm solution developed in the plan, there is an overlap with valuable agricultural land (used as grassland) in the case of one wind turbine position. This is a location planned adjacent to an existing road. The wind turbine can be constructed without significantly fragmenting the agricultural land.

In addition, a substation location has been planned on valuable agricultural land (used as pasture). This location is also adjacent to an existing road, which means that the substation can be built without significantly fragmenting the agricultural land.

4.1.9.4 Measures, need for further studies and assessment

At the site selection stage:

When planning the wind turbine and infrastructure on valuable agricultural land, place the structures on the edge of the land to ensure efficient use of the land. The wind farm must not significantly impair the intended use of valuable agricultural land.

During further design and operation:

Transport and construction machinery that is in good working order and well maintained must be used for construction work. The leakage of hazardous substances from vehicles and machinery into the environment must be prevented.

The topsoil that is removed must be reused on site as much as possible. On farmland, the topsoil that is excavated must be spread on the surrounding agricultural land. If reuse on site is not possible, the soil must be handled in accordance with the applicable regulations, ensuring maximum reuse.

The planning area is an area where sand deposits can be expected (there are several sand quarries in the region). If the excavated soil is suitable for use as a building material, ensure its maximum reuse in construction projects.

Once the soil work has been completed, the area affected by the construction work must be restored.

4.1.10 Possible impact on climate le

4.1.10.1 Assessment methodology

The assessment of climate impacts is based on the principles and guidelines described in the European Commission's Communication "Technical Guidelines for Climate Resilient Infrastructure 2021-2027" (2021/C 373/01). Accordingly, climate impacts are addressed in two parts:

1) the impact of activities on the climate/climate change;
2) climate resilience of activities.

The assessments take into account the degree of planning accuracy and, based on this, no detailed climate impact assessment is carried out for each wind farm.

The impact on the local climate has been assessed on the basis of a review of scientific literature.

4.1.10.2 Impact on climate change

Global warming affects both the human environment and the natural environment. If the global average temperature increase compared to pre-industrial levels cannot be kept below 1.5°C, this will have serious negative consequences for both human living conditions and many other species and communities. In order to slow down global warming, it is necessary to immediately reduce the emission of anthropogenic greenhouse gases into the atmosphere . [137]

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[137] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

The main sources of greenhouse gas emissions are the production, processing, and combustion of fossil fuels and energy production. The construction of wind farms for electricity generation means increasing the share of electricity production based on renewable energy sources, which creates the conditions for reducing greenhouse gas emissions from the combustion of fossil fuels, **thereby having a potentially positive impact on slowing down climate change.**

The production of wind turbines uses resources and emits greenhouse gases. A wind turbine compensates for the energy and CO_2emissions consumed in its production, operation, and dismantling in 7–8 months of operation. For example, in the case of Vestas V162-4.2 MW wind turbines, the payback period is 7.6 months under low wind conditions. **During its lifetime, a wind turbine produces 31 times more energy than it consumes during its entire life cycle.**

The$_{CO_2}$emissions of wind turbines depend on the size of the turbine (e.g., for a Vestas V150 6.2 MW wind turbine, 7.1 g CO_2 /kWh[138]), the higher the capacity of the wind turbine, the lower the greenhouse gas emissions per unit of energy produced (kWh)[139] . The estimated production of the wind farm is 490,000 MWh/a. This means that CO2 emissions related to wind turbine production would be 3,500 tons of CO2.

For comparison, oil shale-based electricity production generates 1000 g CO_2 /kWh [140] , while Estonian electricity production will generate 715 g CO_2 /kWh [141] in 2022. Considering that the plan envisages 21 wind turbines with an estimated nominal capacity of 7 MW. The estimated production of the wind farm is 490,000 MWh/a. This means that if this amount of energy replaces the current fossil fuel-based energy production, approximately 350,000 tons of CO2 will not be emitted into the air.

Therefore, the construction of the wind farm will have a significant positive impact on reducing Estonia's greenhouse gas emissions and thus slowing down climate change.

The carbon footprint assessment of wind turbines also takes into account the SF_6 used in wind turbines, which is a powerful (1 SF_6 =23,500 CO_2). 0.1% of the SF_6 in a wind turbine leaks from the turbine each year, and a total of 2% of the gas used leaks during the lifetime of the turbine[142] . Gas leakage plays a significant role in the carbon footprint of wind turbines. However, even taking this into account, the carbon footprint of wind turbines remains significantly smaller than that of power plants running on fossil fuels.

The establishment of wind farms in potentially suitable areas is accompanied by the clearing of forest land and the drainage of wetlands. The clearing of forest land and the drainage of wetlands cause irreversible changes to the environment, which in turn **affects carbon storage and sequestration.**

The construction of wind farms involves the clearing of forest land in areas where wind turbines overlap with forests. The clearing of forest land causes irreversible changes to the environment and affects carbon storage and sequestration. The total carbon stock (t/ha) of forest woody biomass (coarse roots, trunks, branches) has been estimated for the whole of Estonia in the course of the ELME project. All wind turbine positions overlapping with forest areas are planned for areas with low carbon stock woody biomass (Figure30).The carbon stock stored in wood biomass overlapping with the

[138] https://www.vestas.com/en/energy-solutions/onshore-wind-turbines/enventus-platform/v162-7-2-mw

[139] Raadal, H.L., Gagnon, L., Modahl, I.S., Hanssen, O.J. 2011. Life cycle greenhouse gas (GHG) emissions from the generation of wind and hydro power. Renewable and Sustainable Energy Reviews. Elsevier. 15. pp. 3417-3422.

[140] European Environmental Agency. 2022. Greenhouse gas emission intensity of electricity generation by country.

[141] Elering 2023. Electricity mix emissions 2022.

[142] Vestas. 2023. Life Cycle Assessment of Electricity Production from an onshore EnVentus V162-6.2 MW Wind Plant.

indicative planned wind farm construction area is calculated to be 1.6 thousand tons of CO2 based on ELME project data.

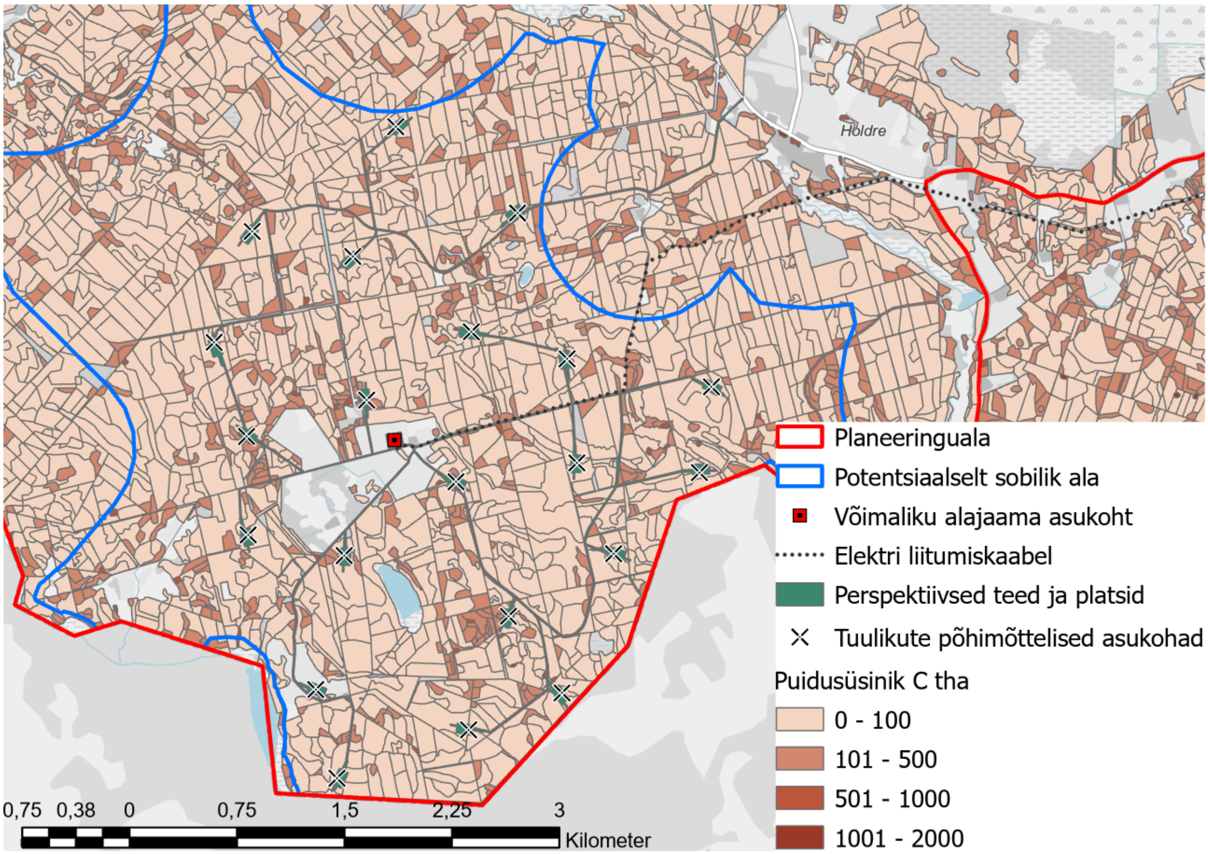

Figure30 . Overlap of wind turbine positions with forest carbon stocks. Source: www.keskkonnaagentuur.ee/elme

At the same time, soil carbon stocks in this region are higher than average. Wind turbines overlap with soils with average and above-average carbon stocks (Figure31). The indicative planned wind farm construction area overlaps with soil carbon stocks of approximately 29.7 thousand tons of CO2. Conservatively, it can be estimated that all soil carbon stocks will be released during construction.

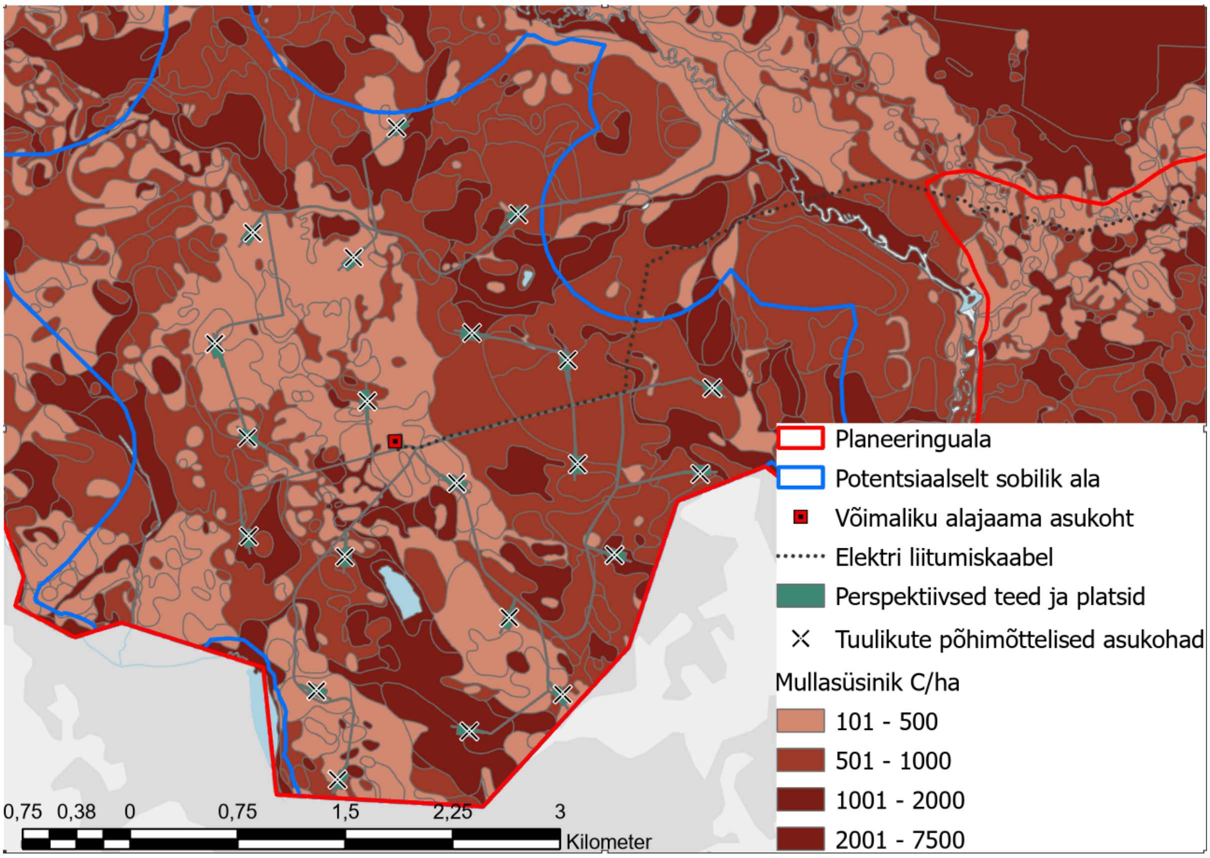

Figure31 . Overlap of wind turbine positions with soil carbon reserves. Source: www.keskkonnaagentuur.ee/elme

Considering the CO_2reduction effect of wind farms, this significantly exceeds the reduction in carbon sequestration resulting from deforestation and soil removal. Therefore, the construction of wind farms has a strong positive impact in terms of reducing climate impact. However, the construction of wind farms also has a negative impact on carbon sequestration targets in the land use sector. **The impact of deforestation must be compensated for in accordance with the Forest Act and the Environmental Charges Act.**

4.1.10.3 Impact on the local climate

The impact of wind farms on the local climate has received relatively little attention so far. However, existing research on the subject suggests that the construction of particularly large wind farms can cause local microclimatic changes. It has been found that wind turbines affect air flows near the ground , which in turn can cause changes in ground-level temperatures and, according to some studies, also in precipitation . The following overview is based on a review article published in 2024[143] , which summarizes the relevant scientific research findings published on this topic. The review article shows that the majority of studies on the local climate impact of wind farms originate from regions with predominantly dry and warm climates. The leading studies are those conducted in China, but when transferring the results to Estonian conditions, it must be taken into account that China has very large wind farm areas and climate conditions that differ from those in Estonia.

[143] Jia Z, Yang X, Chen, A, Yang, D, Zhang, M, Wei, L. Localized Eco-climatic Impacts of Onshore Wind Farms: A Review[J]. Journal of Resources and Ecology, 2024, 15(1): 151-160 https://doi.org/10.5814/j.issn.1674-764x.2024.01.013

According to the review article, studies on the impact of onshore wind farms on ground temperature have mainly used three types of data: remote sensing data, temperature measurements in wind farms, and climate models.

Although some simulation-based studies have found that wind farms can actually lower temperatures in mountainous or canyon areas, the vast majority of studies have found that onshore wind farms cause an increase in ground temperatures in the wind farm area and downwind of it. Most studies agree that wind farms warm the air near the ground, although the extent of the warming varies:

- The temperature difference is usually less than 1°C.
- The change is most noticeable at night (under stable atmospheric conditions).
- The daytime effect is often negligible or non-existent.

Studies on wind speed changes are mainly based on measurement results and climate models. Measurement data from wind farms in China and Mongolia show that after the construction of wind farms, the average annual wind speed decreased by 1.5% and the maximum wind speed decreased by 18.5%. Model simulations confirm these results, showing a significant decrease in wind speed at the height of the turbine rotor downwind of the wind turbine.

Onshore wind farms cause soil drying, with the greatest decrease in moisture content – up to 4.4% – occurring within the wind farm. A negative correlation was observed between moisture content and distance from the wind farm, meaning that the impact was strongest within the farm and dissipated further away. Although the magnitude of the impact varies depending on the area studied and the data used, the overall trend is clear: wind farms affect both evaporation and precipitation patterns. According to studies, precipitation around wind farms increases by ~1% compared to the long-term average. The spatial impact may vary depending on the landscape and modeling choices. There is some inconsistency in the results due to differences in data sets and models. Based on the above, plant growth may be inhibited in arid regions due to a decrease in soil water reserves.

Studies are relatively unanimous on the mechanism by which wind farms affect the local climate. The impact of wind farms on temperature is mainly explained by their effect on the lower layer of the atmosphere. On a day without wind farms, solar radiation warms the ground faster than the air. The air temperature near the ground is warmer than higher up, creating an unstable layer where warm air is below and colder air is above. In such a situation, the lower layer of the atmosphere is unstable and mixing occurs naturally. At night, there is no solar radiation and the ground cools faster than the air. A stable stratification occurs, with cold air below and warmer air above. The lower layer of the atmosphere becomes stable and mixing decreases. The impact of wind farms is therefore more noticeable at night. The turbine rotor causes vertical mixing, which warms the air near the ground. As wind speeds are usually higher at night, the turbulence is stronger and the nighttime warming is more pronounced.

Scientific research therefore shows that wind farms have an impact on the local climate. However, when interpreting the results, the potential significance of the impact must also be considered, taking into account Estonia's normal climate and its inherent variability. It should be understood that the impact on the local climate can be significant if the change in the local climate is large enough to cause a change in climatic conditions that is sufficient to alter the growing conditions for natural or agricultural communities. At the statistical level, the impact of the local climate under certain weather conditions may not necessarily cause the impact necessary to change the growing conditions of communities. This is especially true considering Estonia's temperate climate. Looking at data from the Valga meteorological station, which is closest to the planning area, it appears that there is significant variation in precipitation and average temperature. According to data from the Valga meteorological station, the highest annual precipitation in the period 2004–2024 was ≈ 833 mm in 2012. The lowest annual precipitation was ≈ 295 mm in 2006. Thus, the annual precipitation can vary by almost three times. The highest average annual temperature was ≈ 8.30 °C in 2020. The lowest average annual temperature was ≈ 5.09 °C in 2010. This means that over the last twenty years, the average annual temperature has fluctuated by up to 3.21 °C. The natural communities found in Estonia have developed under varying climatic conditions, and the microclimatic effects associated with wind farms identified in scientific studies to date are lower than the normal variability of our climate.

Considering the data presented in scientific studies on the possible impact of wind farms on the local climate, taking into account the climatic conditions in Estonia and the size of the wind farm planned in this plan, no significant impact on the local climate is expected. The planned wind farm is not expected to cause microclimatic changes that would have a significant impact on vegetation cover or other factors.

Microclimatic impacts in the context of this wind farm are primarily related to productivity (*the* so-called *wake effect*), which the wind farm developer must take into account when selecting a suitable wind turbine model to ensure the efficiency necessary for the economic viability of the wind farm. This issue is not within the scope of the SEA assessment, but should be assessed in the developer's business project profitability analyses.

4.1.10.4 Climate resilience

The following factors have a direct impact on wind energy resources and their use in onshore wind farms:[145]

- average annual wind speed;
- extreme weather conditions (storms, ice and lightning);
- microclimatic conditions (wind turbulence).

Of all renewable energy sources, wind energy benefits most from climate change, as wind speeds have shown a clear upward trend during the cold half of the year when energy demand is highest[144] . When establishing wind farms, it is also important to consider possible changes in prevailing wind directions so as not to lose potential energy due to shadowing between wind turbines caused by incorrect placement.

Due to the possible increase in extreme wind gusts, there may be a greater risk of wind farms being shut down, as wind turbines are shut down for safety reasons in the event of storm winds. For the most common commercial wind turbines, the wind speed range for shutdown is 20–25 m/s. If wind turbines are shut down on a large scale, this jeopardizes the stability of the energy system and requires additional rapid compensation capacity. In addition to the impact of more frequent extreme wind speeds and protective mechanisms, increased precipitation can also hinder maintenance crews' access to onshore wind turbines. This requires the reinforcement of access roads.[145] Wind turbine manufacturers are working to increase the durability of wind turbines in the face of increasingly frequent extreme weather conditions. The climate resilience of wind farm roads, routes, and foundation solutions must be addressed during the construction design process.

The increasing frequency of extreme weather conditions resulting from climate change may increase the frequency of ice formation in Estonia. The risk of wind turbine icing can be minimized, and various technological solutions (e.g., anti-icing systems) have been developed for this purpose. Anti-icing systems are generally solutions that allow hot air to circulate inside the wind turbine blade to melt the ice after it has formed. In addition, modern wind turbines can be equipped with sensors that stop the turbines when ice forms, allowing maintenance technicians to safely remove the ice from the blades.

[144] Kallis, A., Kull, A. Roose, A., Järvet, A., Kriis, E., Abroi, E-L., Põdersalu, H., Laas, I., Võrno, I., Jaagus, J., Kriiska, K., Eerme, K., Lember, K., Rannik, K., Aidla, K., Kaar, K., Kaare, K., Sakkeus, L., Kaasik, M., Mandel, M., Viisimaa, M., Möls, M., Kabral, N., Roots, O., Talkop, R., Laasma, T., Kallaste, T., Anis, T., Räim, T., Adermann, V., & Suursaar, Ü. 2013. Estonia's Sixth Climate Report.

[145] Final report on the strategy for adapting Estonia's infrastructure and energy sector to climate change – https://cdn.sei.org/wp-content/uploads/2017/12/enfra-a-uuringuaruanne-01-04-2016.pdf.

When selecting wind turbines, the climatic conditions in Estonia must be taken into account and suitable technical solutions must be used.

If wind turbines are not equipped with an anti-icing heating system, they must be located at a sufficient distance from sensitive objects (residential buildings, roads). The maximum impact area of ice fragments can be calculated using the formula 1.5×(tower height + rotor diameter)[146] . This is a simplified distance formula that has been used in several guidance documents. If necessary, it is possible to calculate the danger zone and the magnitude of the risk more accurately, but this is only relevant if sensitive objects remain within the initial assessment danger zone[147] . In this case, the danger zone for ice fragments extends up to 540 m. The wind turbines are planned to be located at least 1 km away from residential buildings. **Therefore, in this case, no significant risk to residential areas due to icing is expected. At the same time, several wind farm areas are crossed by forest roads used for forest management and public roads. On icy days, there is a risk of ice chunks being thrown onto the roads.**

Potentially suitable areas are not located in flood-prone areas[148] .

4.1.10.5 Measures, need for further research and assessment

Further design and operation:

The impact of forest clearing must be compensated for in accordance with the Forest Act and the Environmental Charges Act.

This SEA considers the distance from the wind turbine of 1.5×(tower height + rotor diameter) to be the danger zone for ice throw, which is the maximum extent of the danger. As the danger zone has been determined in general terms, the wind farm owner may reduce the extent of the danger zone on the basis of a more precise risk assessment. In order to reduce the risks associated with icing, it is recommended that wind turbines located in danger zones with public access roads be equipped with an anti-icing system. If this is not done, instructions for action in the event of icing must be drawn up for the wind farm and compliance with these instructions must be ensured. In the event of a risk of icing, it may be necessary to mark roads within the danger zone with appropriate warning signs or to use other risk reduction measures.

4.2 Restrictions arising from infrastructure and land use

4.2.1 Roads and traffic safety

Methodology: The impact on roads has been assessed based on the Transport Agency's heavy goods vehicle map application and the Road Register database. GIS analysis and expert assessment have been used to make estimates based on the current legal framework.

The construction and subsequent maintenance of wind turbines requires **high-capacity and permanently accessible** access roads to the turbines. When using existing roads, they will be repaired before the wind farm-related work is carried out and again after the work is completed. Based on current practice, the use of roads in wind farms is not restricted, so the roads to be built will also remain in local use (restrictions due to safety requirements may apply to roads within the wind farm, see4.1.10.5). However, it should be noted that during the construction of the wind farm, there may be disruptions related to the use of local roads, as the transport of materials, including large loads,

[146] Deutscher Naturschutzring Grundlagenarbeit für eine Informationskampagne "Umwelt- und naturverträgliche Windenergienutzung in Deutschland (onshore). 2005.

[147] IEA Wind TCP. 2022. Technical Report International Recommendations for Ice Fall and Ice Throw Risk Assessments.

[148] Piirimäe, K., Raidla, M., Uuemaa, E., Peetersoo, A., Kiiker, K., Reitalu,T. 2021. List of inland water bodies prone to major flooding and high water levels. Report. Public procurement no: 223733.

will cause additional traffic and possible changes in traffic management. **The impact on the local road network and well-being during construction is therefore moderately negative. The impact occurs in both potentially suitable areas. The exact extent of the impact depends on the traffic management during construction.**

The biggest challenge in relation to roads when establishing wind farms is the delivery of wind turbine components. Wind turbines are not currently manufactured in Estonia and are mainly delivered to Estonia via the specially adapted Port of Paldiski. Therefore, it is necessary to transport the wind turbine components from the Port of Paldiski to the selected locations. The distance is approximately 350 km by the most direct route, and the loads are large. According to information published by the Transport Administration (Figure32), there are existing special transport corridors in the special planning area up to the Valga–Uulu main road No. 6. The roads from the special transport corridors to potentially suitable areas will likely require reconstruction during transport, which may include straightening curves and widening roads.

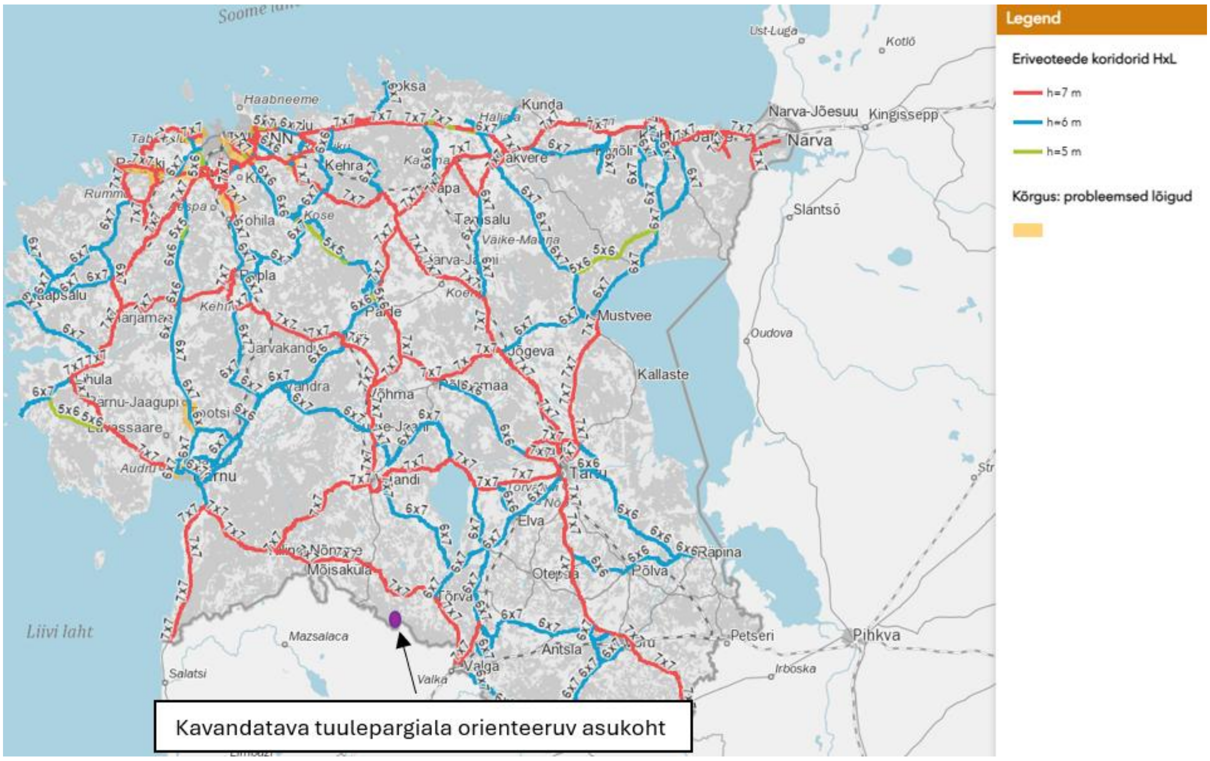

Figure32 . Location of special transport corridors.

From 17 November 2023, the distance of wind turbines from roads will be determined by Regulation No. 71 of the Minister of Climate, "Road Design Standards." The minimum distance of an electric wind turbine from the edge of the road surface is determined by the formula L=(H+0.5D), where:

1) L is the minimum distance of the wind turbine from the edge of the road surface in meters;
2) H is the height of the wind turbine mast in meters;
3) D is the diameter of the wind turbine rotor or blade in meters.

The reason for the distance restriction is primarily **the risk** of wind turbines **freezing** in the Estonian climate**, but the distance also helps to reduce the shadowing of wind turbines on roads and to ensure road safety in the event of possible accidents**. The developed planning solution takes the restriction into account, and the distance is guaranteed for roads designated for public use that pass through the area.

4.2.1.1 Measures, need for further research and assessment

In further design and operation:

Based on the technical requirements of the selected wind turbine, a more detailed analysis of possible access roads must be prepared when drawing up the wind farm project. This requires cooperation with road owners, including the Transport Administration. If necessary, the necessary intersection reconstructions and road widening must be carried out, and traffic management measures must be implemented to ensure the safe delivery of wind turbines.

4.2.2 Impact on mineral resources

Methodology: The impact on mineral resources has been assessed based on the map application of the Land and Spatial Planning Agency's geoportal and the data from the Mineral Resources Register. GIS analysis and expert assessments have been used, based on the current legal framework for mineral resources.

The northern part of the potentially suitable area partially overlaps with the Lagesoo peat deposit (registry card no. 220) on its southern edge. (Figure33) The part of the deposit that overlaps with the potentially suitable area is not included in the list of peat areas suitable for extraction presented in Regulation No. 87 of the Minister of the Environment.

The southern part of the potentially suitable area partially overlaps with the Holdre sand deposit (registry card no. 373) with an area of 16.52 ha, as recorded in the mineral resources register[149] as of 05.04.2024. No wind turbine sites are planned for this deposit area. The Variku sand quarry, which is also covered by the potentially suitable area, is located in this deposit area and does not overlap with any wind turbine sites. The potentially suitable area also partially overlaps with the Holdre III active exploration area (exploration conducted by Maavarauuringud OÜ, exploration permit no. L.MU/509835), which also does not overlap with the planned wind turbine locations. The potentially suitable area borders the service area of the existing Variku sand quarry (mining permit no. VALM 015, permit holder SARAPIKU OÜ) to the north (Figure33).

When planning a wind farm adjacent to a peat production area, it must be taken into account that peat extraction generates dust (fine particles PM_{10}), which can spread both horizontally and vertically. Under favorable weather conditions (very strong winds, long dry periods, low humidity), the dust may spread beyond the peat production area. Peat extraction does indeed generate peat dust, which, according to environmental impact assessments of various peat production areas, can travel up to 5 km. The potentially suitable northern area is directly adjacent to the border of the Lagesoo peat deposit, with the nearest active peat production area, the service area of the mining concession (Lagesoo peat production area, mining permit no. VALM 004, permit holder AS VALMAP GRUPP), located approximately 106 m to the south. The aforementioned (and closest) peat production area is located approximately 2.3 km south of the potentially suitable area and approximately 3.4 km from the indicative location of the closest planned wind turbine. No significant peat dust is expected at this distance.

In the case of sand and gravel quarries, no significant impact of wind farms on mining or mining on wind farms is expected. Mining areas, service areas, and potential mining areas (i.e., exploration areas) should be excluded from the selection of wind farm locations, as they are not land uses that can occur simultaneously. **At the same time, the presence of existing sand and gravel quarries in the immediate vicinity of the wind farm to be built can be considered a factor that reduces the environmental impact. The sand and gravel needed to build the wind farm can therefore be obtained from a nearby quarry, which reduces the impact of transporting construction materials.**

[149] https://geoportaal.maaamet.ee/est/Ruumiandmed/Geoloogilised-andmed/Maavarade-register-p83.html

Pursuant to § 15(1)(1–3) of the Subsoil Act, if activities affecting the condition and use of the subsoil are to be carried out on a deposit, the intended use of a cadastral unit is to be changed, or land granted for use is to be acquired, a permit is required from the Ministry of Climate or, with the authorization of the Minister of Climate, from the state agency responsible for ensuring the state's geological competence (Estonian Geological Survey).

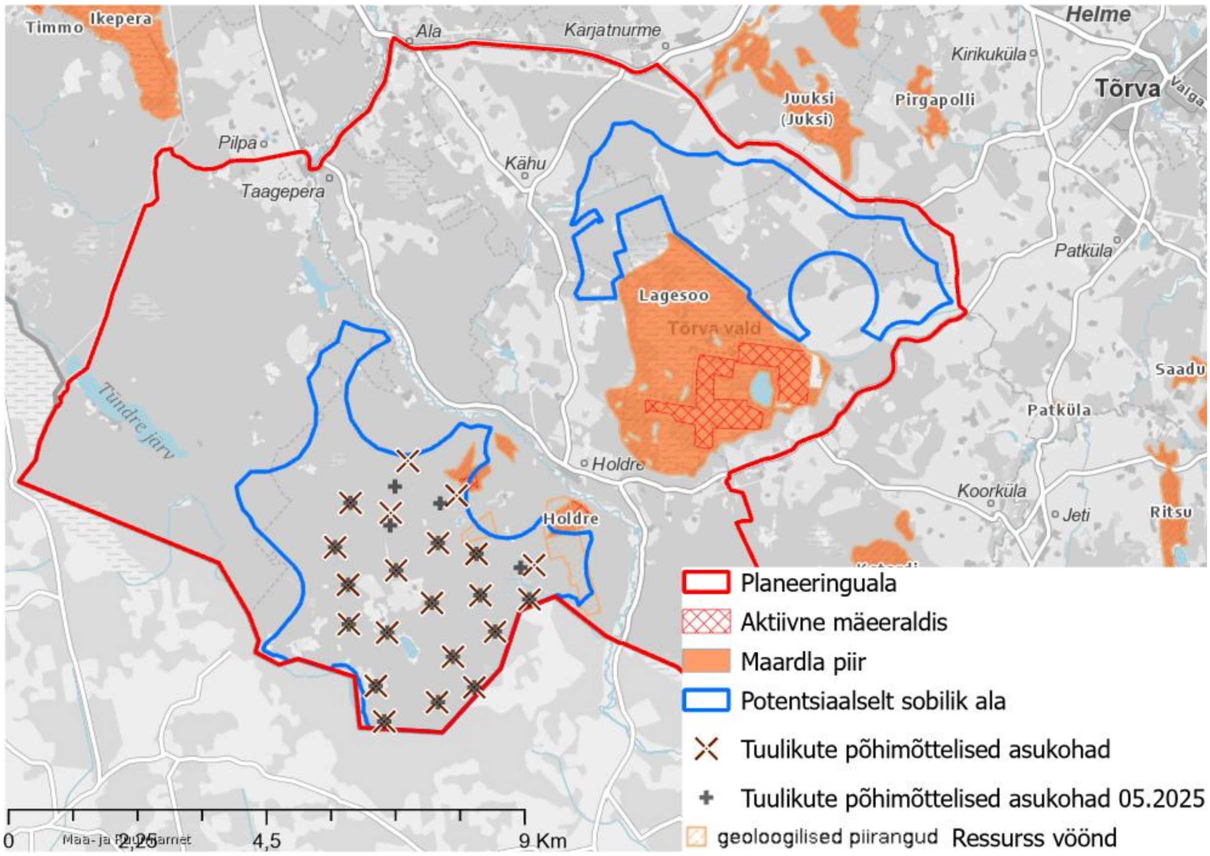

Figure33 . Potentially suitable areas are located in the vicinity of mineral deposits and active/applied-for mining areas and exploration areas.

If the wind farm is not planned for a deposit area or an active geological exploration area, no significant impact on mineral resources is expected.

4.2.2.1 Measures, need for further studies and assessment

In order to avoid conflicts over land use, it is appropriate to exclude mining concessions and their service areas, as well as applied for and active mineral exploration areas (except for general geological research areas) from the selection of locations for wind farms. Due to conflicting land use interests, it is not possible to build wind turbines on mining concessions or their service areas before the relevant mineral resources have been exhausted. However, as special planning is a type of planning that tends to focus on short-term development prospects, it is not appropriate to plan wind farms in locations where it will not be possible to build them in the near future.

4.2.3 Other impacts

4.2.3.1 Impact on national defense objects

Potentially suitable areas were identified based on known information about the location of national defense structures and their restricted areas. Restricted areas have been treated as areas excluded from the location of wind farms.

Potentially suitable areas do not overlap with the impact area of national defense facilities.

The establishment of a wind farm is only possible on condition that it does not affect national defense. The special planning area falls entirely within the sector published by the Ministry of Defense, which includes the Central Estonia compensation area from 2025 (Figure34). Preliminary work on the construction of the wind farm can begin before the implementation of the aforementioned compensation measures in 2025.

Each specific wind turbine location/coordinate must be coordinated with the Ministry of Defense. If the Ministry of Defense deems the location unsuitable for the construction of a wind turbine, the location restriction will remain in force even after the compensation measures have been implemented. If the Ministry of Defense considers the proposed location suitable for the construction of a wind turbine, the national defense height restriction at that location will be lifted after the implementation of the compensation measures. All applications for wind turbine construction permits must be coordinated with the Ministry of Defense.

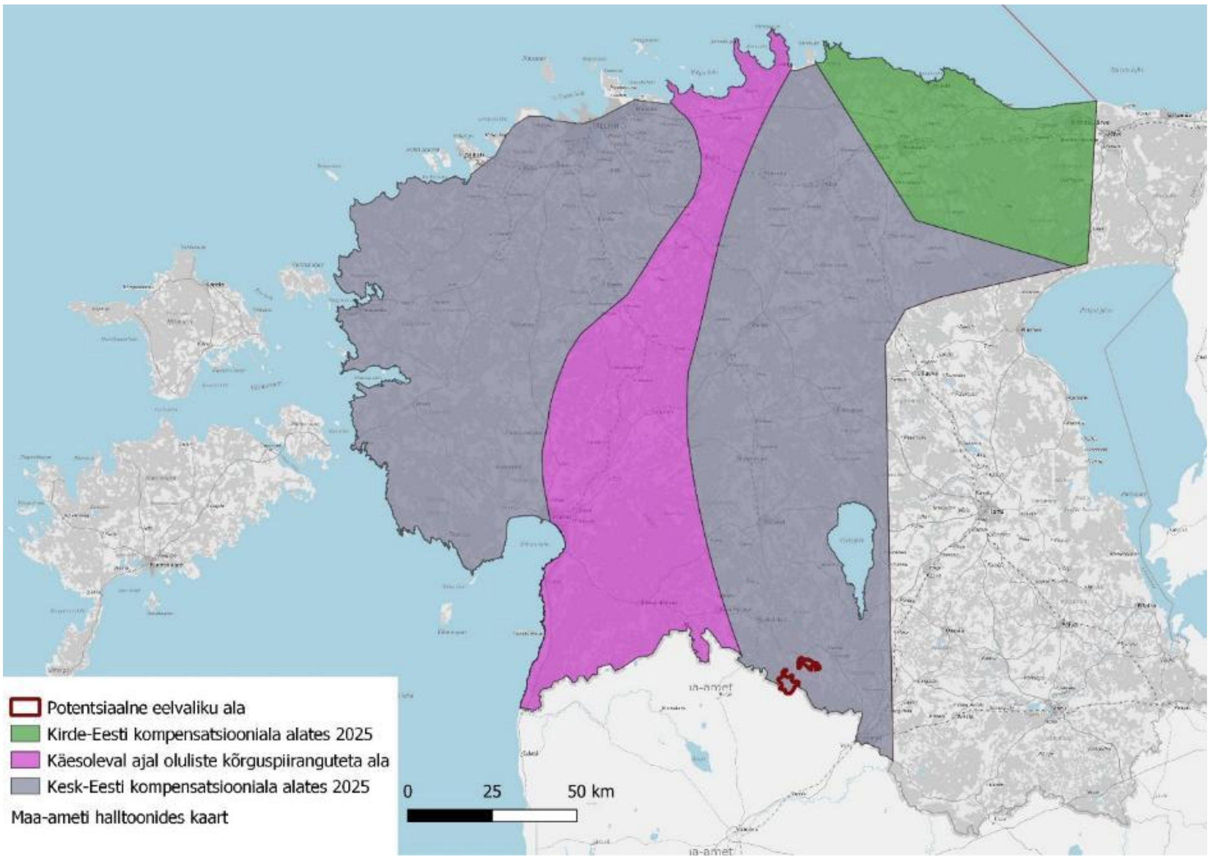

Figure34 . Areas subject to national defense height restrictions. Source: Ministry of Defense.

The planning area, including the potentially suitable area to the south, borders the border of the Republic of Estonia. There are no direct restrictions on construction activities in this section of the state border. According to the assessment of the Police and Border Guard Board, there is no need for a buffer zone for wind turbines along the state border. All wind turbines, assembly sites, roads, and cable corridors can be planned in such a way that the entire construction area (including the blade projection on the ground) remains within the territory of the Republic of Estonia.

Therefore, the implementation of the planning solution is not expected to have a significant adverse impact on national defense.

4.2.3.2 Impact on mobile, radio and television signals

Wind turbines are associated with interference with mobile, radio and television signals. Wind turbines can potentially interfere with electromagnetic waves used in telecommunications, navigation, radar systems, etc.

The occurrence and significance of interference depends on:

- the location of the wind turbine in relation to the transmitter and receiver;
- the characteristics of the wind turbine blades;
- the characteristics of the receiver;
- the signal frequencies.

Interference can be caused by the wind turbine tower, rotating blades, and generator. The tower and blades can block, reflect, or refract electromagnetic waves. The blades of modern wind turbines are generally made of fiberglass, which has a minimal effect on electromagnetic wave radiation. Similarly, the generators of modern wind turbines no longer cause significant interference. Interference may therefore occur in cases where wind turbines are located directly between the transmitter and receiver, and the problem may be significant if the wind turbine is close to the receiver. In this case, the wind turbines are planned to be located at least *approximately* 1 km away from the receivers (residential buildings).

There are several communication masts in the area of potentially suitable sites (Figure35). In order to assess the impact of wind turbines on the operation of communication masts, it is necessary to cooperate with communication companies in the further preparation of the plan. The planned wind farm will not be located between communication masts and residential areas in Estonia. Therefore, it is unlikely that there will be a significant impact on communication services in the region.

Onshore wind farms are not considered a potential threat to the functioning of maritime navigation systems, but they may have an impact on aviation safety and the operation of weather radars.

The closest meteorological radars to the planned activity area are the radar operated by the Estonian Environment Agency in Sürgavere and the radar of the Latvian Environment, Geology and Meteorology Center, which is located on the territory of Riga Airport[150] . The World Meteorological Organization (WMO) and the European Meteorological Services Network (EUMETNET) recommend maintaining certain distances from weather radars, where the construction of wind farms should be avoided (up to 5 km for C-band radars and 10 km for S-band radars) or to coordinate with the radar owner (up to 20 km for C-band radars and 30 km for S-band radars)[151] . However, some studies suggest that the 20 km limit for C-band radars should be increased, as the impact can be observed at greater distances[152] . The two radars in Estonia and Latvia are located more than 100 km from the planned wind farm. Considering the distance of the weather radars from the planned wind farm, it is not expected that the planned turbines will significantly affect the performance of the radars.

The European Organisation for the Safety of Air Navigation (EUROCONTROL), taking into account the International Civil Aviation Organization (ICAO) guidelines for regulating construction in restricted areas of air navigation facilities related to air traffic management, has developed guidelines for air navigation service providers and wind farm developers on the need to assess the impact of wind turbines on navigation systems and the procedures for doing so[153] . The guidelines define the extent of the zones in the vicinity of air traffic surveillance radars where the impact of wind turbines should be assessed. The zones may extend up to 15 km from the radar. In the case of this wind farm, there are no air traffic control radars at such a distance. Nor are there any airports at such a distance whose instrument systems would need to be assessed for impact.

The impact on national defense is discussed in section4.2.3.1 and is largely related to the impact on the operational capability of national defense radars. National defense radars in Estonia are located in Kellavere, Levalõpme, and Otepää. The competent authority in Estonia for providing relevant assessments on this issue is the Ministry of Defense, to which the plan is also submitted for coordination.

The Latvian armed forces use radars in Čalase, Lielvārde, and[154] to monitor airspace. Given the great distance (all more than 100 km away), it can be assumed that the planned wind farm will not affect

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[150] https://www.eumetnet.eu/wp-content/themes/aeron-child/observations-programme/current-activities/opera/database/OPERA_Database/index.html

[151] Finnish Meteorological Institute, EUMETNET OPERA PROGRAMME (2004–2006) – Operational programme for the exchange of weather radar information, Final report, 2007.

[152] VINDRAD. Project report v1.0, A tool for calculation of interference from wind power stations to weather radars, 2011.

[153] European guidance material on managing building restricted areas: 3rd edition, International Civil Aviation Organization, 2015.

[154] https://en.wikipedia.org/wiki/Baltic_Air_Surveillance_Network

Latvian airspace monitoring functions. Latvia will be involved in the planning process based on the potential cross-border impact, and the competent Latvian authorities will have the opportunity to submit their own assessment on this issue.

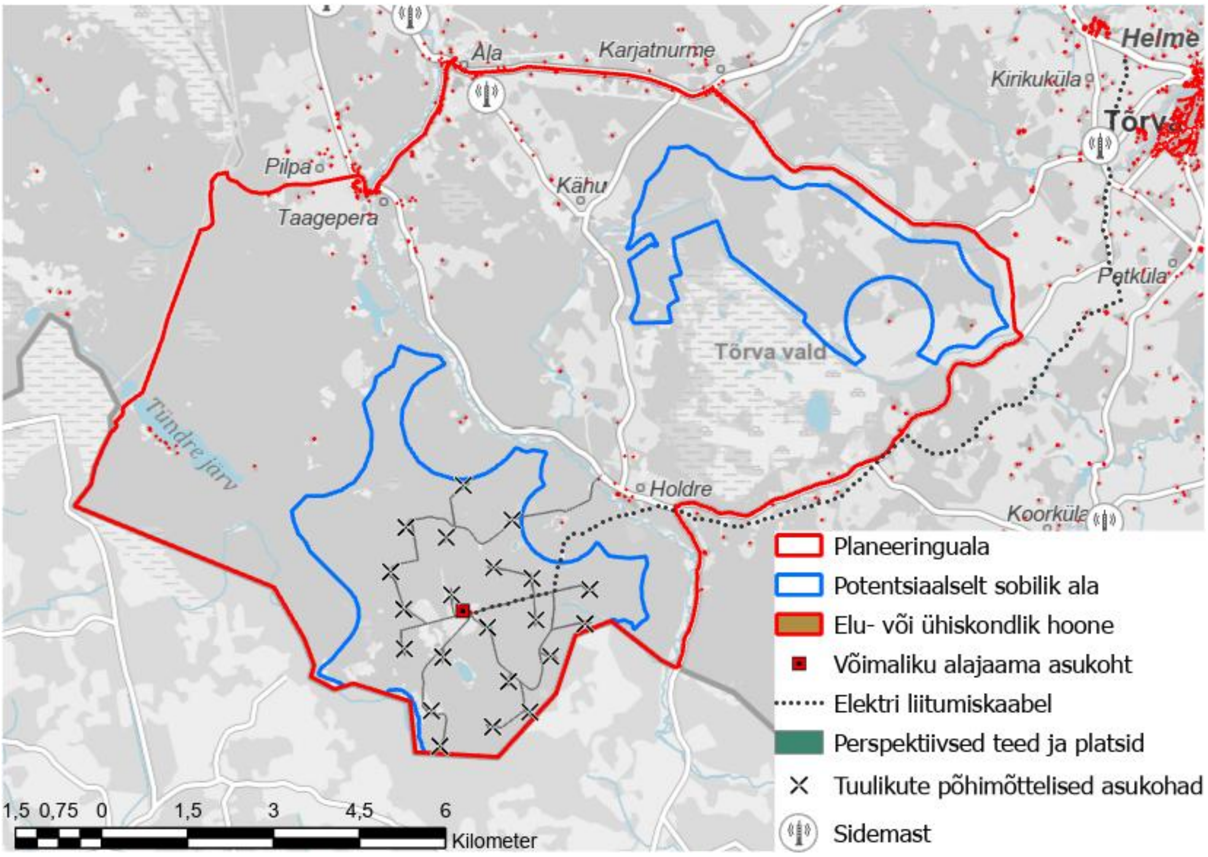

Figure35 Location of communication masts in relation to potentially suitable areas in the special planning area, based on ETAK data as of 10.08.2023.

Impact on television reception: In the case of analog television, electromagnetic waves had a significant impact on TV signals. The impact mainly consisted of TV image distortion (e.g., image flickering in sync with the rotation of wind turbine blades)[155(,)156] . In the case of digital and SAT TV, the impact has been found to be minimal.

Mobile and radio communications: Wind turbines are large structures and, like large buildings, they can create so-called dead zones in mobile communications. Therefore, when placing wind turbines, the direction in which the wind turbine is located from the mobile communication base station should also be taken into account in order to eliminate possible dead zones. In general, wind farms do not have a significant impact on mobile coverage unless the wind turbine is located in the immediate vicinity of a mobile mast (closer than 500 m). In this case, the wind turbines are not located in the immediate vicinity of any known mobile base stations. **Minor interference with mobile communications in the area is possible. In order to clarify the significance of the interference and, if necessary, find mitigation measures, cooperation with mobile operators is required when preparing the plan.**

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[155] Sengupta, D.l., Senior, T.b.a. 1994. Electromagnetic interference from wind turbines. Wind Turbine Technology. ASME, New York.

[156] Anguloa, I., de la Vega, D., Cascón, I., Cañizo, J., Wu, Y., Guerra, D., Angueira, P. 2014. Impact analysis of wind farms on telecommunication services. Renewable and Sustainable Energy Reviews. Volume 32, April 2014, pages 84-99.

4.2.3.3 Measures, need for further studies and assessment

Further design and operation:

During further planning of the wind farm, cooperation with the Ministry of Defense, the Transport Agency, the Information Technology and Development Center of the Ministry of the Interior, and communications network operators is necessary to clarify the possible effects of the wind farm on radars and communications services.

4.3 s and natural resource requirements

4.3.1 Estimated demand for natural resources and adequacy of mineral resources

The projected demand for natural resources for the construction of the planned wind farm based on the draft plan has been estimated based on the demand for construction materials for the construction of the Tootsi-Sopi wind farm. The projected amount of construction materials required for the construction of wind turbines is presented in TableTable21

Table20 . Estimated construction material requirements for the construction of wind turbines in the wind farm.

	Tootsi-Sopi wind turbines [157]	Estimated volumes based on the increase in wind turbine dimensions	Wind farm total (21 wind turbines)	Unit
Tip height	240	300		m
Rotor diameter	163	200		m
Foundation diameter	25	31		
Foundation depth	4.85	6		m
Foundation volume	2380	4648		m^3
Amount of concrete	866.6	1693	3554	m^3
Amount of reinforcement	123	240	5045	t
Quantity of gravel	200	391	8203	m^3
Amount of sand	125	244	5127	m^3

The area under roads, squares, and foundations in the 05.2025 planning solution for the wind farm is 42 ha. In reality, the area partially overlaps with existing roads, which can be used for construction activities. Part of the construction area also consists of the foundation area for the assembly site, for which the material requirements have already been described. To assess the worst-case scenario, it is estimated that 50% of the construction area will require additional roads and squares to be built. The roads and areas will be constructed mainly from gravel, and the thickness of the road structure will normally be around 40 cm. 42× To cover an area of 50% of a hectare with a 40 cm thick layer of gravel, approximately 84,000 m³ of gravel is required. Depending on the construction, sand may also be used as a building material. Considering the very good availability of construction sand in the area, the worst-case scenario is assumed and the use of gravel is expected.

Based on the above, an indicative estimate shows that the construction of the wind farm will require approximately^{5,130} $^{m^3}$of sand,^{8,200} $^{m^3}$of crushed stone, and 84,000 $^{m^3}$of gravel from local natural resources.

Based on the remaining reserves of mineral resources presented inTable21 –Table24 , all the materials required for the planned wind farm can be obtained from existing quarries within a 50 km radius

[157] Based on the construction documents submitted with the application for a permit in the EHR

(taking into account actual transport distances), and there is no need to open additional new quarries for this purpose. Security of supply has been considered within a 50 km radius, as the optimal service area for a quarry is considered to be within a 50 km radius of the quarry, regardless of administrative divisions and taking into account actual transport distances and the technical condition of transport routes[158] .

There are no limestone quarries in the area. The nearest limestone quarry (Otisaare limestone quarry, L.MK/329511) is located approximately 87 km away from the special planning area as the crow flies. Therefore, the crushed stone required for construction must be brought in from further away than the usual quarry service area (50 km). In an area with limited availability of this natural resource, the use of crushed stone as a construction material must be minimized in the design and suitability assessment.

[158] https://envir.ee/media/5916/download

Table21 . The wind farm development area's service area (within a 50 km radius along actual transport routes) includes the quantities of construction gravel mined over the last five years and the remaining reserves to be mined. The data is taken from the consolidated balance sheet of mineral resources[159] .

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Construction gravel extraction volumes over the last five years, thousand m³					Average amount mined over the last five years, thousand m³	Remaining reserves as of 31.12.2023[160], thousand m³
			2019	2020	2021	2022	2023		
VILM-068, Pombre sand quarry	MOREEN Limited Liability Company	47	4.2	0	0	0.3	1.7	1.3	147.6
VILM-069, Pombre II gravel pit	MOREEN Limited Liability Company	47	10.4	9.8	14.6	7.2	11.0	10.6	90.2
VILM-045, Pirmastu II sand quarry	Eureka Limited	49	7.4	4	4.4	3.8	3.3	4.6	11.4
L.MK/331045, Paaslangi sand quarry	Rannar Lehis	48	1.2	1.5	1.7	0.9	2.2	1.5	51.6
L.MK/331942, Murese III gravel pit	AS TREV-2 Group	4	0	12	9.7	14.3	4.1	8.0	70.0
KL-514338, Kassi gravel pit	AS TREV-2 Group	40	–	–	0	0	0	0.0	204.0
VILM-058, Murese gravel pit	Estonian Environmental Services AS	47	0	0	0	0	0	0	41.2
KL-512457, Supsimari II gravel pit	Metsamaahalduse Aktsiaselts	50	–	–	0	0	0.0	0.0	854.6
VILM-048, Mäeküla III sand quarry	EMG Karjäärid OÜ	26	0	0	0	0	0	0	33.0
VILM-053, Mäeküla II sand quarry	State Forest Management Center	26	0	0	0	0	0	0	55
L.MK/319361, Voola sand quarry	State Forest Management Center	17	0	0	0	0	0	0	86.8
L.MK/325591, Helmi-Aakre VI gravel pit	KIVIKANDUR OÜ	42	0.5	13.1	0.4	9.3	30.0	10.7	31.5
L.MK/321323, Helmi-Aakre V sand quarry	Kivikandur OÜ	45	0	0	10.4	3.3	0	2.7	27.4

[159] https://egt.ee/maapouealane-teave/geoloogilised-andmed/maavarade-register#maavarade-koondbilansid

[160] The quarries presented in italics will be open after 31 December 2023 and their remaining reserves are presented as of 30 May 2025. The data is also presented in italics if the mineral resource has been recorded after 31 December 2023.

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Construction gravel extraction volumes over the last five years, thousand m³					Average amount mined over the last five years, thousand m³	Remaining reserves as of 31.12.2023[160], thousand m³
			2019	2020	2021	2022	2023		
VALM 029, Helmi-Aakre III gravel pit	Kivikandur OÜ	43	21.3	0	0	1.4	2.0	4.9	151.7
VALM 028, Helmi-Aakre II gravel pit	AS TREV-2 Group	4	0	0	0	0	0	0	75.2
L.MK/329518, Puka-Teeristi sand quarry	Suuremäe Karjäär OÜ	41	0	10.9	0	0	0	2.2	105.0
L.MK/300327, Siimu gravel pit	SANVA	43	1.9	5.8	1.8	0	0	1.9	78.5
L.MK/332741, Ainja III sand quarry	RONK OÜ	13	0	0	0	6	6.6	2.5	161.4
VILM-062, Ainja II gravel pit	JAVO Group OÜ	14	40	7.5	14.5	27	8.1	19.4	245.0
L.MK/329442, Muri gravel pit	Liivram OÜ	32	37.9	72.9	42	37.1	49.1	47.9	742.2
Total								**118.2**	**3263.3**
Security of supply based on average mining volumes over the last five years								**27.6 years**	

Table22 . Filling gravel extraction volumes over the last five years and remaining reserves within the service area of the wind farm development area (within a 50 km radius along actual transport routes). The data is taken from the consolidated balance sheet of mineral resources[159] .

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Fill gravel extraction volumes over the last five years, thousand m³					Average amount mined over the last five years, thousand m³	Remaining reserves as of 31.12.2023, thousand m³
			2019	2020	2021	2022	2023		
KL-509988, Muri II sand quarry	OÜ Müüripõllu	32	–	0	20.9	8.3	41.7	17.7	149.1
KL-517434, Muri IV gravel pit	OÜ Müüripõllu	32	–	–	–	–	0.0	0.0	367.0
Total								**17.7**	**516.1**
Security of supply based on average mining volumes over the last five years								**29.2 years**	

Table23 . Construction sand extraction volumes over the last five years and remaining reserves within the service area of the wind farm development area (within a 50 km radius along actual transport routes). The data is taken from the consolidated balance sheet of mineral resources[159] .

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Construction sand extraction volumes over the last five years, thousand m³					Average amount mined over 5 years, thousand m³	Remaining reserves as of 31.12.2023[161], thousand m³
			2019	2020	2021	2022	2023		
VILM-068, Pombre sand quarry	MOREEN Limited Liability Company	47	0	2.7	0	0.2	1.0	0.8	565.9
VILM-069, Pombre II gravel pit	MOREEN Limited Liability Company	47	0.3	6.5	0	7.6	0.0	2.9	54.2
VILM-045, Pirmastu II sand quarry	Eureka Limited	49	40.8	12.5	24.8	25.7	19.4	24.6	63.6
VILM-061, Mäeküla sand quarry	OÜ Aigren	2	0	0.0	0.0	0	0	0	2413
KL-517223, Mäeküla IV sand quarry	Roger Puit Joint Stock Company	25	–	–	–	0	0	0.0	235.0
VILM-052, Kärstna sand quarry	AS TREV-2 Group	3	0	0	0	0	2.6	0.5	825.2
L.MK/332957, Pahuvere II sand quarry	Kruusamägi OÜ	42	0	0	0	0	0	0	2406.0
VILM-071, Pahuvere sand quarry	PM KAUBANDUSGRUPP limited partnership	42	20.9	35.6	19	32.4	27.9	27.2	507.3
VILM-058, Murese gravel pit	Estonian Environmental Services AS	47	0	4.9	0	0	0.0	1.0	352.8
KL-518388, Linsi sand quarry	Marina Minerals OÜ	48	–	–	–	–	0.0	0.0	132.0
VILM-048, Mäeküla III sand quarry	EMG Karjäärid OÜ	26	0	0	0	0	0	0.1	595.6
VILM-053, Mäeküla II sand quarry	State Forest Management Center	26	0	0	0	0	0	0	627.0
VALM 015, Variku sand quarry	SARAPIKU OÜ	4	62	33.5	34.5	8.4	10.1	29.7	624.2
VALM 027, Vanaveski sand quarry	VALICECAR OÜ	5	0	0	0	0	0.0	0.0	190.0
L.MK/319361, Voola sand quarry	State Forest Management Center	17	0	0	0	0	0	0	350.9

[161] The quarries presented in italics are open after 31 December 2023 and their remaining reserves are presented as of 30 May 2025. The data is also presented in italics if the mineral resource has been recorded after 31 December 2023.

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Construction sand extraction volumes over the last five years, thousand m^3					Average amount mined over 5 years, thousand m^3	Remaining reserves as of 31.12.2023[161], thousand m^3
			2019	2020	2021	2022	2023		
L.MK/323692, Sulevi sand quarry	Valga Puu Limited Company	28	1.3	4.6	1.4	0.5	0	1.6	138.6
KL-521371, Kurejärve sand quarry	*Makita Karjäärid OÜ*	*34*	–	–	–	–	–	–	*81.0*
L.MK/333675, Ruusamäe II sand quarry	PM Kaubandusgrupp OÜ	41	0	36.4	11	0	6.5	10.8	485.0
L.MK/326336, Ruusamäe sand quarry	OÜ PM Kaubandusgrupp	41	18.5	31	1	0	2.6	10.8	142.2
VALM 022, Ungre sand quarry	OÜ AAB Excavator	3	0	0	1	0	0	0	58.7
KL-520858, Oona sand quarry	*Sakra OÜ*	*43*	–	–	–	–	–	–	*122.6*
L.MK/319043, Helmi-Aakre IV sand quarry	AS TREV-2 Group	42	8.0	2	0	4.3	0.0	3.0	35.4
L.MK/325591, Helmi-Aakre VI gravel pit	KIVIKANDUR OÜ	42	0	0	0	0	0.3	0.1	12.7
L.MK/321323, Helmi-Aakre V sand quarry	Kivikandur OÜ	4	0	0	39.7	18.7	0.2	11.7	360.4
VALM 028, Helmi-Aakre II gravel pit	AS TREV-2 Group	45	0	0	0	0	0	0	44.6
L.MK/329518, Puka-Teeristi sand quarry	Suuremäe Karjäär OÜ	41	–	–	–	–	0.0	0.0	91.0
L.MK/317362, Tinu sand quarry	PM Kaubandusgrupp OÜ	3	0	2	0	0	0	0.5	94.1
KL-509530, Sibula sand quarry	Metsatervenduse OÜ	42	–	2.9	0.2	1.4	0.1	1.2	1449.9
VALM 018, Siimu II sand quarry	OÜ Ronk	43	2.9	14	1	15.9	4.7	7.7	46.5
L.MK/300327, Siimu gravel pit	SANVA	43	0	0	0	0	0	0	19.5
KL-516653, Kösti sand quarry	SANVA	50	–	–	–	–	0.0	0.0	119.9
VILM-049, Timmo sand quarry	VALICECAR OÜ	25	0	0	0	0	0	0	72.2
L.MK/332741, Ainja III sand quarry	RONK OÜ	13	0	0	0	0	0.2	0	1376.8
VILM-042, Ainja sand quarry	Kivikandur OÜ	1	0	0	0	1.1	0.3	0.3	1317.2
VILM-032, Remsi sand quarry	Sakala Teed OÜ	21	11.8	20.1	2	0	0	6.9	925.6
KL-515943, Muri III sand quarry	DPS Invest Limited Liability Company	32	–	–	–	0	0	0.0	2158.0
KL-509988, Muri II sand quarry	OÜ Müüripõllu	32	–	0	0	0	0.0	0.0	283.0
VILM-064, Ahimäe sand quarry	OÜ Aigren	34	0	0	0	0	0	0	246.0
Total								**141.7**	**19,623.6**

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Construction sand extraction volumes over the last five years, thousand m³					Average amount mined over 5 years, thousand m³	Remaining reserves as of 31.12.2023[161], thousand m³
			2019	2020	2021	2022	2023		
Security of supply based on average extraction volumes over the last five years								**138.5 years**	

Table24 . Full sand extraction volumes over the last five years and remaining reserves within the service area of the wind farm development area (within a 50 km radius along actual transport routes). Data from the consolidated balance sheet of mineral resources[159] .

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Fill sand extraction volumes over the last five years, thousand m³					Average amount mined over 5 years, thousand m³	Remaining reserves as of 31.12.2023[162], thousand m³
			2019	2020	2021	2022	2023		
VILM-069, Pombre II gravel pit	MOREEN Limited Partnership	47	0	0	0	0	0.0	0.1	23.9
KL-520903, Nõmme-Koordi sand quarry	*Holstre-Nõmme Kalastus OÜ*	*48*	–	–	–	–	–	–	*1138.764*
KL-520904, Nõmme-Koordi II sand quarry	*LAVO Kaubanduse Osaühing*	*48*	–	–	–	–	–	–	*165.37*
KL-522403, Pirmastu III sand quarry	*Eureka Limited Liability Company*	*49*	–	–	–	–	–	–	*108,045*
VILM-045, Pirmastu II sand quarry	Eureka Limited Liability Company	49	13.1	10	7.7	6.7	14.8	10.5	189.7
L.MK/331045, Paaslangi sand quarry	Rannar Lehis	48	1	0	0	0	0	0.4	86.9
KL-517223, Mäeküla IV sand quarry	Roger Puit	25	–	–	–	0	0	0.0	711.0
VILM-038, Ärma sand quarry	Sakala Teed OÜ	31	0	0	7.2	2.3	3.0	2.5	311.4
VILM-052, Kärstna sand quarry	AS TREV-2 Group	34	0	0	0	0	0	0	104.0
VILM-071, Pahuvere sand quarry	PM KAUBANDUSGRUPP limited partnership	42	0	0	0	0	0	0	12.2

[162] The quarries presented in italics are open after 31 December 2023 and their remaining reserves are presented as of 30 May 2025. The data is also presented in italics if the mineral resource has been recorded after 31 December 2023.

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Fill sand extraction volumes over the last five years, thousand m^3					Average amount mined over 5 years, thousand m^3	Remaining reserves as of 31.12.2023[162], thousand m^3
			2019	2020	2021	2022	2023		
VILM-048, Mäeküla III sand quarry	EMG Karjäärid OÜ	26	0	0	0	0	0	0	333.7
VILM-053, Mäeküla II sand quarry	State Forest Management Center	26	0	0	0	0	0	0	196.0
VALM 027, Vanaveski sand quarry	VALICECAR OÜ	5	0	0	0	0	0.0	0.0	371.0
L.MK/319361, Voola sand quarry	State Forest Management Center	17	0	0	0	0	0	0	31.7
KL-521538, Voola II sand quarry	*Päidre Põllud OÜ*	*14*	–	–	–	–	–	–	*31.0*
L.MK/322934, Patküla sand quarry	Metsatervenduse OÜ	16	0	0	0	0	0	0	165.0
L.MK/323692, Sulevi sand quarry	Valga Puu Limited Company	28	0	0	0	0	0.7	0.1	70.3
L.MK/322524, Rumba sand quarry	Metsatervenduse OÜ	40	0	0	0	0	0	0	189.0
L.MK/320295, Puurina sand quarry	AS TREV-2 Group	44	1.8	12	2.6	3	3.6	4.5	1034.0
VALM 022, Ungre sand quarry	OÜ AAB Excavator	3	0	0	1	0	0	0.3	219.7
L.MK/319043, Helmi-Aakre IV sand quarry	AS TREV-2 Group	42	3.0	1	0	1.6	0.0	1.1	12.6
L.MK/321323, Helmi-Aakre V sand quarry	Kivikandur OÜ	45	0	0	0	0	0	0	32.0
VALM 028, Helmi-Aakre II gravel pit	AS TREV-2 Group	4	0	0	0	0	0	0	11.1
L.MK/329518, Puka-Teeristi sand quarry	Suuremäe Karjäär OÜ	41	–	–	–	–	0.0	0.0	159.0
L.MK/317362, Tinu sand quarry	PM Kaubandusgrupp OÜ	3	0	14	0	0	0	3.0	586.6
VALM 018, Siimu II sand quarry	OÜ Ronk	43	8.2	8.8	7.5	1.5	4.3	6.1	50
KL-509365, Siimu III sand quarry	OÜ Marvald	4	–	4	6.6	19.3	2.9	8.2	198.5
L.MK/300327, Siimu gravel pit	SANVA	43	6.4	0	0	0	0.0	1.3	98.7
VILM-049, Timmo sand quarry	VALICECAR OÜ	25	0	0	0	0	0	0	224.3
L.MK/332741, Ainja III sand quarry	RONK OÜ	13	–	–	–	–	–	0.0	1521.416
VILM-074, Ainja II sand quarry	AS Roger Puit	13	0	0	0	0	0	0	1977
VILM-032, Remsi sand quarry	Sakala Teed OÜ	21	1	0	0	0	0	0.2	390.1
KL-517434, Muri IV gravel pit	OÜ Müüripõllu	32	–	–	–	–	0.0	0.0	557.0

Mining permit no. and quarry	Mining permit holder	Distance of wind farm development areas~ from the quarry via actual transport routes, km	Fill sand extraction volumes over the last five years, thousand m^3					Average amount mined over 5 years, thousand m^3	Remaining reserves as of 31.12.2023[162], thousand m^3
			2019	2020	2021	2022	2023		
VILM-064, Ahimäe sand quarry	OÜ Aigren	34	0	0	0	0	0	0	390.7
KL-516111, Veskimäe sand quarry	*Roger Puit*	*39*	–	–	–	–	–	–	*448.0*
Total								**38.3**	**12,149.7**
Security of supply based on average extraction volumes over the last five years								**317.2 years**	

4.3.2 Wind resources

As part of the IRENES project, data on average wind speeds at a height of 100 m in Estonia has been compiled[163] . Based on this data, the preliminary selection area has an average wind speed of 5.2-5.7 m/s. According to the data, the average wind speed at a height of 100 m in Estonia ranges from 4.4 to 10.4 m/s. The average value is 6.1 m/s. Areas with higher wind speeds are located on the coast.

In the context of Tõrva municipality, average wind speeds at an altitude of 100 m range from 4.7 to 7.6 m/s. The average value is 5.9 m/s. Areas with higher than average wind speeds in Tõrva Parish overlap almost entirely with the 1 km buffer zone around residential buildings. To a lesser extent, areas with higher than average wind speeds also occur in the potentially suitable area 1 discussed in this SEA report, in the vicinity of Ridasoo and Rubina.

Based on the above, the expected average wind speeds in the preliminary selection area are close to the average wind speeds in Estonia and Tõrva municipality, but can still be considered relatively low. In order to ensure effective electricity production, it is appropriate to plan for the highest possible wind turbines in this area and to ensure sufficient distances between the wind turbines to avoid the wind shadow effect between them.

The optimal height and suitable model of the wind turbines must be determined on the basis of the predicted yield based on local wind measurement data.

4.3.3 Predicted waste generation

The waste generated during the construction phase of wind farms and its management is similar to normal construction waste management. If appropriate measures are taken (proper collection and removal of waste, etc.), the waste is unlikely to have a significant impact on the environment.

The operation of a wind farm also generates waste, such as various consumables, waste oil, etc. Wind turbine blades generally last as long as the rest of the turbine (i.e., 20-30 years). The need to replace blades, as well as other parts of the wind turbine, during the lifetime of the wind turbine may arise if the blade has a manufacturing defect, the blade is significantly damaged by lightning, or in other rare circumstances. Under normal circumstances, the main parts of wind turbines are not replaced during their lifetime. The waste management of a wind farm during its lifetime must comply with the applicable waste legislation. If waste management is carried out in accordance with the law, no significant environmental impact is to be expected.

The service life of wind turbines is 20–30 years. After that, the wind turbines may be replaced with new ones or the farm may be decommissioned. In both cases, the decommissioning of wind turbines will generate waste in the form of metal and (glass) plastic from the foundation and wind turbine components. Modern wind turbines are relatively easy to dismantle and most of their components are reusable or recyclable (approximately 85% of modern wind turbines). The wind turbine tower and nacelle are mainly made of metal, which is recyclable and, at the end of the wind turbine's life, is likely to be a valuable resource that will be sent for recycling.

It is somewhat more complicated to liquidate and reuse concrete foundations, but this is also feasible if deemed necessary. In general, underground parts of buildings are not often excavated, as the environmental impact of doing so would be greater than leaving the structures in the ground. Considering that the foundation consists of crushed stone, sand, concrete, and iron, it does not pose any environmental hazard, and if the area is left unused, vegetation will eventually cover the foundation area.

[163] https://keskkonnateadlik-kaur.hub.arcgis.com/content/6d32cfef4a5b42b5bbf35fbaefc0c566

The biggest problem in terms of waste is caused by the handling of wind turbine blades. However, this is an area where active research and development is taking place.[164] On a small scale, it is possible to recycle blades to produce, for example, outdoor furniture, playground equipment, outdoor gyms, and other outdoor accessories.[165] . As the material of wind turbines is exceptionally resistant to weather conditions, there are many possibilities for its reuse. Another option is to mechanically and chemically reprocess wind turbines. During the crushing of wind turbine blades, glass fibers and fine fractions are separated, which can be used as composite fillers. For example, wind turbine blades can be used to make glass fiber pellets and material needed for cement production[166] . It is also possible to separate the polymers in wind turbines by chemically dissolving them, but this process consumes a lot of energy. These polymers can be used in various products, such as insulation materials or shoe soles, but this technology is still under development[167] . The largest wind turbine manufacturers are also actively engaged in the development of wind turbines that are up to 100% recyclable[168] .

The blades of electric wind turbines are made of composite materials and consist of approximately 70% glass fiber and 30% heat-resistant plastic[169,170] .

The approximate composition of a wind turbine in terms of mass percentage is shown in the following figure.

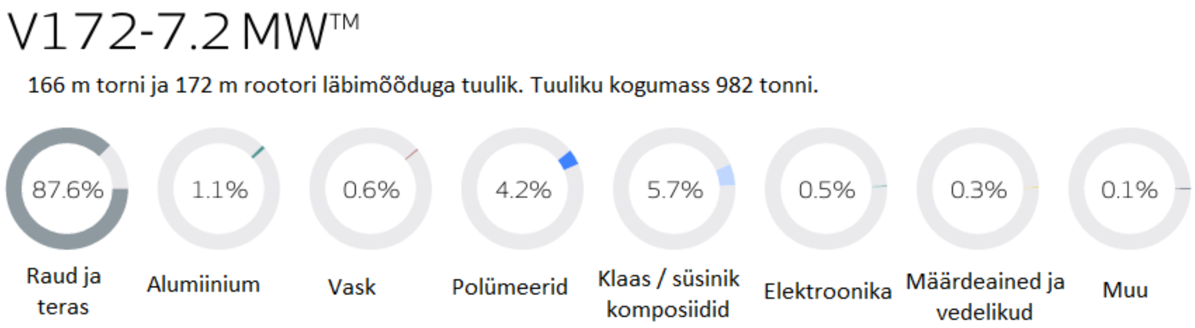

Figure36 . Wind turbine components (without foundation). Source: https://www.vestas.com/en

The plan envisages that the estimated total mass of a wind turbine with a tip height of up to 300 m (without foundation) would be approximately 1,170 tons, assuming a proportional increase in mass. Considering that the blades account for up to 10%, the mass of the blades of a single wind turbine is up to 117 tons.

Considering the worst-case scenario, where despite the increasingly established principles of the circular economy and the development of wind turbine blade processing options, the blades of the wind turbines to be built would be unusable at the end of their life, 21 wind turbines would generate 21*117,≈ ,2460 tons of waste. This would be a one-time waste generation. In the context of Tõrva municipality, this is a significant amount of waste (for comparison, in 2023, 7644 tons of waste was

[164] Jensenab, J.P., Skeltonab, K. 2018. Wind turbine blade recycling: Experiences, challenges and possibilities in a circular economy. Renewable and Sustainable Energy Reviews. Volume 97, December 2018, Pages 165-176.
[165] https://www.superuse-studios.com/projectplus/blade-made/
[166] Jensenab, J.P., Skeltonab, K. 2018. Wind turbine blade recycling: Experiences, challenges and possibilities in a circular economy. Renewable and Sustainable Energy Reviews. Volume 97, December 2018, Pages 165-176.
[167] https://www.vestas.com/en/media/company-news/2023/vestas-unveils-circularity-solution-to-end-landfill-for-c3710818
[168] Clean Energy Brief. 2020. Vestas to produce zero-waste wind turbines by 2040. GO ECO GREEN21.
[169] Cooperman et al., (2021), Wind turbine blade material in the United States: Quantities, costs, and end-of-life options, https://www.sciencedirect.com/science/article/abs/pii/S092134492100046X?via%3Dihub
[170] Svensk Vindenergi (2021), Vindkraften är Hållbar – ekonomiskt, ekologiskt, social, https://svenskvindenergi.org/wp-content/uploads/2021/05/Vindkraften-ar-hallbar-ett-faktablad-fran-Svensk-Vindenergi.pdf

generated in Tõrva municipality). If the waste cannot be reused, it will be deposited in a landfill. The closest landfill to Tõrva municipality is the Paikre landfill in Pärnu County. In 2023, approximately 24,000 tons of waste was deposited in the Paikre landfill. Finding a way to reuse the blades would significantly reduce the need for landfill and the negative impact that comes with it. Pan-European regulations, which are increasingly tightening waste disposal options and promoting waste reuse, are also likely to contribute to the search for reuse options.

Compared to the current waste generation in the Estonian energy sector, the waste generated at the end of the life cycle of wind turbines is relatively modest. In 2023 alone, oil shale power plants generated a total of 5,880,796 tons of semi-coke, bottom ash, and fly ash, of which 5,749,433 tons were landfilled. In total, 5,974,559 tons of waste were landfilled in Estonia in 2023, meaning that 96% of the waste landfilled was related to oil shale-based electricity production. Therefore, assuming that the construction of the wind farm will help reduce the need for oil shale-based electricity, it can be expected that even if it becomes necessary to landfill the wind turbine blades at the end of the wind farm's lifetime, this will reduce the amount of waste generated by electricity production in Estonia.

During the construction and operation of the wind farm, no waste is expected to be generated in quantities that could have a significant impact on the environment. The possibility of recycling the waste generated at the end of the wind farm's lifetime will be determined at the appropriate time based on the best available knowledge. The wind farm can be decommissioned on the basis of a demolition project, which will also address waste volumes and management. Considering the long-term goals of the circular economy, maximum reuse of the wind farm's materials must be ensured at the end of its life.

A newer topic in waste management and wind turbine planning is the possible formation of microplastics during operation[171] . Microplastics can be defined as any piece of plastic that is not soluble in water and is smaller than 5 mm in size[172] . The possible formation of microplastics and their release into the environment is associated with wind turbine blades, which are mainly made of fiberglass and wear down due to precipitation and wind when operating outdoors. There is still little research in this area (as with microplastics in general), but studies to date suggest that wind farms are not significant sources of microplastics. Studies in this field have so far found that microplastics are present in wind farm areas, but their composition is not characteristic of wind turbine blade material. Nor has it been observed that the concentration of microplastics in wind farm areas is higher than in surrounding areas[173] . At the same time, it is clear that wind turbines undergo a certain amount of wear and tear due to precipitation and wind erosion, and, similar to other plastics used in human activities, some of the plastic in wind turbines ends up in the natural environment. The blades of wind turbines, which consist exclusively of fiberglass, epoxy adhesive and, in some cases, carbon fiber, are the part of the wind turbine that is most susceptible to wear and tear. According to current knowledge, various studies have found that between 3 g and 14 kg of material, mainly paint covering the blades, is "sanded off" from wind turbine blades each year. The latest studies on this topic have found that the amount of plastic worn away is 240 g per year per wind turbine (the study looked at wind turbines with blades 117 m long (i.e., with a diameter of 234 m), which are significantly larger than those planned in the Tõrva special plan)[174] . For 21 wind turbines, this would mean up to 5 kg of microplastics

[171] For more information on microplastics, see https://kliimaministeerium.ee/elukeskkond-ringmajandus/poliitika-ja-seadusandlus/plastid-ja-plastijaatmed#mikroplast

[172] Frias, J.P.G.L., Nash, R. 2019. Microplastics: Finding a consensus on the definition, Marine Pollution Bulletin, Volume 138, Pages 145-147.

[173] Teng. W., Xinqing, Z., Baojie, L., Yao, Y., Li, J., Hejiu, H., Yu, W., Chenglong, W. 2018. Microplastics in a wind farm area: A case study at the Rudong Offshore Wind Farm, Yellow Sea, China. Marine Pollution Bulletin. 128. 10.1016/j.marpolbul.2018.01.050.

[174] Caboni, M., Schwarz, A. E., Slot, H., and van der Mijle Meijer, H.: Estimating microplastics emissions from offshore wind turbine blades in the Dutch North Sea, Wind Energ. Sci. Discuss. [preprint], https://doi.org/10.5194/wes-2024-175, in review, 2024.

generated by the wind farm per year. Wind farms around the world are not considered to be a significant source of microplastics. The main sources of microplastics are sources that are more characteristic of everyday human activity, such as paints, tires, textiles, laundry capsules, etc. The European Union is actively working to reduce the generation of microplastics by regulating the intentional addition of microplastics to everyday products[175] .

Microplastics that are sanded off wind turbine blades due to weather conditions may also contain small amounts of chemicals found in the epoxy adhesive used in the blades, including bisphenol A and epichlorohydrin. Studies to date do not consider such emissions to have a significant impact. It should be noted that the surface of a wind turbine blade is primarily made up of paint. The epoxy adhesive layers are located under the paint layers and wear during the lifetime of the wind turbine is minimal[176(,)177] .

Wind turbines (regardless of their model) are technological devices that must comply with the requirements in force at a given time and are approved for use in the European Union and, therefore, in Estonia. Therefore, the materials used in wind turbines are not regulated by planning, but by regulations applicable to equipment, which are predominantly pan-European (e.g., the use of SF6, bisphenol A, and other chemicals is regulated at the substance level, not at the planning level).

4.3.4 Measures, need for further research and assessment

In further design and operation:

- During the construction, operation, and decommissioning of wind farms, appropriate waste prevention measures must be implemented and care must be taken to ensure that the waste generated does not pose an excessive risk to health, property, or the environment. The waste generated must be collected separately in containers that are suitable for the type of waste and resistant to its physical and chemical properties. When collecting waste in piles, preference should be given to hard-surfaced areas or, if necessary, the ground and/or waste should be covered with a weatherproof and leak-proof cover to prevent pollutants from entering the environment as a result of waste or leaching and spreading with the wind.
- Long-term storage of waste at the place of generation should be avoided and the waste generated should be transferred to an authorized waste handler for treatment at the earliest opportunity. When selecting a waste handler, it is advisable to apply the principle of proximity in order to reduce the negative impact of waste transport on the environment.
- When developing waste prevention and waste management measures and handling waste, the waste hierarchy should be followed in order of priority. Waste that can be reused or recycled should be sent for treatment accordingly. When directing waste for reuse, recycling should be given priority.
- Waste that is suitable and permitted for reuse at the place of generation must be reused on site to the greatest extent possible. The reuse of waste at the place of generation must be guided by the requirements set out in the relevant legislation. As there is a high probability of construction sand suitable for construction activities (including foundation pits) being present in the area, it should be reused as a construction material to the maximum extent possible.
- In order to reduce the likelihood of emergency situations, continuous monitoring of waste management must be implemented and, in the event of pollution, its appropriate and rapid elimination must be ensured.

[175] For more information on microplastic restrictions, visit https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4581.
[176] Epoxy Resin Committee. 2015. EPOXY RESINS IN WIND ENERGY APPLICATIONS ASSESSMENT OF POTENTIAL BPA EMISSIONS. www.epoxy-europe.eu
[177] Norwea. 2021. Klare faktafeil fra motvind om vindkraftsforurensning https://www.fornybarnorge.no/

– At the end of the wind farm's life, the owner of the wind farm is responsible for its reconstruction or demolition. In the event of demolition, this must be carried out in accordance with the demolition project, including the proper handling of all waste generated during the demolition process.

4.4 Impact on human health, well-being, and property

Wind turbines can potentially affect human health, well-being, and property, so to assess this, it is necessary to know the parameters and locations of the wind turbines. The initial selection of potentially suitable areas has been made on the principle that the areas should be located at least 1 km away from residential buildings, unless an agreement has been reached with the owner of the residential building to locate the wind turbines closer. Due to aspects related to the natural environment, infrastructure, land use, and cultural heritage, sections 4.1–4.4 of this SEA report present proposals for narrowing down the potentially suitable areas in . The proposals are to be taken into account when making a preliminary selection of the planning location. No preliminary selection decision is planned for the northern potentially suitable area. In the case of the southern potentially suitable area, the preliminary selection decision will be made for a significantly narrowed area. Based on the known areas with adverse effects, a conceptual solution for a wind farm has been developed for the potentially suitable area in the south. The following assessment of the impact on human health, well-being and property is based on the conceptual solution for the wind farm.

4.4.1 Noise

Noise is an unpleasant or disturbing sound or other sound that is harmful to human health and well-being, and is one of the most common and significant factors that reduce the quality of the living environment. Noise affects health and well-being in many ways – it can disturb or hinder work, communication, and rest; cause permanent damage to the ear and hearing loss; and cause stress or various functional disorders.

Most people find a constant noise level of 55–60 dB in their everyday living environment disturbing, with traffic often being the main source of noise. Although this level of noise does not directly harm the body, it can lead to difficulty concentrating, low mood, and sleep disturbances at night, as it is difficult to fall asleep with the window open. A constant noise level of 60 dB can interfere with activities such as thinking, communicating, and concentrating. At 70 dB, it becomes more difficult to understand others, and constant exposure to noise levels above 75 dB increases residents' complaints and the risk of health problems. Noise levels above 85 dB are considered harmful to health if they last for a long time, for example 8 hours. Noise levels of 130–140 dB can be dangerous to hearing. In general, an increase in noise level of 10 dB is perceived as a doubling of the noise level.

Studies comparing disturbances associated with different sources of environmental noise (e.g., traffic noise and wind turbine noise) have found that although wind turbines are perceived as a disturbance at relatively low noise levels (e.g., 35-40 dB)[178] . From a health perspective, broad-based studies on wind turbine noise have not found a direct link to chronic diseases, and the main impact may be in the form of disturbance[179] .

Wind turbine noise disturbance has been studied in various countries (e.g., the US, Germany, Finland, and Sweden), and it has been found that even at noise levels between 35 and 40 dB (and even lower), a significant proportion of the population (up to 15–25%) may feel disturbed. Residents also associate

[178] Radun, J., Maula, H., Saarinen, P., Keränen, J., Alakoivu, R., Hongisto, V. 2022. Health effects of wind turbine noise and road traffic noise on people living near wind turbines,

[179] van Kamp, I.; van den Berg, F. 2021 . Health Effects Related to Wind Turbine Sound: An Update. Int. J. Environ. Res. Public Health 2021, 18, 9133.

their health problems with wind turbines[180(.)181(,)182] . At the same time, studies indicate that, in the case of low noise levels, the disturbance is often related to other factors, such as the visual impact of wind turbines, general attitudes towards wind turbines, involvement in the planning process, etc. This explains why even very low noise levels (25–30 dB) cause disturbance to some members of the population. Similar disturbance occurs with other noise sources, such as traffic or industrial noise, even when noise levels remain within the norm.

4.4.1.1 Assessment methodology

This draft SEA was completed before the Ministry of Climate completed its new guidelines for assessing the impact of wind farms. As the SEA sought to use the best available information, the section on noise assessment was updated in May 2025 based on **the methodology presented in the guidelines prepared by the Ministry of Climate**[183] . In addition, the accuracy of the wind turbine positions was taken into account in connection with the additional measures planned to mitigate the impact on birdlife (comparative assessments were made of the initial and modified positions).

Outdoor noise is regulated by the Atmospheric Air Protection Act and the noise standards established by Regulation No. 71 of 16 December 2016, based on § 56(4) of the same Act "Noise standards for outdoor noise and methods for measuring, determining and assessing noise levels."

The noise target value is the maximum permissible noise level in areas subject to new planning. A new planned area within the meaning of Regulation No. 71 is a new noise-sensitive area outside a densely populated area or a compactly built-up area that is not yet built up.

The noise limit value is the maximum permissible noise level, the exceeding of which causes significant environmental disturbance and requires the implementation of noise reduction measures. The target and limit values for noise vary depending on the main functions of the areas. Noise categories are determined in accordance with the main purpose of land use in the comprehensive plan.

The assessment of wind turbine noise during operation was based on the Atmospheric Air Protection Act and Regulation No. 71 of the Minister of the Environment. Wind turbine noise is classified as industrial noise. The limit value for construction noise is the standard level of industrial noise for the relevant noise category between 9 p.m. and 7 a.m.

The limit value for industrial noise in residential areas is 60 dB(A) during the day and 45 dB(A) at night, with a target value of 50 dB(A) during the day and 40 dB(A) at night.

As wind turbines operate around the clock and the noise they generate can be considered more disturbing than some other types of industrial noise, it is strongly recommended that wind farm planning aims to ensure compliance with the night-time target value (40 dB(A)). Noise target values have been established to prevent health risks.

The noise standards applicable in Estonia take into account the recommendations of the World Health Organization. The World Health Organization recommends that wind turbines comply with the

[180] Pohl, H., Firestone, H., Rand, J., Haac, E. 2019. Monitoring annoyance and stress effects of wind turbines on nearby residents: A comparison of US and European samples.

[181] Pedersen, E. 2007. Human response to wind turbine noise – perception, annoyance and moderating factors, University of Gothenburg.

[182] Turunen, A., W. Tiittanen, P., Yli-Tuomi, T., Taimisto, P., Lanki, T. 2021. Self-reported health in the vicinity of five wind power production areas in Finland, Environment International, Volume 151, 2021, 106419, ISSN 0160-4120, https://doi.org/10.1016/j.envint.2021.106419.

[183] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadowing.

standard level $L_{(den)}$ < 45 dB[184] . $L_{(den)}$ is the average sound pressure level, which takes into account the average of all days, evenings, and nights in a year.

It should be noted that the noise standards apply as averages for the daytime (7 a.m. to 11 p.m.) and nighttime (11 p.m. to 7 a.m.) periods. However, when calculating wind turbine noise, it is conservatively assumed that the noise occurs at a maximum level throughout the entire period.

The industrial noise standards applicable in the Republic of Latvia are set out atTable25 .

Table25 . Noise standards applicable in the Republic of Latvia[185] .

Function of the building area	Noise standards		
	L_{Day} (dB(A))	$L_{evening}$ (dB(A))	L_{night} (dB(A))
Detached houses (private houses, low-rise or farmhouses), residential buildings, childcare facilities, medical, healthcare and social welfare facilities	55	50	45
Multi-story residential buildings	60	55	50
Public building territory (territory of public and administrative buildings, including cultural institutions, educational and research institutions, state and local government agencies, and hotels) (together with residential buildings)	60	55	55
Mixed-use buildings, including commercial and service buildings (with residential buildings)	65	60	55
Quiet areas in settlements	50	45	40

It became apparent that Latvian residential areas are subject to less stringent noise standards than those in Estonia. This impact assessment is based on the principle that there is no significant noise impact in residential areas in both Estonia and Latvia if 40 dB is guaranteed in residential yards around the clock or 45 dB with the consent of the homeowner.

It is important to note that, in the case of noise, there may be a difference between noise levels that exceed the standards and noise levels that cause disturbance. Noise standards are set in such a way as to ensure that noise levels do not harm human health. However, this does not mean that the source of the noise cannot be heard. In the case of disturbance, a person hears the source of the noise and may not like it, but it is not a situation that is harmful to health. The disturbance caused by sound depends largely on the individual's perception. Based on the analysis of various studies, the threshold for noise disturbance (disturbance level) during the operation of wind farms has been set at 35 dB[186] . However, as mentioned above, people's sensitivity to wind turbine noise varies.

The noise generated by wind turbines during operation is assessed mathematically in the case of new developments. In this case, special software WindPRO 4.0 was used for this purpose. The calculation was based on the international standard ISO 9613-2: "*Acoustics – Abatement of sound propagation outdoors, Part 2: General method of* calculation", which is the European Union's recommended method of calculating industrial noise for member states that do not have their own national calculation methods (Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise). This standard is also widely used in other parts of the world to assess noise propagation from wind farms.

[184] Compendium of WHO and other UN guidance on health and environment, 2024 update: https://iris.who.int/bitstream/handle/10665/378095/9789240095380-eng.pdf?sequence=1
[185] https://likumi.lv/ta/id/263882-troksna-novertesanas-un-parvaldibas-kartiba
[186] Schmidt, J., H., Klokker, M. 2014. Health effects related to wind turbine noise exposure: a systematic review.

In this case, noise propagation was modeled under unfavorable conditions – downwind in all directions, which promotes noise propagation, Cmet=0. According to the technical data provided by wind turbine manufacturers, wind turbine noise emissions typically increase up to wind speeds of 7–10 m/s[187] . In this study, the worst-case wind speed was used, i.e., noise maps were presented for the situation where wind turbine noise emissions were highest.

Noise modeling was performed at a height of 4 m above ground level. The ground roughness factor was set at 0.5 for the entire area. The accuracy of the calculation grid was set at 20 m. The ground relief was entered based on elevation data from the Land Board (5 m grid ground elevation model) and Latvian elevation data (20 m grid ground elevation model). In accordance with the methodology guidelines, atmospheric conditions were set at a temperature of 10–˚ °C and 70% humidity.

The modeling did not directly take into account objects that obstruct noise propagation, such as tall trees and forest areas. Similarly, existing buildings were not designated as objects that obstruct noise propagation in this case. If there are forest patches or outbuildings between the wind turbines and the observer, the actual noise levels will be lower than those shown in the calculations.

The actual daily noise levels caused by wind turbines are therefore expected to be lower than the results of the modeling.

The specific model of wind turbine to be installed in the wind farm is not known within the framework of the special plan SEA. Noise emissions vary between different wind turbine models. The SEA uses one of the largest wind turbines currently in production, the 7.2 MW Vestas V172 (rotor diameter 172 m, tower height 166 m), to assess noise levels. According to the wind turbine manufacturer's data, the maximum sound power level Lw of a single wind turbine (model with "serrated blades") is= 107.8 dB[188] . In addition, a correction factor of +2 dB was added to the noise level of each wind turbine in the noise calculations to take into account the possible additional uncertainty in the case of prospective wind turbines and to describe the most unfavorable situation possible.

The guidelines for the computational assessment of wind turbine noise stipulate that if the wind turbine being modeled has a larger blade diameter than the similar wind turbine used as a basis, a correction factor of +1 dB should be added to the wind turbine's noise emission for each 10 m increase in blade diameter. Based on data from existing wind turbines, there is no linear relationship between the diameter of the wind turbine blades and the sound power level. However, it is possible that as the dimensions of the hub increase, the sound power level may also increase. As the noise calculation showed that the use of an existing wind turbine with a sound power level of 107.8 dB may cause problems with meeting the noise target value in the nearest residential areas, wind turbines with even higher sound power levels were not assessed separately.

Table26 . Sound power levels (Lw) of the Vestas V172 7.2 MW model in 1/3 octave bands at a wind speed of 8 m/s

1/3 octave band Center frequency, Hz	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315
Sound power level LWA, dB	48.8	53.4	58.1	62.7	67.9	72.6	76.4	81	84.9	87.2	89.7	92	93.6	95.7	97.2	96.9
1/3 octave band Center frequency, Hz	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10,000	Total LwA, dB

[187] Conclusion based on the WindPro wind turbine database.

[188] Based on the WindPro wind turbine database, this wind turbine is available in models with different noise levels. In this study, data from the model with the highest noise level (sound pressure level) and jagged edges in the database was used to assess the most unfavorable situation.

Sound power level LWA, dB	95.8	95.4	95.6	96.2	96.4	96	95.5	95.2	94.6	94.8	94.3	90	83.7	79.4	75.2	107.8

As sub-alternatives, the same Vestas V172 wind turbine model with a capacity of 6.8 MW, with Lw= 106.9 dB, and the same wind turbine model operating in reduced noise mode (SO3), with Lw=103 dB, were used for noise assessment.

For modern wind turbines, the noise level (i.e., the sound pressure level Lp at a certain distance from the noise source, for example, directly below the wind turbine on the ground) is usually in the range of 50–60 dB. However, wind turbine manufacturers provide the sound power level (LwA) value for specific models, which characterizes the total amount of acoustic energy emitted by the wind turbine, i.e., noise emission. The sound power level of wind turbines is generally in the range of 105–108 dB.

It is important to understand that the noise level at a specific point (sound pressure level Lp) and the sound power level (Lw) are different concepts. The sound power level is a theoretical value used in noise propagation calculations and for comparing noise sources. This does not mean that the noise level experienced in the vicinity of a wind turbine or even directly below it would be equivalent (i.e., close to 100 dB).

Noise maps were drawn up to show the spread of noise, presenting A-weighted equivalent sound pressure $_{\text{levels}}$ $L_{pA,eq}$in decibels at 5 dB intervals. Residential and public buildings and residential areas located within a maximum distance of 2000 m from the wind farm boundary were used as receptors in the noise modeling. The ETAK database was used to identify residential areas in Estonia. In the case of Latvia, orthophotos were used. A total of 11 residential areas in Estonia and 11 in Latvia were taken into account in the model. Within Estonia, noise levels in noise-sensitive areas were calculated on noise propagation maps, for which the courtyards of residential buildings within the possible impact area were designated. Residential buildings were transferred from the base map of the program (orthophotos on the Latvian side) and the extent of the courtyards of residential areas was designated as noise-sensitive objects. In addition, it was examined whether the areas designated as noise categories I and II in the comprehensive plan are guaranteed to meet the target values. According to the comprehensive plan of Tõrva Municipality ( ), there are no areas designated as noise categories I and II in the vicinity of Holdre, and no new noise-sensitive areas (residential buildings, public buildings, recreational areas) are known to be planned.

The noise level of wind turbines is generally highest at wind speeds of 7–10 m/s. Such wind speeds do not normally persist throughout the night. As a result, there is often a difference between the average noise level measured over a period of time and the worst-case noise level forecast presented in this assessment. This assessment assumes that the wind turbines will operate at their maximum noise level continuously.

The noise during the construction of the wind farm has been assessed by experts.

[189]The standard levels for low-frequency noise are based on the annex to Regulation No. 42 of the Minister of Social Affairs of 04.03.2002 "Noise standards in living and recreation areas, residential buildings and public buildings and methods for measuring noise levels" (Table27). The recommended sound pressure levels for assessing the disturbance caused by low-frequency noise in living and sleeping areas of residential buildings and equivalent areas at night, as specified in the annex to the regulation, are provided atTable27 . These are therefore not standards applicable to outdoor areas, but standard levels applicable inside buildings.

Table27 . Recommended low-frequency sound values in living spaces.

1/3 octave band center	10	12.5	16	20	25	31.5	40	50	63	80	10	125	160	200

[189] https://www.riigiteataja.ee/aktilisa/1291/2202/0047/myra_tabel.pdf#

frequency, Hz														
Sound pressure level Lp,eq, dB	95	87	79	71	63	55.5	49	43	41.5	40	38	36	34	32

The assessment of low-frequency noise is based on the guidelines of the Ministry of the Environment[190] and uses the WindPRO program module "Decibel" setting "*Finnish Low Frequency* Sound," which is consistent with the calculation methodology according to the guidelines of the Ministry of the Environment.

As the standard value for low-frequency noise applies inside buildings, the sound insulation of buildings must also be taken into account when calculating it. The sound insulation values used are those found in scientific literature, which are appropriate for use according to the current guidelines (Table28)[191] .

Table28 . Low-frequency noise insulation of buildings.

Frequency, Hz	20	25	31.5	40	50	63	80	10	125	160	200
Insulation, dB	7.6	8.3	9.2	10.3	11.5	13	14.8	16.8	18.8	21	22.8

Infrasound is sound transmitted through the air at a frequency below 20 Hz. The standard levels for infrasound are established by Regulation No. 75 of the Minister of Social Affairs of May 6, 2002, "Limit values for ultra- and infrasound sound pressure levels and measurement of ultra- and infrasound sound pressure levels." The regulation establishes limit values for ultra- and infrasound sound pressure levels in residential and public buildings in order to prevent damage to human health and unpleasant sensations. The limit value for the G-corrected sound pressure level LpG of constant-level infrasound or the G-corrected equivalent sound pressure level LpG,eq,T of variable-level infrasound is 85 dB. Devices, machines, and other sources of ultra- and infrasound regardless of their location, shall be installed and maintained or used in such a way that the sound pressure level of ultra- and infrasound generated by them in residential and public buildings does not exceed the limit values specified in the regulation.

4.4.1.2 Construction noise

The construction of wind farms is accompanied by construction noise similar to that associated with normal construction activities. General construction activities include vegetation clearing, road construction, and activities related to the erection of foundations and wind turbines. These activities are likely to involve the use of excavators, concrete mixers and pumps, cranes and trucks. The noise levels generated by the most common equipment are presented inTable29 -s[192] .

Table29 . Noise levels from construction activities.

Equipment/activity	Typical sound pressure level (at a distance of 1 m)
Excavator	85–95 dB(A)
Concrete mixer	75–85 dB(A)
Concrete pump	80–90 dB(A)

[190] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadowing.
[191] Keränen, J., Hakala, J., Hongisto, V., 2018: Façade sound insulation of residential houses within 5-5000 Hz, Euronoise 2018.
[192] Natural Forces Developments LP. 2021. Sound Level Impact Assessment Study. Benjamins Mill Wind Project.

Equipment/activity	Typical sound pressure level (at a distance of 1 m)
Crane	70–85 dB(A)
Dump truck / truck	75–95 dB(A)

Table30 shows the noise levels that may occur at different distances from the construction site, according to the WSDoT (2017) guidelines[193] . Based on the source, the combined noise level in the immediate vicinity of the construction site is 86 dB(A) due to the combined effect of various construction noise sources.

Table30 . Noise levels at different distances from the source of noise.

Distance, m	Approximate noise level of construction activities, dB(A)
15	86
30	78
60	70
120	63
244	56
489	49
975	41

Considering the distance of the prospective construction areas from residential areas, the construction noise associated with the establishment of the wind farm is not expected to cause significant disturbance to residents in the vicinity. As can be seen fromTable30 , the noise level at a distance of 1 km (the distance to the nearest residential areas) from the construction site is less than 40 dB(A), which does not exceed the standard construction noise levels applicable in residential areas.

Although increased noise levels are unavoidable during construction, noise levels in nearby residential areas are not expected to be significant, as the construction sites are located away from noise-sensitive areas.

Noise during construction must not exceed the standards set out in the Atmospheric Air Protection Act and Regulation No. 71 of the Minister of the Environment of 16 December 2016, "Standards for noise in outdoor air and methods for measuring, determining, and assessing noise levels," and Regulation No. 42 of the Minister of Social Affairs of 4 March 2002 "Noise standards in residential and recreational areas, residential buildings and public buildings and methods for measuring noise levels". Avoid noisy construction work during the night.

4.4.1.3 Operational noise

Sound sources in wind farms can be divided into two categories:

- **mechanical noise** generated by the wind turbine gearbox, motor, and other mechanisms**;**
- **aerodynamic noise** generated by the movement of rotor blades through the air.

In modern wind turbines, considerable attention has been paid to noise reduction, and mechanical noise has been reduced to a relatively insignificant level through the use of various insulation materials and technical measures. Technical solutions have also been implemented to reduce aerodynamic noise, but since these are large technical devices, a certain amount of noise emission occurs when the wind turbines are in operation.

The assessment of the noise level caused by wind turbines in residential areas was carried out in parallel with the development of the indicative location of the wind turbines. In addition to mapping

[193] Washington State Department of Transportation. (2017). Chapter 7 – Noise Impact Assessment. Retrieved from Biological Assessment Preparation for Transportation Projects.

areas unsuitable for wind turbine construction due to the natural environment, interested parties submitted their own views on the desired number and location of wind turbines. Based on yield calculations, the distances between wind turbines have been increased and their number reduced compared to the initial plans, which has also contributed to lower noise levels in noise-sensitive areas.

The noise assessment showed that the nearest noise-sensitive areas are located approximately 1 km from the planned wind turbines. The residential building registered as a residential building in the Lossimäe ETAK in the center of the wind farm was not taken into account as a residential building because the building is not in use and there are usage agreements for the land plot (a wind turbine position and, in the future, a substation are planned there). No further residential use of the building is planned.

The computational assessment of noise levels showed that neither the target value nor the limit value for industrial noise is exceeded in residential areas with a noise level of 107.8 dB (taking into account + 2 dB uncertainty), except for the residential area of the Pelgu land plot. The nighttime target value for noise may be exceeded in unfavorable weather conditions in the residential area of Pelgu, which is closest to the wind turbines. The limit value for noise in this residential area will not be exceeded. With the modified layout, the expected sound pressure level in this residential area will be approximately 1 dB lower than with the initial layout. For this land parcel, either a noise tolerance easement must be established or, alternatively, the sound power level of the wind turbines used must be reduced, especially during the night. According to the assessment, the noise target value in the Pelgu residential area can be achieved by using wind turbines with an uncertainty of Lw=103 dB+2dB.

The noise levels generated on land parcels located within a 2 km radius are presented atTable31 .

Table31 . Noise levels in noise-sensitive areas within the impact area of the wind farm in Holdre village, Tõrva municipality.

Name of noise-sensitive area	Y	X	Original positions Lw= Noise level generated by a wind turbine with a sound power level of 107.8+2 dB, [dB(A)]	Modified positions Lwxml-ph-0000@deepl.internal107.8+2 dB noise level generated by a wind turbine with a sound power level of [dB(A)]	Modified positions Lw= Noise level generated by a wind turbine with a sound power level of 106.9+2 dB, [dB(A)]	Modified positions Lw=103 +2 dB noise level generated by a wind turbine with a sound power level, [dB(A)]
Ellemäe	603147	6423741	37.9	37	37.1	34
Elli	603206	6423881	37.3	36.9	36.5	33.4
Holdre cordon	604108	6420818	37	36.9	36.5	33.4
Holdre Manor	602969	6423865	38.1	37.6	37.2	34.1

Name of noise-sensitive area	Y	X	Original positions Lw= Noise level generated by a wind turbine with a sound power level of 107.8+2 dB, [dB(A)]	Modified positions Lwxml-ph-0000@deepl.internal107.8+2 dB noise level generated by a wind turbine with a sound power level of [dB(A)]	Modified positions Lw= Noise level generated by a wind turbine with a sound power level of 106.9+2 dB, [dB(A)]	Modified positions Lw=103 +2 dB noise level generated by a wind turbine with a sound power level, [dB(A)]
Jaanimäe	603207	6423702	37.8	37.4	37	33.9
LV_Aizupes	597230	6418854	33.4	33.4	33.2	29.9
LV_Andreni	603968	6419077	34.3	34.3	34	30.8
LV_Apsinas	602739	6419152	38.4	38.4	37.9	34.9
LV_Attekas	604054	6418852	33.6	33.6	33.3	30.1
LV_Cesnieki	597076	6419130	33.4	33.4	33.2	29.9
LV_Dzintari	597052	6421010	35.6	35.7	35.3	32.2
LV_Gundegas	601305	6418583	39.9	39.9	39.4	36.4
LV_Lejasumpuli	596841	6419991	33.9	33.9	33.7	30.5
LV_Medni	602900	6418460	35.6	35.6	35.3	32.1
LV_Omuli RPP	604040	6420788	37.2	37.1	36.7	33.6
LV_Rozas	603714	6418652	34	34	33.8	30.5
LV_Strazdini	603237	6418615	35.2	35.2	34.9	31.7
LV_Vecunguri	601828	6418274	37.4	37.4	37	33.9
LV_Vilci	596922	6420706	34.9	35	34.6	31.5
LV_Zeltkalni	597464	6420724	37	37	36.6	33.5
LV_Zimelnieki	596772	6421004	34.6	34.7	34.4	31.2

Name of noise-sensitive area	Y	X	Original positions Lw= Noise level generated by a wind turbine with a sound power level of 107.8+2 dB, [dB(A)]	Modified positions Lwxml-ph-0000@deepl.internal107.8+2 dB noise level generated by a wind turbine with a sound power level of [dB(A)]	Modified positions Lw= Noise level generated by a wind turbine with a sound power level of 106.9+2 dB, [dB(A)]	Modified positions Lw=103 +2 dB noise level generated by a wind turbine with a sound power level, [dB(A)]
Lindmäe	603301	6423760	37.4	37	36.6	33.4
Luhe	600408	6425096	39.1	37.8	37.3	34.2
Mekro	604447	6422126	36.1	35.8	35.4	32.3
Männiku	603159	6423907	37.4	36.9	36.5	33.4
Park	603278	6423652	37.8	37.4	36.9	33.8
Pelgu	602052	6423371	43.5	42.8	42.2	39.2
Sepakõrtsi	604023	6423604	35.4	35.1	34.8	31.6
Silla	602950	6424034	37.6	37.2	36.7	33.6
Vanaveski	604535	6422818	35	34.7	34.4	31.2
Vastseveski	602675	6424067	38.3	37.8	37.4	34.3
Veski	604268	6422631	36.4	36	35.6	32.5
Viitaku	600344	6425072	39.3	37.9	37.5	34.4

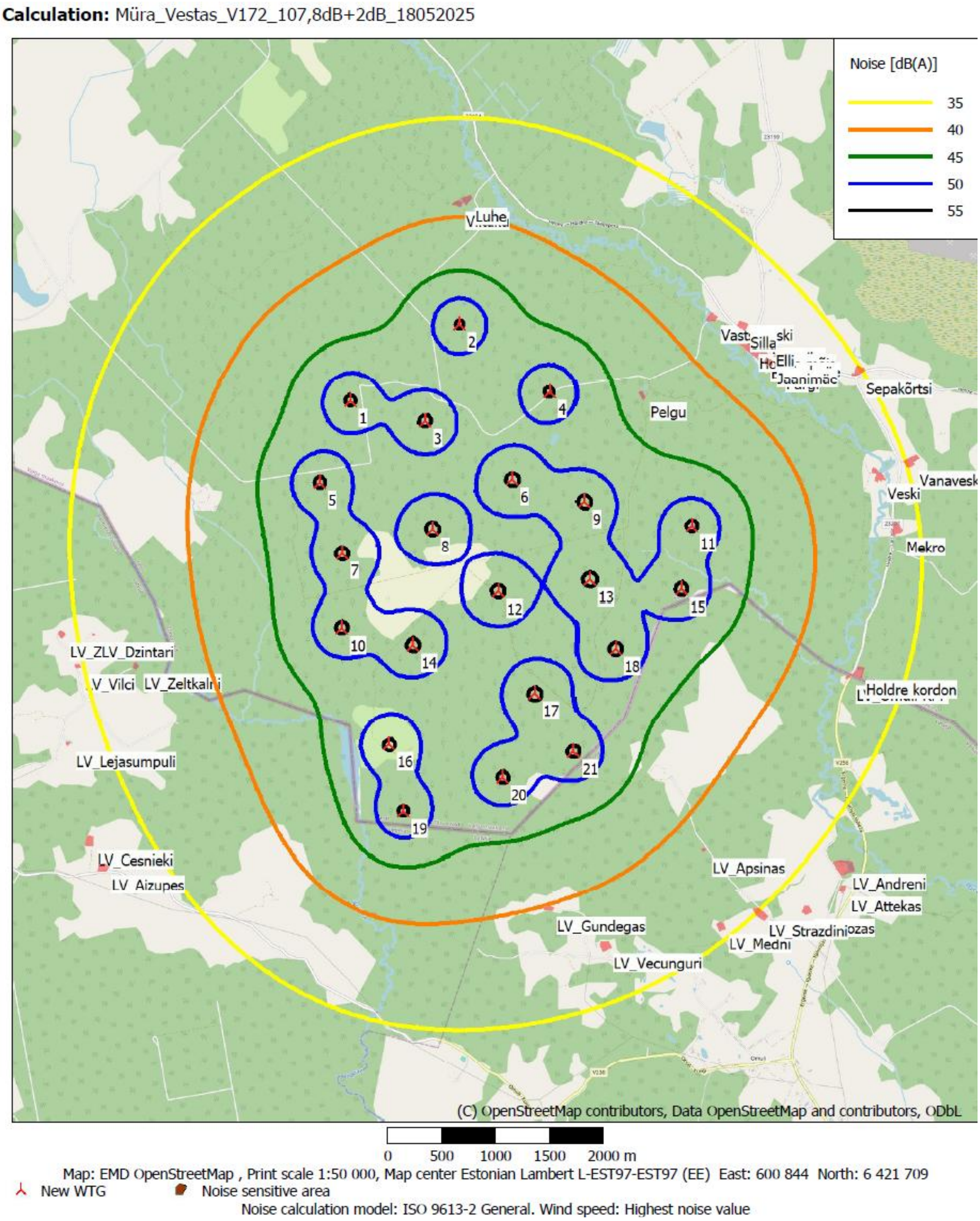

Figure37 . Noise map at a height of 4 m for wind turbines with a sound power level of 107.8 dB, initial wind turbine layout + 2dB uncertainty.

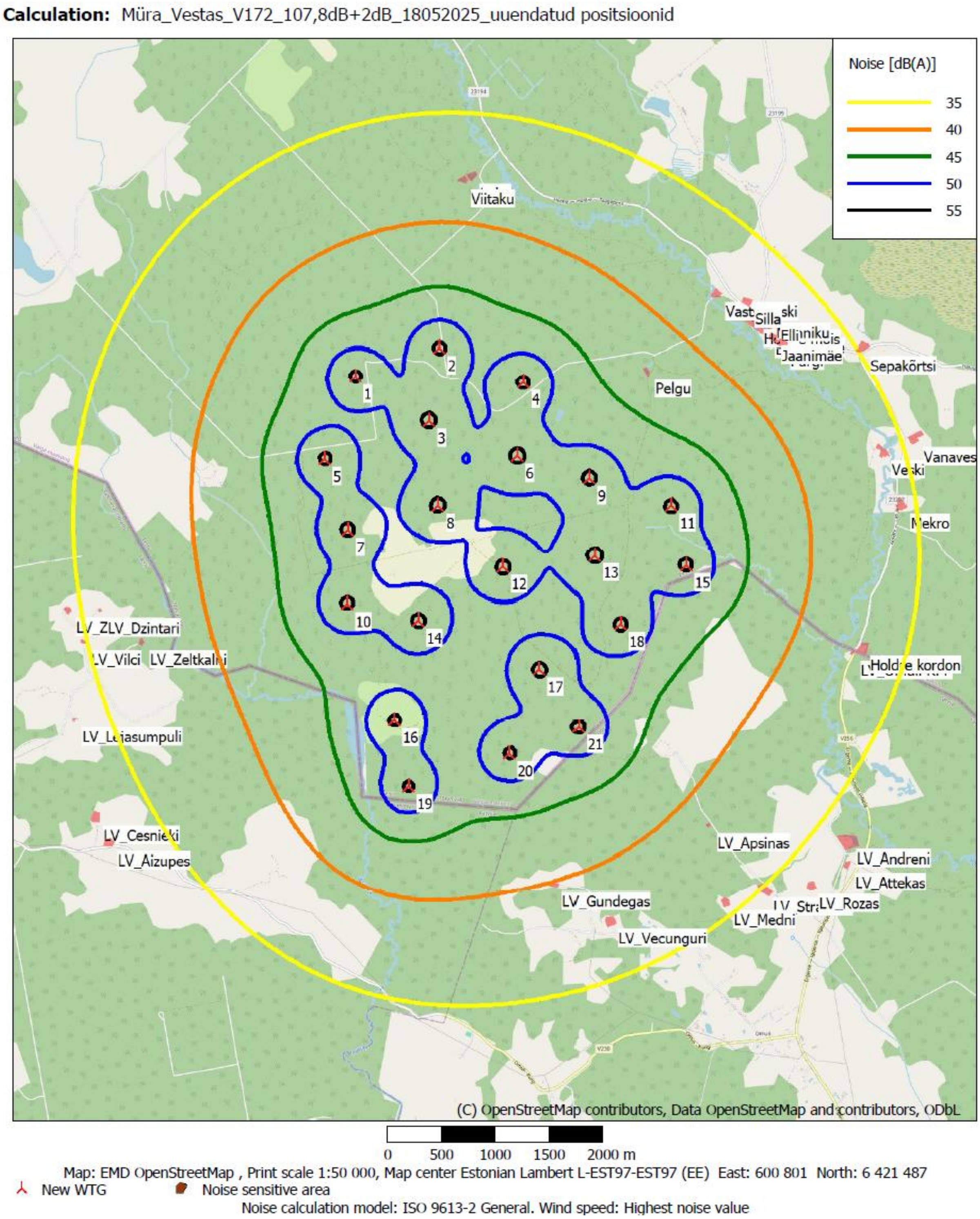

Figure38 . Noise map at a height of 4 m with a sound power level of 107.8 dB for wind turbines with modified wind turbine placement + 2dB uncertainty.

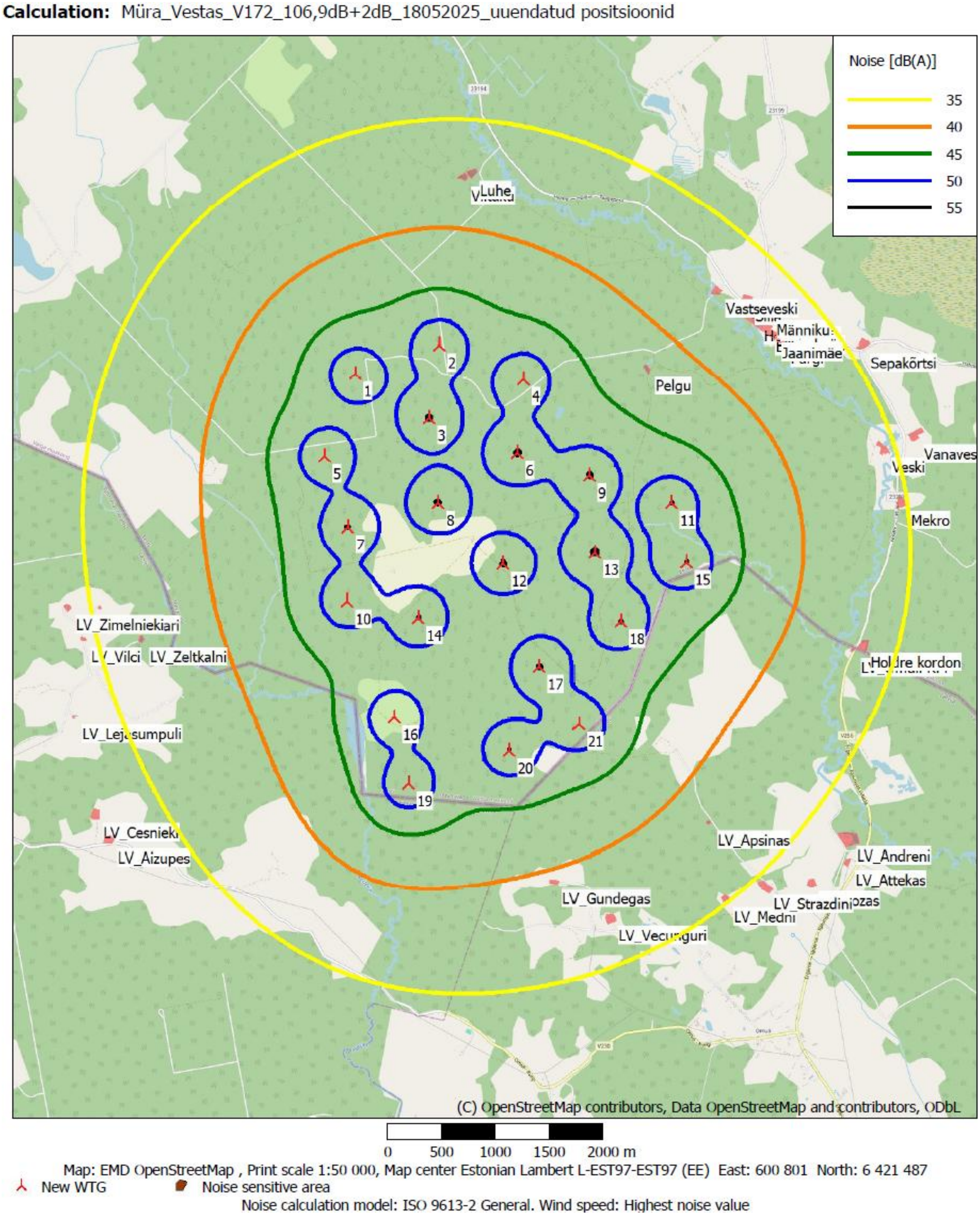

Figure39 . Noise map at a height of 4 m for wind turbines with a sound power level of 106.9 dB, modified wind turbine layout + 2dB uncertainty.

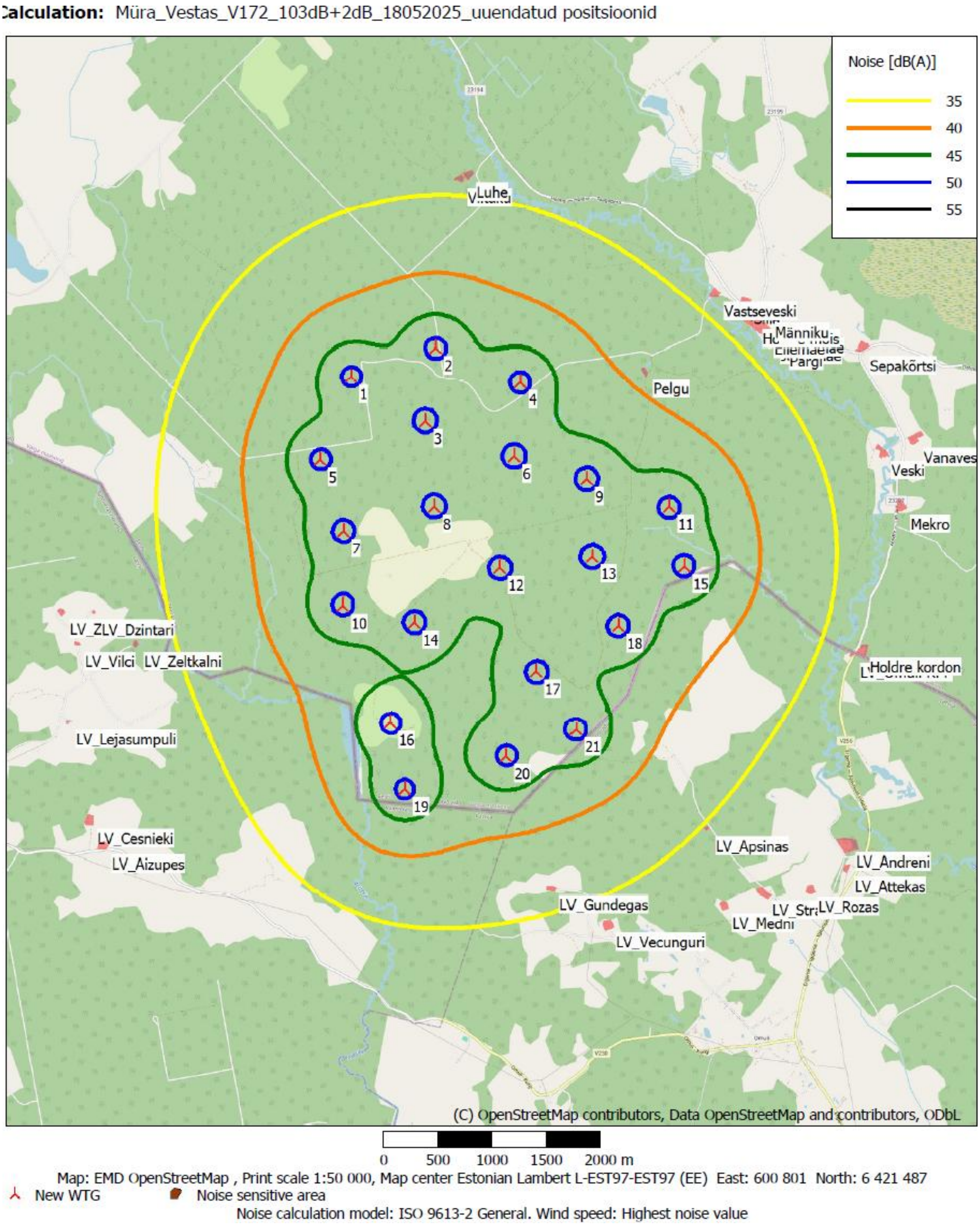

Figure40 . Noise map at a height of 4 m for wind turbines with a sound power level of 103 dB, modified wind turbine layout + 2dB uncertainty.

The difference between indoor and outdoor noise levels is usually estimated at approximately 10 dB for an open window, 15 dB for a half-open window, and approximately 25 dB for a closed window[194] .

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[194] Locher B, Piquerez A, Habermacher M, Ragettli M, Röösli M, Brink M et al. (2018). Differences between outdoor and indoor sound levels for open, tilted, and closed windows. Int J Environ Res Public Health. 15(1): 149.

If the target value for industrial noise in outdoor air is met, it can therefore be assumed that the standard levels applicable indoors[195] will also be met, even with an open window.

4.4.1.4 Low-frequency noise

Low-frequency sound (20–200 Hz) is present in most sounds. It is caused by both man-made (traffic) and natural (wind) sources. For low-frequency sound to be disturbing or harmful to health, its sound pressure is important.

Low-frequency noise has consistently been considered an important issue in relation to wind turbines, as the noise from wind turbines spreads over a very large area. When noise spreads, the mid- and high-frequency components of the sound dissipate in the air more quickly than the low-frequency components[196] .

The low-frequency noise generated by wind turbines needs to be assessed when planning a wind farm. A noise assessment for low-frequency noise can be prepared based on the spectral distribution of the noise generated by the wind turbine used[197] . This was also done when compiling this SEA report. **Low-frequency noise modeling showed that no residential area is expected to exceed the standard values for low-frequency noise indoors (Table32 and**Table34 **).**

Table32 . Results of low-frequency noise modeling for Vestas V172 7.2 MW wind turbines in their initial location. The modeled value of low-frequency noise indoors is presented.

Frequency, Hz	20	25	31.5	40	50	63	80	10	125	160	200
Standard level, dB	71	63	55.5	49	43	41.5	40	38	36	34	32
Ellemäe	44	42.4	40.7	38.4	37	34.9	30.9	27.1	22.8	17.1	14.4
Elli	43.6	42	40.3	37.9	36.6	34.5	30.5	26.6	22.4	16.6	13.8
Holdre cordon	43.3	41.8	40	37.7	36	34.2	30.2	26.4	22.1	16.3	13.5
Holdre Manor	44.1	42.6	40.8	38.5	37	35	31.1	27.2	23	17.3	14.5
Jaanimäe	43.9	42.4	40.7	38.3	36.9	34.8	30.9	27	22.8	17.1	14.3
LV_Aizupes	40.9	39.3	37.6	35.2	33.8	31.7	27.7	23.7	19.3	13.3	10.2
LV_Andreni	41.6	40	38.2	35.9	34.5	32.3	28.3	24.4	20	14.1	11.1
LV_Apsinas	44.3	42.7	41	38.6	37.3	35.2	31.3	27.4	23.2	17.5	14.7
LV_Attekas	41.1	39.5	37.8	35.4	34	31.8	27.9	23.9	19.5	13.5	10.5
LV_Cesnieki	41	39.4	37.6	35.3	33.9	31.7	27.7	23.7	19.3	13.4	10.3
LV_Dzintari	42.5	40.9	39.2	36.8	35.4	33.3	29.3	25.4	21.1	15.3	12.3
LV_Gundegas	45.3	43.7	42	39.6	38.3	36.2	32.3	28.5	24.3	18.7	16
LV_Lejasumpuli	41.3	39.7	38	35.6	34.2	32.1	28.1	24.1	19.7	13.8	10.8
LV_Medni	42.4	40.8	39.1	36.7	35.4	33.2	29.3	25.4	21	15.2	12.3
LV_Omuli RPP	43.5	41.9	40.2	37.8	36.5	34.4	30.4	26.6	22.3	16.5	13.7
LV_Rozas	41.4	39.8	38.1	35.7	34.3	32.2	28.2	24.2	19.8	13.9	10.9
LV_Strazdini	42.1	40.6	38.8	36.5	35.1	32.9	29	25.1	20.7	14.9	11.9
LV_Vecunguri	43.6	42	40.3	37.9	36.6	34.5	30.5	26.7	22.4	16.7	13.9
LV_Vilci	42	40.4	38.7	36.3	34.9	32.8	28.8	24.9	20.5	14.7	11.7

[195] https://www.riigiteataja.ee/akt/129122020047
[196] Hansen, C.H., Doolan, C.J., Hansen, K., L. 2017. Wind Farm Noise: Measurement, Assessment and Control.
[197] Chiu, CH., Lung, SC.C. 2020. Assessment of low-frequency noise from wind turbines under different weather conditions. J Environ Health Sci Engineer 18, 505–514.

LV_Zeltkalni	43.4	41.8	40.1	37.7	36.4	34.2	30.3	26.4	22.1	16.4	13.5
LV_Zimelnieki	41.8	40.2	38.5	36.1	34.7	32.6	28.6	24.7	20.3	14.4	11.4
Lindmäe	43.6	42.1	40.3	38	36.6	34.5	30.5	26.7	22.4	16.7	13.9
Luhe	44.6	43	41.3	39	37.6	35.5	31.6	27.8	23.6	17.9	15.2
Mekro	42.7	41.1	39.4	37	35.6	33.5	29.5	25.7	21.3	15.6	12.7
Männiku	43.6	42.1	40.3	38	36.6	34.5	30.6	26.7	22.4	16.7	13.9
Park	43.9	42.3	40.6	38.2	36.9	34.8	30.8	27	22.7	17	14
Pelgu	47.9	46.4	44.7	42.3	41	38.9	35	31.3	27.2	21.7	19
Sepakõrtsi	42.3	40.7	39	36.6	35.2	33.1	29.1	25.2	20.9	15.1	12.1
Bridge	43.8	42.2	40.5	38.1	36.8	34.7	30.7	26.9	22.6	16.9	14.1
Vanaveski	42	40.4	38.7	36.3	34.9	32.8	28.8	24.9	20.6	14.7	11.8
Vastseveski	44.3	42.7	41	38.7	37	35.2	31.3	27.4	23.2	17.5	14.7
Veski	42.9	41.3	39.6	37.2	35.8	33.7	29.8	25.9	21.6	15.8	12.9
Viitaku	44.7	43.1	41.4	39.1	37.7	35.6	31.7	27.9	23.7	18	15.4

Table33 . Results of low-frequency noise modeling for Vestas V172 7.2 MW wind turbines with modified layout. The modeled value of low-frequency noise indoors is presented.

Frequency, Hz	2	25	31.5	40	50	63	80	100	125	160	200
Standard level, dB	71	63	55.5	49	43	41.5	40	38	36	34	32
Ellemäe	43.7	42.2	40.5	38.1	36.7	34.6	30.7	26.8	22.5	16.8	14
Elli	43.3	41.8	40	37.7	36	34.2	30.2	26.4	22.1	16.3	13.5
Holdre cordon	43.3	41.7	40	37.6	36	34.1	30.2	26.3	22	16.2	13.4
Holdre Manor	43	42.3	40.6	38.2	36.8	34.7	30.8	26.9	22.7	16.9	14.1
Jaanimäe	43.7	42.1	40.4	38	36.7	34.6	30.6	26.8	22.5	16.8	14
LV_Aizupes	41	39.4	37.6	35.3	33.9	31.7	27.7	23.8	19.3	13.4	10.3
LV_Andreni	41.6	40	38.2	35.9	34.5	32.3	28.3	24.4	20	14.1	11.1
LV_Apsinas	44.3	42.7	41	38.7	37.3	35.2	31.3	27.4	23.2	17.5	14.8
LV_Attekas	41.1	39.5	37.8	35.4	34	31.8	27.9	23.9	19.5	13.5	10.5
LV_Cesnieki	41	39.4	37.7	35.3	33.9	31.8	27.8	23.8	19.4	13.4	10.3
LV_Dzintari	42.5	41	39.2	36.9	35.5	33.4	29.4	25.5	21.2	15.3	12.4
LV_Gundegas	45.3	43.7	42	39.7	38.3	36.2	32.3	28.5	24.3	18.7	16.1
LV_Lejasumpuli	41.4	39.8	38.1	35.7	34.3	32.1	28.2	24.2	19.8	13.9	10.8
LV_Medni	42.4	40.9	39.1	36.8	35.4	33.3	29.3	25.4	21.1	15.2	12.3
LV_Omuli RPP	43.4	41.9	40.1	37.8	36.4	34.3	30.3	26.5	22.2	16.5	13.6
LV_Rozas	41.4	39.8	38.1	35.7	34.3	32.2	28.2	24.2	19.8	13.9	10.9
LV_Strazdini	42.1	40.6	38.8	36.5	35.1	33	29	25.1	20.7	14.9	11.9
LV_Vecunguri	43.6	42	40.3	37.9	36.6	34.5	30.5	26.7	22.4	16.7	13.9
LV_Vilci	42.1	40.5	38.7	36.4	35	32.9	28.9	25	20.6	14.7	11.8
LV_Zeltkalni	43.4	41.9	40.1	37.8	36.4	34.3	30.4	26.5	22.2	16.4	13.6
LV_Zimelnieki	41.9	40.3	38.5	36.2	34.8	32.7	28.7	24.7	20.4	14.5	11.5
Lindmäe	43.4	41.8	40.1	37.7	36.4	34.2	30.3	26.4	22.1	16.4	13.5
Luhe	43.8	42.3	40.5	38.2	36.8	34.7	30.8	26.9	22.7	17	14.2
Mekro	42.5	40.9	39.2	36.8	35.5	33.3	29.4	25.5	21.1	15.3	12.4

Männiku	43.4	41.8	40.1	37.7	36.4	34.2	30.3	26.4	22.1	16.4	13.5
Park	43.6	42.1	40.3	38	36.6	34.5	30.6	26.7	22.4	16.7	13.9
Pelgu	47.5	45.9	44.2	41.9	40.6	38.5	34.6	30.8	26.7	21.2	18.6
Sepakõrtsi	42.1	40.5	38.8	36.4	35	32.9	28.9	25	20.7	14.8	11.8
Silla	43.5	42	40.2	37.9	36.5	34.4	30.4	26.6	22.3	16.5	13.7
Vanaveski	41.8	40.2	38.5	36.1	34.8	32.6	28.6	24.7	20.3	14.5	11.5
Vastseveski	44	42.4	40.7	38.3	37	34.9	30.9	27.1	22.8	17.1	14.3
Veski	42.6	41.1	39.3	37	35.6	33.5	29.5	25.6	21.3	15.5	12.6
Viitaku	44	42.4	40.7	38.4	37	34.9	31	27.1	22.9	17.2	14

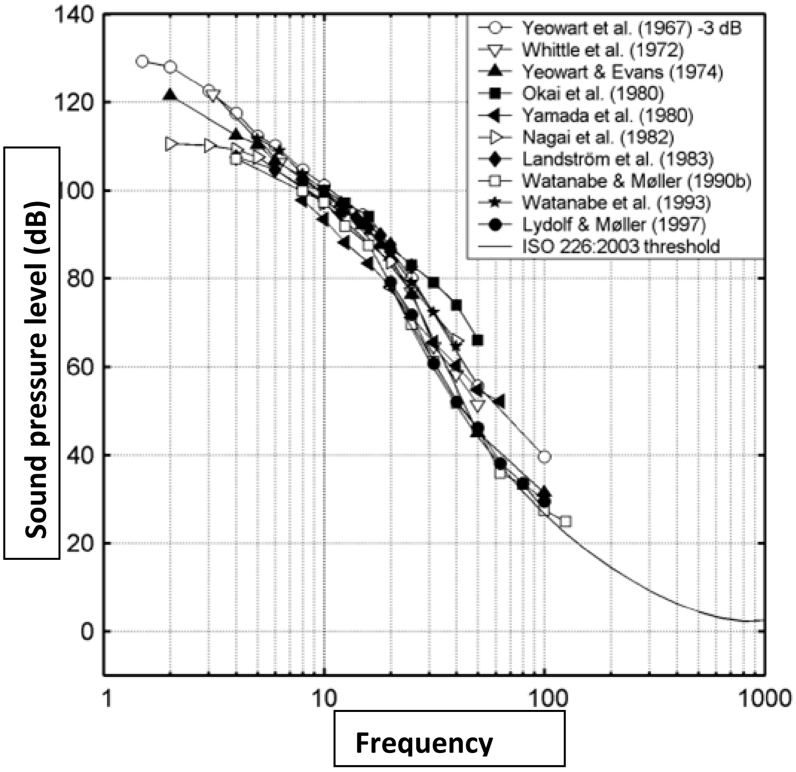
Based on the above, current knowledge does not suggest that the low-frequency sounds emitted by wind turbines and their propagation would cause the standard values for low-frequency noise to be exceeded in residential buildings when wind turbines are constructed.

4.4.1.5 Infra-sound

The assessment of extremely low-frequency noise, or **infrasound** (sound in the frequency range of approx. 0–20 Hz), is based on the guidelines prepared by the Ministry of Climate in 2025[198] . No computational assessment of infrasound is carried out, as, according to relevant scientific research, the infrasound generated by wind turbines remains below the human perception threshold and therefore has no significant impact on human health (see section 2.4.2 of the guidelines, the Health Board's wind farm website[199] and the letter from the Ministry of Social Affairs[200]).

[198] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadowing.
[199] https://www.terviseamet.ee/tuulepargid#kas-terviseamet-on-s
[200] Ministry of Social Affairs 10.03.2025 No. 5.1-2/679-1

In the case of wind turbines, the question of the possible impact of **particularly low-frequency noise, or infrasound** (sound in the frequency range of approximately 0–20 Hz), is often raised. When discussing infrasound, it is appropriate to consider two variables that characterize sound: the sound frequency spectrum (Hz) and sound pressure level (dB). The effect of infrasound (as with other sounds) on humans depends primarily on its intensity (dB). With regard to infrasound, it is understood that in order for infrasound to affect health, its pressure must be close to the human perception threshold



(Figure41).

Figure41 . Human sound perception as a function of sound frequency and pressure based on various scientific studies[201] .

The standard levels for infrasound are established by Regulation No. 75 of the Minister of Social Affairs of May 6, 2002, "Limit values for ultra- and infrasound sound pressure levels and measurement of ultra- and infrasound sound pressure levels." The limit value for the G-corrected sound pressure level LpG of constant-level infrasound or the G-corrected equivalent sound pressure level LpG,eq,T of variable-level infrasound is 85 dB. The G-corrected sound pressure level is the sound pressure level measured with measuring equipment that complies with the requirements of the recommended standard series EVS-EN 61672 or other equivalent documents and frequency-corrected in accordance with the requirements of the recommended standard EVS-ISO 7196 (*Acoustics – Frequency-weighting characteristic for infrasound measurements)* or other equivalent documents. The applicable infrasound standards are comparable to the standards applicable in other countries[202(,)203] .

[201] Møller, H., Pedersen, C. 2004. Hearing at low and infrasonic frequencies. Noise & health. 6. 37-57.

[202] Lo Castro, Fabio & Iarossi, Sergio & Luca, Massimiliano & Orlando, Maria & Giliberti, Claudia & Mariconte, Raffaele. 2020. Health Protection Criteria for Airborne Infrasound Exposure: An International Comparison. 10.1007/978-3-030-50946-0_10.

[203] Pawlaczyk-Łuszczyńska, Małgorzata & Dudarewicz, Adam. (2022). Review of evaluation criteria for infrasound and low frequency noise in the general environment. 10.54215/Noise_Control_2022_A_Digital_Monograph_Pawlaczyk-Luszczynska_M_Dudarewicz_A.

The impact of infrasound on human health has been studied worldwide and it has been found that intense infrasound affects the human nervous system, causing various disorders such as fear, concentration problems, fatigue, drowsiness, nausea, weight problems/loss of appetite, headaches, etc. The possible infrasound caused by wind turbine operation has been studied in several countries, including a large number of test measurements. The general conclusion of the studies is that the infrasound generated by modern wind turbines operating in headwind conditions is at a low level, i.e., significantly lower than the threshold associated with health effects[204] . Therefore, infrasound can cause health problems, but in order for it to pose a real threat or cause disturbance (perception), the sound pressure must be extremely high (intense). Infrasound with such an intense sound pressure level is not associated with the operation of modern wind turbines[205(,)206] .

The development of more accurate measurement methods for wind turbine infrasound continues to be an area of research[207] , but measurements taken to date at wind farms in different countries have yielded relatively similar results.

Scientific research on wind turbine infrasound and current noise standards (including infrasound) was analyzed in the UK in 2023, when a very thorough analysis was conducted on behalf of the UK government to update national noise guidelines for onshore wind farms. During the analysis, relevant scientific literature was reviewed[208] . It was found that several studies have investigated the alleged links between health symptoms and wind turbine infrasound. Although some experimental studies have linked infrasound to changes in physiological indicators[209(,)210] , these have generally been based on infrasound levels that are not present in wind turbine infrasound. To date, there is no convincing evidence that exposure to infrasound from wind turbines could cause adverse health effects at the frequencies and levels that can be expected in noise-sensitive locations near wind farms[211] .

Controlled experiments conducted in scientific studies involving participants who claimed to be sensitive to wind turbine infrasound have shown that exposure to infrasound at levels produced by wind turbines in residential areas is not associated with physiological or psychological health

[204] Swen., M, Stefan., H, Martin., H, Susanne., K. 2022. Can infrasound from wind turbines affect myocardial contractility? A critical review. Noise Health 2022;24:96-106. https://www.noiseandhealth.org/text.asp?2022/24/113/96/351963

[205] LUBW State Agency for the Environment Baden-Württemberg. 2020. Low-frequency noise including infrasound from wind turbines and other sources. https://pd.lubw.de/84558

[206] Maijala, P., Turunen, A., Kurki, I., Vainio, L., Pakarinen, S., Kaukinen, C., Lukander, K., Tiittanen, P., Yli-Tuomi, T., Taimisto, P., Lanki, T., Tiippana, K., Virkkala, J., Stickler, E., Sainio, M. 2020. Infrasound Does Not Explain Symptoms Related to Wind Turbines. Publications of the Government's analysis, assessment and research activities 2020:34.

[207] Nykänen, H. 2023. Health risks of noise and vibration generated by wind turbines – preliminary study.

[208] WSP. 2023. A REVIEW OF NOISE GUIDANCE FOR ONSHORE WIND TURBINES. Department for Business, Energy & Industrial Strategy. https://www.wsp.com/en-gb/insights/wind-turbine-noise-report

[209] Salt, AN & Hullar, TE, 2010. Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research, 268 (1-2), 12-21. https://www.sciencedirect.com/science/article/abs/pii/S0378595510003126

[210] Weichenberger, M., Bauer, M., Kühler, R., Hensel, J., Forlim, C. G., Ihlenfeld, A., Ittermann, B., Gallinat, J., Koch, C., & Kühn, S. (2017). Altered cortical and subcortical connectivity due to infrasound administered near the hearing threshold - Evidence from fMRI. PLoS ONE, 12, e0174420. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0174420

[211] van Kamp, I & van den Berg, F, 2021. Health effects related to wind turbine sound: An update. International Journal of Environmental Research and Public Health, 18 (17), 9133. https://www.mdpi.com/1660-4601/18/17/9133

effects[212(,)213(,)214(,)215] . However, expectations of exposure to infrasound from wind turbines and positive or negative messages that influence these expectations may have an impact on the reporting of health symptoms[216] .

One of the most recent and, to date, most comprehensive studies of low-frequency sound, including infrasound, in relation to wind turbines was conducted in Finland and published in English in 2020[217] . The study was commissioned by the Finnish government and conducted by the Technical Research Centre of Finland[218] . The study combined long-term (308 days) sound measurements in wind farms with hearing tests and questionnaires among residents living near wind farms. The aim was to clarify the characteristics of low-frequency noise generated by wind turbines and its associated effects on humans. The study was prompted by the problem that some residents living near wind farms associate the presence of wind turbines with health problems, particularly sleep disorders.

According to the study, 5% of residents living near the wind farms included in the study associated their health problems (respondents with symptoms) with the low-frequency noise of wind turbines. The highest number of symptom respondents) lived in the vicinity of wind farms, which was defined in the study as a radius of 2.5 km. Among residents in the vicinity, 15% were symptom respondents.

According to the study, the frequencies of particularly low-frequency sounds measured in the vicinity of the wind farm remained in the range of 0.1–1 Hz, which is below the human hearing threshold (16–20 Hz). The lower the sound frequency, the higher the sound pressure must be for the sound to be perceptible. The study also found that wind turbines can cause isolated low-frequency sound peaks (short-term low-frequency sound pressure up to 102 dB). Theoretically, such peaks may be perceptible to some people, and therefore, tests were also conducted with humans. The study did not find that people who believed they were experiencing health effects caused by wind turbines were able to hear/perceive low-frequency sounds better. Hearing tests were used to identify the nervous system's response to low-frequency sounds in people complaining of health problems, but no such connection was found. No response was detected in the nervous system or various physiological indicators of these people when they were exposed to the low-frequency sound of wind turbines.

The study also found that within a radius of approximately 1.5 km from the wind farm, a change in the sound spectrum can be observed, i.e., the proportion of low-frequency sounds, including infrasound, in the frequency distribution increases. The sound spectrum becomes very similar to that found in urban conditions.

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[212] Tonin, R, Brett, J & Colagiuri, B, 2016. The effect of infrasound and negative expectations to adverse pathological symptoms from wind farms. Journal of Low Frequency Noise, Vibration and Active Control, 35 (1), 77-90. https://journals.sagepub.com/doi/10.1177/0263092316628257

[213] Nelson, P., Bryne, A., Waggenspack, M., Lueker, M., Feist, C., Herb, B., & Marr, J., 2019. Testing the human response to wind turbine emissions. Wind Turbine Noise 2019, June 12–14, Lisbon. INCE-Europe.

[214] Maijala, PP, Kurki, I, Vainio, L, Pakarinen, S, Kuuramo, C, Lukander, K, Virkkala, J, Tiippana, K, Stickler, EA & Sainio, M, 2021. Annoyance, perception, and physiological effects of wind turbine infrasound. Journal of the Acoustical Society of America, 149 (4), 2238- 2248. https://doi.org/10.1121/10.0003509

[215] Krahé, D, Alaimo Di Loro, A, Müller, U, Elmenhorst, E, De Gioannis, R, Schmitt, S, Belke, C, Benz, S, Großarth, S, Schreckenberg, D, Eulitz, C, Wiercinski, B & Möhler, U 2020. Noise effects of infrasound emissionshttps://www.umweltbundesamt.de/publikationen/laermwirkungen-von-infraschallimmissionen

[216] Crichton, F, Dodd, G, Schmid, G, Gamble, G & Petrie, KJ, 2014. Can expectations produce symptoms from infrasound associated with wind turbines? Health Psychology, 33 (4), 360-364. https://doi.org/10.1037/a0031760

[217] Maijala, P., Turunen, A., Kurki, I., Vainio, L., Pakarinen, S., Kaukinen, C., Lukander, K., Tiittanen, P., Yli-Tuomi, T., Taimisto, P., Lanki, T., Tiippana, K., Virkkala, J., Stickler, E., Sainio, M. 2020. Infrasound Does Not Explain Symptoms Related to Wind Turbines. Publications of the Government's analysis, assessment and research activities 2020:34.

[218] Maijala, P. 2020. VTT studied the health effects of infrasound in wind turbine noise in a multidisciplinary cooperation study. VTT Technical Research Centre of Finland.

The study concluded that the low-frequency noise of wind turbines, including infrasound, cannot be linked to the health effects reported by people. At the same time, a hypothesis was put forward that the amplitude variation of wind turbine noise may be more significant than low-frequency noise.

Another recent and representative health impact study on this topic was conducted in Australia. The aim of the study was to identify the possible occurrence of wind turbine syndrome. During the study, three different noise exposures were tested in a sleep laboratory over a period of 72 hours at 10-day intervals. The study included 37 healthy but noise-sensitive adults. They were exposed to infrasound (1.6-20 Hz ~90 dB, simulating the infrasound signature of wind turbines), apparent infrasound (the same speakers that did not generate infrasound), and traffic noise. Changes in various physiological and psychological indicators in humans were studied. The results of the study did not support the idea that infrasound causes wind turbine syndrome. High-level but inaudible infrasound had no effect on any of the physiological or psychological indicators tested among the study participants[219] .

There are several scientific theories as to why some people feel unwell in the vicinity of wind turbines and associate this with the infrasound generated by the turbines. One explanation offered is that when infrasound encounters buildings, it can cause secondary structural vibrations that may be perceived by the building's occupants. Most people are not affected by wind turbine infrasound, but some people may have a phobic reaction to it[220] .

4.4.1.6 Measures, need for further research and assessment

- Since the sound generated by wind turbines can travel long distances under certain conditions and be disturbing, models with lower noise levels that use technical noise reduction measures (e.g., serrated blade edges, etc.) should be preferred when selecting wind turbines. Use new, fully functional wind turbines.
- When installing wind turbines, including when choosing the distance between them, the technical requirements of the wind turbine manufacturer must be followed. Wind turbine manufacturers guarantee the noise emissions specified in the technical documentation of the wind turbine if the wind turbines are installed and maintained in accordance with . If wind turbines are placed closer to each other than is technically recommended, noise emissions may exceed the guaranteed noise level. This, in turn, may lead to a situation where the actual noise levels in noise-sensitive areas exceed the predicted levels.
- When applying for a building permit, data on the sound power level corresponding to the parameters of the recommended wind turbine and the corresponding noise level modeling must be submitted, on the basis of which the local government can verify that the use of the corresponding wind turbine model complies with the noise standards in noise-sensitive areas. The noise assessment must take into account the combined impact with other wind farms being developed in the area, based on the best available knowledge at the time. It must be ensured that the combined impact of wind farms does not exceed the night-time noise target value in noise-sensitive areas. Exceeding the target value is only permitted with the consent of the owner of the noise-sensitive area, but it must be taken into account that even with the owner's consent, it is not permitted to exceed the night-time limit value for industrial noise in noise-sensitive areas.
- Noise during construction must not exceed the limits set out in the Atmospheric Air Protection Act and Regulation No. 71 of the Minister of the Environment of 16 December 2016, "Noise levels

[219] Marshall, N. S., Cho, G., Toelle, B. G., Tonin, R., Bartlett, D. J., D'Rozario, A. L., Evans, C. A., Cowie, C. T., Janev, O., Whitfeld, C. R., Glozier, N., Walker, B. E., Killick, R., Welgampola, M. S., Phillips, C. L., Marks, G. B., & Grunstein, R. R. 2023. The health effects of 72 hours of simulated wind turbine infrasound: a double-blind randomized crossover study in noise-sensitive, healthy adults. Environmental Health Perspectives, 131(3), 037012-1-037012-12. Article 037012. https://doi.org/10.1289/EHP10757

[220] Flemmer, F., and Flemmer, R. 2023. Wind turbine infrasound: Phenomenology and effect on people, Sustainable Cities and Society, Volume 89, 2023, 104308, https://doi.org/10.1016/j.scs.2022.104308

in outdoor air and methods for measuring, determining and assessing noise levels," and Regulation No. 42 of the Minister of Social Affairs of 4 March 2002 "Noise standards in residential and recreational areas, residential buildings and public buildings and methods for measuring noise levels". Avoid noisy construction work during the night.

Follow-up:

- After completion of the wind farm (within 6 months), control measurements of noise levels must be carried out in the yards of at least two residential buildings closest to the wind farm and compliance with industrial noise standards must be assessed. The measurements must be carried out in accordance with the relevant EVS-EN ISO standard and by an accredited measurer. The measurement results must be submitted to the local government.
  If it turns out that noise standards are exceeded in residential areas, the wind farm owner must develop measures to reduce wind farm noise (e.g., limiting wind turbines to a quieter operating mode at night).
- After the completion of the wind farm (within 6 months), low-frequency noise measurements must be carried out in the interior of the residential buildings closest to the wind farm. Low-frequency noise measurements shall be carried out in accordance with standard EVS-EN ISO 16032:202453 or an equivalent document.
  If it turns out that the sound insulation of the residential building is not sufficient to ensure compliance with low-frequency noise standards in the interior, the sound insulation must be improved (this is the responsibility of the wind farm owner, who must cooperate with the owner of the residential building to implement this). Low-frequency noise levels in indoor spaces must be ensured across the entire low-frequency noise frequency curve.

4.4.2 Shading

4.4.2.1 Assessment methodology

This draft SEA was completed before the Ministry of Climate completed its new guidelines for assessing the impact of wind farms. As the SEA sought to use the best available information, the section on shadow assessment was updated in May 2025 based on **the methodology presented in the guidelines prepared by the Ministry of Climate**[221] . In addition, the accuracy of the wind turbine positions was taken into account in connection with the additional measures planned to mitigate the impact on birdlife (comparative assessments were made of the initial and modified positions).

Wind turbines, as tall structures, inevitably cause shadows in sunny weather. There are two types of environmental impacts caused by the combined effect of wind turbines and sunlight: moving shadows and periodic reflections. Moving shadows are caused by the structural parts of the wind turbine . The moving shadows of wind turbines are caused by the rotating blades of the turbine. As the blades move, the shadow also moves continuously. This can disturb people in nearby homes and drivers on the road in the mornings and evenings.

Reflections occur when the sun is reflected momentarily from the blades of the wind turbine, causing unpleasant glare at certain viewing points. Reflections are caused by the material of the blades; to prevent this, modern wind turbines use matte surface treatment methods.

There is no disturbing shadowing when there is no direct sunlight (cloudy weather) or when the wind turbine is not operating. The lower the sun is in the sky, the greater the extent of the shadows. Therefore, shadows are most extensive in the morning and evening hours and during the winter period. At the same time, the potential duration of shadows is greatest in summer (the days are longer).

[221] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadowing.

Considering the movement of the sun across the sky at our latitude, wind turbines (or other objects) never cast shadows south of the turbine tower. The shadows extend furthest to the west and east. The total duration of the shadow is greatest in the immediate vicinity of the wind turbine tower in the northwest, north, and northeast directions.

The level of shadowing is affected by the diameter of the wind turbine rotor, the height of the mast, and the location of the wind turbine in relation to the residential area.

When calculating the actual duration of the shadow, the duration of direct sunlight is taken into account based on observation data from meteorological stations, and the operating time of the wind turbines is based on wind directions (i.e., the location of the wind turbine blades) and the occurrence of wind calm.

The extent of the shadow can be calculated using appropriate software and a shadow calendar can be compiled for each residential area. Theoretically, shadows can extend several kilometers. In reality, however, the shadow does not cause significant disturbance beyond a distance of approximately 10 times the diameter of the wind turbine rotor. When viewed from a greater distance, the effect of the optical properties of the atmosphere becomes so great that the shadow is no longer perceptible. Shadow flicker can also be a real issue in locations where the wind turbine is visible. The rotor diameter of today's largest onshore wind turbines is up to 175 m. In five years' time, it can be expected that wind turbines with even larger diameters will come into production, which will result in a calculated shadow range of up to 2 km. Again, it must be taken into account that the shadow range is highly dependent on the direction of the wind, the season, the time of day, the visibility of the wind turbine, etc.

The shadow calendar shows whether and when shadowing may occur and whether it is at a level that may be disturbing. The placement of wind turbines is usually optimized based on the duration of shadowing. It is also possible to avoid the disturbance caused by shadowing, for example, by stopping the operation of wind turbines at certain times (in cases where there is sun, wind, and disturbing shadowing in relation to residential areas).

Specialized software WindPRO version 4.0 was used for modeling. The shadow impact area and shadow intensity were modeled with WindPRO software using the SHADOW module.

The shadow was modeled theoretically for a future possible 200 m diameter rotor and 200 m mast (with a tip height of 300 m). In terms of shadow, there is a correlation between the height of the wind turbine and the distance the shadow can reach.

The assessment was carried out according to the following principle

- If the worst possible situation is ≤30 hours/year or 30 minutes/day, no further action is required;
- If the worst-case scenario is >30 hours/year or 30 minutes/day, calculations based on real-life conditions must be carried out;
- If the situation based on real conditions is >8 hours/year or 30 minutes/day, mitigation measures must be planned and implemented.

Calculation assumptions:

- Worst-case scenario: wind turbines operate all day, the sun shines in a cloudless sky from sunrise to sunset, the rotor surface is perpendicular to the sun's rays, and the wind direction is in line with the sun at all times. Light refraction in the atmosphere (which has a negligible effect on shadow location compared to other factors) and objects (buildings, trees, etc.) that obstruct the spread of sunlight, except in situations where the presence of an object (especially a building) is guaranteed at a given location for the entire duration of the wind farm's operation.

- Real-world conditions: actual meteorological conditions in the region (duration of sunshine, wind direction). In the case of Estonia, it is possible to use long-term meteorological data from the Estonian Weather Service on the duration of sunshine and the distribution of prevailing winds in the region. More specifically, data from the nearest possible weather station/meteorological station should be used. Objects (buildings, trees, etc.) that obstruct the spread of sunlight are taken into account.
- Situations where the sun is below 3° will not be taken into account.

Impact points and their determination:

- Impact points are considered to be indoor and outdoor spaces where shading may cause disturbances.
- Worst-case scenario:
  - The impact is assessed on residential and public buildings, which are determined on the basis of data from the Estonian Topographic Database (ETAK). Where appropriate, commercial buildings and residential and public buildings that have been granted building permits but have not yet been constructed shall also be included, based on data from local authorities.
  - More specifically, the assessment is carried out in an area measuring 15 m x 15 m, the center of which is located on the building mentioned in the previous point.
  - The calculation height is 1.5 m (normal human eye level).
- Situation based on real conditions:
  - The impact is assessed only for buildings that exceed the standard levels for the worst-case scenario.
  - The impact points are determined based on the principles set out in the previous point (worst-case scenario).

The duration and extent of shading were assessed using average meteorological data for many years regarding the duration of sunshine[222] and the distribution of prevailing winds in the region. In order to assess the possible theoretical impact on more distant areas, no distance restrictions were used in calculating the shadowing, and the shadowing was calculated up to the possible theoretical maximum distance from the wind turbines (approximately 3 km).

The modeling used data from the Estonian Land Board's ground elevation model (5 m accuracy data grid) and Latvian elevation data (20 m grid ground elevation model), which are the most accurate data available. The viewing height of the shadow map was set at 1.5 m, which is the normal viewing height for a person. The height of the shadow receptors was set at 1.5 m above ground level.

For modeling the actual total eclipse (*the* so-called *real case*), data from the nearest weather station measuring sunshine duration, i.e., the Tartu-Tõravere weather station, was used. Long-term average meteorological data on sunshine duration was used to estimate the duration and extent of the eclipse (Table34) and the distribution of prevailing winds in the region (Table35). If weather conditions differ significantly from statistical data, the amount of shading will also differ.

[222] State Weather Service. Duration of sunshine. https://www.ilmateenistus.ee/kliima/kliimanormid/paikesepaiste-kestus/

Table34 . Data on hours of sunshine per day used in modeling. Source: https://www.ilmateenistus.ee/kliima/kliimanormid/paikesepaiste-kestus/

Month	Average duration of sunshine per day, h
January	1.08
February	2.33
March	4.53
April	6.36
May	8.58
June	8.60
July	8.67
August	7.34
September	5.07
October	2.56
November	1.00
December	0.78

Table35 . Estimated annual operating time of wind turbines by compass direction. It is assumed that wind turbines operate up to 90% of the time. Based on wind rose data from the Valga meteorological station.

Wind direction	Operating time (hours per year)
N	67
NE	1025
E	670
SE	828
S	1143
SW	1577
W	1262
NW	710

4.4.2.2 Occurrence and impact of shadow flicker

The shadow cast by wind turbines is highly disruptive when it falls on areas where people are present. This is particularly true in areas where people spend long periods of time, such as residential areas.

Long-term shadow flicker has been observed to have a disturbing effect, especially on people staying indoors. Due to continuous light flickering lasting more than 30 minutes, stress and impaired concentration have been observed in people[223] .

In Estonia, there are no legal standards for the occurrence of shadowing. In the case of shadow flicker, the significant impact threshold is based on the recommended values set out in the guidelines prepared by the Ministry of Climate in 2025[224] , according to which, if the shadow flicker situation in a sensitive area based on actual conditions is >8 hours/year or 30 minutes/day, mitigation measures must be planned and implemented.

The occurrence of shadowing has also been linked to the onset of epileptic seizures. It is important to note that flashing light does not cause epilepsy, but it can trigger epileptic seizures in people who suffer from photosensitive epilepsy. Up to 0.03% of the population (up to 3 people in 10,000) suffer

[223] Department of Energy and Climate Change; Parsons Brinckerhoff. Update of UK Shadow Flicker Evidence Base.
[224] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadow flicker.

from epilepsy. Up to 5% of people with epilepsy are photosensitive. This means that in their case, epileptic seizures can be triggered by changes in light intensity at frequencies above 2.5 Hz (flashing at frequencies of 15-25 Hz is most likely to trigger epileptic seizures). It has been found that changes in light intensity at frequencies of 3 Hz and below can cause epileptic seizures in 1.7 people per 100,000 of the light-sensitive population. To mitigate this risk, the flashing frequency of wind turbine shadows must remain below 60 flashes per minute.[225] . The rotational speeds of modern wind turbines are too low (less than 20 revolutions per minute even at maximum rotational speed) to cause light flickering at frequencies above 3 Hz. Theoretically, it is possible for the shadows of several wind turbines to fall on a residential area at the same time, in which case the flashing frequency is higher than that of a single wind turbine. If each wind turbine rotates at 20 RPM and has 3 blades, then the shadows of 3 wind turbines would have to fall on the residential area at the same time to cause a total flicker frequency of 3 Hz. Such a situation is extremely unlikely.

The results of the shadow modeling are presented in FigureFigure42 . Shadow reports with shadow calendars for residential areas where disturbing levels of shadowing may occur are presented in FigureFigure44 .

The shadow assessment showed that the shadow disturbance level (8 h/a) is expected to be exceeded in the case of a wind turbine with a tip height of 300 m and a rotor diameter of 180 m at two residential buildings (Table36). Shadow modeling shows that the recommended shadow levels are guaranteed in most residential areas near wind farms. However, there are residential areas that may experience shadow disturbance.

Table36 . Duration of shadow (flickering shadow) cast on residential areas by wind turbines in the case of the initial and modified layout of wind turbines.

Name	X	Y	Initial wind turbine layout			Modified wind turbine layout		
			Worst total (theoretical), h/a	Maximum duration of shadowing per day min/day	Actual total (climate-adjusted), h/a	Worst total (theoretical), h/a	Maximum shadow duration per day min/day	Real total (climate-adjusted), h/a
Ellemäe	603191	6423757	31:00	00:32	02:25	30:21	00:29	02:27
Elli	603231	6423888	25:21	00:29	01:57	00:00	00:00	00:00
Holdre cordon	604147	6420836	21:21	00:28	05:18	21:21	00:28	05:18
Holdre Manor	603065	6423826	36:20	00:31	04:17	27:26	00:29	02:09
Jaanimäe	603272	6423722	33:18	00:31	02:39	29:22	00:29	02:25
LV_Aizupes	597186	6418869	00:00	00:00	00:00	00:00	00:00	00:00
LV_Andreni	604017	6419050	00:00	00:00	00:00	00:00	00:00	00:00

[225] Harding, G., Harding, P., Wilkins, A.J. 2008. Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia, 49(6):1095–1098, 2008.

LV_Apsinas	602756	6419153	18:48	00:31	04:52	6:47	00:30	04:52
LV_Attekas	604065	6418836	00:00	00:00	00:00	00:00	00:00	00:00
LV_Cesnieki	597051	6419070	00:00	00:00	00:00	00:00	00:00	00:00
LV_Dzintari	597036	6421015	00:00	00:00	00:00	00:00	00:00	00:00
LV_Gundegas	601358	6418575	33:12	00:33	08:33	33:04	00:33	08:31
LV_Lejasumpuli	596820	6419987	00:00	00:00	00:00	00:00	00:00	00:00
LV_Medni	602931	6418461	00:00	00:00	00:00	00:00	00:00	00:00
LV_Omuli RPP	604066	6420797	31:23	00:30	07:53	31:19	00:30	07:52
LV_Rozas	603733	6418606	00:00	00:00	00:00	00:00	00:00	00:00
LV_Strazdini	603309	6418557	00:00	00:00	00:00	00:00	00:00	00:00
LV_Vecunguri	601858	6418244	00:00	00:00	00:00	00:00	00:00	00:00
LV_Vilci	596903	6420716	00:00	00:00	00:00	00:00	00:00	00:00
LV_Zeltkalni	597432	6420734	00:00	00:00	00:00	00:00	00:00	00:00
LV_Zimelnieki	596750	6421013	00:00	00:00	00:00	00:00	00:00	00:00
Lindmäe	603314	6423782	30:57	00:30	02:27	27:55	00:27	02:17
Luhe	600416	6425156	53:39	00:45	04:21	21:31	00:31	01:41
Mekro	604485	6422161	11:03	00:26	02:33	00:00	00:00	00:00
Männiku	603206	6423903	24:11	00:29	01:51	00:00	00:00	00:00
Park	603339	6423662	35:00	00:31	02:50	23:32	00:29	02:01
Pelgu	602076	6423374	236:00	01:46	34:17:00	182:03	01:35	23:00
Sepakõrtsi	604072	6423618	00:00	00:00	00:00	00:00	00:00	00:00
Bridge	603006	6424018	25:14	00:26	03:08	00:00	00:00	00:00
Vanaveski	604582	6422810	00:00	00:00	00:00	00:00	00:00	00:00
Vastseveski	602721	6424090	20:56	00:30	02:53	00:00	00:00	00:00
Mill	604315	6422679	11:46	00:27	02:25	00:00	00:00	00:00

Viitaku	600317	6425095	59:52	00:48	04:51	23:40	00:33	01:52

Calculation: Varjutus_d200_h200_300m_real case_21052025_eskiisi paigutus

0 500 1000 1500 2000 m

Map: EMD OpenStreetMap , Print scale 1:45 000, Map center Estonian Lambert L-EST97-EST97 (EE) East: 600 970 North: 6 421 980

New WTG   Shadow receptor

Figure42 . Shadow map for wind turbines with a tip height of 300 m, initial layout based on climate-sensitive modeling. 21 wind turbines.

Calculation: Varjutus_d200_h200_300m_real case_21052025_muudetud paigutus

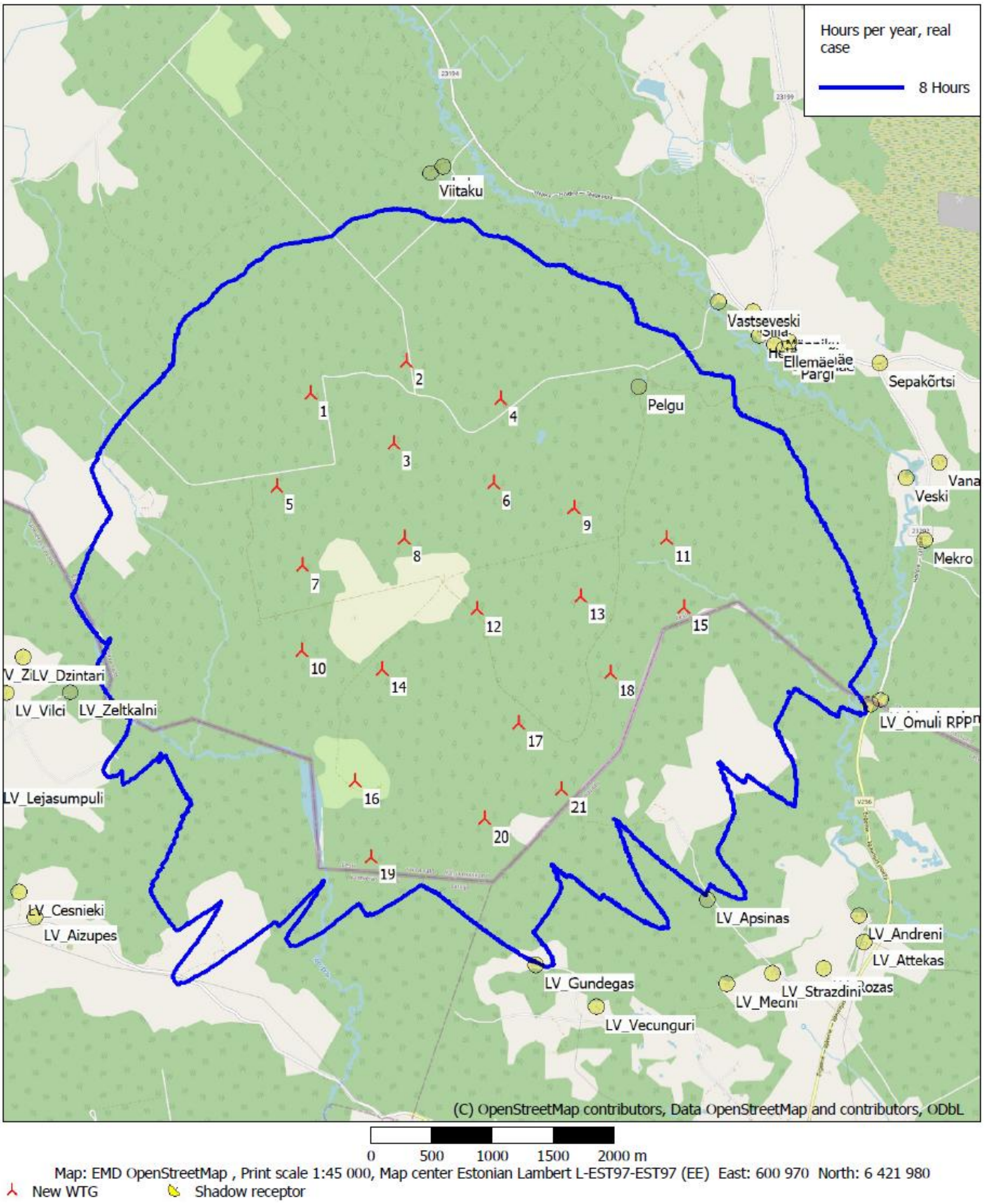

Figure43 . Shadow map for wind turbines with a tip height of 300 m, modified layout based on climate-conscious modeling. 21 wind turbines.

The shadow assessment revealed that the two residential buildings may experience a total shadow duration of more than 8 total shadow hours per year. Based on the shadow calendars (Figure44), it is clear that the Pelgu residential building is shadowed by a total of six wind turbines. In the case of the residential building in Lätti, the shadow is caused by one wind turbine. The necessary measures to reduce shadow disturbance are presented in section 4.5.2.3. When assessing , it must be taken into account that this is given for the maximum wind turbine dimensions. As the extent of the shadow depends on the dimensions of the wind turbine, the shadow will be smaller in the case of lower wind turbines.

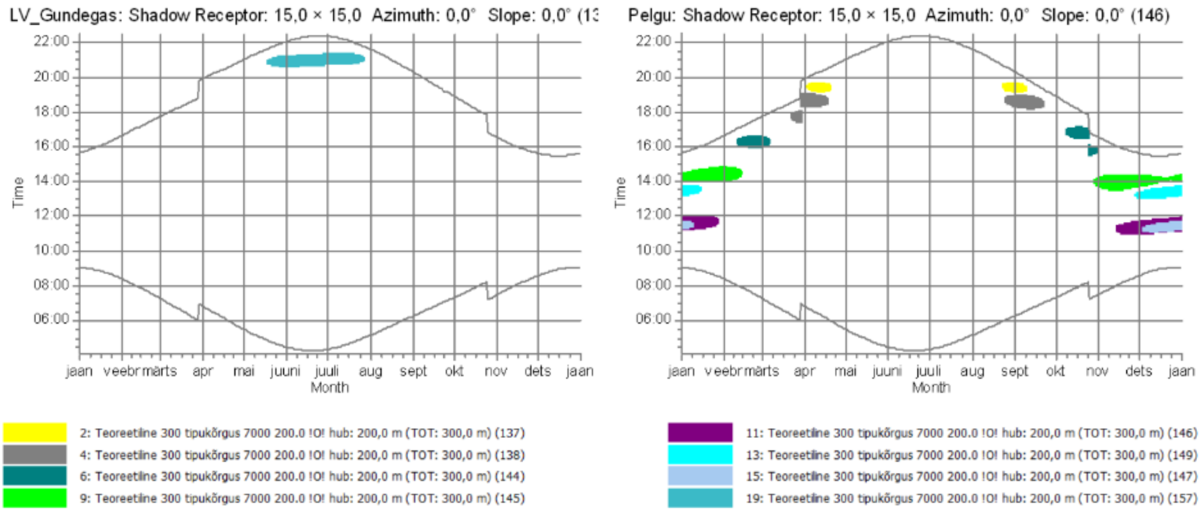

Figure44 . Shadow calendar for the residential area of Pelgu and for the residential area of Gundegas on the Latvian side for wind turbines with a tip height of 300 m in the case of a modified wind turbine layout.

In order to assess the effectiveness of the planned shadow mitigation measures, additional shadow modeling was carried out, taking into account that the Pelgu residential area will be protected by maintaining a shadow barrier of greenery throughout the lifetime of the wind farm and that smaller wind turbines will be used (285 m tip height and up to 180 m rotor diameter) will be used as wind turbines. The corresponding assessment showed that the recommended shadow values are guaranteed in all residential areas when the relevant measures are implemented. An alternative measure that is equally effective is the implementation of a wind turbine control system that takes into account the duration of shadowing.

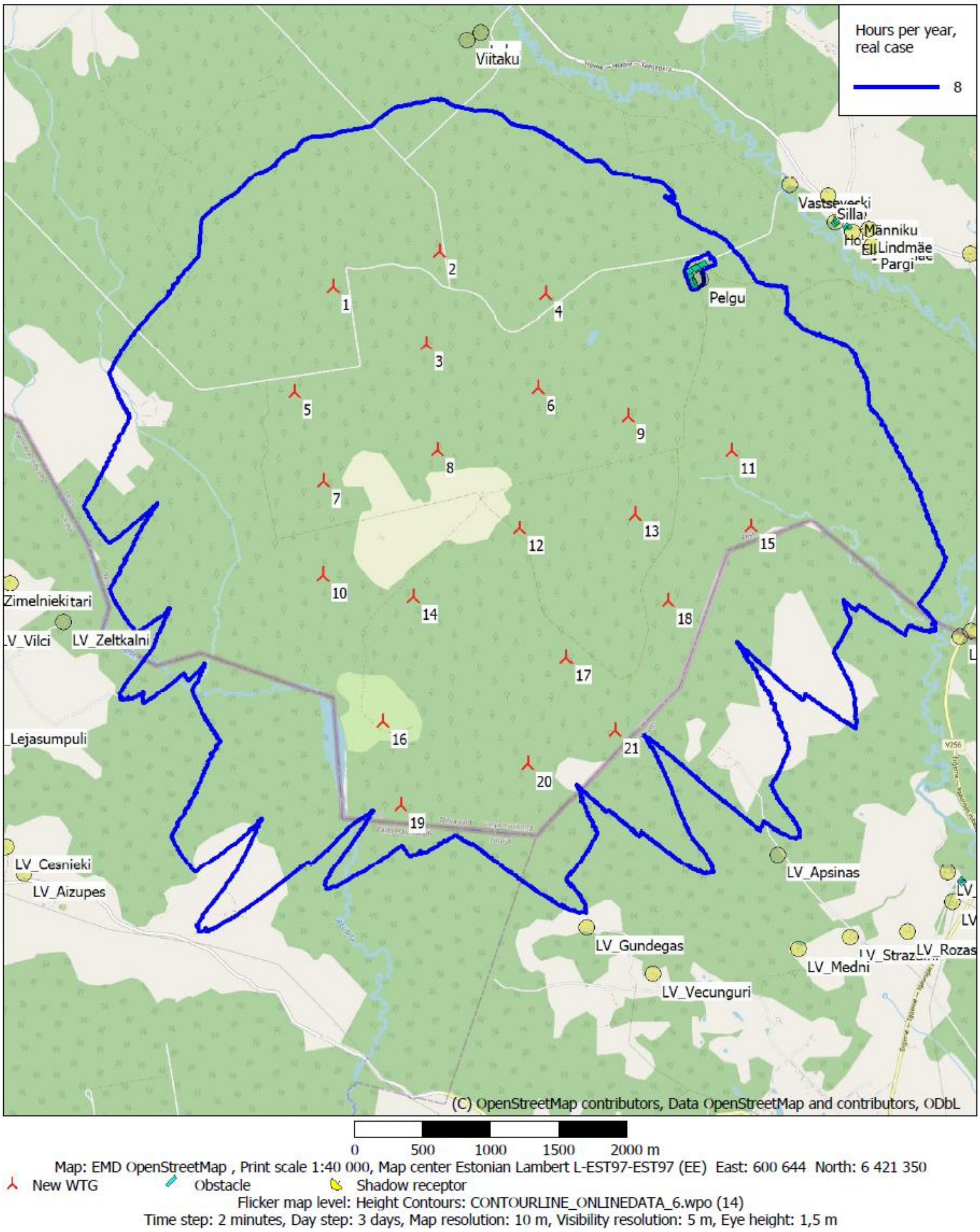

Figure45 . Shadow map with mitigation measures: modeling that takes climate conditions into account for wind turbines with a tip height of 285 m and a forest area to be preserved to protect the Pelgu residential area. 21 wind turbines (layout as of May 21, 2025).

4.4.2.3 Measures, need for further studies and assessment

- Shadowing at a disturbing level (i.e. more than 8 hours of shadowing per year or more than 30 minutes per day, taking climate conditions into account) in residential areas must be avoided.

Shadowing at a disturbing level is only permitted in residential areas with the consent of the owner of the shadow-sensitive area. There are two options for avoiding shadowing:

- Establish/maintain a green screen to reduce disturbance in areas sensitive to shading – evergreen species such as spruce should be used to ensure year-round effectiveness. The barrier (a dense row of trees) should be created to protect the courtyard area on the wind farm side of the residential area affected by the shadow. This measure can primarily be used to protect the Pelgu residential area. To the west and north of the residential area are forest areas for which the person interested in the plan has a building rights agreement. The forest area (at least 30 m wide) to the east and north of the residential area must be designated as preserved. In some places, the area is currently grassland, which should be reforested.
- Wind turbines that cause significant shading (more than 8 hours per year) should be equipped with an automatic shading monitoring system that allows the turbine to be stopped during periods of disruptive shading in cooperation with light intensity sensors and the turbine's automatic control system. When developing a control system-based restriction plan, the location of the impact points can be specified as follows:
    - The exact point of impact indoors is the center of the actual size of the window in the relevant room on the most affected facade of the building.
    - The exact point of impact in the outdoor space is selected as a point that reflects regular use of the outdoor space (e.g., the center of a terrace or seating area) and is located no more than 15 m from the building.
- As a mitigating measure, it is also possible to use smaller wind turbines than those assessed in the SEA for the special plan. This measure is particularly effective in the courtyard of the Gundegas residential building in Latvia to avoid exceeding the shadow disturbance level, as it is possible to avoid exceeding the disturbance level by reducing the size of the wind turbines to a relatively small extent.

– This SEA has assessed the shadowing that would occur with the maximum wind turbine dimensions. When using smaller wind turbines, the extent of the shadow created and, therefore, the duration of the shadow in residential areas is smaller. When applying for a building permit, the parameters of the recommended wind turbine and the corresponding shadow level modeling must be submitted, along with a description of the measures used to avoid disturbing shadows, on the basis of which the local government can verify that the use of the wind turbine model in question will not exceed the shadow disturbance level in sensitive areas.

4.4.3 Other possible health effects e

In the case of wind farms, the impact on human health is primarily related to the noise and shadowing effects of wind turbine operation, which are discussed in detail in sections4.4.1 and4.4.2 .

More indirectly and in broader terms, the construction of wind farms can have a positive impact on health by helping to reduce dependence on fossil fuel-fired and emission-intensive power plants, which in turn improves overall air quality. No positive impact on air quality is expected from this particular wind farm. The wind farm is planned for an area where there are currently no fossil fuel-based emission sources.

In many countries, some people living near wind energy production areas have reported symptoms that they associate with wind turbines. The causes of these symptoms remain controversial. A recent study in Finland selected four wind energy production areas in Finland. A questionnaire was sent to 4,847 adults in four distance zones (≤ 2.5 km, > 2.5–5 km, > 5–10 km, > 10–20 km from the nearest wind turbine), and 28% of the people responded. In the closest zone (≤ 2.5 km), 15% of respondents reported symptoms that they intuitively associated with the infrasound from wind turbines. Across the entire study area, the prevalence of symptoms was 5%. Many symptomatic respondents found the noise from the wind turbines disturbing and also associated their symptoms with the vibration or electromagnetic fields caused by the wind turbines. One-third of symptomatic respondents rated their symptoms as severe, and the range of symptoms was very broad, affecting multiple organ systems. [226]The analysis of the study found that factors such as proximity to wind turbines, poor health, annoyance with various aspects of wind turbines, and perception of wind turbines as a health risk were associated with the presence of infrasound-related symptoms.

The potential health effects of wind turbines are primarily associated with the impact of the noise they generate. Studies of disturbances associated with various sources of environmental noise (e.g., comparing normal traffic noise and wind turbine noise) have found that wind turbines are perceived as a disturbance at relatively low noise levels (e.g., in the range of 30-40 dB)[227] . From a health perspective, broad-based studies on wind turbine noise have not found a direct link to chronic diseases, and the main impact may be in the form of certain disturbances[228] . Unlike other sources of environmental noise, wind turbines are generally located much further away from residential areas, and the number of homes located within the area affected by noise levels that could be harmful to health is small (unlike, for example, traffic noise). In certain cases, people living near wind turbines may experience difficulties sleeping.

As the potential health effects of wind turbines are a topical issue in many countries, various studies reflecting different health effects have been conducted in recent years. A study conducted in Finland on the use of medications showed that the use of diabetes medications, cardiovascular medications (including medications for arrhythmia), medications affecting the nervous system (including sleeping pills, sedatives, antidepressants, painkillers, and anti-dizziness medications), and anti-inflammatory and rheumatism medications near wind farms was no higher than in control areas during the same period, both before and after the start of wind energy production. Similarly, there was no increase in the number of new users of the aforementioned prescription drugs after the start of wind energy production compared to the period before production began[229] .

The most comprehensive study of the health effects of wind turbines is known to have been conducted in Denmark[230] . The nationwide Danish study was based on a long-term and comprehensive analysis of the health data of the Danish population. Based on this:

[226] Turunen AW et al. 2020. Symptoms intuitively associated with wind turbine infrasoundLink to another websiteOpens in a new tab. Environmental Research 192: 110360.
[227] Radun, J., Maula, H., Saarinen, P., Keränen, J., Alakoivu, R., Hongisto, V. 2022. Health effects of wind turbine noise and road traffic noise on people living near wind turbines. https://doi.org/10.1016/j.rser.2021.112040
[228] van Kamp, I.; van den Berg, F. 2021. Health Effects Related to Wind Turbine Sound: An Update. Int. J. Environ. Res. Public Health, https://doi.org/10.3390/ijerph18179133
[229] Turunen A et al. 2022. Use of prescription drugs in the vicinity of wind power production areas. Link to another website Opens in a new tab Environment and Health magazine 1/2022.
[230] Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2018. Short-term nighttime wind turbine noise and cardiovascular events: A nationwide case-crossover study from Denmark. Environment International, 114, 160-166.
Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2018. Long-term exposure to wind turbine noise and redemption of antihypertensive medication: A nationwide cohort study. Environment International, 121 (1), 207-215.
Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2018. Long-term exposure to wind turbine noise at night and risk for diabetes: A nationwide cohort study. Environmental Research, 165, 40-45.
Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2018. Pregnancy exposure to wind turbine noise and adverse birth outcomes: A nationwide cohort study. Environmental Research, 167, 770-775.

- No strong evidence was found of a link between higher noise levels from wind turbines and an increased risk of the following health problems: heart attack, stroke, hypertension, diabetes, adverse birth outcomes.
- Some evidence was found for an association between higher nighttime wind turbine noise and an increased risk of clinical depression (antidepressant prescriptions). This finding was based on a comparison between the group with the highest noise levels (≥42 dB LAeq, at night) and the group with the lowest noise levels (<24 dB LAeq, at night). A gender-specific analysis showed that the effect was stronger in men than in women.
- A link was also found between long-term average nighttime wind turbine noise levels (≥42 dB LAeq) and the purchase of sleeping pills among people aged 65 and older.

4.4.3.1 Electromagnetic fields

An electromagnetic field is a physical field generated by electric charges and influenced by them, combining electric and magnetic fields into a single whole. Electronic devices cause electromagnetic waves. Measurements taken at existing wind farms have shown that wind turbines do not cause any particular electromagnetic waves. The magnetic field in the immediate vicinity of wind turbines remains at a lower level than that of conventional household electronic devices[231] . Electromagnetic fields are primarily associated with the high-voltage power lines that may accompany wind farms. No new overhead power lines are planned in the Tõrva special plan.

4.4.4 Vibration

The assessment of possible vibration from the wind farm was based on the methodology presented in the guidelines prepared by the Ministry of the Environment[232] . The guidelines state that, considering that the spread of vibration depends, among other things, on the properties of the soil at the site and the capacity of the wind turbines, it is advisable, based on the precautionary principle, to ensure that wind farms are located at least 500 m away from vibration-sensitive buildings (residential and public buildings) in order to avoid negative (including cumulative) impacts. If this distance is ensured, it is not necessary to carry out detailed vibration studies. In the case of this special plan, the distance between the wind turbine and vibration-sensitive buildings is greater than 500 m, and therefore no vibration assessment is carried out in the preparation of the SEA report.

The standard vibration values are specified in Regulation No. 78 of the Minister of Social Affairs of 17 May 2002, "Vibration limit values in residential and public buildings and methods for measuring vibration."

Table37 . Vibration limit values during the day (07:00–23:00) and at night (23:00–07:00) in accordance with Regulation No. 78.

Buildings and rooms	Vibration exposure time	Vibration *acceleration* α_v limit values, (m/s^2)	Vibration acceleration levels $L_{\alpha v}$ limit values, (dB)

Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2019. Long-term exposure to wind turbine noise and risk for myocardial infarction and stroke: A nationwide cohort study. Environmental Health Perspectives, 127 (3), 037004.

Poulsen, AH, Raaschou-Nielsen, O, Peña, A, Hahmann, AN, Nordsborg, RB, Ketzel, M, Brandt, J & Sørensen, M, 2019. Impact of long-term exposure to wind turbine noise on redemption of sleep medication and antidepressants: A nationwide cohort study. Environmental Health Perspectives, 127 (3), 037005.

[231] McCallum, L.C., Whitfield Aslund, M.L., Knopper, L.D. et al. 2014. Measuring electromagnetic fields (EMF) around wind turbines in Canada: is there a human health concern?. Environ Health 13, 9.

[232] Ministry of Climate, 2025. Guidelines for assessing the environmental impact of wind farms. Noise, vibration, shadowing.

Living rooms, group rooms and bedrooms in residential buildings, dormitories, care institutions and pre-school childcare facilities	During the day At night	1.26×10^{-2} 8.83×10^{-3}	82 79
Accommodation facilities	During the day At night	1.26×10^{-2} 8.83×10^{-3}	82 79
Healthcare service provision premises, excluding hospital wards	24 hours a day	1.26×10^{-2}	82
Hospital wards	24 hours a day	8.83×10^{-3}	79
Educational institution premises where teaching takes place	During the day	1.26×10^{-2}	82
Offices and administrative buildings	Daytime	2.52×10^{-2}	88

The operation of wind turbines causes a certain amount of vibration in the blades and rotor, which is then transmitted to the tower. However, technological solutions have minimized vibration and prevented its transmission. An important part of preventing and dampening vibration is the wind turbine foundation, which must be designed to be sufficiently strong, taking into account the specific wind turbine and the geological conditions of the location. The specific foundation solution is developed during the design phase. To ensure the stability of the wind turbine (including over a long period of time and in extreme conditions), the foundations of wind turbines are built to be massive and of a suitable construction, which ensures minimal vibration in the foundation and surrounding soil.

Recent scientific analyses of wind turbine vibration focus on technical vibration in wind turbine structures in order to identify possibilities for automatic monitoring [233] or to improve technical solutions[234] . The aim of such studies is to reduce the risk of technical failures and accidents in wind turbines. As with other technical equipment and tall structures, it is important that vibration is minimized.

In the case of ground vibration, the level perceptible to sensitive individuals is 0.15 mm/s. Measurements taken at wind farms have occasionally recorded vibration levels exceeding human sensitivity in the immediate vicinity of wind turbines (at the base of the turbine). Further away, vibration levels are below the human perception threshold.[235] Even more recent studies have not been able to measure vibration levels in homes located in the vicinity of wind turbines that exceed the human perception threshold or the applicable vibration limit values[236] . However, very low levels of

[233] Escaler, X., Mebarki, T. 2018. Full-Scale Wind Turbine Vibration Signature Analysis. Machines.
[234] Xie, F., Aly, A-M. 2020. Structural control and vibration issues in wind turbines: A review. Engineering Structures Volume 210.
[235] Meunier, M. 2013. Wind Farm - Long term noise and vibration measurements. The Journal of the Acoustical Society of America 133.
[236] Borowski, S. 2019. Ground vibrations caused by wind power plant work as environmental pollution - case study. MATEC Web of Conferences: 18th International Conference Diagnostics of Machines and Vehicles.

vibration caused by wind turbines can be measured with sensitive seismographs at a distance of 10–15 km from the wind turbines[237] .

Considering that in this case the potential suitable areas are generally located at least 1 km away from residential areas, vibrations exceeding the human perception threshold or the applicable vibration limit values are not expected.

In the context of the Environmental Impact Assessment and Environmental Management System Act, the impact on property is considered to be the impact on property resulting from changes in environmental conditions – typically, such an impact may manifest itself, for example, through the generation of vibrations that may affect neighboring buildings. The construction and operation of the wind farm will not cause vibrations that could affect surrounding buildings. Therefore, there is no direct impact on property.

4.5 Potential impact on cultural heritage

4.5.1 Assessment methodology

The impact on cultural values was assessed on the basis of databases containing information on cultural heritage (the Register of Cultural Monuments, the EELIS database of heritage sites, and data on archaeologically sensitive areas compiled by the National Heritage Board). The purpose of the assessment was to identify areas of cultural heritage protection that are known to be potentially suitable for areas, the preservation of which would prevent significant adverse effects on cultural heritage.

4.5.2 Location and impact of cultural values

Historically, there were two villages in the northern area – Laugaste or Metsaküla and Kannu or Koive village, each with more than ten families[238] . Today, people still live in the southern part of Kannu village, on the Soosaare farm and the Tõntso cattle farm. In the southern part of the potentially suitable area, there was the village of Eera (including a cattle farm), which was surrounded by the forests of the Taagepera forest district.

There are no cultural monuments in the potentially suitable areas, so **it is unlikely that there will be any** direct **impact on them. An indirect impact may occur through changes in views. The visual impact is discussed in section4.4.2 . The location of cultural monuments has been taken into account.**

There are no inventoried natural sacred sites in potentially suitable areas. **Therefore, an impact on them is unlikely.**

There are numerous heritage culture objects in potentially suitable areas[239] . Heritage culture is one form of cultural heritage, which refers to man-made cultural heritage objects in the landscape. Heritage culture objects are not protected, but as they are part of cultural heritage, it is advisable to preserve and, if possible, restore them. The overlap of potentially suitable areas with heritage culture objects is presented atTable38 . The condition (preservation) and resulting value of heritage cultural objects varies greatly among objects located in potentially suitable areas. The construction of wind farms may have an adverse impact on heritage cultural objects if the construction areas are planned in such a way that the objects are destroyed.

[237] Nguyen, D-P., Hansen, K., Zajamsek, B. 2020. Human perception of wind farm vibration. Journal of Low Frequency Noise, Vibration and Active Control, Vol. 39(1) 17–27.

[238] https://xgis.maaamet.ee/xgis2/page/app/parandkultuur

[239] Eelis data as of 03.01.2023.

There are no archaeologically sensitive areas in the potentially suitable areas. **There is no impact on archaeological heritage.**

Neither of the potentially suitable areas overlaps with valuable landscapes according to the comprehensive plan. The southern potentially suitable area includes the Mäsajärve area, which is a valuable landscape of local importance (class III) according to the county plan. When compiling the comprehensive plan for Tõrva municipality, it was found that, as this landscape has no distinctive and prominent values that require additional protection, there are no grounds for designating it as valuable. Therefore, no valuable landscape has been designated in the established comprehensive plan for the potentially suitable area.

There are no cultural monuments located closer than 5 km from the planned wind turbine sites in Latvia[240] , therefore there is no impact on cultural monuments.

Table38 . There are heritage sites in potentially suitable areas. EELIS (Estonian Nature Information System), Environmental Agency data as of 03.01.2023.

Name	Code	Type	Status	Comments
Potentially suitable area in the north				
Mägra farmstead	824:TAK:002	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Laugaste farmstead	824:TAK:007	Ancient farmsteads	Destroyed, no traces of the object remain in the landscape.	
Mäe-Kuke farmstead	203:TAK:047	Ancient farmsteads	20–50% of the object or its original functionality remains.	
Kapermäe farmstead	203:TAK:046	Ancient farmsteads	20–50% of the object or its original functionality has been preserved.	
Potentially suitable area in the south				
Linden tree site	203:POP:002	Vabadiku (popsi) saunas, soldier stations, square stations	Type can be determined, less than 20% of the object or its original functionality preserved.	
Lilla farmstead	203:AST:009	Settlement farms	Signs have been preserved in the landscape, but do not allow for a clear determination of type.	
Eera hunting lodge	203:JKM:001	Places related to hunting, fishing, and beekeeping	20–50% of the object or its original functionality has been preserved.	
Raupa farmstead	203:TAK:006	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality preserved.	
Eera table factory	203:EST:002	Forestry roads and sawmills	Destroyed, no traces of the object remain in the landscape.	An old road leads to the site. During both the Tsarist and Estonian Republican periods, there were many board factories in Holdre, and the products were mainly transported to

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Name	Code	Type	Status	Comments
				Latvia, for which a special railway (Eera railway) was built.
Pelgu forest guard house	203:VKK:006	Guard cordons	50–90% of the object or its original functionality has been preserved.	The sauna and woodshed are located about 70 meters west of the forest guard house, the new sauna was built to replace the old one, and the woodshed is the same as before.
Lohu farmstead	203:AST:001	Settlement farms	Type undetermined, less than 20% of the object or its original functionality preserved.	One of the so-called stump farms. Schein, a Jewish owner of large forest areas, sold some of the stumps as farms. The forest material was transported to the Omuli (Hoomuli) railway station.
Laane farmstead	203:TAK:015	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Piiri farmstead	203:AST:008	Settlement farms	Signs have been preserved in the landscape, but do not allow for unambiguous determination of the type.	
Vahtra farmstead	203:AST:007	Settlement farms	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Flax drying sites at Lake Pupsi	**203:LLA:001**	**Fishing holes**	**Object well or very well preserved.**	
Field farmstead	203:TAK:017	Ancient farmsteads	Signs have been preserved in the landscape, but do not allow for a clear determination of the type.	
Kase farmstead	203:AST:004	Settlement farms	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Vana-Eera (Eera semi-manor)	203:TAK:005	Ancient farmsteads	Signs have been preserved in the landscape, but do not allow for a clear determination of type.	
Uue-Eera farm and cattle farm	203:TAK:008	Ancient farmsteads	20–50% of the object or its original functionality has been preserved.	
Kure farmstead	203:TAK:013	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality preserved.	

Name	Code	Type	Status	Comments
Lavina farmstead	203:TAK:011	Ancient farmsteads	Type determinable, less than 20% of the object or its original functionality preserved.	
Tilgali farmstead	203:POP:003	Vabadiku (popsi) saunas, soldier's quarters, platforms	Type determinable, less than 20% of the object or its original functionality preserved.	
Place of origin	203:KAR:001	Gravel, sand, clay, and phosphorite quarries	Signs remain in the landscape, but do not allow for unambiguous determination of type.	
Stone farmstead	203:TAK:007	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Island farmstead	203:AST:006	Settlement farms	Type determinable, less than 20% of the object or its original functionality preserved.	One of the first stump farms.
Tsirgutare farmstead	203:POP:004	Vabadiku (popsi) saunas, soldier's quarters, square	Type determinable, less than 20% of the object or its original functionality preserved.	
Nõmme farmstead	203:AST:005	Settlement farms	Type determinable, less than 20% of the object or its original functionality preserved.	
Villa farmstead	203:POP:008	Saunas, soldier's quarters, campsites	Signs have been preserved in the landscape, but do not allow for a clear determination of type.	
Pupsi farmstead	203:TAK:009	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality has been preserved.	The largest ancient farmstead in Eera village was approximately 150 ha.
Ojaniidu farmstead	203:TAK:010	Ancient farmsteads	Type can be determined, less than 20% of the object or its original functionality has been preserved.	
Kulla farmstead	203:AST:003	Settlement farms	Type determinable, less than 20% of the object or its original functionality preserved.	

4.5.3 Measures, need for further research and assessment

Well-preserved and very well-preserved heritage culture objects must be preserved in the further planning of wind farms. It is recommended to restore heritage culture objects, mark them and ensure public access.

4.6 Impact on the landscape, including visual impact

4.6.1 Assessment methodology

The assessment of the visual impact of the wind farm takes into account the recommendations of the guidance material prepared by AB Artes Terrae OÜ in 2020,[241] , to the extent that they are transferable to onshore wind farms. The visual impact assessments of the wind farm are based on the scale described in the 2022 article[242] .

The planned underground cable connection has no impact and is therefore not assessed in detail. Similarly, the impact of the wind farm's roads and substations on the landscape is negligible and they are not considered separately.

Special software *WindPRO 4.0* was used to assess the visibility of the wind farm. The relief data used was the Land Board's ground elevation model with an accuracy of 25 m and the Latvian ground elevation model with an accuracy of 20 m. Corine Land cover 2018 data with a calculation grid accuracy of 100 m was used as the vegetation height model. This approach makes it possible to obtain an indicative map of the visibility of the wind farm, i.e., to identify areas from which the wind farm may be significantly visible. The software also allows the vertical and horizontal viewing angles of the wind turbine to be calculated, which makes it possible to determine the significance of the change in view caused by the wind farm.

The vertical viewing angle is the angle formed between the viewpoint and the top of the wind turbine (Figure46). The horizontal viewing angle is the angle formed between the two furthest points of the two furthest wind turbines from the viewing point (Figure47). Based on the product of the horizontal and vertical viewing angles, it is possible to assess the significance of the change in view for the human eye.

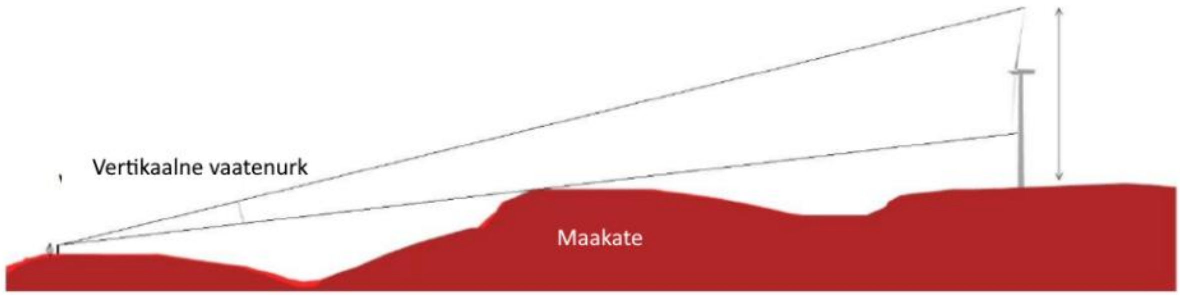

Figure46 . Vertical viewing angle. Source: WindPro user manual.

[241] AB Artes Terrae OÜ. 2020. Guidance material on methodological recommendations for assessing the visual impact of offshore wind farms. https://www.fin.ee/media/2706/download.
[242] Tara, A. 2022. DVC as a Supplement to ZVI: Mapping Degree of Visible Change for Wind Farms.

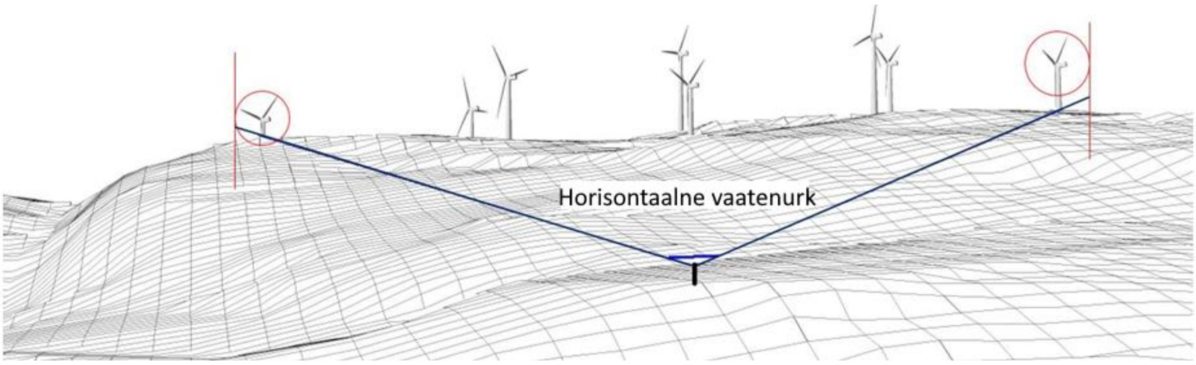

Figure47 . Horizontal viewing angle. Source: WindPro 4.0 user manual.

Visibility and viewing angles were modeled using a 25×25 m grid. The viewing height for the visibility map was set at 1.5 m, which is the normal viewing height for a person.

The Valga County Plan was used as a basis for determining valuable landscapes and views.

Based on the visibility analysis, eight viewpoints were selected – places with public access from which the wind farm may remain visible, with preference given to areas with valuable landscapes and/or beautiful road sections. Photo montages were compiled from Taagepera and Holdre Castle, which are also listed in the register of cultural monuments. Viewpoints located within a radius of up to 6 km from the planned wind turbines were preferred, as the wind farm does not appear clearly distinguishable/dominant to the human eye at greater distances. Viewpoints located in valuable landscapes were preferred. For more distant viewpoints, it is appropriate to compile photo montages if the viewpoint is very important (e.g., an important tourist attraction) and has extensive visibility. There are no known observation towers in the area and there is no visual impact. Within the framework of this SEA, the RMK Lasajärve and Tündre lake campfire sites were identified as nature tourism sites.

The locations of the viewpoints were specified using an integrated solution of *WindPRO 4.0* and *Google StreetView*. *WindPRO* allows the *Google StreetView* application to be used to find viewpoints (photos) from which the wind turbines are actually visible. This means that using *StreetView* photo material, it is possible to immediately change the viewing angle to find the angle from which the wind turbines are most visible. Real photos were taken from the viewpoints where the wind farm remained visible based on the initial photo montages *in StreetView*.

The photo montages were taken on October 6, 2023, with a Canon EOS 1100D camera and a focal length of 50 mm and 17 mm.

The photomontages are 1.5 m above ground level. The parameters used for the wind turbines were a 300 m tip height, a rotor diameter of 200 m, and a tower height of 200 m. In all images, the blades of the wind turbines are positioned perpendicular to the viewer in order to achieve maximum visual impact.

4.6.2 Landscape value

The basis for determining valuable landscapes is the Valga County Plan 2030+ and the Tõrva Municipality Comprehensive Plan, and the special plan area includes valuable landscapes in accordance with the Valga County Plan 2030+ (the area around Lake Tündre, Taagepera-Ala, and Holdre). The southern part of the potentially suitable area overlaps with the valuable landscape around Holdre (Figure48).

The Tõrva Municipal Council adopted the comprehensive plan for Tõrva Municipality with its decision no. 1-3/2024/6 on March 21, 2024. The comprehensive plan was based on the Valga County Plan 2030+ for the designation of valuable landscapes. Following the adoption of the comprehensive plan, the area around Lake Tündre, Taagepera-Ala and Holdre still belongs to the valuable landscapes.

The valuable landscape **of Taagepera-Ala** is of county importance in importance class I. Its value is created by Taagepera Castle and Park, well-maintained houses and plots along Taagepera-Ala Road, memorials, and the floodplains of the Õhne River.

The valuable landscape **around Lake Tündre** is classified as a Class II landscape of county importance. It is a nature conservation and recreation area of aesthetic and natural value.

The valuable landscape **around Holdre** is classified as a Class II site of county importance. It is a flat area of the Sakala Uplands, the northern part of which resembles the structure of an old farm landscape. Other noteworthy features include the former village of Peetri, the floodplain of the Saksniidu stream, and hayfields.

The comprehensive plan of Tõrva municipality sets the following conditions for preserving valuable landscapes and increasing their value:

- preserve the architectural and landscape environment of valuable landscapes – preserve existing values and harmonize new elements with existing ones; maintain the historical settlement structure, follow traditional building volumes and building structures; preserve former farmyards and farmsteads where possible; maintain traditional land use and landscapes where the settlement structure, road network and architecture have been better preserved than usual; preserve and, if necessary, renew roadside trees, avenues, and hedges and ensure their maintenance;
- preserve and open up beautiful viewpoints – take beautiful viewpoints into account when establishing recreational areas; pay attention to preserving valuable elements of the view, especially along publicly accessible roads;
- When planning new structures and linear constructions, ensure the preservation of values that characterize the valuable landscape and the suitability of the landscape architecture with the historical and cultural background of the valuable landscape – generally avoid objects that dominate the landscape (masts, etc.). allow the planning of solar panels (parks) rather for the use of one's own household, production complex, apartment and row house or public building on the building's yard and production territory;
- Remove ruins and other untidy objects that spoil the overall appearance of the landscape – in cooperation with the landowner, find solutions for tidying up or, if necessary, demolishing former large-scale farm buildings (cattle sheds, workshops, etc.) or putting them to use for other purposes suitable for the area.
- avoid the use of new quarries where possible.

The special planning area does not contain any beautiful viewpoints or enjoyable views of the natural and cultural landscape and cultural monuments from roads, as defined in the Valga County Plan 2030+ or the Tõrva Municipality Comprehensive Plan. The nearest beautiful road sections and scenic viewpoints are located in Koorküla, approximately 5 km from the nearest planned wind turbine.

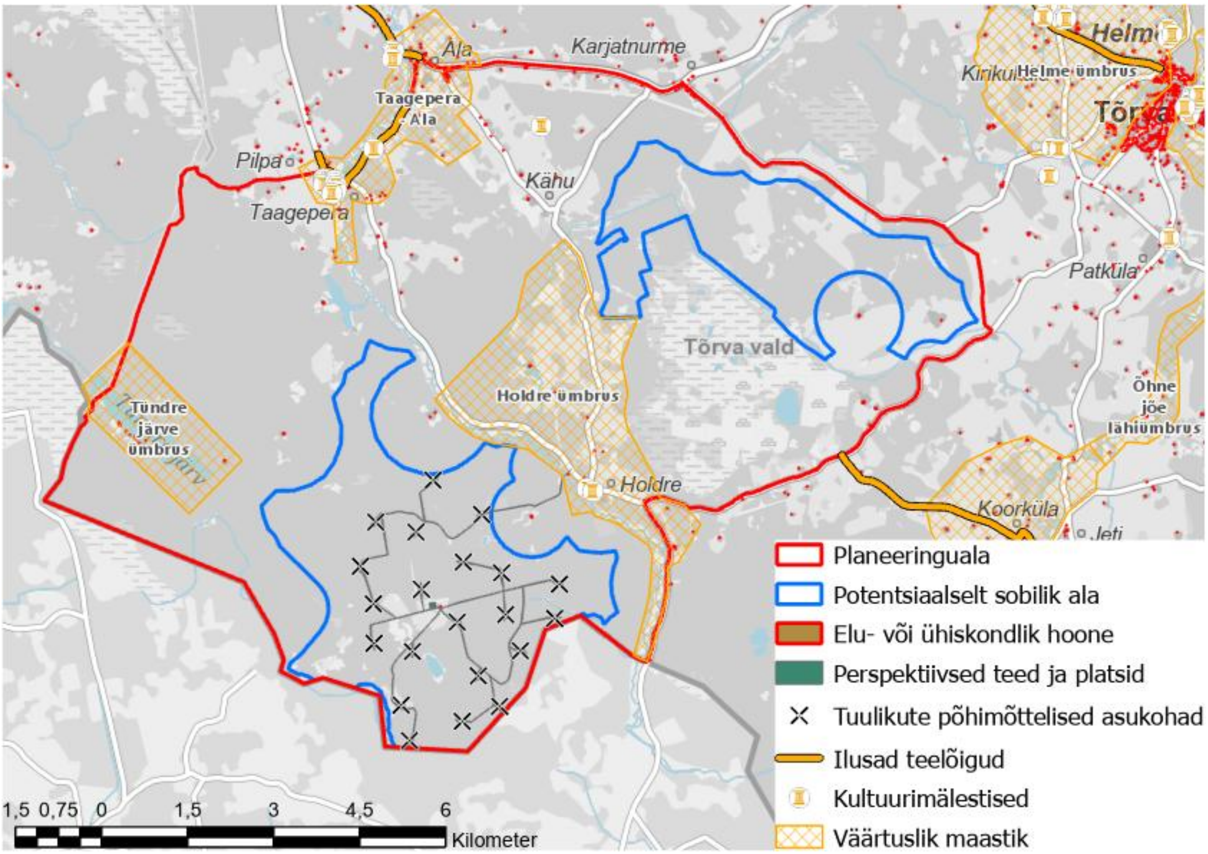

Figure48 . Valuable landscapes and scenic road sections in accordance with the comprehensive plan of Tõrva municipality in relation to potentially suitable areas.

4.6.3 Possible impacts

The visual impact of the wind farm depends on the size of the wind turbines, the distance of the observer, the characteristics of the landscape, including the relief and vegetation cover, the time of day, atmospheric conditions, etc. In clear weather conditions and with open sightlines, a wind farm can be visible from a distance of up to 40 km (in the case of large wind farms, visibility of up to 58 km has been observed)[243] . In Estonia, the visibility of wind turbines is not significantly affected by the terrain, but is affected by extensive forest areas and built-up areas. Due to obstacles in the vicinity of the observer (e.g., forests, buildings, etc.), a wind turbine may not be visible even if it is located close to the observation point. At the same time, viewing corridors may occur at greater distances.

Visibility analysis showed that the ground level in the vicinity of the wind turbines is between 80 and 117 meters, and there are mountains in the area. Therefore, visibility restrictions due to the relief are significant in the area. At the same time, it is a forested area and the tree stand significantly reduces the visibility of the planned wind farm. In populated areas, buildings reduce visibility.

The visibility analysis was prepared for wind turbines with a tip height of 300 m.

The visibility analysis of the planning area was carried out on an area of 156,779 ha (approximately 40 × 40 km). It was found that the wind turbines remain visible in 28.1% of the analyzed area. The study area covers regions in Estonia and Latvia.

The wind turbines are visible from open areas such as agricultural land in the region and areas bordering wider standing water bodies and clearings.

[243] Sullivan, R., Kirchler, L., Lahti, T., Roché, S., Beckman, K., Cantwell, B., Richmond, P. 2012. Wind Turbine Visibility and Visual Impact Threshold Distances in Western Landscapes.

The significance of the visual impact caused by the wind farm has been assessed based on the scale described in the article published in 2022[242] . The significance of the vertical and horizontal viewing angle impact caused by the wind farm and the size of the affected area are presented inTable39 .

Table39 . Significance of the impact of changes in vertical and horizontal viewing angles.

Vertical viewing angle	Significance of change	Size of affected area (ha) Wind turbine with a tip height of 300 m
Over 25⁰	Very large	445
10–25⁰	Large	550
5–10⁰	Moderate	1,088
3–5⁰	Low	1,577
1–3⁰	Very low	10,685
Horizontal perspective	**Significance of change**	**Size of affected area (ha) Wind turbine with a tip height of 300 m**
Over 124⁰	Very large	48
50–124⁰	Large	1,724
25–50⁰	Moderate	6,097
10–25⁰	Low	23,841
Below 10⁰	Very low	128,056

Based on the change in the vertical (v) and horizontal (h) viewing angles, the total change in the landscape view (v×h) was calculated and used to assess the significance of the change in the view. The significance of the change in the view is shown inFigure49 .

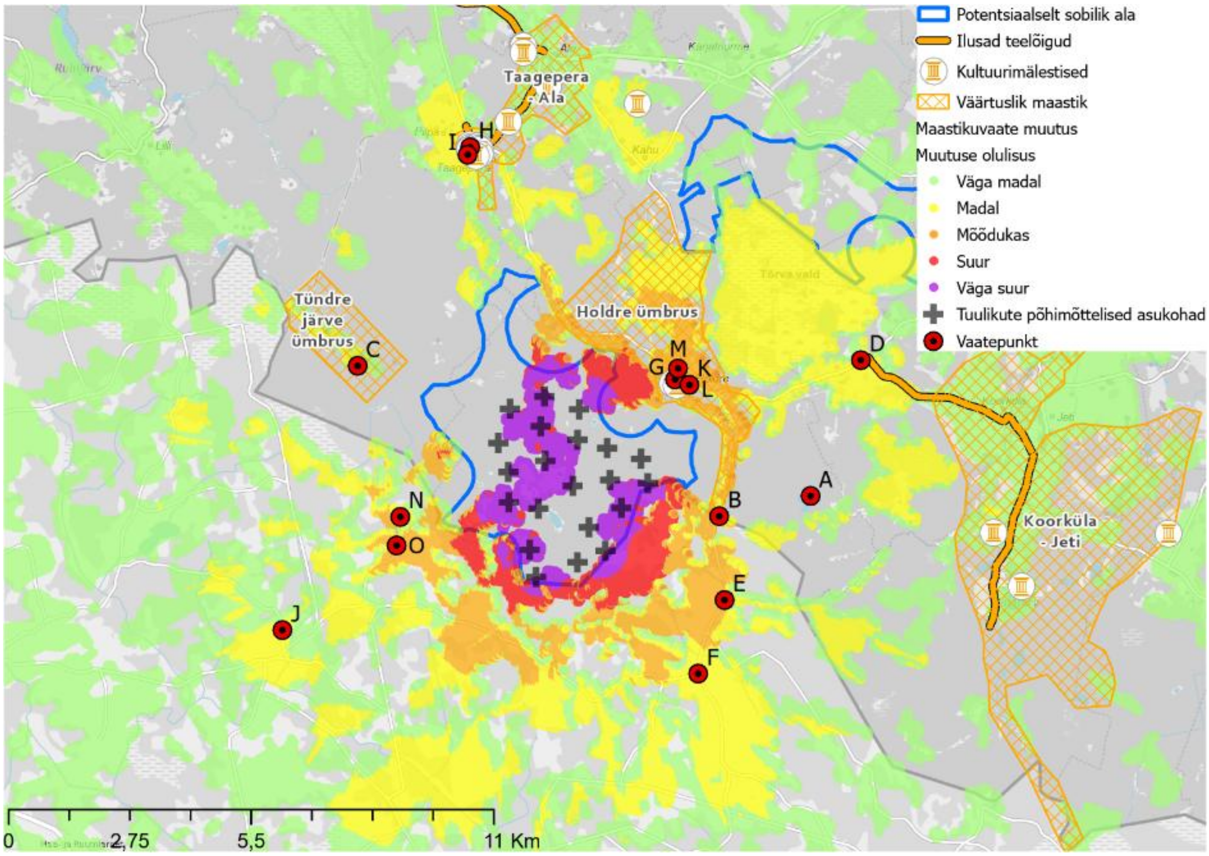

Figure49 . Landscape change in the case of wind turbines with a tip height of 300 m.

The visibility analysis of the planning area showed that there is no change in the view at human eye level in forested areas. As this is a very forested area, the extent of areas with large and very large changes in the landscape view is relatively small.

4.6.3.1 Impact on cultural monuments

A separate visual impact analysis has been prepared as supplementary material to this SEA for the Holdre and Taagepera manor complexes (presented in Annex 6 to the SEA).

The special plan for Tõrva municipality does not propose a wind farm or related structures in the protection zone of any registered monument. According to § 14(2) of the Heritage Conservation Act (MuKS):

(2) The purpose of the protected zone of a registered monument is to ensure:

1) the preservation of the immovable monument in a suitable and supportive environment and the preservation of the cultural value objects and elements associated with the monument surrounding it;

2) the visibility of the immovable monument and the preservation of the original views from the monument;

3) the preservation of the archaeological cultural layer surrounding the immovable monument.

The MuKS does not address anything more than the visibility of the monument referred to in the above paragraph. None of the buildings planned in the special plan extend into the protected zone of the immovable monument. No monument has been assigned a larger protection zone based on visibility considerations. Based on the above, there is no conflict between the special plan and the MuKS. There is no direct impact on cultural monuments.

The possible visual impact on cultural monuments is indirect in nature and does not impair the preservation of cultural values.

The assessment of landscape change has revealed that a significant change in the landscape view (very large to moderate change on the scale used) occurs within a radius of up to 3 km from the wind farm from viewing points with sufficient visibility. For objects that are particularly sensitive to changes in the view, the change in the view may be significant within a radius of up to 8 km from the wind turbines (low impact on the landscape change scale used).

Three cultural monuments (one manor complex) are located within the area of possible significant visual impact of the planned wind farm. These are the Holdre manor main building (23083), the Holdre manor stable (23085), and the Holdre manor park (23084).

The Taagepera manor complex, which consists of the following monuments, also falls within the area of potential significant change in view for sensitive objects Taagepera manor main building (23098), Taagepera manor park and avenue (23099), Taagepera Manor cattle shed (23112), Taagepera Manor farmhand's house (23111), Taagepera Manor watermill (23110), Taagepera Manor coach house (23109), Taagepera Manor schoolhouse (23108), Taagepera Manor Stables (23107), Taagepera Manor Steward's House (23106), Taagepera Manor Cellar (23105), Taagepera Manor Ice Cellar (23104), Taagepera Manor Bird House (23103), Taagepera Manor well and pumping station (23102), Taagepera Manor servants' quarters (23101).

The Holdre manor complex is located near the planned wind farm, but as the area surrounding the manor is very wooded and the manor park also has a lot of tall trees, open views of and from the manor are limited. As a result, there are no places within the manor's buffer zone that offer an open view of the wind farm. Even the balcony of the manor's main building and the windows on the third floor are significantly obscured by tall trees. However, there are several places in the manor park where the blades of the nearest wind turbines can be seen above the forest or between the trees. The wind turbines are particularly visible during the period when the trees have no leaves, as the manor park (especially the avenue) is dominated by deciduous trees. The view from the avenue leading to the main building of the manor is likely to be the most affected. Wind turbines 11 and 9 will be particularly visible. In summer, when the trees are in leaf, there will be no distant view from this vantage point.

Considering the terrain, the Taagepera manor complex is located higher than the planned wind farm. Outside the manor park, in the direction of the wind farm, there is farmland, i.e., open landscape with extensive views. However, visibility of the wind farm from the manor park and between the buildings is minimal, as the elements of the park itself (the surrounding embankment) and the tall vegetation limit the range of views from the park. However, the manor tower and the viewing platform currently under construction offer clear views of the wind farm in good weather. Considering the location of the wind farm in relation to the manor house ( ), the wind farm does not affect the view of the park from the manor tower or the view of the park/manor complex from the viewing platform.

A more detailed analysis of the change in views is presented in a separate report, "Analysis of the visual impact of the Tõrva municipality special plan on cultural monuments." The analysis did not identify any changes in the views of cultural monuments to an extent that would diminish their cultural value.

During the planning process, the positions of the wind turbines were specified in the plan (in particular, the positions of wind turbines 2, 4, 11, and 3 were shifted in accordance with the mitigation measures for the impact on birds presented in section4.1.3.3 of the SEA). As a result of the relocation, the distance between the nearest wind turbine positions and Holdre Manor has increased slightly, which reduces visibility to a small extent compared to the analysis prepared. However, the difference in impact is minor.

The clarification of the locations of the wind turbines will not cause a significant change in the view of Taagepera Manor compared to the initial solution.

4.6.3.2 Photo montages

Viewpoints from which the wind turbines would be visible were selected for the visualization of the wind farm. For the photomontages, locations with public access from which the wind farm would remain visible were selected, with preference given to areas with valuable landscapes and/or beautiful road sections, i.e., areas with a higher value due to their landscape or cultural heritage. The viewing height of the photomontages is generally 1.5 m above ground level. The only high viewing point was created from the tower of Taagepera Castle (height approx. 25 m) and from a new viewing platform (height approx. 6 m) to be built near the castle park.

The visual impact assessment revealed that there are several nature tourism sites in the area, such as the hiking trail along the banks of the Õhne River, but these are forested areas. The tall and dense forest obstructs the visibility of the wind turbines from several recreational areas in the region. The same was observed in the case of cultural heritage sites, such as the Holdre manor complex. Estonian manors, churches, and castles are often surrounded by old parks with dense tall vegetation, which reduces the visual impact of wind turbines on the views of such sites.

Given the nature of the land cover, there are more places with open views located 5 km from the wind farm, from which the wind farm is clearly visible, on Latvian territory than in Estonia. In Estonia, the area is predominantly forested and there are few open views in the vicinity of the wind farm.

Table40 . Location of photo montage viewpoints.

Mark	Description	x	y
A	Lake Lasa. Distance to nearest wind turbine 3697m	606188	6421278
B	Estonian-Latvian border crossing. Distance to nearest wind turbine: 1787 m.	604115	6420819

C	Lake Tündre. Distance to nearest wind turbine: 3582 m.	595917	6424230
D	Kiinimäe bus stop, Koorküla. Distance to nearest wind turbine: 5454 m	607328	6424359
E	Omuļu muiža, Latvia. Distance to nearest wind turbine 2918 m	604236	6418918
F	Hoomuli, Latvia. Distance to nearest wind turbine 3560 m	603638	6417249
G	Holdre Castle, Piano Museum. Distance to nearest wind turbine: 1958 m.	603113	642392
H	Taagepera Castle Tower, nearest windmill 5895 m	598470	6429190
I	Taagepera Castle's new viewing platform, nearest windmill 5748 m	598411	6429018
J	Latvia Piksāri, nearest windmill 5864 m	594210	6418235
O	Latvia, Naukšēni municipality, nearest windmill 2721	596800	6420155
K	Helme-Kirikuküla-Holdre road, nearest wind turbine 2003 m	603438	642380
L	Helme-Kirikuküla-Holdre road, nearest wind turbine 2350 m	603439	6423798
M	Karjatnurme-Holdre road, nearest wind turbine 2213 m	603182	6424170
N	Latvia, Naukšēni municipality, nearest wind turbine 2477 m	596885	6420803

The photomontages are presented in Annex 3 of the SEA report to enable the photos to be viewed in higher resolution. When viewing the photomontages, it should be noted that the locations of the wind turbines are indicative and may be refined during further planning and design. Similarly, if smaller wind turbines are built, the visible view may also differ.

The photomontages and visibility analysis showed that the most important viewpoints that would be affected by the construction of the wind farm are primarily roads bordering farmland with higher ground relief in the immediate vicinity and areas bordering wider bodies of standing water. Based on the photomontages, wind turbines can be considered clearly distinguishable if they are located closer than 5 km from the viewpoint; at greater distances, the wind turbines are certainly visible in clear weather, but they can no longer be considered dominant in the view. The visualizations showed that no cultural heritage sites or places of high recreational value are expected to be visually impacted to an extent that would have a significant adverse effect on the view. There are no situations where the wind turbines would dominate the views from important vantage points. The wind farm is clearly visible from the tower of Taagepera Castle in clear weather.

4.6.3.3 Aviation safety lights

In addition to the changes in views during the day, it must be taken into account that, in order to ensure flight safety requirements, tall structures must be equipped with aviation safety lights to ensure their visibility at night and in poor visibility conditions. These are usually red lights that burn continuously. Aviation safety lights change the view in the dark. The lights can be visible at a distance of 30–40 km in good visibility conditions. In some countries, it is permitted to use aviation safety lights with adjustable intensity, the power of which is reduced in good visibility conditions. [244]

There are also flight safety light solutions where the lights only come on when necessary (when an aircraft is approaching)[245] . Such solutions are mainly relevant for large wind farms or highly sensitive landscapes. The solution must also be permitted under nationally applicable aviation safety requirements.

It is possible to shield the lights to some extent, which reduces their visibility from the ground.

[244] Van der Zee H.T.H. 2016. Obstacle Lighting of Onshore Wind Turbines - Balancing aviation safety and environmental impact.
[245] https://www.youtube.com/watch?v=6nqBnGUbVGY

Aviation safety lights have a visual impact. Red lights are visible in the dark when looking out over a wind farm, thereby altering the nighttime view. There is no data in scientific literature on the impact of aviation safety lights on human health. There are studies that suggest that aviation safety lights may cause irritation . [246]

4.7 Impact on social needs and property

4.7.1 Location in relation to residential areas

Methodology: The assessment is based on data from the Estonian Topographic Database (ETAK) and the Latvian https://lvmgeoserver.lvm.lv/geoserver database, which were analyzed using QGIS software.

The territory of Tõrva municipality borders the territory of the Republic of Latvia to the south. The southern part of the potentially suitable wind farm area is also located in the area adjacent to the municipality's border. According to the terms of reference for the special plan for Tõrva municipality, the distance between wind turbines and the nearest residential building must be at least 1 km, and 2 km from densely populated areas.

In Estonia, the distance between wind turbines and residential buildings is not directly regulated. The distance is indirectly regulated by noise standards. Based on noise modeling of various wind farms, compliance with the applicable noise standards is guaranteed at a distance of less than 1 km from the wind turbines. Based on this, the initial map analysis determined a minimum distance of 1 km between the edge of the wind farm area and residential areas, i.e. a buffer zone.

Looking at the practices of other European countries, many countries also regulate the distance of wind turbines based on noise standards, which are similar to those in force in Estonia. The distance requirements or recommendations in European countries range from 500 to 2000 m[247] . Often, the distance restriction is calculated based on a specific wind turbine parameter. For example, in Denmark, wind turbines must be located at a distance of four times the height of the turbine, and in Northern Ireland, at a distance of ten times the diameter of the rotor blade from residential buildings. Alternatively (including in Estonia), in many countries, the distance of wind turbines from residential buildings is regulated by noise standards, for example.

To estimate the number of potential residents/residential buildings in the vicinity of the areas, the areas were examined based on ETAK data and a comparison was made of how many residential and public buildings are located within the potential direct impact area of the potential pre-selection areas. Defining the extent of the impact area can be complicated in the case of wind farms (a wind turbine is potentially visible over a very large area, for example). The environmental disturbance fee regulation in force in Estonia stipulates that for wind turbines up to 250 meters high, the fee is paid to residents located up to 2 km away, and for taller wind turbines, to residents located up to 3 km away. Accordingly, the impact area of a wind farm is considered to be 2 or 3 km.

The special planning area is located in a sparsely populated area.

[246] Pohl, J., Hübner, G., Mohs, A. 2012. Acceptance and stress effects of aircraft obstruction markings of wind turbines. Energy Policy. 50. 592–600. 10.1016/j.enpol.2012.07.062.

[247] Dalla Longa, F., Kober, T., Badger, J., Volker, P., Hoyer-Klick, C., Hidalgo, I., Medarac, H., Nijs, W., Politis, S., Tarvydas, D. and Zucker, A. 2018. Wind potentials for EU and neighboring countries: Input datasets for the JRC-EU-TIMES Model, EUR 29083 EN, Publications Office of the European Union, Luxembourg.

Table41 . Number of residential and public buildings (not including the number of dwellings) located in the vicinity of the indicative locations of the planned wind turbines in the potentially suitable area to the south. Source: Land Board ETAK data as of 14.03.2024.

Distance from the indicative location of the planned wind turbine in the potentially suitable area, km	up to 2 km	2–3 km	Total 0–3 km
Residential and public buildings within the impact area of the indicative locations of wind turbines in the southern potentially suitable area, pcs	13 (10[248])	13 (14)	26

The spatial analysis carried out revealed that within a radius of up to 2 km from the indicative wind turbine locations planned for the potentially suitable area in the south, there are 13 residentialor public buildings within a radius of up to 2 km from the indicative wind turbine locations planned for the southern area, and 13 residential or public buildings within a radius of 2–3 km, for a total of 26 residential or public buildings within a radius of 0–3 km.

To our knowledge, there has been no broader analysis in Estonia of the number of residential units within the impact area of existing and planned wind farms, but based on the work experience of the author of this SEA report, the number of residential units within the impact area is very small in the Estonian context. In the case of the above assessment, it should be noted thatTable41 only presents data on residential buildings located on the Estonian side.

The number of residential buildings located in Latvia within a 2–3 km radius of the indicative wind turbines can be found atTable42 .

Table42 . Number of residential and public buildings located in the vicinity of the indicative locations of planned wind turbines in the southern potentially suitable area[249] (the number of residential units has not been taken into account).

Distance from the indicative location of the planned wind turbine in the potentially suitable area, km	up to 2 km	2–3 km	Total 0–3 km
Residential and public buildings in Latvia are located within the impact area of the indicative wind turbine locations in the potentially suitable area in the south.	6[250]	21	27

[248] Mitigating the impact on bird populations by relocating wind turbines in accordance with the wind turbine layout solution.

[249] Latvian WFS data https://lvmgeoserver.lvm.lv/geoserver/publicwfs/ows?version=2.0.0&layer=publicwfs:Adreses_celu_tikls

[250] In addition, there are two buildings that are registered as residential buildings but are not in use according to the orthophoto (dilapidated, no yard area).

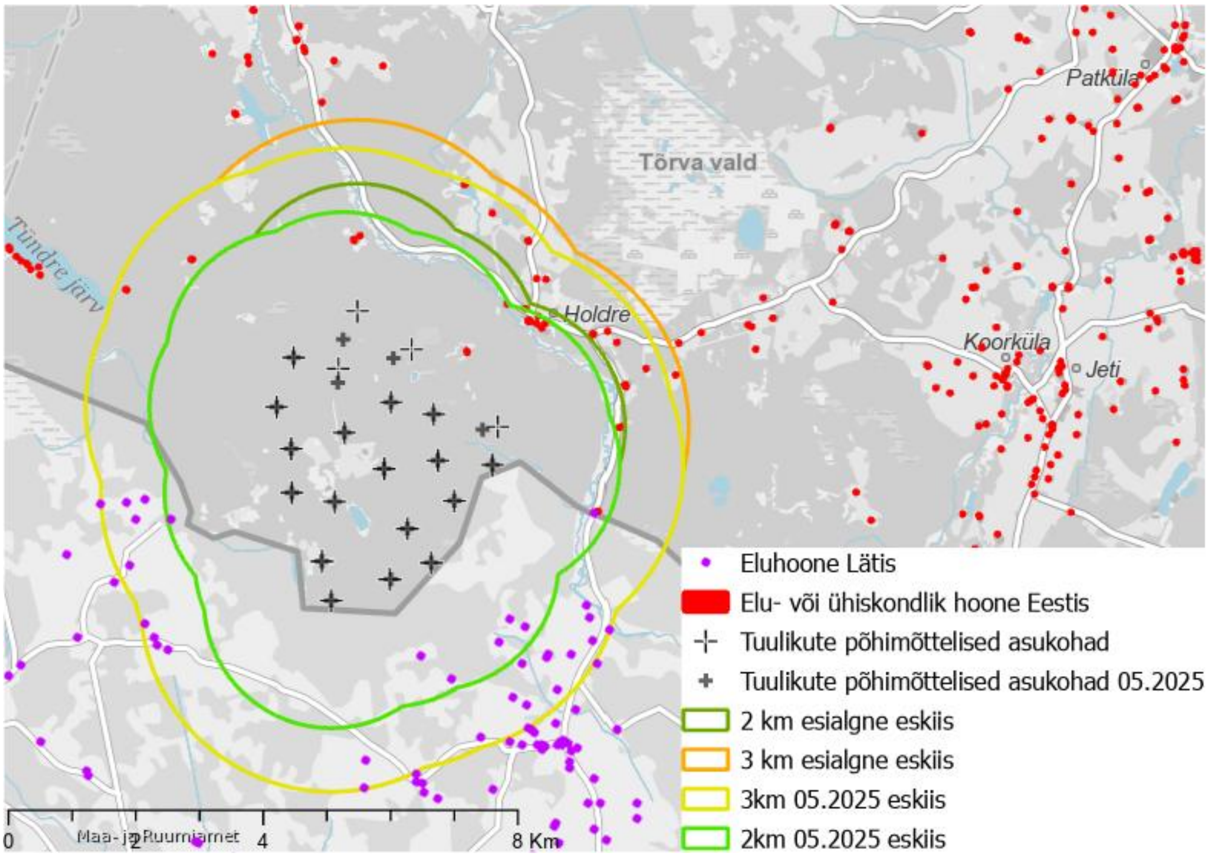

Figure50 . Residential and public buildings are located within a 2–3 km radius of the indicative locations of wind turbines planned for the potentially suitable southern area of the special planning area.

4.7.2 Impact on the economy (jobs, direct line)

Methodology: The assessment is based on an analysis of scientific literature and legislation and a spatial analysis based on land and spatial data collections, which was carried out using QGIS and ArGIS software.

The construction of a wind farm creates additional **jobs**. The average estimated number of additional jobs created by the construction of wind farms varies in different scientific and applied studies. A review article published in 2019,[251] , examines jobs related to wind farms per 1 MW of installed wind farm capacity. The review article shows that the results of individual studies vary widely in terms of employment (in some contexts, the number of jobs is less than 1, while in others it is more than 15 jobs per MW).

According to this study, the likely number of jobs created during the construction and installation phase is 2.5–5.5 jobs per megawatt of wind farm capacity. The construction of a wind farm is a labor-intensive but temporary process. It directly involves builders, engineers, technicians, and logisticians, but indirectly also involves industry (e.g., wind turbine manufacturing, transport) and other services. For example, during the construction of Estonia's largest wind farm, Sopi-Tootsi (255 MW), approximately two hundred workers were employed on site each working day[252] .

[251] Aldieri, L., Grafström, J., Sundström, K., Vinci, C., P. Wind Power and Job Creation. Sustainability 2020, 12, 45; doi:10.3390/su12010045.

[252] Enefit Green. (2024, Aug. 13). *Enefit Green's Sopi-Tootsi wind farm fed its first electricity into the grid.* [Press release]enefitgreen.ee

Based on this research article, the number of additional jobs created during the operation of a wind farm can be estimated at 0.3–2 jobs per megawatt. However, the actual employment generated by modern wind farms during operation may be lower due to the use of automation. Typically, an onshore wind farm requires approximately 0.1 direct permanent jobs per 1 MW, which means that approximately one full-time maintenance technician can service ~10 MW of wind farm capacity. In other words, one technician manages approximately 7–10 wind turbines (depending on the size of the turbines)[253] . It should also be noted that jobs related to the operation of wind turbines are mainly related to wind turbine maintenance, which requires specialized education.

The employment analysis for wind farms does not take into account indirectly affected areas where demand may increase – primarily services, but also other supporting areas, as their forecasting depends to a large extent on factors other than the construction of wind turbines. In this region, significant employment needs can be expected in the service and accommodation sectors, especially during the construction period. Similar to the construction period of the Tootsi-Sopi wind farm, significant demand for accommodation and catering services can be expected in the vicinity of the wind farm during the construction period.

Jobs related to the manufacture of wind turbines are not usually linked to the location where the wind farm is being built, as manufacturing requires resources, know-how, and a skilled workforce. Wind turbines are not currently manufactured in Estonia. Therefore, there is no impact on employment in the region.

Jobs related to logistics, installation, and operation can be filled partly by local workers, depending on the level of specific knowledge required for the construction of the wind farm.

Jobs related to maintenance and administration are long-term, stable jobs. However, such jobs require professional training. Wind turbine maintenance specialist courses are being launched at both the Kuressaare Vocational School and the Pärnu County Vocational Education Center. The impact of the construction of the wind farm on employment is therefore expected to be potentially positive to a small extent.

Direct line[254]

According to the Electricity Market Act in force at the time of compiling this SEA, it is permitted to construct a direct line on the same registered immovable property as the power plant, on a registered immovable property adjacent to it, or **to an electrical installation located up to six kilometers from the production facility**. There is some uncertainty regarding wind farms, which are considered to be 6 km away (from the wind turbine, the substation within the wind farm, or even the point connecting the wind farm to the main grid).

In the direct line area, it is possible to use electricity at a lower network fee. In addition, wind power plants produce environmentally friendly renewable energy. This is an important factor for energy-intensive companies and/or companies that prefer renewable energy, which may affect companies already operating in the area and encourage new companies and the creation of jobs associated with them to establish themselves in the area. Therefore, the construction of a direct line connected to the wind farm in the potential area may have a positive impact on the competitiveness of the region.

[253] Kotarbinski, M., Keyser, D., & Stefek, J. (2020). Workforce and Economic Development Considerations from the Operations and Maintenance of Wind Power Plants (NREL Report No. NREL/TP-5000-76957). National Renewable Energy Laboratory

[254] Direct line – a line located in the service area of a network operator that does not have a separate connection to the network, except for a closed distribution network, but which may be indirectly connected to the grid via a market participant's electrical installation and which is intended for the transmission of electricity from one power plant to another or to another market participant for its own use, resale or transmission.

There are several misconceptions surrounding the topic of direct lines. Electricity is not automatically cheaper for companies in the potential area of the direct line (within a 6 km radius of the wind farm). It is necessary to build a power line from the production facility to the relevant electricity consumer, and the cost of building such a line is generally borne by the company interested in the matter. Therefore, in reality, it is realistic (i.e., economically viable) to locate the power line as close as possible to the power generation equipment and in the case of a company with high electricity consumption. Therefore, in order to take advantage of the positive impact on the competitiveness of business development in the region, it is necessary that companies with high energy consumption be established as close as possible to the wind farm or already exist in the region.

When compiling the SEA, the location of commercial and industrial land within a 6 km radius of the indicative wind turbine locations planned for the potentially suitable southern area was analyzed (Figure51). Within a 6 km radius of the indicative locations of the wind turbines, there are three cadastral units designated for commercial use and four cadastral units designated for industrial use.

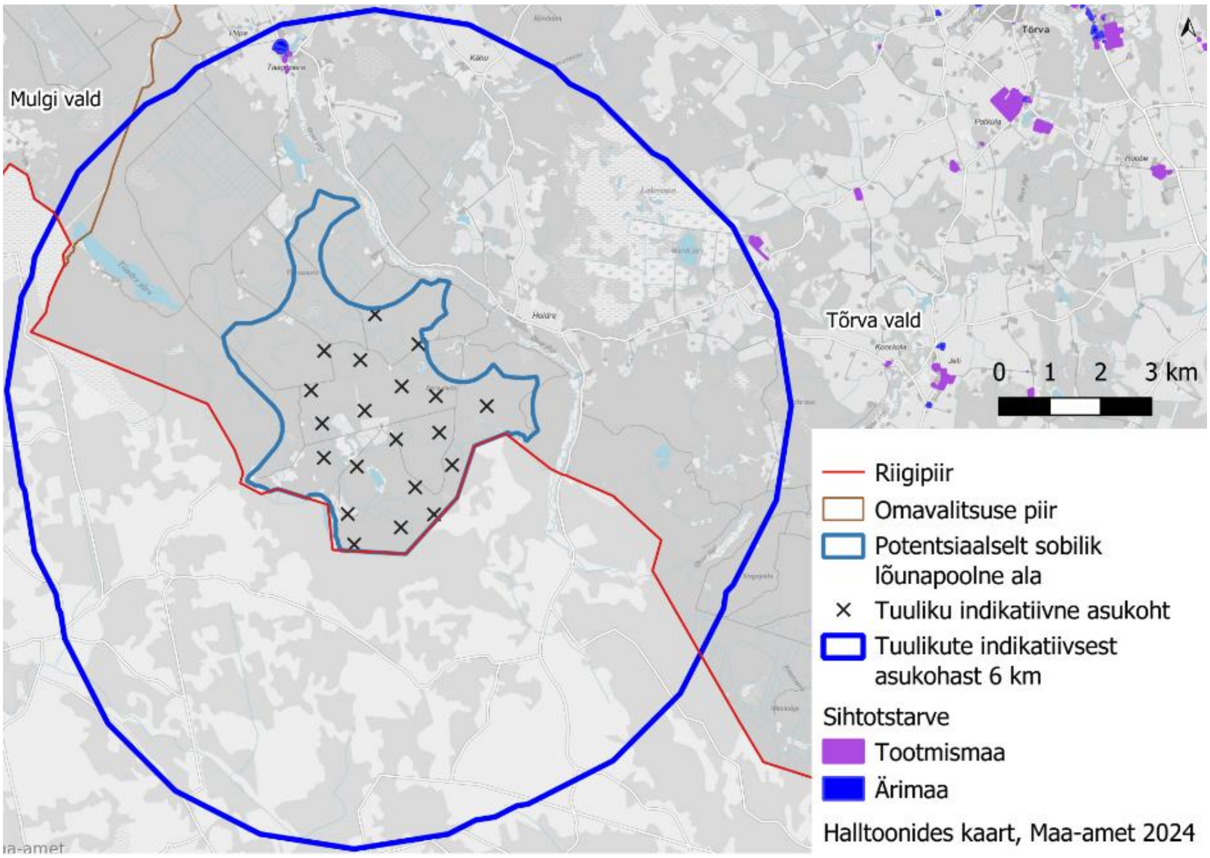

Figure51 . The possible extent of the direct line of the indicative locations of wind turbines in the potentially suitable southern area and the commercial and industrial land use areas located in this area (The intended uses of commercial and industrial land are based on the cadastral units of Valga County as of 08.04.2024).

Given the location of the area in a sparsely populated area, there are no existing production areas or production areas planned in the comprehensive plan in the vicinity.

4.7.3 Impact on real estate

Methodology: In the context of the Environmental Impact Assessment and Environmental Management System Act, the impact on property is considered to be the impact on property resulting from changes in environmental conditions – typically, such an impact may manifest itself, for example, through the generation of vibrations that may affect neighboring buildings. The construction of a wind farm will not have such an impact on property. The occurrence of vibrations is discussed in section4.4.4 . The construction and operation of the wind farm will not cause vibrations that could damage buildings and thus have an impact on property within the meaning of the KeHJS. However, this SEA will be carried out in an extended manner, also addressing the relevant impacts within the meaning of PlanS, and thus the impact on the value of real estate will also be addressed.

It is not possible to assess the impact on the price of each specific property when preparing the SEA for the special plan, as the price of real estate depends on the condition of the specific property, the marketing associated with the sale, the potential buyer's ability to obtain a loan, etc. Given the scarcity of wind farms in Estonia, there is also no sufficient database of real estate transactions to provide estimates of changes in the value of real estate in the vicinity of Estonian wind farms. In view of the above, the following is an overview of possible changes in real estate value based on studies in other countries, but no location-based real estate valuation was performed.

Impact of wind farm construction on the value of land under wind farms

The construction of a wind farm does not significantly interfere with the current intended use of agricultural land. The land under the wind turbines will remain the property of the owner (at their request), and agreements on easements or building rights regulating the construction of the wind farm and infrastructure will be concluded between the wind turbine developer and the landowners. The value of these agreements depends on the agreement between the developer and the landowner. In general, the landowner receives direct income in the form of a building fee under the building rights agreement. In order to construct technical networks, it is necessary to conclude personal use agreements in favor of the (network) owners in their protection zones, which may also include agreements on technical network tolerance fees.

Agricultural land that is directly under the wind turbines (vertical projection of the blades on the ground) may be reclassified as production land or the land parcel may be partially designated as production land. This change affects the calculation of land tax for the land parcel in question. The intended use of the remaining part of the land parcel will not be changed and it may continue to be used for forestry or agriculture. On forest land, trees must be removed (cleared) within the area required for the construction of wind turbines (approximately 1 ha) and the area required for the construction of infrastructure.

Along with the construction of wind farms, it is also possible to develop other activities suitable for production land, such as solar parks or other production projects.

In summary, the establishment of a wind farm generally brings direct economic benefits to the owners of the land on which the wind farm is located. At the same time, the current use of the land is restricted only in the area directly affected by the construction activities.

Impact of wind farm construction on the change of intended use of registered immovable property within a 1 km radius

Areas suitable for wind farms are identified taking into account the location of existing residential buildings. If the criterion for selecting the location of the area has been a 1 km buffer from existing residential buildings, this also means that there will be no residential or public buildings within a 1 km radius of the wind farm (unless otherwise agreed with the owner of the respective residential building).

Pursuant to § 110(1) of the Planning Act, the organizer of the preparation of a local government special plan may establish a temporary planning and construction ban in the planning area or part thereof for the duration of the preparation of the detailed solution of the local government special plan, if the plan being prepared is intended to change the building rights previously established for the planning area. This prevents the planning of new noise-sensitive objects in a potentially unsuitable area, i.e. an area where noise levels exceeding the target value for industrial noise may occur and where the construction of noise-sensitive buildings is therefore not recommended. The restriction does not apply to the construction of buildings necessary for infrastructure, agriculture, forestry, and mineral resource extraction. However, the construction of residential buildings, holiday homes, etc. in the area may become impossible in the future. **The restriction limits the possible uses of land in the area.** Depending on the noise emitted by the wind turbines, the extent of such a restriction area is usually up to 1 km from the wind turbines (isocontour line corresponding to the target value for industrial noise). The local government of has an important role to play in ensuring that all persons who may be affected by such a restriction are involved in the planning process.

The establishment of wind farms often leads to the development of infrastructure in the region. If necessary, direct lines without network charges are established and the road network is developed. The possibility of establishing direct lines without network charges may promote the development of energy-intensive businesses in the region and thus the creation of jobs. The possibility of establishing direct lines may (but does not necessarily) lead to an increase in the proportion of commercial and industrial land in the region. Considering that it is economically more advantageous to build direct lines that are as short as possible, the construction of a wind farm may encourage the use of land within the immediate vicinity of the wind farm as commercial and industrial land. Commercial and industrial enterprises are not noise-sensitive areas and can be established in the immediate vicinity of the wind farm.

Impact of wind farm construction on the value of residential properties more than 1 km away

The planned activity will not have a direct (physical) impact on residential properties and their yards, as wind turbines are generally not planned to be located closer than 1 km from residential buildings. The impact may be reflected in a change in property values. To our knowledge, no studies have been conducted in Estonia on the impact of wind farms on real estate prices. It is not possible to conduct such a study in Estonia because the amount of real estate located in the vicinity of wind farms is still so small that there is no sample of comparable transactions available to assess changes in real estate prices. However, studies on changes in real estate prices related to wind farms have been conducted in many other parts of the world.

In general, studies show a negative impact or no impact on real estate prices. In certain cases, there may also be a positive impact, for example, if the construction of a wind farm significantly improves access to the land or if other factors affecting real estate prices come into play.

<u>Distance</u>

The main factor affecting real estate prices is presumably the proximity of the wind farm.

Parsons and Heintzelman (2022)[255] compiled a summary of previous studies in this regard. They used four distance ranges and found that the variation in impact is large in each distance range. For example, at a distance of < 1 km, the impact ranged from -13% to 1.6%. As the distance increased, the variation decreased but remained high. At a distance of 3–4 km, the impact ranged from -8% to 3.6%. The average impact decreased steadily with increasing distance. At a distance of < 1 km, the average impact of all data was -5.0%. In the following three ranges, it decreased to -4.0%, -2.6%, and -1.2%, respectively. Thus, the evidence points to an average negative impact of

[255] Parsons, G., & Heintzelman, M. D. (2022). The Effect of Wind Power Projects on Property Values: A Decade (2011-2021) of Hedonic Price Analysis. *ResearchGate.* https://www.researchgate.net/publication/361261371_The_Effect_of_Wind_Power_Projects_on_Property_Values_A_Decade_2011-2021_of_Hedonic_Price_Analysis

wind turbine distance, which dissipates relatively quickly with increasing distance. Thirdly, the proportion of studies in which no impact is found within the distance range increases with increasing distance: < 33% of studies for 1 km, 28% of studies for 1–2 km, 50% of studies for 2–3 km, and 72% of studies for 3–4 km.

<u>Visibility</u>

Parsons and Heintzelman (2022) summarize previous studies on the importance of visibility as follows: in studies comparing the effects of view and distance, the results were mostly the same. They highlight Gibbons' (2015)[256] approach, in which binary view[257] is linked to distance ranges in the model. His hypothesis was that effects only occur when there is a view, i.e., direct visibility between the residence and the wind farm. The price decline was found to be on average about 5–6% for homes located within sight (up to 2 km radius) of a wind farm. The price decline decreased to less than 2% at a distance of 2–4 km and to almost zero at a distance of 8–14 km, which is the likely threshold for significant visibility.

<u>Number of wind turbines</u>

The impact of wind farms on real estate prices has been examined in several studies. Gibbons (2015) used the number of wind turbines for each distance range in his analysis to examine scale effects. He divided the number of wind turbines into three groups: 1–10, 11–20, and >20 wind turbines. In the 0–2 km range, the visibility of more than 20 wind turbines caused a 15% decline in real estate value. The two smaller groups in the same distance range caused a decrease in property value of approximately -8%. The impact of the "> 20 wind turbines" group was greatest in all other distance ranges, and even in the furthest range (8–14 km), there was a negative impact on value (-1.8%). The other groups showed no impact in this furthest range.

Vyn (2018)[258] addressed scale effects in three separate models. Each model used one distance range, which was either 1, 2, or 5 km. In all three models, he found that more wind turbines correlated with a greater decline in property values. However, the decline slowed at a decreasing rate. For example, in the 1 km model, the first wind turbine reduced property values by $8,141[259], while the fifth wind turbine reduced values by $1,982 and the twentieth wind turbine by $491 (the average house price was $231,000). Similar but smaller effects were also observed in the 2 km and 5 km models.

Jensen et al. (2018)[260] used the number of wind turbines within a 3 km radius and a weighted density measure that combined number and distance to account for scale effects. The weighted density measure essentially gave greater weight to wind turbines located closer to the house. Both measures pointed to scale effects — "... each additional wind turbine within a 3 km radius reduced prices by between -0.2% and -1.1%." The number of wind turbines ranged from 0 to 15. Like Vyn (2018), they also reported a decrease in impact as the number of wind turbines increased.

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[256] Gibbons, S., 2015. Gone with the wind: Valuing the visual impacts of wind turbines through house price. Journal of Environmental Economics and Management. 72:177-196.

[257] In this context, binary means whether something is visible or not visible from that location.

[258] Vyn, R. J. (2018). Property value impacts of wind turbines and the influence of attitudes toward wind energy. *Land Economics,* 94(4), 496–516. https://doi.org/10.3368/le.94.4.496

[259] 2018 USD/EUR - €0.88.

[260] Jensen, C.U., Panduro, T.E., Lundhede, T.H., Nielsen, A.S.E., Dalsgaard, M., Thorsen, B.J., 2018. The impact of on-shore and off-shore wind turbine farms on property prices. Energy Policy 116, 50–59. https://doi.org/10.1016/j.enpol.2018.01.046

To understand the scale effect, Parsons and Heintzelman (2022) reviewed the previous three studies along with eight other studies that examined it. Of the eight studies, five found that the scale effect exists and three did not identify its impact. Dröes and Koster (2021[261] , 2016[262]) and Eichholtz et al. (2021)[263] , using similar data from the Netherlands, found a negative impact on property values. They did not identify the significance of the scale effect.

Overall, the evidence on scale effects is somewhat contradictory, but at least in the studies that found negative effects on property values, these effects tended to increase as the number of visible or nearby wind turbines increased.

<u>Height of wind turbines</u>

The characteristics of wind turbines, particularly their height, also influence the variability of the impact on property prices.

Dröes and Koster (2021) have found that the extent and magnitude of the impact depend mainly on the height of the wind turbines. The study considered wind turbines located within a 2 km radius of residential properties and divided them into three groups according to height: < 50 m, 50–150 m, and > 150 m. The taller the nearest wind turbine, the greater the impact was found to be. The < 50 m group reduced property values by -1.1%, but without statistical significance. The 50–150 m and > 150 m groups reduced property values by -2% and -5.5%, respectively, with statistical significance.

Most modern wind turbines are significantly taller than 150 m. It can be assumed that the impact of taller wind turbines may be greater than previously indicated. As the height of wind turbines increases, the same amount of energy is generally produced with fewer wind turbines, so the effects of the number and height of wind turbines may balance each other to a certain extent.

<u>Differences between real estate market segments or regional differences</u>

Skenteris et al. (2019)[264] studied two different wind farm projects on different Greek islands and found that there was no impact on the island focused on tourism (4 wind turbines), but there was a negative impact on the island with a more extensive residential area (13 wind turbines). Although the number of wind turbines differed, the capacities of the wind farms were similar.

Jensen et al. (2018) found a negative impact on real estate prices in five regions of Denmark, ranging from 0.2% to 1.1% per additional wind turbine within a 3 km radius. The impact was smaller in areas with holiday homes.

Dröes and Koster (2016) found that the average impact, when different market segments in the Netherlands were not separated, was approximately -1.6% per additional wind turbine within a 2 km radius. When the markets were separated, the impact was up to -4% in several areas, while in some areas the impact was also positive.

Other similar studies have also found that the impact on real estate prices may vary when the context and characteristics of the real estate market are examined more closely. For example, the impact may be smaller in tourist areas than in areas with permanent residents. Most studies have

[261] Dröes, M.I., & Koster, H.R.A. (2021). Wind turbines, solar farms, and house prices. Energy Policy. 155:112327.
[262] Dröes, M.I., Koster, H.R.A., 2016. Renewable energy and negative externalities: The effect of wind turbines on house prices. J. Urban Econ. 96, 121–141. https://doi.org/10.1016/j.jue.2016.09.001
[263] Eichholtz, P., Kok, N., Langen, M., van Vulpen, D., 2021. Clean Electricity, Dirty Electricity: The Effect on Local House Prices. J. Real Estate Finance Econ. https://doi.org/10.1007/s11146-021-09878-6
[264] Skenteris, K., Mirasgedis, S., Tourkolias, C., 2019. Implementing hedonic pricing models for valuing the visual impact of wind farms in Greece. Econ. Anal. Policy 64, 248–258. https://doi.org/10.1016/j.eap.2019.09.004

so far been conducted in rural areas, as wind energy projects are often built there due to the availability of land resources and fewer restrictions. However, as time goes on, wind energy projects closer to urban areas are being considered more and more. The fact that there are more affected properties in urban areas also plays a role here, as smaller individual impacts can still lead to larger cumulative impacts.

Later studies investigating the differences between urban and rural areas (Jensen et al. (2018)) found that the first wind turbine has the greatest impact, but the impact of subsequent wind turbines gradually decreases. Their main recommendation is to establish wind farms in isolated areas and develop them on a large scale. Dröes and Koster (2016) and Eichholtz et al. (2021) support this conclusion. Using similar data covering a large part of both rural and urban areas in the Netherlands, both studies found a greater negative impact in urban areas.

The real estate market's anticipatory response to the announcement of wind farm construction

Parsons and Heintzelman (2022) found that 10 out of 18 studies examined real estate price behavior in the period prior to the actual construction of wind farms. In six of the 10 studies, no pre-construction effects on prices were identified. The so-called anticipatory effect is the market's reaction to a future event before it has become a reality. Four studies identified anticipatory market behavior. The onset of the anticipatory effect can be linked to either the first public announcement of the wind farm project or the disclosure of information during the environmental impact assessment process. (Dröes and Koster, 2016; Heintzelman and Tuttle, 2012[265]; Jarvis, 2021[266]; Vyn, 2018) have found that the anticipatory effect can occur approximately two years before the actual completion of a wind farm. In areas where people have a negative attitude towards wind farms, some studies have found that the impact on real estate prices has been similar to the period when the wind turbines actually began to have an impact on the landscape.

Conclusions

In summary, based on the results of the study of changes in real estate values, it can be concluded that the development of a wind farm may have a negative impact on residential real estate prices. Based on various studies, it can be argued that the negative impact on real estate values is greater when the wind farm is closer to residential buildings and visible from them.

[265] Heintzelman, M.D., Tuttle, C.M., 2012. Values in the Wind: A Hedonic Analysis of Wind Power Facilities. Land Econ. 88, 571–588. https://doi.org/10.3368/le.88.3.571

[266] Jarvis, S., 2021. The Economic Costs of NIMBYism - Evidence From Renewable Energy Projects (No. crctr224_2021_300), CRC TR 224 Discussion Paper Series, CRC TR 224 Discussion Paper Series. University of Bonn and University of Mannheim, Germany.

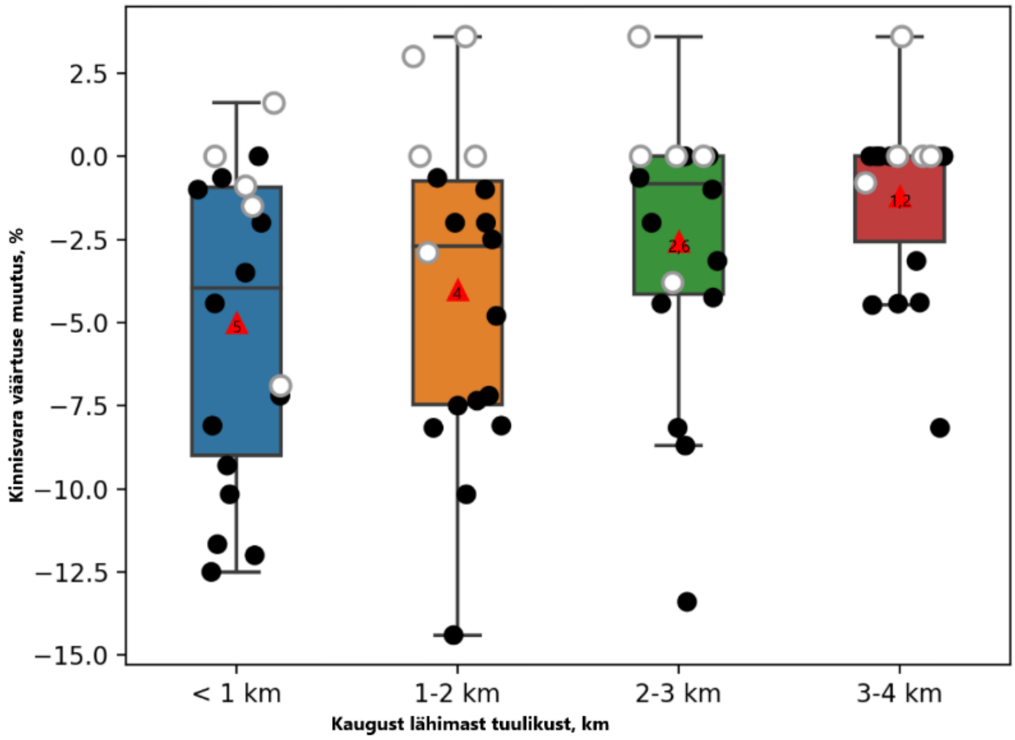

Figure52 . Net impact on real estate prices based on a study of 18 wind turbines. The black line in the box represents the median[267] . The red triangle shows the mean. Black dots represent studies with statistically significant coefficient estimates, while white dots represent studies with statistically insignificant estimates. Source: Parsons and Heintzelman (2022).

The figure above shows that moving 1 km away from wind turbines is expected to cause an average change in real estate prices of -5.0% at a distance of up to 1 km, -4.0% at a distance of 1-2 km, -2.6% at a distance of 2–3 km, and -1.2% at a distance of 3–4 km. No significant change in the value of dwellings located further than 4 km away is expected.

There are currently no regulations in Estonia regarding compensation based on real estate value. As far as we know, compensation for a decline in real estate value is a relatively rare practice worldwide. An exception is Denmark, where a separate system has been developed for assessing changes in real estate value, compensation, and buyouts by developers at the request of property owners.

To our knowledge, no compensation for changes in real estate value has been paid in Estonia for any development project. The impact is not limited to wind farms. Roads, quarries, and other objects can also affect the value of real estate in the surrounding area. Studies to date have shown that the impact of wind farms on the value of residential real estate is closely linked to their visual impact. At the same time, it has also been found that the negative impact is at least partially reversed over time.

The decline in property values can be minimized if the construction of a wind farm is accompanied by infrastructure development that improves accessibility and promotes, for example, the economic development of the region. The potential decline in property values should be offset by the so-called tolerance fee for wind turbines (see section4.7.5).

[267] The median is a number that has an equal number of larger and smaller values in the variation range.

4.7.4 Social conflicts

Methodology: the following overview is based on opinion polls conducted in Estonia and publicly available information.

In many cases, the construction of wind farms in Estonia is met with resistance from the local community. There are several instances where the planning of wind farms has been halted by the collection of signatures from local residents or strong opposition (Hiiumaa offshore wind farm, Vormsi wind farm, Risti wind farm, etc.). Numerous petitions have been organized through Rahvaalgatus.ee and petitsioon.ee against wind farm plans. The main reasons given in the objections are usually fears about possible noise, shadowing, and health effects. Visual disturbance is also often mentioned, and there are also situations where no clear reason can be given. It seems somewhat surprising that the opposition is just as intense in the case of offshore wind farms.

Despite very sharp conflicts and opposition to several wind farm projects, according to a 2021 survey by Kantar Emor[268] , 72% of respondents support the construction of offshore wind farms and 62% support the construction of onshore wind farms. The construction of wind farms is viewed more positively by younger residents aged 15–34 than the average. Nearly three-quarters (71%) of those who live near a wind farm support the expansion of onshore wind farms (26% are opposed). At the same time, only 40% of those who have a wind farm planned near their home support its construction (58% are against it). Of those who have not yet had any contact with wind turbines, 60% are in favor of the construction of onshore wind farms and 30% are against it, while of those who have been in the vicinity of wind farms, 66% are in favor and 28% are against it. Thus, those who have experience of living near wind turbines and who have visited areas with wind turbines are the most positive about their construction. When comparing those who live near wind farms with those who have no contact with wind farms, it appears that residents who have contact with wind farms have a more positive attitude towards them. The less exposure the survey participants had to wind farms, the more respondents were unable to form an opinion. With the most effective compensation measure, 53% of residents would have a positive attitude toward a wind farm being built in their neighborhood. The most positive attitudes were found among the 15–24 and 25–34 age groups, of whom 69% and 68%, respectively, would support the construction of a wind farm near their home with a compensation measure. During the survey, 74% of respondents considered the increase in the share of green energy generated by wind farms to be important, 68% of respondents considered the impact of wind farms on local infrastructure (electricity supply, roads) to be important, 64% of respondents considered the impact of wind farms on the promotion of local life through tolerance payments (e.g., improvement of kindergartens, schools, health trails) to be important, and 57% of respondents considered the impact of wind farms on the creation of jobs in the region to be important.

Since the 2021 survey, this topic has attracted a lot of public attention, and new opinion polls have been conducted, which continue to show strong support for renewable energy. People are in favor of a diverse energy portfolio and do not believe that we should invest in only one existing technology. Solar and wind energy receive the most support. The least popular methods of electricity generation in the future are oil shale, wood chip burning, and nuclear energy. According to the survey, the strongest mitigating factor for the acceptance of wind farms is a more favorable electricity price (price per unit of electricity consumed per hour), in which case nearly 70% of people agree to the construction of a wind farm in their vicinity.[269] .

When choosing a location, social conflicts cannot be ruled out when establishing a wind farm. In the southern area of the areas assessed in the KSH report, the number of residential units in the impact area is significantly smaller than in the northern area, which may somewhat reduce the magnitude of

[268] https://kliimaministeerium.ee/sites/default/files/documents/2023-07/Tuuleparkide%20meelsusuuring%20%282021%29.pdf

[269] https://salk.ee/artiklid/tuulikusoda-mida-arvavad-inimesed-energeetikast/

possible conflicts. In addition to the local benefits described in section4.7.5 , additional compensation measures offered by the wind farm developer may also help to reduce conflicts. According to a survey conducted by SALK in 2024-2025, compensation measures help to increase the acceptability of the planned wind farm in the surrounding area.

4.7.5 Local benefits

Methodology: based on the calculation methodology specified in the Environmental Charges Act.

When compensating for the impact of disturbances, the ability of compensation mechanisms to alleviate the situation of people affected by the development is considered important. Currently, the local benefits received are regulated by the Environmental Charges Act[270] . According to the Act, the fee for the production of electricity from wind energy is a compensation fee for environmental disturbance, which is paid by the owner of the wind farm or the person entitled to use it and is distributed to the local government unit in whose territory the onshore wind farm is located. The fee for producing electricity from wind energy is paid from the date of registration of the notification of the start of construction of the wind farm until the wind farm is removed from its location. The fee for the production of electricity from wind energy at an onshore wind farm is set at between 0.7% and 1% of the product of the following two indicators:

- the amount of electricity produced by the wind farm in megawatt-hours per quarter, but not less than 70% of the nominal capacity of the wind farm multiplied by 750;
- the arithmetic mean of the next day's market price of electricity in the Estonian price area for the corresponding quarter.

The rate of the fee for the production of electricity from wind energy by an onshore wind farm is established by a regulation of the council of the local government unit in whose territory the wind farm is located.

If the local government unit has not established a fee for the production of electricity from wind energy at an onshore wind farm, the lowest possible fee specified in § 21^3 lg-s 1 of the Environmental Charges Act shall be applied when determining the fee.

The fee for the production of electricity from wind energy by an onshore wind farm shall be paid into the budget of the local government unit in whose territory the wind farm is located.

Of the fee for the production of electricity from wind energy by an onshore wind farm received by the local government unit, 50% shall be paid by the local government unit to the owners of residential premises located within the area of influence of the onshore wind farm (hereinafter *referred to as the wind energy electricity production fee related to the place of residence)* to the owners of residential premises located within the area of influence of the onshore wind farm, provided that the residential premises meet the following conditions:

- the residential property is owned by a natural person;
- the residential property is the owner's place of residence according to the population register.

The fee for electricity production from wind energy related to the place of residence is paid once a year for the calendar year.

Indicative fee calculations are presented atTable43 . The calculation has been made conservatively.

Table43 . Indicative calculation of environmental disturbance fees.

Very illustrative calculation based on a conservative annual fee (minimum production)		Unit
21	wind turbine	

[270] https://www.riigiteataja.ee/akt/109082022028?leiaKehtiv

7	Nominal capacity per wind turbine	MW
147	Park capacity	MW
77	70% total capacity of wind farm x 750 - minimum even when the park is idle	
50	Expected average exchange price	€/MWh
1	Fee rate	
154,350	Annual fee for electricity production from wind energy at wind farms	€
77,175	The municipality receives	€
77,175	Residents receive	€
A very illustrative calculation of the conservative annual fee (based on projected production)		
21	wind turbines	
7	nominal capacity per wind turbine	MW
147	Park capacity	MW
490,000	Estimated annual electricity production of the park	MWh
50	Expected average market price	€/MWh
1	Fee rate	
245,000	Annual fee for electricity production from wind energy at a wind farm	€
122,500	The municipality receives	€
122,500	Residents receive	€

The impact area of an onshore wind farm within the meaning of the Environmental Charges Act is the area of the Republic of Estonia extending **up to two kilometers in the case of a wind farm with a height of up to 250 meters** and **three** kilometers in the **case of a wind farm with a height of 250meters for wind farms up to 250 meters high, and three kilometers for** wind farms higher **than 250 meters**, from the center of the nearest tower of the wind farm (Figure50). If the boundary line extending two or three kilometers from the center of the nearest tower of the wind farm crosses the registered immovable, the area of impact extends to the furthest boundary of the registered immovable.

The maximum amount of the fee for the production of electricity from wind energy related to the place of residence is the minimum wage in Estonia for six months of the corresponding calendar year. The local government unit shall publish information on its website about the fee for the production of electricity from wind energy related to the place of residence. If the maximum total amount of the fee for the production of electricity from wind energy related to the place of residence exceeds 50% of the fee received by the local government unit per year, 50% of the fee received shall be distributed proportionally among the owners of residential premises located within the area of influence of the wind farm.

If the total amount of fees for the production of electricity from wind energy related to the place of residence to be paid per year is less than 50% of the fees for the production of electricity from wind energy received by the local government unit from the onshore wind farm, the portion of the fee received that exceeds the amount paid shall remain with the local government unit.

The local government unit shall pay the fee for the production of electricity from wind energy related to the place of residence for a wind farm located in its territory also for a dwelling located in the territory of another local government unit if there is no wind farm in the local government unit where the dwelling is located.

4.7.6 Impact on tourism

Methodology: The current state of the tourism industry in Tõrva municipality has been characterized on the basis of public information materials and tourism development documents and information materials concerning the region. The impact assessment on the tourism sector has been compiled as an overview based on scientific literature and research.

4.7.6.1 Current status and strategic objectives of the tourism sector in Tõrva municipality

Tõrva municipality is located in southern Estonia, in the historic Mulgimaa region, which attracts visitors with its unique nature, cultural heritage, and active communities. Tõrva has been an official summer resort since 1937 and remains a resort in Mulgimaa today. During the summer months, several factors attract vacationers to Tõrva: there are four lakes in the town of Tõrva, and right in the heart of the town is the untouched nature of the Õhne River valley. The municipality has many beautiful swimming spots (such as Vanamõisa, Riiska, and Valgjärv), hiking trails, and sports facilities. In addition to nature, the area offers cultural experiences – there are historic manor complexes (e.g., Taagepera Castle, Holdre Manor), museums, and the recently opened Mulgi Experience Center (2023). Tõrva has even earned the nickname "Estonian Tuscany," referring to the beauty of the landscape and the richness of its cultural heritage[271] .

In recent years, Tõrva Municipality has made significant investments in tourism infrastructure and the living environment, making the region more attractive to both residents and visitors. Between 2018 and 2024, a new central square (known as "Tõrva Tuleskväär") was built in Tõrva, Tõrva Veemõnula (water center/spa) was opened, the health center was renovated, a gymnasium stadium and bridge were built, and the Mulgi Experience Center was created in cooperation with neighboring municipalities. At the same time, new services and attractions have been developed in the private sector – for example, Taagepera Castle was renovated into a high-quality accommodation and event center, and other tourism businesses were added[272] . Well-known events are also organized in Tõrva (e.g., Tõrva Fire Days, Night of Lights festival), which attract large numbers of visitors[273] .

The share of tourism in the Estonian economy was approximately 3.6–4.7% in 2023, and with indirect effects (i.e., spillover effects), it may reach 5.3–7%. In Valga County, tourism accounted for 8.2–10.0% of the economy, and with indirect effects, 12.0–14.8%, which is above average[274] .

According to the development plan of Tõrva municipality, tourism is one of the important development directions for Tõrva municipality. According to the municipality's strategic vision, it is desired to become the best place in South Estonia to live, visit, and invest. The contribution of the tourism sector is reflected in both local business income and image building – satisfied visitors spread a positive image, which in turn helps attract new residents and businesses. The municipality's development plan emphasizes that tourism is an area that must be continuously developed in cooperation with entrepreneurs and the community. Although tourism is seasonal (there are many more visitors in the summer than in the winter), the goal is to promote year-round visitation. The municipality's development plan states that the desired situation by 2035 is an increase in the number of overnight stays and greater recognition of Tõrva as a tourist destination.

The Tõrva municipality development plan for 2025–2035 sets tourism development as one of its priorities (strategic direction “Come to Tõrva”). The vision is that *“Tõrva Municipality is a unique and well-known tourist destination that offers visitors enjoyment at any time of year”* (objective E7.1).

The tourism objectives of Tõrva Municipality are linked to the South Estonia Tourism Development Strategy (2025–2030), whose vision is to make South Estonia an exciting, welcoming, and sustainable tourist destination for every visitor, regardless of the season. The joint strategy for Southern Estonia emphasizes the uniqueness of communities, the preservation of natural heritage, and the balanced

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[271] https://visittorva.ee/

[272] https://www.riigiteataja.ee/aktilisa/4260/3202/5028/Torva%20valla%20arengukava%20aastani%202035.pdf

[273] https://visittorva.ee/

[274] Ministry of Economic Affairs and Communications. 2024. Long-term outlook for tourism 2025–2035.

development of diverse areas of tourism (nature tourism, cultural tourism, adventure and health tourism, food tourism, business tourism). As part of Valga County, Tõrva contributes primarily to the symbiosis of nature and culture – for example, the rich heritage of Mulgimaa and the natural potential of Tõrva offer unique experiences for nature lovers all year round. The strategy also provides for strengthening cooperation with neighboring countries (e.g., Latvia) and emphasizes the principles of sustainable tourism.

The current state of the tourism sector in Tõrva municipality is characterized by growing attractiveness and a clear goal of becoming a well-known destination. The municipality's strengths include its beautiful natural environment, rich cultural heritage (manors, Mulgi identity), renovated infrastructure, and events that attract visitors. At the same time, challenges have been identified – the seasonality of tourism, lack of cooperation, insufficient promotion of the Mulgi theme – and strategic steps have been taken to address them. Tourism plays an important role in the municipality's economy, accounting for up to 15% of the municipality's economy, including indirect effects.

4.7.6.2 Possible impacts

To our knowledge, no studies have been conducted in Estonia on the impact of wind farms on tourism. Studies conducted in other countries show that visitors' attitudes towards wind energy can be positive, negative or neutral, and these attitudes influence whether they consider a wind farm to be a suitable holiday destination or not[275] .

Surveys have been conducted among tourists in many places to understand their opinions. The overall picture from the surveys is that most tourists do not consider wind farms to be a decisive factor in their travel decisions. For example, in a survey conducted in Great Britain and Scotland, ~80% of tourists said that the presence of a wind farm at their destination would not affect their decision to visit or stay there[276] . However, many factors influence opinions. In Sweden, it was found that 70% of people with a positive attitude towards wind farms would be happy to visit a wind farm, while only 32% of people with a negative attitude towards wind energy would be willing to visit a wind farm. The same study revealed that people who spend more time in nature (hikers) would also like to visit wind farms more often (62% of respondents)[277] . An earlier Swedish study found that foreign nature tourists may be more critical of wind turbines than locals – foreign visitors expect "wild nature" and are more disappointed when they find large wind turbines, while locals may be more accustomed to or accepting of them[278] . A 2023 survey of attitudes toward tourism in Iceland showed that there are differences between nationalities: for example, French tourists were the most negative about the planned wind energy development in Iceland, while Asian tourists expressed the greatest interest in visiting the wind farm[279] . This points to the importance of cultural background – different countries have different wind energy marketing strategies and habits.

It is important to note that the development of a negative attitude does not necessarily mean that a visit will not take place – many tourists may not find wind turbines attractive, but this does not affect their decision to visit the area. At the same time, it has been found that an extremely negative attitude can lead to changes in travel plans. For example, the Icelandic study mentioned above emphasizes

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[275] Tverijonaite, E., Sæþórsdóttir, A. D., & Kövi, Z. 2025. New Winds: Tourist Attitudes Toward Wind Energy Projects in Iceland. *Sustainability, 17(*10), 4257. https://doi.org/10.3390/su17104257

[276] Dinnie, E. 2012. *The Impact of Wind Farms on Scottish Tourism.* ClimateXChange report to the Scottish Government.

[277] Prince, S., Chekalina, T., Peters, A. 2024. Wind power infrastructure and perceived value of tourism experience in nature areas. Holistic perspective and assessment tools.

[278] Wall-Reinius, S., Olausson, F., Ankre, R., Dahlberg, A., Lexhagen, M., Lundberg, C., Sandell K., & Bodén., B. 2015. Survey among visitors to southern Jämtlandsfjällen in 2013. ETOUR Report 2015:2.

[279] Tverijonaite, E., Sæþórsdóttir, A. D., & Kövi, Z. 2025. New Winds: Tourist Attitudes Toward Wind Energy Projects in Iceland. *Sustainability, 17(*10), 4257. https://doi.org/10.3390/su17104257

that if tourists perceive a wind farm as incompatible with their experience, they may avoid the area, which would result in a loss for the local economy. On the other hand, positive attitudes can even turn a wind farm into a tourist attraction [280(,)281] . There are several examples of this: in many places, guided tours have been organized in wind farms or viewing platforms have been built so that interested parties can learn about "green energy" activities[282] .

The largest empirical study on wind farms and tourism is known to have been conducted in Scotland. This study did not find a strong negative correlation between wind farms and the tourism industry. Scotland has built hundreds of wind turbines in its mountainous and rural areas, but a thorough analysis of 44 wind farms found that tourism-related employment did not suffer in these areas – rather, it continued to grow in line with the general trend. The study concluded that the development of wind farms has no discernible negative impact on tourism-related employment at the national, county, or specific wind farm level. In many municipalities located near wind farms, the number of tourists and employment grew even faster than the county average, suggesting that the presence of wind turbines did not hinder positive trends[283] .

Elsewhere, it has also been found that it is difficult to identify a direct cause and effect (wind turbines => loss of tourism). For example, case studies conducted in Portugal[284] and Canada[285] did not find that wind farms had reduced the number of visitors or spending in the region.

On the other hand, there are also studies with the opposite result. In Germany, it was found that in inland regions, an increase in the density of wind turbines has been accompanied by a decline in demand for tourist accommodation – thus, a negative correlation was identified[286] .

Given the varying conclusions of studies conducted around the world and the fact that the tourism sector is influenced by many different factors, it is not possible to provide a quantitative assessment of the impact of the planned wind farm on the tourism sector in Tõrva municipality. There is a risk that the planned wind farm may have a negative impact on the tourism sector in Tõrva municipality, but the extent of the impact depends on how other tourism opportunities can be promoted. The risk of a negative impact is primarily on nature tourism. In terms of nature tourism, the wind farm may reduce the region's competitiveness as a clean and peaceful destination. However, this does not necessarily mean that all tourism in the region will disappear: Tõrva municipality has several other strengths (lakes, events, local community) that will continue to attract visitors. For many tourists, wind turbines may remain a marginal aspect that they will adapt to. Some may even like the idea that their vacation spot contributes to green energy. Therefore, the final impact will depend greatly on how the construction and existence of the wind farm is communicated. If the wind farm can be communicated as part of the value of a sustainable tourist destination, the accompanying negative impact will be minimal.

The potential negative impact of the wind farm planned in the special plan on the tourism sector is mitigated by the fact that the area surrounding the planned location is very densely forested. This, in

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[280] Beer, M.; Rybár, R.; Kaľavský, M. 2018. Renewable energy sources as an attractive element of industrial tourism. *Curr. Issues Tour. 21,* 2139–2151.

[281] Liu, D.; Curtis, C.; Upchurch, R.S. 2019. The evolving field of wind energy tourism: An application of the theory of reasoned action. Tour. Rev. Int. 23, 37–53.

[282] https://www.whiteleewindfarm.co.uk/visitor-centre/what-we-offer/bus-tours

[283] BiGGAR Economics (2021). *Wind Farms and Tourism Trends in Scotland: Evidence from 44 wind farms.*

[284] de Sousa, A. J. G., & Kastenholz, E. (2015). Wind farms and the rural tourism experience–problem or possible productive integration? The views of visitors and residents of a Portuguese village. Journal of Sustainable Tourism, 23(8–9), 1236–1256.

[285] Fortin, M. J., Dormaels, M., & Handfield, M. (2017). Impact of wind farm landscapes on the tourist experience. Survey in the Gaspé Peninsula (Quebec, Canada). Téoros, 36(2)

[286] Broekel, T.; Alfken, C. (2015). Gone with the wind? The impact of wind turbines on tourism demand. Energy Policy, 86, 506-519. https://doi.org/10.1016/j.enpol.2015.08.005

turn, significantly reduces the visibility of the wind farm to the extent that it dominates the landscape (the relevant discussion is presented in section4.6). Similarly, no significant visual impact has been identified on the cultural monuments closest to the area.

4.7.7 Measures, need for further studies and assessment

In order to increase the acceptability of the wind farm, it is recommended that the person interested in the plan find additional opportunities to increase local benefits in addition to the disturbance fee specified in the Environmental Charges Act. The measure is not directly applicable in the special plan.

4.8 Emergency situations

When wind turbines are installed correctly and high-quality equipment that meets the requirements is used and operated, the environmental risk posed by wind turbines is not particularly high. Accidents in wind farms are rare. Risks are also mitigated by the interest of wind farm developers in ensuring the long-term and stable operation of their equipment, which is why modern wind farms are under constant electronic monitoring to detect deviations from normal operating mode.

At the same time, it is **impossible to completely rule out accidents with any technical equipment**.

Wind turbine mast breakage

The risk of wind turbine mast breakage and collapse is low if new wind turbines are installed properly and maintained regularly. Wind turbines are designed to be resistant to weather conditions, especially strong winds. Regular and proper maintenance of wind turbines prevents vibration and resonance. Vibration and resonance can cause deviations from the calculated stability, and therefore the risk of breakage is minimized by the stability of the tower.

Breakage of the wind turbine blade or tip

Similar to the breakage of the wind turbine tower, proper installation and maintenance of the wind turbine minimizes the probability of the blade or part of the blade breaking and falling down or, in the worst case, flying away. Wind turbine blades are usually made of fiberglass, which means that if a crack appears or, in the worst case, a break occurs, it will not fall down immediately. Thanks to a continuous automatic monitoring system that uses information from special sensors and error messages, it is possible to prevent a major accident by detecting the problem in time (the wind turbine must be stopped and the broken part removed/replaced). Part of wind turbine maintenance is also periodic inspection of the wind turbine, which can also be carried out using drones. Periodic inspection helps to prevent such accidents and their consequences.

Pollution risk

The main source of pollution risk is the oil used in the gearbox located in the nacelle of some wind turbines (up to 500 liters in total), which can enter the soil and, in the worst case, surface or groundwater if the nacelle breaks. Oil change is a maintenance process for which each wind turbine manufacturer has instructions. Wind turbine maintenance is carried out by trained personnel. In general, wind turbines do not have their oil changed every year. For wind turbines in Estonia, oil changes are performed approximately once every five years, depending on the type of wind turbine, and for newer wind turbines, oil changes are even less frequent. Precautionary measures are always taken during oil changes (e.g., a collar is installed around the wind turbine tower) to prevent oil from entering the environment. According to the 1:400,000 map of groundwater protection in Estonia, this is a relatively protected groundwater area, i.e. an area with a low risk of pollution.

There are watercourses and drainage ditches near the wind farm. Therefore, there is a risk of pollution spreading to the aquatic environment. The nature of the accident is similar to, for example, a fuel truck accident on a highway, and the main measure is the rapid response of the rescue service and the wind turbine maintenance team and their ability to resolve the situation. To prevent accidents, the wind farm owner must ensure continuous monitoring of the condition of the wind turbines and maintenance in accordance with the technical specifications of the specific wind turbines installed.

Fire

Another safety risk is the possibility of a wind turbine catching fire as a result of a technical malfunction. However, compared to other energy sectors (gas or oil), wind turbine fires are generally considered to be very rare in the energy industry[287] . In Estonia, a wind turbine caught fire in the village of Tüükri in Lääne-Viru County in 2015, which also burned an area of approximately 3000 m(2). Therefore, when constructing wind turbines, there is a risk of landscape fires in the event of a wind turbine fire.

Various studies have found that wind turbine fires account for an estimated 10-30% of all wind turbine-related accidents.[288] In addition, it has been found that 1 wind turbine catches fire for every 2,000 wind turbines worldwide each year[289(,)290] , meaning that the probability of such accidents occurring is relatively low.

In order to prevent fire accidents, the owner of a wind farm must ensure continuous monitoring of the condition of wind turbines and maintenance in accordance with technical requirements. In recent years, fire alarm systems have increasingly been installed in wind farms to help detect fires as early as possible. As a rule, fire extinguishing systems are not installed on wind turbines, as it is not possible to extinguish them from the ground. In the event of a fire, the Rescue Board will focus on containing the fire, as ladder trucks and water jets cannot reach the wind turbine nacelle. Therefore, in the event of a fire, it is possible to limit the spread of the fire beyond the area, but it is not possible to save the wind turbine itself (for example, in 2004, when a wind turbine caught fire in Finland, a helicopter was used to extinguish the fire and a total of 24 tons of water was poured onto the fire, but the extinguishing effect was negligible)[291] .

The preliminary selection area is partially within the 30-minute response zone of the Tõrva Rescue Command[292] , which can be considered a good indicator, given that wind farms cannot be built directly in populated areas.

Icing

In the Estonian climate, one risk factor for wind turbines is the icing of blades and the danger of ice fragments breaking off at high blade speeds and flying off. The ice chunks that form on rotating blades are small, but theoretically they can travel several hundred meters. However, the distance usually does not exceed the height of the wind turbine blade tip. Larger and more dangerous ice chunks can also break off from a stationary wind turbine, but their impact area is smaller[293] . Various technological solutions are used to minimize the risk, such as monitoring systems that stop the wind turbine in case

[287]Smith, C. 2014. Fires are major cause of wind farm failure, according to new research. Imperial College London. https://www.imperial.ac.uk/news/153886/fires-major-cause-wind-farm-failure/

[288] Uadiale, S., Urban, E., Carvel, R., Lange, D., Rein, G. 2014. Overview of Problems and Solutions in Fire Protection Engineering of Wind Turbines. Fire Safety Science 11:983-995. https://doi.org/10.3801/IAFSS.FSS.11-983

[289] WPED Contributor. 2020. Is rope-based descent emergency evacuation at the end of its tether? https://www.windpowerengineering.com/is-rope-based-descent-emergency-evacuation-at-the-end-of-its-tether/

[290] Whitlock, R. 2015. Windmill Aflame: Why Wind Turbine Fires Happen, How Often and What Can Be Done About it. https://interestingengineering.com/windmill-aflame-why-wind-turbine-fires-happen-how-often-and-what-can-be-done-about-it

[291] http://www.tuuleenergia.ee/2017/02/mis-saab-kui-tuulegeneraator-suttib-polema/

[292] https://arcg.is/0SOiSC0

[293] Tammelin, B., Iaitos, I. 2005. Wind Turbines in Icing Environment: Improvement of Tools for Siting, Certification and Operation. Finnish Meteorological Institute, pp 127.

of icing, blade heating systems, etc. The wind turbine installer must choose the most suitable solution that ensures safety. In most modern wind turbines, an anti-icing heating system is part of the standard equipment, which means that the problem has largely been eliminated.

If wind turbines are not equipped with an anti-icing heating system, they must be located at a sufficient distance from sensitive objects (residential buildings, roads). The impact area of flying ice chunks can be calculated using the formula 1.5×(tower height + rotor diameter)[294] . In this case, it would be up to 560 m. The wind turbines are planned to be located at least 1 km away from residential buildings. **Therefore, in this case, no significant danger to residential areas due to icing is to be expected.**

4.8.1 Environmental measures

- A firefighting water intake point must be located 3 km from the wind turbines (along the road) in case of a possible fire to extinguish a wildfire. When planning the firefighting water intake, ensure that it is no closer than 200 m from the wind turbines to avoid an increased risk of bat mortality.
- Wind turbines must be equipped with fire extinguishing equipment, alarm devices, and an automatic fire extinguishing system. In the event of an emergency, the rescue team must be guaranteed access to buildings and essential equipment. If necessary (if oil or other liquid chemicals that are hazardous to the environment are used in the wind turbines), suitable means for pollution control must be installed in the wind turbines.
- If necessary (if oil or other liquid chemicals that are hazardous to the environment are used in wind turbines), suitable means for organizing pollution control must be installed in the wind turbines.
- The owner of the wind farm must ensure continuous monitoring of the condition of the wind turbines and maintenance in accordance with technical requirements. The wind farm must be safe throughout its existence and must not pose a threat to people, property, or the environment. The owner of the structure is responsible for ensuring its safety.
- This SEA considers the distance of 1.5×(tower height+rotor diameter) from the wind turbine to be the danger zone for flying debris, which is the maximum extent of the danger. As the danger zone has been determined in general terms, the owner of the wind farm may reduce the extent of the danger zone on the basis of a more precise risk assessment. The wind farm must draw up instructions for action in the event of icing and ensure that they are followed. In the event of a risk of icing, it may be necessary to temporarily close public access roads within the danger zone and/or mark them with appropriate warning signs.

4.9 Combined effects and cumulative impact

Combined effects, or cumulative effects, are the cumulative impact of individual factors. For example, the simultaneous impact of the implementation of different plans and projects. The cumulative nature of the impacts is taken into account in the assessment of each topic discussed in the above chapters as an integral part of the logical assessment of normal environmental impacts. The assessment of combined effects and cumulative impacts is complicated in the case of this SEA by the fact that although several wind farm plans have been initiated in the region, most of them are in the early stages and it is not known where and how many wind turbines may be built.

The Valga County Plan 2030+ applies in the region. The Valga County Plan does not designate any preferred areas for the construction of wind farms, but section 4.2.5 of the explanatory memorandum to the Valga County Plan sets out the principles for the development of renewable energy. According

[294] Deutscher Naturschutzring Grundlagenarbeit für eine Informationskampagne "Umwelt- und naturverträgliche Windenergienutzung in Deutschland (onshore). 2005.

to the Valga County Plan, in the case of distributed energy, where it is necessary to use agricultural land for energy production, less valuable areas (outside the green network, valuable landscapes, and valuable agricultural land) should be preferred. The Valga County Plan does not specify specific areas for the development of renewable energy in the county.

The comprehensive plan of Tõrva municipality does not provide for industrial wind turbines in the territory of Tõrva municipality. If there is a desire to develop wind turbines, a special plan must be initiated by the local government.

There are no existing wind farms in the potential impact area of the Tõrva municipality special plan. Neighboring municipalities are searching for wind areas within the framework of their general and special plans, but **as far as is known**, **no other wind areas are being planned within a 15 km radius of the preliminary selection area for a possible wind farm in Tõrva municipality as part of any ongoing planning process.** A second special plan is also being prepared in Tõrva municipality, but as the process is in its early stages, it is not known whether and where a wind farm may be planned. Therefore, the cumulative impact with other wind farms cannot be assessed within the framework of this SEA . If other wind farms are to be planned in the area, the impact of the farm planned in this special plan must be taken into account when preparing their SEA. Cumulative impacts will be assessed in the context of later planning/projects.

A special plan for a wind farm in Valga Parish is being prepared and is in the coordination stage as of May 2025. According to the planning solution completed for the coordination stage, the preliminary selection areas for possible locations are more than 15 km (approx. 19 km) away from the preliminary selection area for possible locations assessed in this SEA.

The Estonian state is also mapping potential wind energy development areas on state-owned land. Two potential state wind energy priority development areas are located 2.4 and 4.4 km away from the potentially suitable areas in the special plan for Tõrva municipality. Further planning of priority development areas will be determined after conducting environmental studies in these areas. Based on the environmental study data available in August 2024, Tõrva municipality is unlikely to be included in the planning of priority development areas for wind farms.

As far as is known, there are no other wind farms planned within a 15 km radius of the location of this plan on the territory of the Republic of Latvia.

Based on the above, no other wind farm plans or projects that could have a cumulative impact have been identified in the course of this SEA. No other developments with a significant impact that could have cumulative effects have been identified in the planning area. There are some existing sand quarries (Variku sand quarry, Vanaveski sand quarry), sand quarry exploration areas (Holdre III and IV) and environmental permit application areas (Variku sand quarry) in the area of potentially suitable areas, However, considering that these are relatively small-scale sand quarries, their establishment is not expected to have a significant combined impact with the effects of the construction and operation of the wind farm. Rather, the nearby quarries can be considered a positive factor in terms of environmental impact, as the need to transport construction materials for the wind farm will be reduced and disturbances caused by traffic during construction will be avoided.

4.10 Cross-border impact

The planning area, including the potentially suitable area in the south, borders the border between the Republic of Estonia and the Republic of Latvia. The territory of the Republic of Latvia was treated as equivalent to the territory of Estonia in the SEA report, i.e. an attempt was made to take into account possible restrictions on Latvian territory. Cross-border cooperation with Latvia is conducted through the Ministry of Climate, and the relevant planning and SEA materials are submitted by the Ministry of Climate to the Latvian contact point at the same time as the public display of the plan in Estonia.

When conducting biodiversity surveys, the survey areas were observed, which also extended to the territory of the Republic of Latvia. The location of the state border was not taken into account when conducting the inventories (if the 500 m buffer zone extended into Latvian territory, the species present there were also recorded). In addition, the database https://ozols.gov.lv/pub was used for data on the locations of protected species in Latvia. A Latvian ornithologist was also consulted by a bird expert.

According to information entered in the Latvian nature data management system Ozols, there is a micro-reserve for the corncrake (micro-reserve code: 2609) and a micro-reserve for the capercaillie (micro-reserve code: 2185) in the territory adjacent to the Latvian planning area. Based on the position of the Republic of Latvia at the SEA program stage, it is necessary to observe a buffer zone of at least 2 km around these micro-reserves when planning wind farm development areas. The distance buffer is ensured for both micro-reserves. No adverse impact on the habitats of species protected by the micro-reserves is expected.

The areas where the habitat types listed in the Habitats Directive occur and the growing sites of protected plants in Latvia are outside the area of influence of the planned wind farm.

All residential areas in use within the territory of the Republic of Latvia are located at least 1.2 km from the planned wind farm[295] . This complies with the requirement in force in Latvia, according to which wind turbines must be located at least 800 m from residential areas. In addition, there are two former residential buildings in the border area, which, according to the orthophoto, are dilapidated and uninhabited (this was also confirmed in a letter of cooperation sent by the Republic of Latvia on 07.07.2023, no. 7-15/23/2751-2). Their distances from the nearest wind turbine are 550 m and 770 m, respectively.

When assessing noise and shadowing, inhabited residential buildings within a 2 km radius of the wind farm on Latvian territory were taken into account. The noise levels applicable in Latvia and Estonia are guaranteed in all residential areas. In one residential area, the recommended shadow level (8 h/a) may be exceeded, but measures to prevent this are presented in the SEA report. The implementation of these measures will prevent the shadow disturbance level from being exceeded.

The main impact on the territory of the Republic of Latvia is visual. As the landscape in Latvia is more open (there is more agricultural land), the wind farm will be clearly visible and, in some places, will dominate the view, especially in Latvia. At the same time, no significant cultural or recreational objects were identified in areas with large or very large changes in the landscape on Latvian territory, where the change in views could be considered a significant environmental impact.

By implementing the mitigation measures presented in the SEA report, it is therefore possible to construct the wind farm in a way that avoids significant adverse effects on the territory of the Republic of Latvia.

[295] Latvian WFS data https://lvmgeoserver.lvm.lv/geoserver/publicwfs/ows?version=2.0.0&layer=publicwfs:Adreses_celu_tikls

5 Comparison of alternatives and likely development if the special plan is not implemented

5.1 Comparison of location alternatives

The purpose of the preliminary selection stage of the local government special plan is to determine the location for the desired object (in this case, a wind farm), for which a detailed plan will be drawn up. According to the starting points of this special plan, the aim is to find not just one, but all potentially suitable areas within the special plan area where it would be possible in principle to establish a wind farm. Since the aim is to find all potentially suitable areas, it is not appropriate to compare location alternatives. Therefore, this SEA report presents recommendations for reducing the number of areas or setting additional conditions to reduce and avoid adverse impacts, but does not compare the areas with each other.

5.2 Likely development if the special plan is not implemented

At the local level, there will be no significant impact if the special plan is not implemented. This means that no positive effects on the business environment are to be expected, which could accompany the establishment of a wind farm in the region. Potentially suitable areas are largely forest areas, where forest management will continue in accordance with the Forest Act. The current use of other areas (foraging, tourism, hunting, etc.) will also continue, meaning that the development of the region will continue as before.

From a national perspective, there is a risk that if the special plan is not implemented, renewable energy targets will not be met and Estonia will not be able to sufficiently reduce its greenhouse gas emissions and thus slow down climate change.

6 Establishment of a network connection, possible route corridors and impacts

In order to connect the wind farm to the main grid, a 110 kV power line/cable must be constructed from the substation to be built in the wind farm area, which will be connected to the existing substation or to a new substation to be built near the line. The nearest existing substations in the special planning area are the substation located in the village of Helme on the 110 kV line.

The nearest 330 kV line and substation are located in Valga municipality (Tsirguliina substation).

6.1 Positive and negative aspects of overhead lines and underground cables

High-voltage power lines are usually constructed as overhead lines. There are several technical and economic considerations behind this. Compared to low- and medium-voltage lines, constructing high-voltage lines as underground cables is technically much more complicated and economically more expensive. The positive and negative aspects of underground and overhead lines have been thoroughly analyzed, for example, in the planning of the Harku-Lihula-Sindi 330/110 kV power line[296]
.

According to the analysis, the positive characteristics of overhead lines include:

- simplicity of construction;
- relative reliability;
- speed of fault detection and removal;
- long service life;
- high transmission capacity;
- seasonal (winter) overload capacity;
- low cost.

The main negative aspects are:

- visual pollution;
- wide corridors along the line route that require maintenance (in the case of forests, clear-cutting in line corridors);
- negative impact on birdlife (deaths in collisions).

The positive characteristics of underground cables are:

- no visual pollution;
- possibility of short-term overload;
- few faults;
- storm resistance.

The negative characteristics are:

- large capacity;
- lower throughput;
- expected shorter technical service life;
- long duration of fault repair;
- high cost.

It is also possible to construct a **combined** power line (partly as an overhead line and partly as an underground cable). Certain negative aspects must be taken into account in the case of combined lines:

.[296] TTÜ Institute of Electrical Power Engineering. 2013. Harku-Lihula Sindi 330/110 kV overhead line *versus* cable line. Expert assessment.

- the positive feature of overhead lines, which can be overloaded seasonally, and the positive feature of cable lines, which can be overloaded for short periods, are lost;
- there is a risk of more frequent faults in underground cable sections, as various lightning surges can be transmitted from overhead lines;
- it takes significantly longer to locate the fault and, in the event of a fault in the underground cable, it is very time-consuming to repair it.

The main **impact** of high-voltage overhead lines on people is **visual**. High-voltage lines, especially their pylons, are large and prominent features in the landscape. Pylons for power lines with different voltages are illustrated in FigureFigure53 .

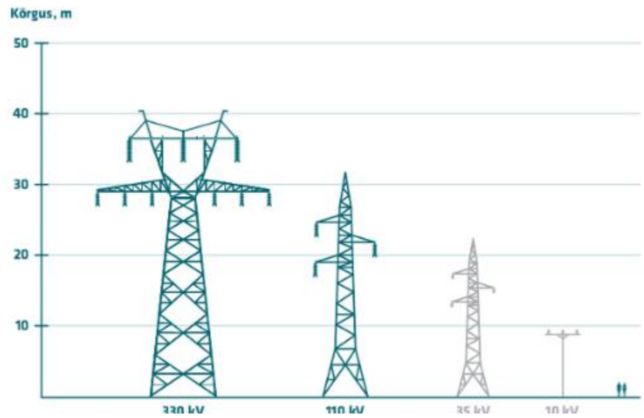

Figure53 . Pylons for overhead lines with different voltage classes. Source: Elering AS.

According to Regulation No. 73 of the Minister of Economic Affairs and Infrastructure of 25.06.2015 "Extent of the protective zone of a building, rules for operating in the protective zone and requirements for marking the protective zone", the extent of the protective zone of an electrical installation for lines with a nominal voltage of 110 kV is 25 m on both sides of the line axis. The protection zone of an underground cable line is the area along the cable, bounded on both sides by imaginary vertical planes located 1 m from the outermost cables of the line. Around substations and distribution equipment, the protection zone extends 2 m from the fence, wall or, in their absence, the equipment.

The construction of an overhead line therefore requires a route corridor approximately 50 m wide, within which **any forest land** must **be cleared**.

One factor affecting the natural environment of overhead power lines is **the risk of birds colliding with the lines**. Large or fast-flying bird species are most at risk: ducks, geese, swans, cranes, herons, cormorants, birds of prey, etc. In the United States, power lines have been found to be one of the three main causes of bird deaths due to human activity. The frequency of bird deaths due to collisions with power lines varies widely, ranging from 2.95 to 489 birds per kilometer of line per year[297] .

To reduce the likelihood of bird deaths and as a mitigating measure, power lines are marked with deterrents such as streamers, balls, or other devices.[298]

Based on the above, high-voltage power lines have a significant negative impact when they are located:

- near residential buildings (especially line masts) – spoils the view;

[297] Nellis, R. 2014. Harku-Lihula-Sindi 330/110 kV high-voltage overhead line bird monitoring plan and assessment of marking requirements.

[298] Maves AS. 2016. Strategic environmental assessment of the thematic plan specifying the planning of Harju, Lääne and Pärnu counties, "Determination of the location of the Harku-Lihula-Sindi 330/110 kV power line route". APPENDIX 2 Sections of the line in Harju, Lääne and Pärnu counties that require marking.

- in or near the habitats of protected bird species – power lines are one of the most significant causes of death due to human activity;
- in high-value forest habitats – the forest is cleared when the line is built.

High-voltage power lines are sometimes associated with **noise**. Noise measurements have been carried out near a 330 kV power line and substation to determine the noise level[299]. The noise measurements showed that the noise level falls to the natural background level (estimated at 35 dB) in the protection zone of the 330 kV power line. The noise from the 330 kV substation falls to the natural background level at a distance of 75 m. Therefore, no long-range noise disturbance from the line or substations is expected. No noise emissions have been observed from underground cables.

Another possible impact associated with high-voltage power lines is the health effects associated with **electromagnetic fields**. The nature of electromagnetic fields and their occurrence around various electrical devices is thoroughly described in the SEA report on determining the location of the Harku-Lihula-Sindi 330/110 kV power line route, and will not be repeated here.

In order to avoid exposure to stronger electromagnetic fields that pose a risk to humans, both national and international limit values have been set for the strength of fields in the environment. The maximum permissible values established in Estonia are set out in Regulation No. 38 of the Minister of Social Affairs of 21 February 2002[300] "Limit values for non-ionizing radiation in living and recreational areas, residential buildings and public buildings, classrooms, and measurement of non-ionizing radiation levels."

According to Regulation No. 38, the limit value for the strength of a 50 Hz electric field for the population is 5000 V/m and the limit value for magnetic flux density is 100 µT. Magnetic flux density values are directly dependent on the load of the high-voltage line, i.e. the current in the line. Outside the protection zone of a 330/110 kV power line, the magnetic flux density (limit value 100 µT, actual value under the line less than 10 µT) and electric field strength (limit value 5000 V/m, actual value at the boundary of the protection zone less than 1000 V/m) are below the standard levels set out in[301]. In the case of high-voltage cables, it has been observed that the magnetic flux density directly above the cable may be higher than under a high-voltage line with the same voltage (e.g. 2.6 µT has been measured under a 500 kV high-voltage line and 105 µT above the cable), but as the distance increases, the decrease in magnetic flux density is significantly greater for cables than for overhead lines (e.g., 2.6 µT has been measured 15 m from a 500 kV high-voltage line and 0.25 µT 15 m from the cable[302]).

There are no significant environmental impacts associated with underground cables. The cable requires a route width of up to a few meters. This does not have any visual impact, significant impact on the natural environment, or radiation that could affect health.

6.1.1 Measures, need for further research and assessment

Use cable lines to connect the wind farm to the electricity grid in order to reduce the negative impact on birds.

If possible, place the underground cable corridor as close as possible to existing power lines or other technical infrastructure corridors or in their immediate vicinity to avoid additional interference with the natural environment caused by artificial objects and to reduce the burden on the land through various protection zones.

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[299] Health Board Central Laboratory Physics Laboratory. Noise measurement report 6/4-6-2/1004. 29.09.2014.
[300] https://www.riigiteataja.ee/akt/163816
[301] Maves AS. 2016. Strategic environmental assessment of the thematic plan specifying the planning of Harju, Lääne and Pärnu counties, "Determination of the location of the Harku-Lihula-Sindi 330/110 kV power line route".
[302] Moorabool Shire Council. 2020. Comparison of 500 kV Overhead Lines with 500 kV Underground Cables.

Avoid overlapping of power cables and their protection zones with protected natural objects.

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Annexes

The annexes are presented as separate files.

Annex 1 – Noise, including low-frequency noise modeling reports

Annex 2 – Shading modeling reports

Annex 3 – Visibility analysis and visualizations

Annex 4 – Report on the bat and green network survey (for internal use)

Annex 5 – Bird survey drawings and background data on bird survey methodology (for internal use)

Annex 6 – Analysis of the visual impact of the Tõrva municipality special plan on cultural monuments

Annex 7 – Report on summer bird observations in the Holdre wind farm area covered by the Tõrva municipality special plan for wind energy

Annex 8 – Assessment of the impact of the Holdre wind farm on surface water and groundwater