FICHTNER

Executive Summaries

Based on Updated ESIA

Wind Farm Bogdanci - Phase II Project

Client: Akcionersko drushtvo za proizvodstvo na elektrichna energija ELEKTRANI NA SEVERNA MAKEDONIJA
(AD ESM – SKOPJE)

ENGINEERING CONSULTING

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

AD	Akcionersko drushtvo (Joint Stock Company)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung/ German Federal Ministry for Economic Cooperation and Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon dioxide
COVID-19	Coronavirus Disease 2019
DEG	Department for Electricity Generation
DSO	Distribution System Operator
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESM	Elektrani na Severna Makedonija
ESMMP	Environmental and Social Management and Monitoring Plan
EVN	EVN Distribution System Operator
GM	Grievance Mechanism
HSE	Health, Safety and Environment
ID	Identity Document
IFI	International Financial Institution
ILO	International Labour Organization
IPA	Important Plant Area
JSC	Joint Stock Company
KfW	Kreditanstalt für Wiederaufbau (KfW Development Bank)
MoEPP	Ministry of Environment and Physical Planning
MW	Megawatt
NGO	Non-Governmental Organization
NTS	Non-Technical Summary
PIU	Project Implementation Unit
PPE	Personal Protective Equipment
PS	Performance Standard
PS1	IFC Performance Standard 1
PS2	IFC Performance Standard 2
RES	Renewable Energy Sources
RNM	Republic of North Macedonia
SCADA	Supervisory Control and Data Acquisition
SEP	Stakeholder Engagement Plan
TES	Technical Executive Summary
tCO_2	Tonnes of carbon dioxide
UTM	Universal Transverse Mercator
WB	World Bank
WBG	World Bank Group
WGS84	World Geodetic System 1984
WP	Wind Park
WBP2	Wind Park Bogdanci - Phase II
WTG	Wind Turbine Generator
kV	Kilovolt
m.a.s.l	Metres above sea level

Non-Technical Executive Summary

Non-Technical Executive Summary

The Wind Park (WP) Bogdanci - Phase II Project (hereafter "the Project") represents an extension of the existing wind park in the Municipality of Bogdanci, located in the south-eastern part of Republic of North Macedonia. The Project, owned by AD ESM, will add four (4) new wind turbines and supporting infrastructure, in order to produce clean, renewable electricity. This development is part of the country's efforts to increase its share of renewable energy, reduce greenhouse gas emissions, and strengthen energy security. At the same time, the Project will contribute towards AD ESM's green transition, producing green electricity for the citizens and protecting the environment and the communities.

The Project will generate enough green energy to supply approximately six thousand (6,000) households. Therefore, it will help Republic of North Macedonia meet its climate and energy goals and reduce reliance on fossil fuels and electricity imports. The additional generation capacity will also cut carbon dioxide emissions by about thirty-five thousand (40,000) tonnes each year, making a significant contribution to climate change mitigation.

The new wind turbines will be installed in the Mamino area, east-northeast of the settlement of Prdejci and north of the settlements of Bogdanci and Gjavato. This location was chosen because it offers strong and consistent wind resources, it is situated away from populated areas, and has low environmental sensitivity. The Site mostly consists of open land and shrubs, which helps avoid conflicts with current land use and limits possible effects on local communities and nature.

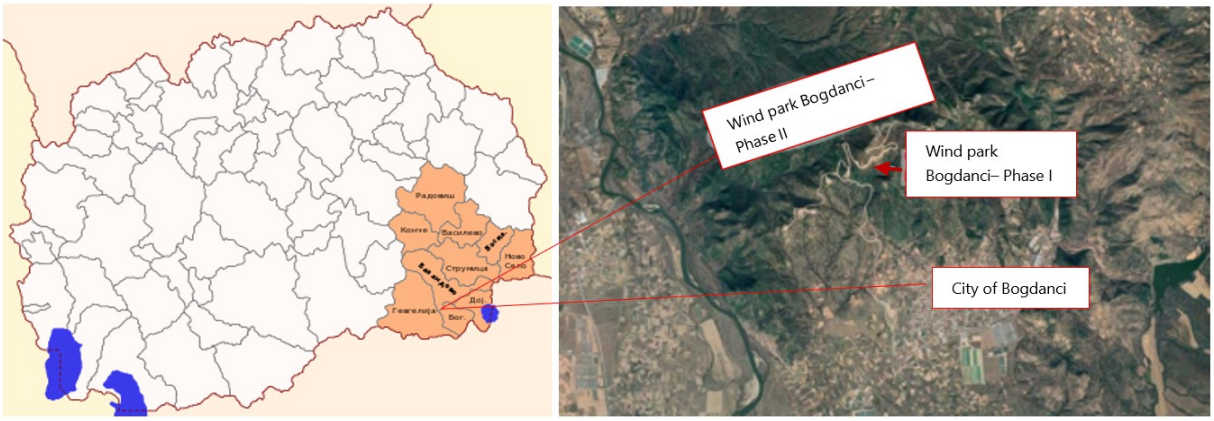

Figure 1: Location of the Municipality of Bogdanci, City of Bogdanci, Windpark Bogdanci - Phase I and Windpark Bogdanci - Phase II Project

The Project will include the geotechnical investigations, preparation of main design, manufacturing of wind turbine foundations, supply, erection, installation, commissioning and testing of wind turbines, as well as civil works and electrical works, including construction of internal access roads, refurbishment of the existing asphalt access road, crane platforms and hardstands, internal cable network (MV cables and fibre optic cables), extension of the 20 kV Switchgear, SCADA (MySite 360 and Omnivise) connection to the existing substation, and temporary facilities for workers and equipment. Once operational, the wind park will operate for approximately twenty 20 years. After this time, the wind turbines will be removed and the land will be restored to its original condition.

Developing the Wind Park brings many benefits, but it also requires careful management of environmental and social impacts. During the construction phase, activities such as excavation and transportation may

generate dust and short-term noise emissions. These effects will be temporary and controlled through measures like watering roads and scheduling noisy works at appropriate times (only during daytime). The Project area includes a rare plant species, *Astragalus physocalyx* (bladder vetch), which will be protected by avoiding sensitive areas and supervision during works by the Engineer. Birds and bats may face collision risks during the operational phase, so the Project will apply measures such as turbine shutdowns during migration periods and continuous monitoring to minimize harm. Traffic safety will be managed through clear signage and traffic plans, and cultural heritage will be safeguarded by avoiding archaeological sites and applying a Chance Finds Procedure if artefacts are discovered.

Public consultations have already taken place, and no major concerns were raised. Communities emphasized the importance of maintaining access for hunting and recreation, which will continue after construction. A grievance mechanism will remain available throughout the Project to ensure that any concerns from residents or workers are addressed promptly and fairly.

The Wind Park Bogdanci Phase II is currently in the implementation phase. Geotechnical surveys have been undertaken and wind turbine installation is expected in mid-2027. The Project aims to minimize environmental and social impacts, while providing significant benefits for North Macedonia's clean energy transition. With the planned mitigation and monitoring measures, the Wind Park can operate safely and reliably.

1 Introduction

This Technical Executive Summary (TES) presents the main findings of the Environmental and Social Impact Assessment (ESIA) prepared for the Wind Park Bogdanci Phase II ("the Project"), which represents an extension of the existing Wind Park Bogdanci located in the Municipality of Bogdanci, in the southeastern part of Republic of North Macedonia. The purpose of the TES is to provide a clear and understandable overview of the Project, the context for its development, and the key environmental and social considerations assessed in accordance with the national legislation and international best practices.

The goal of the Project is to increase the production of clean, renewable energy from wind as a renewable source of energy, strengthen the national energy security, contribute for the reduction of greenhouse gases emissions and foster the just transition process, by phasing out coal and addressing persistent air and health pollution challenges. By developing a larger renewable energy portfolio production, the Project supports national climate and energy goals and reduces dependence on fossil fuels and both coal and electricity imports.

The ESIA has been carried out in line with the national Law on Environment of the Republic of North Macedonia (Official Gazette No. 53/2005 and subsequent amendments), relevant by-laws, and ESHS requirements of International Financial Institutions, including the KfW Sustainability Guideline, IFC Performance Standards, and the World Bank Environmental, Health and Safety Guidelines. The purpose of the ESIA is to evaluate how the construction, operation, and future decommissioning of the additional wind turbines and associated infrastructure may affect:

- the physical environment (air, soil, water, noise, climate),
- biodiversity and habitats,
- nearby settlements, land use, and local activities,
- cultural heritage,
- community health and safety, and
- workers' health, safety, and labour conditions.

As part of the ESIA process, specialists reviewed existing environmental and social data, carried out field surveys and site assessments, analyzed technical information, and engaged with relevant authorities, municipalities, the community and other stakeholders. These findings were used to refine the Project layout, identify sensitive environmental and social receptors, and develop appropriate mitigation and monitoring measures in the Environmental and Social Management and Monitoring Plan (ESMMP).

2 Project Overview

The Project comprises the installation of four (4) new wind turbine generators (WTGs or "turbines") and includes geotechnical investigations, preparation of the main design, manufacturing of wind turbine foundations, supply, erection, installation, commissioning, and testing of the turbines. The scope also covers associated civil and electrical works, including construction of internal access roads, refurbishment of the existing asphalt access road, crane platforms and hardstands, underground cables, internal cable network (MV and fibre optic cables), extension of the 20 kV switchgear, and SCADA connection (MySite 360 and Omnivise) to the existing substation.

Temporary construction infrastructure will include access roads, material laydown areas, storage zones, and facilities for workers and equipment during the construction phase.

Once operational, the wind park is expected to operate for twenty years. At the end of its operational life, the wind turbines will be decommissioned and the land restored to its original condition.

The developer is the utility Akcionersko drushtvo za proizvodstvo na elektrichna energija ELEKTRANI NA SEVERNA MAKEDONIJA, vo drzhavna sopstvenost, Skopje (hereafter "AD ESM").

The total installed capacity of the Project goes up to 14.6 MW (overall capacity based on the warranted power curve of the WTGs).

The Project is being implemented through 2 (two) Tenders:

Tender 1: Wind Energy Converters, which includes the Detailed Design, manufacturing, supply, installation and testing of four (4) wind turbines. Tender 2: Balance of Plant, includes all civil works and electrical works: internal roads, refurbishment of the existing asphalt access road, crane platforms and hardstands, etc.

In terms of the order of implementation, Tender 2 related activities shall commence first and during their phasing out, Tender 1 activities will phase in.

The Turbine Supply Agreement between AD ESM and the Tender 1 Contractor was signed on 28 May 2025. The Contract for Engineering, Procurement, Construction and Supply and Construction of the Project, for Tender 2: Balance of Plant was signed between AD ESM and the Tender 2 Contractor on 9 July 2025.

AD ESM – Skopje is supported by the Implementation Consultant (IC) during the Project implementation, including supervision of works.

The Project is financed through a loan provided by the KfW Development Bank, backed by a sovereign guarantee. The Loan Agreement and the Separate Agreement for the Project were signed on 13 December 2018. Additionally, a WBIF investment grant for the Project has been provided, for which a Grant Agreement was signed on 18 March 2024. Additional loan financing for the Project, was provided on 19 December 2024, when a Loan Agreement was signed between KfW and AD ESM.

The turbine layout has been preliminarily defined based on wind resource assessments, terrain conditions, distance from settlements, environmental sensitivities, and applicable planning requirements. The final layout will be confirmed at a later stage. The design approach aims to optimize energy production while minimizing environmental and social impacts. The additional generation capacity of the Project will contribute to North Macedonia's renewable energy targets and reduce reliance on fossil fuels. When

operational, the new turbines are expected to produce enough clean electricity to supply approximately 6,000 households and reduce annual CO_2 emissions by around 40,000 tonnes.

The wind park will operate for an estimated twenty years, after which decommissioning will occur, including removal of turbines and restoration of the site.

Overall, the Project represents an important contribution to national renewable energy development, climate action, and regional energy security, while being designed to minimize environmental and social impacts through careful site selection, engineering, and environmental management. The benefits of implementation of the Project are the following: renewable, green energy provided to approximately 6,000 households, annual reduction of approximately 40,000 tonnes of CO_2, an increase in AD ESM's share of generation capacities from RES in its portfolio, contributions to national energy and environmental goals, and local economic growth and development.

2.1 Wind Farm Layout

The wind farm layout was defined considering wind resource availability, terrain, archaeological constraints, and transport requirements. Several turbine layouts and technology options were compared, and the final 2020 design was selected because it avoids archaeological areas, minimizes land disturbance, and offers the best technical performance. The key design parameters are:

- Number of wind turbine generators (WTG): 4
- Total capacity of the Project: 14.6 MW
- Rotor diameter: 132 m
- Wind class: IEC IIA

The overall layout is presented in Figure 2, with Phase II turbines indicated alongside the existing Phase I wind farm.

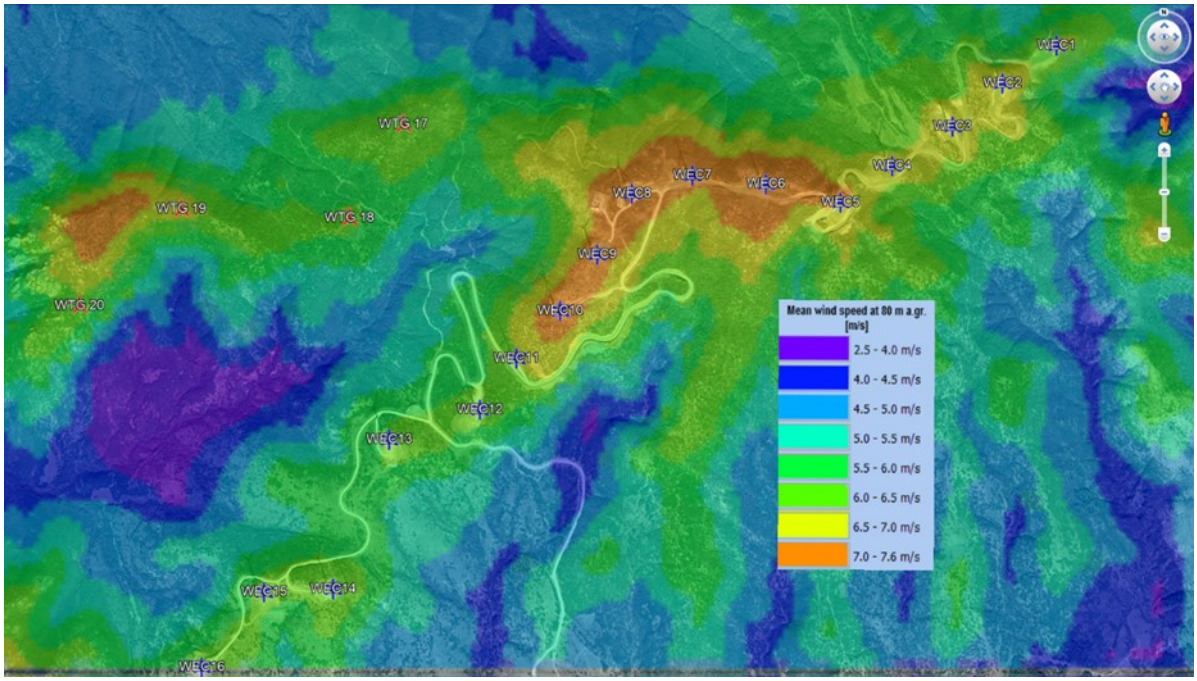

Figure 2: Wind Farm layout. Wind turbines 17 to 20 represent Windpark Bogdanci - Phase II (the Project); Wind turbines 1 to 16 belong to the existing wind farm (Windpark Bogdanci Phase I)

2.2 Main and Associated Facilities

The Project includes:

- Four (4) wind turbines and foundations
- Internal medium-voltage (20 kV) cable network and optical cables
- Extension of the existing 20 kV switchgear
- SCADA system extension
- Internal access roads and crane platforms
- Refurbishment of the existing asphalt access road
- Mobile diesel generator for backup supply
- Connection to the existing Bogdanci 20/110 kV substation and Bogdanci–Valandovo 110 kV transmission line

2.3 Grid Connection

Grid connection will be achieved through the existing Phase I electrical infrastructure, with the MV cables placed in trenches alongside internal roads (see

Figure 3). A mobile diesel generator will provide backup power during outages.

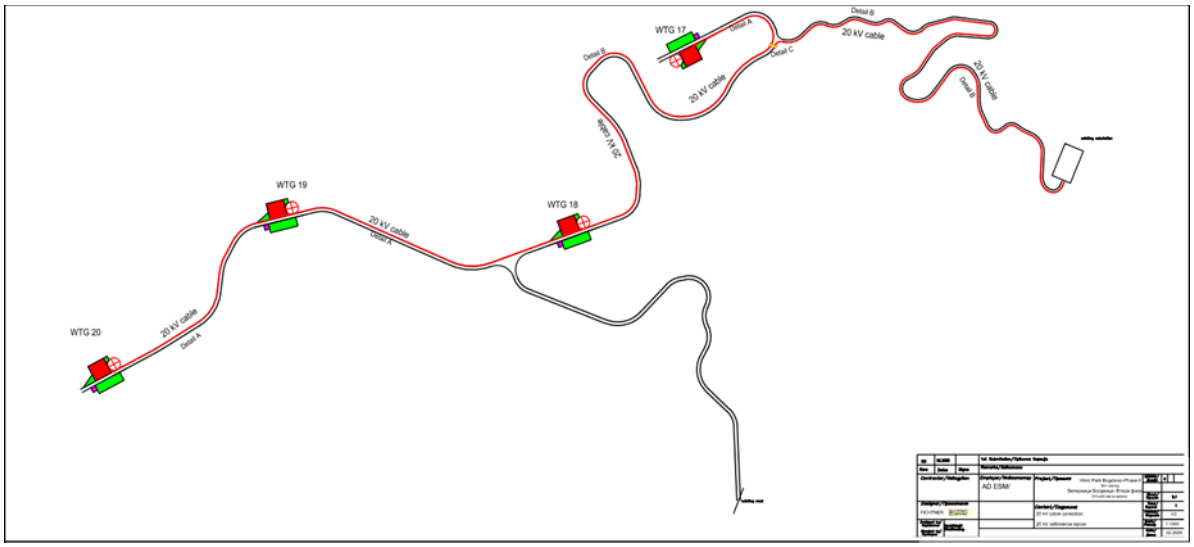

Figure 3: 20kV cable connection layout(source Conceptual Design)

2.4 Environmental permits and social studies

The Project is being developed in accordance with the national legislation of the Republic of North Macedonia and the requirements of IFIs.

Under the Law on Environment and the Decree on EIA Projects, wind farms are placed in Annex II, for which the Macedonian Ministry of Environment and Physical Planning (MoEPP) determines whether an EIA is required.

The timeline of activities is the following:

- EIA for Wind Park Bogdanci – Phase I
  - A full EIA Study was prepared in 2010 and approved by MoEPP in January 2011 (Decision No. 11-119/2).
- EIA procedure for Wind Park Bogdanci - Phase II
  - In June 2019, AD ESM submitted a request for extension of the earlier approval.
  - The MoEPP required submission of a Notification of Intention for the Phase II development.
  - AD ESM submitted the Notification on 16 October 2019.
  - The MoEPP issued a Decision on 8 November 2019 requiring preparation of an Environmental Protection Elaborate (EIA Report), instead of a full EIA.
  - AD ESM submitted the Elaborate on 25 February 2020.
  - The MoEPP issued the Decision for acceptance on 19 March 2020 (UP1-11/4-291/2020). This Decision refers to an extension layout of four (4) to six (6) wind turbines with an overall capacity of 13.2 MW.
  - Economy of scale reasons lead to considering the use of less wind turbines (three (3) in total) with greater individual rated power.
  - AD ESM requested a decision from MoEPP for the 3-turbines alternative layout.
  - The MoEPP issued the Decision for approval of the updated Elaborate for Environmental Protection on 17 March 2022 (UP1-11/4-257/2022). This act refers to a 3-turbines layout with an overall capacity from 13,2 MW up to 15 MW.
  - Due to technological/commercial reasons, a final layout for four (4) wind turbines has been adopted.
  - According to consultations undertaken with the responsible authorities, both EIA Elaborates and respective Decisions for acceptance are valid and have no expiry date.

The Site's environmental documentation and management at the pre-construction, construction and operation stages assure consideration of impacts of all turbines finally considered during all phases of the works.

The development of the Project requires a series of administrative steps and environmental permits according to the national legislation, details are provided below.:.

2.5 Permits and Approvals required for the Project

The Project has obtained environmental approval through accepted Environmental Protection Elaborates (2020 and 2022 updates). Additional consents from relevant authorities are being secured. Grid connection procedures and construction-related permits, including the Authorization for Construction and the Construction Permit, are ongoing and will be obtained prior to implementation.

.

3 Project Location

The Project is an extension of the existing Wind Park Bogdanci located in the Municipality of Bogdanci in southeastern North Macedonia. The Project area is situated near the settlements of Prdejci, Gjavato, and Bogdanci, within a region characterized by open terrain and favorable wind conditions. The general location of the Municipality of Bogdanci and the Phase I and Phase II wind park sites is shown in Figure 5.

Figure 4: Location of the Municipality of Bogdanci, City of Bogdanci, WP Bogdanci phase I and WP Bogdanci phase II

The new wind turbines will be installed in the Mamino area, east-northeast of the settlement of Prdejci and north of the villages of Bogdanci and Gjavato. The nearby settlements and their distances from the Project site are illustrated in Figure 6 and summarized in Table 1.

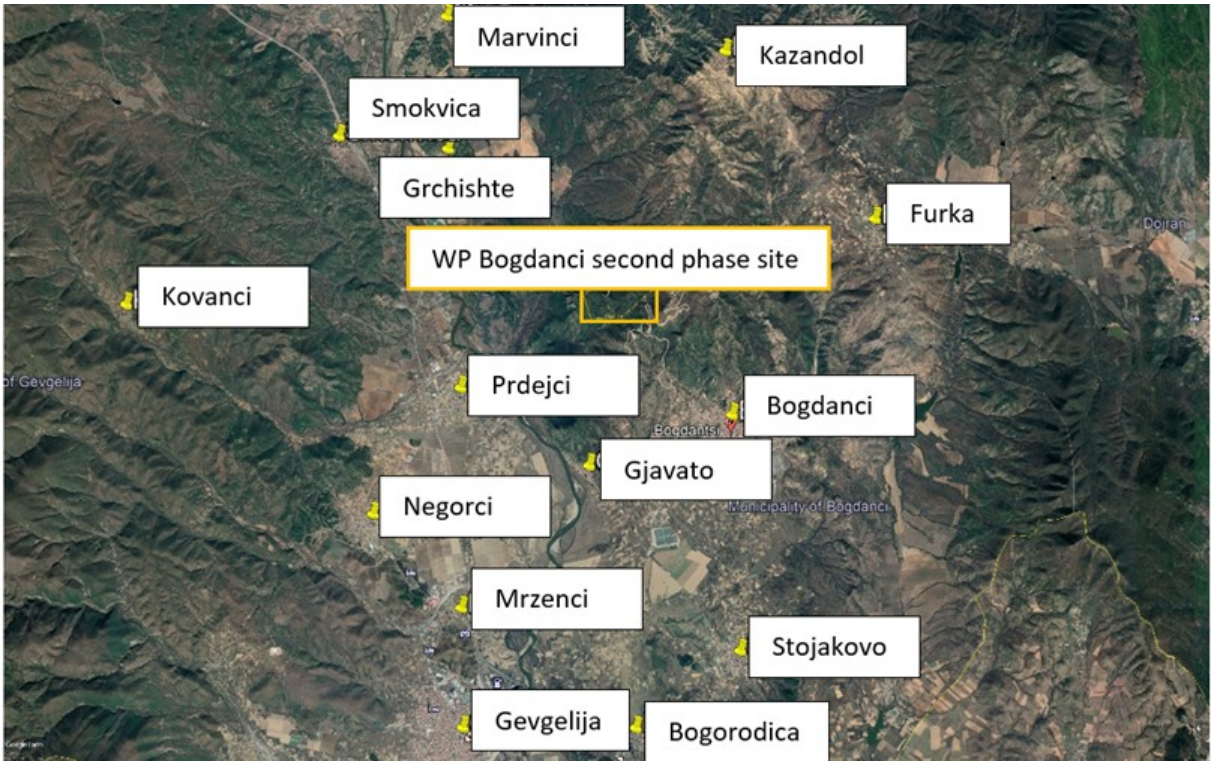

Figure 5: Neighboring settlements to the Project site

Table 1: Distances of the settlements to the Project site

Settlement	Distance from the Project site
Marvinci	7.5 km north
Kazandol	6.4 km north east
Smokvica	7.0 km north west
Grchishte	5.0 km north west
Kovanci	11.0 km west
Furka	6.4 km east
Prdejci	3.5 km south west
Bogdanci	3.7 km south east
Gjavato	3.4 km south
Negorci	6.5 km south west
Mrzenci	7.0 km south west
Stojakovo	8.5 km south east
Gevgelija	9.5 km south
Bogorodica	9.3 km south

The landscape across the Project area is dominated by open shrubland, sparse vegetation, and gently undulating hilly terrain, typical of the broader Bogdanci region. No sensitive community facilities, critical infrastructure, or vulnerable structures are located within or immediately adjacent to the Project footprint. The topographical conditions and land characteristics provide favorable conditions for wind park development while ensuring limited interference with existing land uses.

The assessment found that the Mamino area is the most suitable site because it has strong wind resources, sits next to the existing Wind Park Bogdanci – Phase I, requires little new grid infrastructure, and has low ecological sensitivity.

4 Baseline Environmental and Social Conditions

The key physical, biological, and social characteristics of the Project area are summarized below. The information is based on baseline surveys and assessments presented in the ESIA, including geology, soil, climate, biodiversity, water resources, noise, and local socio-economic conditions.

The environmental and social baseline conditions around The Project are generally suitable for wind-energy development, with:

- low ecological sensitivity within the Project footprint,
- no protected areas on-site,
- manageable physical constraints, and
- limited potential for community impact.

Baseline studies, including biodiversity surveys and noise monitoring, provide a strong foundation for assessing and managing Project impacts in accordance with national legislation and international requirements.

4.1 Physical Environment

Geology and Soil: The Project site is located within the hilly Mamino area and belongs to the Vardar geotectonic zone, a region characterized by ancient metamorphic and magmatic rock formations. The dominant rock type is biotite gneiss, with smaller occurrences of amphibolite-pyroxenite, gneiss variants, and quartz monzonites. The wider geological structure is stable and suitable for wind turbine foundations.

Soils in the area include cinnamon soils, cambisols, and local pockets of colluvial and alluvial deposits. These soils are typical of the surrounding shrubland and oak-forest ecosystems. Soil erosion is present in some steep areas, especially along existing access roads, requiring erosion-control measures during construction.

Climate and Meteorology: The Project area has a sub-Mediterranean climate, with warm, dry summers and mild winters. Average annual temperatures are around 14°C, with July as the warmest month and January the coldest. Annual rainfall ranges from 600 to 700 mm, concentrated in winter. Two major wind patterns influence the site:

- Vardarec – strong north–south winds, frequent year-round
- Jugo – warm winds from the southeast

The wind-pattern analysis for the area shows strong and consistent winds, confirming its suitability for wind-energy generation.

Hydrology: The Project area contains no permanent rivers or streams. Most smaller watercourses are torrential and active only during heavy rain. The larger Vardar River, located several kilometers away, is the dominant hydrological feature in the region.

Groundwater is mainly found in alluvial deposits closer to Gevgelija and Bogdanci and is not expected to be affected by the Project due to the elevated terrain and distance from water-bearing layers.

Seismicity: According to national seismic maps, the site lies within the Valandovo epicentral area, which is part of the Vardar seismic zone. The region is considered seismically active, as is typical for North Macedonia.

Wind turbines and related structures will be designed according to international seismic standards to ensure structural safety.

Noise: Baseline noise monitoring conducted in February 2020 shows:

- 44–45 dB(A) daytime levels
- 41–42 dB(A) nighttime levels

These values comply with national and international (World Bank Group) guidelines and represent typical background conditions for a rural area near an existing wind park.

4.2 Biological Environment

Habitats and Flora: The Project area is dominated by shrublands and mixed oak forests, typical of sub-Mediterranean ecosystems. The main habitat types are:

- Kermes oak shrublands
- Deciduous oak-hornbeam forests
- Riparian vegetation (in stream valleys)

Baseline botanical surveys identified several plant species, including some considered rare or locally significant, such as Astragalus physocalyx, a priority species whose locations are mapped below. Mitigation measures are included in the ESIA to avoid or minimize impacts on sensitive flora.

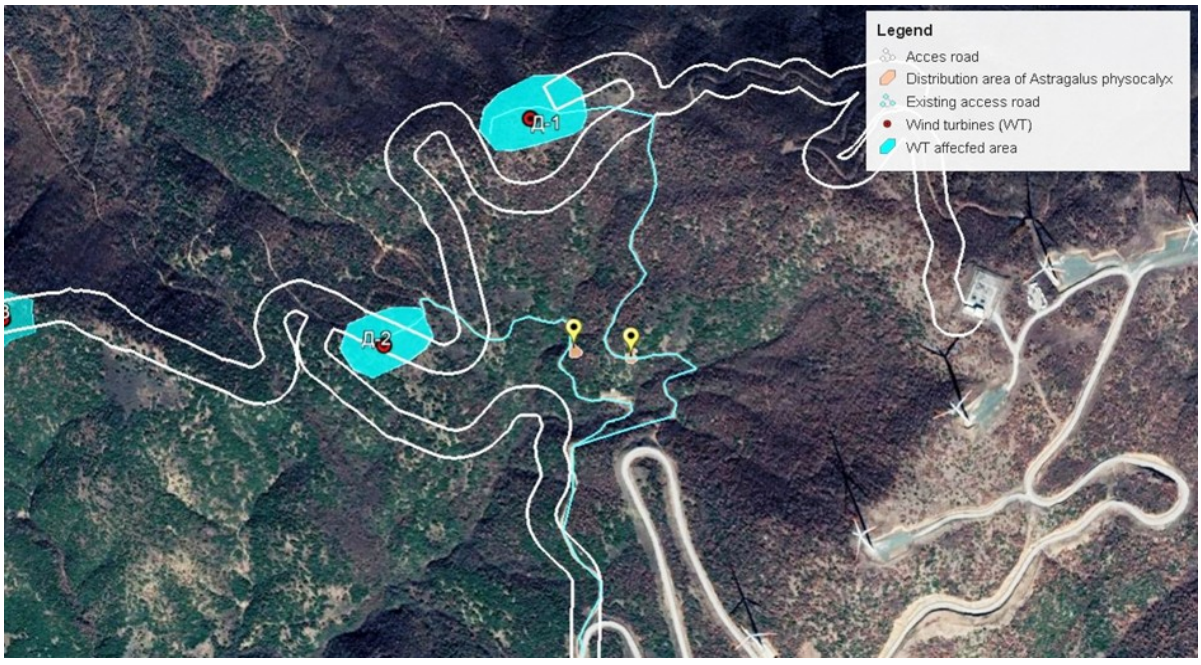

Figure 6: Two populations of Astragalus physocalyxin the Project area.

Figure 7: *Detailed picture of distribution area of Astragalus physocalix in the corridor area. Existing access road No. 1 intersecting the first population area while the existing access road No. 2 passes in close proximity to the second population area.*

Fauna: Baseline faunal surveys recorded a diversity of species typical for the region:

- Terrestrial mammals: fox, hare, hedgehog, wild cat
- Reptiles: Hermann's tortoise, Greek tortoise
- Amphibians: yellow-bellied toad

Birds and bats are key considerations for wind park projects. Surveys recorded:

- 76 bird species (including migratory raptors), including the near-threatened (NT)[1] species Rock Partridge (*Alectoris graeca)* and Hen Harrier (*Circus cyaneus*), the vulnerable (VU)[1] species European Turtle-dove (*Streptopelia turtur*), and the nationally strictly protected (SP) species European Honey-buzzard (*Pernis apivorus*) and Black Kite (*Milvus migrans*).
- 14 bat species, all protected under the Bern Convention, including the near-threatened (NT)[1] species Schreiber's Bent-wing Bat (*Miniopterus schreibersii*)

The ESIA includes additional monitoring and turbine-shutdown procedures to reduce collision risks.

Protected and Internationally Recognized Areas: No nationally protected areas lie within the Project footprint. Several internationally recognized areas are located in the wider region, including:

- Important Plant Area (IPA) Bogdanci (~4.5 km away)
- Emerald Site "Churchulum–Paljurci" (~4.5 km away) – future Natura 2000 site

With proper mitigation measures during construction, no significant adverse impacts on these areas are expected.

[1] According to the IUCN Red List of Threatened Species, available at www.iucnredlist.org

4.3 Human and Social Environment

Communities and Land Use: The Project is located in the Municipality of Bogdanci. The surrounding area contains small rural settlements, agricultural lands, and open shrubland. The closest structures include a hunters' cottage and scattered agricultural plots.

Land within the Project boundary is state-owned, according to the national Cadastre. No land acquisition or physical displacement is expected.

Population and Socio-economic Conditions: The wider region is rural, with key economic activities including:

- agriculture and livestock
- transport and small manufacturing
- textile industry
- services and tourism (Valandovo, Dojran)

Employment levels vary, but Bogdanci and Gevgelija have higher employment rates than the national average.

The Project may support local employment during construction and operation but is not expected to create significant long-term population change.

Cultural Heritage: An archaeological site, Late-Ancient Castel Mamino, is located near the Project area (Figure 9). Early layout adjustments were made to avoid impacts, and the National Institute for the Protection of Cultural Monuments confirmed that the revised design does not threaten heritage sites.

A Chance Finds Procedure will be applied during construction.

Figure 8: Location of relevant archaeological site Late – ancient Castel Mamino and necropolis

5 Key Environmental and Social Impacts

The environmental and social impacts of the Project were assessed based on detailed baseline studies, field surveys, modelling exercises, and stakeholder inputs documented in the ESIA. These include biodiversity surveys, hydrological and geological analyses, cultural-heritage screening, noise and shadow-flicker modelling, public consultation, and socio-economic assessments.

The findings indicate that most potential impacts during construction, operation, and decommissioning are localized, short-term, and manageable, provided that the mitigation and monitoring measures outlined in the Environmental and Social Management and Monitoring Plan (ESMMP) are properly implemented. When these measures are applied, the Project is expected to operate with low to low-moderate residual impacts while delivering significant positive environmental and socio-economic benefits.

5.1 Environmental Impacts

5.1.1 Pre-Construction phase and Construction Phase

Construction activities include site preparation, foundation excavation, upgrading existing asphalt access roads, constructing new internal roads, laying underground cables, installing crane pads, and transporting large turbine components to the Site. These activities are conducted over a relatively short period of time, and are confined to clearly defined work areas.

Air Quality (Dust and Emissions): During construction, trucks, excavators, cranes, and other machinery will generate dust and exhaust emissions. Dust may become noticeable along access roads, excavation areas, and material stockpiles, particularly during dry and windy weather. Considering the relatively large distance to the nearest villages (between 3.4 km and 11.0 km), an impact on communities is mostly expected along the access roads. Exhaust emissions will come primarily from diesel engines used in machinery and transport vehicles.

These impacts are short-term, reversible, and generally expected to be low-moderate in magnitude. With standard practices such as water-spraying dusty areas, covering transported materials, and proper equipment maintenance, air-quality impacts can be effectively controlled.

Noise: Construction equipment, such as generators, cranes, trucks, and excavators, will generate temporary noise. Baseline noise measurements demonstrate that existing sound levels meet both national regulations and World Bank Group (WBG) limits. The closest receptor (a hunters' cottage) is located approximately 500 m from the proposed turbine locations; therefore, noise levels are not expected to exceed applicable thresholds.

Noise during construction is expected to be short-term, intermittent, and low-moderate in significance.

Soil, Geology and Groundwater: Excavation and earthworks may disturb soils, particularly along internal roads and turbine foundations. The movement of heavy machinery can cause soil compaction, while accidental spills of fuel, oil, or chemicals could contaminate soil if not properly handled.

The geological profile and groundwater depths indicate that groundwater is not expected to be encountered at foundation depths, limiting risks to underground water resources. *With proper waste*

disposal, spill-prevention measures, and good housekeeping, these impacts are expected to be moderate prior to mitigation and low afterward.

Surface Water: There are no permanent watercourses within the Phase II area. However, temporary runoff through small gullies can occur during heavy rainfall. Poor management of construction materials or accidental spills could result in pollution being carried out by runoff.

With drainage controls, erosion-prevention measures, and strict hazardous-materials handling, *impacts on surface water are expected to remain low to moderate*.

Biodiversity – Flora and Fauna

Flora:
The Project area consists mainly of shrubland habitats. A critically endangered plant species, Astragalus physocalyx, has been documented along certain existing asphalt access roads. Construction activities could affect this species through vegetation clearing, dust deposition, and habitat disturbance.

Therefore, strict avoidance measures, on-site botanist supervision, and dedicated monitoring programs are required. *For this species, impact magnitude is high, but residual impact is expected to become moderate when mitigation is applied*.

Fauna:
Construction may temporarily disturb mammals, reptiles, amphibians, and insects due to noise, increased vehicle movement, and human presence. Amphibians and reptiles using seasonal movement routes may be at higher risk if work overlaps with migration periods. The ESIA foresees, among others, that the reproductive sites of amphibians must be determined in the construction area in order to create buffer zones (where, for example, no waste water can enter). These and other measures are to be considered in a Plan on Biodiversity Protection to be prepared including preventive and mitigating measures.

Overall impacts on fauna are expected to be moderate, and expected to decreas to low after mitigation.

Birds and Bats:
During construction, birds and bats may experience temporary disturbance due to increased human activity and machinery noise. Baseline studies (Annex 1) confirm that no major roosts, nesting areas, or high-value foraging sites are located within the immediate footprint.

Accordingly, impacts are expected to be low to moderate and limited to the construction period.

5.1.2 Operational Phase

Once operational, the wind farm will generate renewable electricity with minimal ongoing environmental impacts. Most operational impacts are long-term but of low or low-moderate significance.

Air Quality and Climate: Wind turbines produce no emissions during normal operation. A backup diesel generator may cause occasional emissions, but these are minor.

The Project provides important climate benefits by avoiding an estimated 40,000 tCO_2 per year, or roughly 800,000 tCO_2 over 20 years.

Noise: Operational noise modelling shows that daytime noise levels comply with WBG guidelines. Night-time exceedances are possible if the hunters' cottage becomes a regularly occupied building; these can be mitigated by operating turbines in noise-reduced mode (N3). *Residual impact is expected to be low*.

Soil, Groundwater, and Surface Water: Routine operation presents minimal risk. Potential impacts relate mainly to transformer oil leakage at substations. Oil leakage at the turbine nacelle, or in the turbine hub, can be identified during regular inspections and can be mitigated before coming in contact with the environment.

With containment structures (110% capacity), spill kits, and proper maintenance, *impacts are expected to remain low*.

Biodiversity:

Flora and Fauna:
During operation, the main long-term ecological concerns include:

- increased accessibility to natural areas,
- habitat fragmentation from roads,
- occasional disturbance by maintenance crews.

Astragalus physocalyx remains the primary sensitive species and requires periodic monitoring. *Residual impacts are expected to be low*.

Birds and Bats:
Unlike the construction phase, the operation phase introduces a collision risk for birds and bats. Risk levels vary by species, season, and weather. Key mitigation measures include:

- operational curtailment during peak bird migration,
- blade feathering,
- increased turbine cut-in speeds to avoid collision with bats,
- two-year post-construction monitoring.

Residual impacts are expected to be low to moderate.

5.2 Social Impacts

Land Use and Land Acquisition: No private land is located within the Project footprint. The land is state owned, and no physical or economic displacement will occur. No residential properties or active agricultural land lie within turbine locations.

Livelihoods and Resource Use: Temporary disturbance to grazing, plant collection, and informal land uses may occur during construction. *These impacts are short-term and reversible*, with reinstatement planned after works.

Employment and Local Economy:

The Project will provide *several socio-economic benefits*:

- creation of temporary construction jobs in construction work and a few permanent jobs during the operation and maintenance (plant monitoring, equipment inspections and repair services),
- opportunities for local procurement,
- income opportunity for the local business community in Bogdanci,
- indirect employment in services (food, transport, accommodation),
- development of technical skills in renewable sources of energy.

Community Health and Safety: Construction traffic, particularly heavy component transport, poses temporary safety risks along public roads and near nearby settlements (Bogdanci, Prdejci, Gjavato). Workers' presence may also raise minor concerns among communities. During operation, *public risks are minimal* due to restricted access and turbine safety systems.

With traffic management plans, signage, fencing, and ongoing communication with residents, these impacts are expected to decrease to *low significance*.

Potential risks during operation include:

- unauthorized public access,
- electrical hazards,
- rare events such as blade throw or ice shedding.

The ESIA confirms these risks are extremely low, and with guarded access control, signage, emergency preparedness, and safe turbine design, *residual impacts are expected to remain low*.

Cultural Heritage: The archaeological site "Mamino" lies close to the Project footprint. The turbine layout has been revised to avoid this sensitive area. Chance-Find Procedures will ensure immediate reporting and protection if cultural artefacts are discovered during earthworks. *Residual impact is expected to be low*.

Transport of Abnormal Loads: Turbine components such as blades and tower sections require specialized transport from the Dojran border crossing to Bogdanci. Temporary disruptions may occur.

A dedicated Transport Management Plan, coordination with authorities, and public notifications are expected to reduce impacts to *low significance*.

Visual Aspects: The only sensitive receptor is a hunters' cottage. *Visual impacts are expected to be moderate* but acceptable due to the remote landscape.

Shadow Flicker: Shadow flicker modelling indicates exceedance of WBG recommended limits under worst-case conditions for the hunters' cottage (only sensitive receptor). Automatic shadow-flicker control systems will address this, ensuring compliance. *Residual impact is expected to be low*.

Aviation Safety and Electromagnetic Interference: The Project lies far from major airports and outside major radio-communication pathways. With standard aviation warning lights, *no significant impacts are expected*.

Community Concerns and Engagement: Consultations revealed no significant objections. Communities expressed the importance of continued access for recreation and hunting, which will be maintained after construction.

5.3 Decommissioning Phase

Decommissioning is foreseen to take place after approximately 20 years of operation. Impacts will resemble those experienced during construction:

- noise and dust,
- temporary disturbance to flora and fauna,
- waste generation,
- transportation of large components.

These impacts are short-term, reversible, and can be effectively managed through a Decommissioning Plan to be prepared prior to the start of dismantling works.

5.4 Positive Impacts

The Project provides multiple long-term benefits:

- Clean Renewable Energy,
- Generating electricity for ~6,000 households, reducing reliance on fossil fuels,
- Climate Change Mitigation,
- Avoiding ~40,000 tonnes of CO_2 annually, a major contribution to national climate goals,
- Energy Security,
- Increasing the renewable share of AD ESM's generation by ~3%,
- Local Employment and Economic Growth,
- Supporting jobs during construction and operation, boosting local services and supply chains,
- Infrastructure Improvements,
- Refurbished access roads and utility upgrades benefit both the Project and local users.

5.5 Cumulative Impacts

Cumulative impacts consider the combined effects of the Project with the existing Wind Park Bogdanci Phase I. Areas of potential overlap include:

- bird migration,
- landscape/visual character,
- shadow flicker,
- noise.

Modelling demonstrates that cumulative impacts remain within acceptable limits, and *residual effects are expected to be low with mitigation.*

5.6 Transboundary Impacts

The Project is located near the border with Greece. Potential transboundary considerations include:

- bird migration through the Vardar valley and Lake Dojran corridors,
- regional greenhouse-gas emissions.

Bird monitoring confirms that most migratory species fly above rotor height, reducing collision potential. Meanwhile, the Project provides positive transboundary climate benefits by reducing CO_2 emissions by ~40,000 tonnes/year. *Residual impacts are expected to be low*.

6 Mitigation Measures

To ensure that the Project is developed in an environmentally sound and socially responsible manner, a comprehensive Environmental and Social Management and Monitoring Plan (ESMMP) has been prepared. The ESMMP outlines practical measures to avoid, reduce, or manage potential impacts throughout construction, operation, and decommissioning.

Avoidance and Design Measures: Careful turbine placement to avoid sensitive habitats, including areas supporting *Astragalus physocalyx* and wildlife movement corridors. Adjusted turbine layout and micro-siting to avoid archaeological heritage ("Mamino") and comply with cultural heritage protection requirements.

Biodiversity Protection: Measures to reduce habitat disturbance, including controlled access, minimizing vegetation clearance, and restoring disturbed areas. Measures to prevent and mitigate impacts on flora (including the nationally protected species *Astragalus physocalix*), amphibians, reptilians, terrestrial mammals, birds, and bats.

Construction Environmental Controls: Dust and noise control, including watering of roads, proper equipment maintenance, and scheduling noisy works away from sensitive times. Soil erosion and drainage management, using temporary channels, sediment traps, and protection of natural water flow paths. Waste and hazardous material management, including safe storage, spill-prevention systems, and use of authorized waste contractors.

Traffic and Community Safety: Traffic Management Plan to regulate construction vehicles, enforce speed limits, and minimize disturbance near Bogdanci, Prdejci, and Gjavato. Warning signs, fencing, and access restrictions to prevent accidents involving community members.

Workers Health, Safety and Conduct: A strict Health and Safety Plan, including training, personal protection equipment (PPE) requirements, emergency procedures, and safe work systems. Worker Code of Conduct to prevent misconduct, protect community relations, and ensure respectful behavior.

Land Restoration and Site Reinstatement: Replanting and stabilization of disturbed areas after construction. Restoration of access routes and reinstatement of temporary work zones.

Operational Mitigation Measures: Noise-reduced operational modes if needed, particularly for the nearby hunting cottage. Shadow-flicker control systems that automatically shut down turbines when guideline thresholds may be exceeded. Regular maintenance of turbines and transformers to prevent leaks or equipment failures. Measures to mitigate impact on birds and bats include: turbine curtailment during peak bird migration periods, blade feathering at low wind speeds, increased cut-in speeds during periods of high bat activity to avoid collision with bats, and at least two years of post-construction monitoring to assess impacts and inform any necessary adaptive management measures.

Emergency Preparedness and Response: Site-specific Emergency Response Plans for fire, hazardous materials, accidents, and severe weather. Coordination with local authorities, emergency services, and communities.

Ongoing Stakeholder Engagement: Continuous communication with local communities about Project activities, safety measures, and environmental performance. A transparent Grievance Mechanism enabling residents to submit comments, concerns, or complaints and receive timely responses.

7 Monitoring and Reporting

To ensure that the Project is constructed and operated in accordance with environmental and social standards, a detailed Environmental and Social Monitoring Programme forms part of the ESMMP. Monitoring will verify that mitigation measures are effectively implemented, and that environmental and social performance remains within national and international requirements.

Environmental Monitoring

Bird and Bat Monitoring:

Bird and bat monitoring programs before and after construction to track activity, detect risks, and guide operational measures such as temporary shutdowns during migration or high-risk periods. These will record bird activity, flight behavior, and potential collisions.

- Bat monitoring (including acoustic detectors on turbines) will track activity levels and guide operational mitigation such as turbine curtailment.
- Mortality surveys will be carried out around each turbine at regular intervals.

Noise Monitoring:

Noise levels will be measured at identified receptor locations, including the nearby hunting cottage, to confirm compliance with national and World Bank/IFC limits. Additional checks will be conducted if turbine maintenance or equipment upgrades occur.

Surface Water, Soil, and Pollution Control:

Routine inspections will ensure proper management of hazardous materials, spill-prevention systems, drainage controls, and erosion protection measures. Any spills or incidents will be recorded, cleaned, and reported.

Waste Management Monitoring:

Regular inspections of waste storage areas and collection practices. Verification that all waste, including hazardous waste, is handled by licensed contractors.

Social Monitoring

Worker Health and Safety:

Ongoing monitoring of compliance with the HSE Plan, including use of PPE, safe-work procedures, and emergency preparedness. Recording and investigation of incidents, near-misses, and safety observations.

Community Health and Safety:

Monitoring of traffic behaviour, access restrictions, and signage near populated areas. Follow-up on community grievances and feedback through the Project's Grievance Mechanism.

Compliance and Reporting

ESMMP Compliance Reporting:

Regular reporting to national authorities, the Project Owner (ESM), and, where applicable, international lenders (e.g., KfW, World Bank/IFC). Reports will document compliance with mitigation measures, monitoring results, and any corrective actions taken.

Environmental and Social Performance Reports:
Periodic summaries of environmental and social performance will be prepared. Where required by lenders or national regulations, these reports will be publicly disclosed to ensure transparency and continued community engagement.

8 Stakeholder Engagement

Stakeholder engagement for the Project is an ongoing and inclusive process carried out throughout the entire Project lifecycle. The purpose is to ensure that all individuals, groups, and institutions who are affected by the Project, or who have an interest in it, receive timely, clear information and have meaningful opportunities to express their views.

Stakeholders include Project-affected people and communities, as well as interested parties such as local authorities, NGOs, public institutions, and any other groups who may influence or be influenced by the Project.

Stakeholder engagement for the Project has been undertaken in accordance with national and international standards, ensuring:

- timely disclosure of information,
- meaningful public consultation,
- accessible mechanisms for community and worker feedback,
- ongoing communication during construction and operation,
- a transparent, fair, and responsive grievance system.

This process supports strong relationships with nearby communities and helps ensure that the Project is developed responsibly, safely, and with respect for local needs and expectations.

8.1 Stakeholder Engagement Plan (SEP)

A dedicated Stakeholder Engagement Plan (SEP) has been prepared for the Project (Annex 6 of the ESIA). The SEP outlines how AD ESM will:

- provide accessible information about the Project,
- engage with communities in a culturally and timely appropriate manner,
- receive and respond to stakeholder feedback,
- ensure compliance with national legislation and international standards (IFC PS1 and PS2, KfW Sustainability Guideline, World Bank ESF).

AD ESM is responsible for implementing, reviewing, and updating the SEP and for coordinating all public engagement activities.

All relevant stakeholders were contacted through the Stakeholder Engagement Plan (SEP), as well as the Environmental and Social Impact Assessment (ESIA) process. Moreover, the ESIA shall be closely monitored during the Project's construction and operation phases, through the implementation of Environmental and Social Management Plan and site-specific ESMPs, in accordance with the Loan Agreement and the Separate Agreements concluded with the KfW Development Bank, as well as in compliance with the IFC environmental and social standards and the World Bank Group and sector-specific EHS Guidelines and Sustainability Criteria for Wind Energy projects of KfW.

8.2 Public Consultations

Public consultation activities were carried out in line with national requirements and international good practice. Earlier engagement was undertaken during the ESIA for Phase I, including consultations with:

- Municipalities of Bogdanci, Dojran, and Valandovo,
- Ministry of Agriculture, Forestry and Water Economy,
- Environmental and social NGOs and other relevant institutions.

For the Project, the consultation process was expanded to meet KfW's and IFC's requirements. The following Project information was publicly disclosed on the ESM website (www.esm.com.mk), the Municipality of Bogdanci website, and in hard copy at municipal and ESM offices:

- General Public Grievance Form and Workers Grievance Form,
- Project Grievance Leaflet,
- Announcements on public meetings and the disclosure period.

A Public Consultation Meeting was held on 7 July 2021, where the Project and ESIA findings were presented.

No significant concerns were raised. Local participants mainly emphasized the importance of maintaining access for hunting, recreation, and mobility. They were informed that access within the wind park will be permitted during the operational phase, with standard site-security procedures (e.g., ID registration).

8.3 Grievance Mechanism

To support transparent communication, AD ESM has established a formal Grievance Mechanism (GM) for both the public and Project workers.

General Public Grievance Mechanism:

Community members may submit concerns verbally or in writing, free of charge, via telephone, email, mail, or the official grievance forms.

- Complaints may be submitted anonymously if preferred.
- All grievances are registered in a dedicated log, and AD ESM's Grievance Coordinator ensures that each case is reviewed.
- Responses are provided within 15 days (or up to 25 days for complex issues).
- If the issue cannot be resolved, complainants may escalate the case to the Grievance Committee, or ultimately pursue resolutions through national legal channels.

This mechanism ensures that issues related to construction impacts, traffic, environmental concerns, communication gaps, or contractor behavior can be addressed promptly and effectively.

Workers' Grievance Mechanism:

A separate grievance mechanism is in place for workers engaged by Contractors and the Operator (AD ESM) to raise workplace concerns confidentially, including:

- health and safety issues,
- discrimination or labour-rights violations,

- working conditions or accommodation issues,
- non-compliance with COVID-19 safety measures.

Complaints must be handled without fear of retaliation. Site managers are required to respond within 3 working days, or to develop an action plan if further steps are required.

Both grievance mechanisms ensure that feedback is logged, tracked, and resolved, and that workers and community members have fair, accessible ways to raise concerns.

9 Conclusions and Recommendations

The Environmental and Social Impact Assessment (ESIA) concludes that the Project is environmentally and socially feasible and can be constructed and operated in a manner that maintains the environmental and socio-economic sustainability of the Project area. While certain negative impacts are expected during construction and operation, these impacts are generally local, temporary, and manageable with the implementation of the mitigation measures and monitoring requirements defined in the Environmental and Social Management and Monitoring Plan (ESMMP).

9.1 Overall Environmental and Social Feasibility

The assessment shows that:

- Residual environmental impacts (after mitigation) are low or low-moderate, affecting primarily dust, noise, local habitat disturbance, and visual character.
- Positive environmental impacts are substantial, particularly reductions in greenhouse gas emissions and improvements in national energy security.
- Socio-economic impacts are generally positive, with short-term employment opportunities, increased demand for local goods and services, and long-term benefits from clean energy generation.

9.2 Key Environmental Considerations

Biodiversity:

With full implementation of avoidance, protection, and monitoring measures, no major disruption of local biodiversity is expected. Particular attention must be given to:

- the critically endangered plant *Astragalus physocalyx*,
- sensitive amphibian and reptile habitats,
- migratory birds and bats.
- Required actions include continued monitoring and the ability to adjust mitigation measures if required.
- Noise and Shadow Flicker

Noise:

Modelling indicates that night-time limits may be exceeded at the nearby hunting cottage for certain turbine types. Final compliance must therefore be confirmed once the turbine model is selected. If required, noise curtailment (reduced-mode operation) must be used.

Shadow flicker:

Modelling shows exceedances under worst-case conditions. Automatic shadow-flicker control systems must be installed to ensure compliance with international guidelines. The status of the hunting house—as a potentially sensitive receptor—must be verified every two years, and curtailment applied only if its usage changes to that of a dwelling or regularly occupied building.

Cultural Heritage:

After adjusting the turbine layout to avoid the "Mamino" archaeological site, impacts to cultural heritage are low. A Chance Finds Procedure must remain in place during construction.

9.3 Key Social Considerations

The Project requires no land acquisition and causes no physical or economic displacement, as all land within the site boundary is publicly owned.

Temporary social impacts, such as construction traffic, increased worker presence, and short-term noise, are manageable with the defined mitigation and communication measures. Consultations revealed no major community concerns, and access for recreation and hunting will be restored during operation.

A functional Grievance Mechanism (for both communities and workers) must remain active throughout construction and operation.

9.4 Positive Impacts

The Project provides major long-term benefits, including:

- generation of clean renewable electricity for approximately 6,000 households,
- reduction of approximately 40,000 tonnes of CO_2 per year,
- increased share of renewable energy in AD ESM's production portfolio (approx. 3%),
- strengthened national energy security, and
- local economic opportunities during construction and operation.

9.5 Monitoring and Adaptive Management

The ESIA recommends that AD ESM implement the following monitoring activities:

- continuous monitoring of SEP implementation and stakeholder engagement,
- monitoring of *Astragalus physocalyx* populations during construction and operation,
- a two-year post-construction monitoring programme for birds and bats,
- noise verification and shadow-flicker tracking,
- environmental monitoring of soil, water, waste, and emissions,
- regular reporting to authorities and international financiers.

These measures allow adaptive management and ensure compliance with national legislation and lender requirements.

9.6 Final Recommendations

Provided that the ESMMP, mitigation measures, and monitoring programmes described in the ESIA are fully implemented, and continuously adapted to evolving site conditions, the Project can be constructed and operated in accordance with North Macedonian legislation and international environmental and social standards (IFC Performance Standards, KfW Sustainability Guideline, and World Bank EHS Guidelines).

With these measures in place, the Project is expected to have **low to moderate residual impacts** while delivering significant environmental, climate, and socio-economic benefits to the region and the country.