



**Tafila Wind Energy Project
Tafila Governorate
(Hashemite Kingdom of Jordan)**

Executive Summary

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JWPC

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List of abbreviations

ESIA	Environmental and Social Impact Assessment
GHG	Greenhouse Gas
IBA	Important Bird Area
JWPC	Jordan Wind Project Company PSC
kV	Kilovolt
MW	Megawatt
NEPCO	National Electric Power Company
PPA	Power Purchase Agreement
WTG	Wind Turbine Generator

Preface

Certain environmental and social impacts are associated with energy projects in general. Therefore an Environmental and Social Impact Assessment (ESIA) was conducted to evaluate the level of adverse effects of the new project, if any. This executive summary provides the key aspects of the ESIA and gives an overview on the environmental effects raised by Tafila Wind Farm.

Introduction

Jordan Wind Project Company PSC (JWPC) is proposing the development of the first large scale wind farm in Jordan in the Governorate of Tafila. The proposed project comprises 38 turbines with an installed capacity of 3,075 MW each. The total installed capacity proposed is 117 MW. This wind farm is aimed to supply Jordan with approximately 388 GWh/a of clean, renewable and environmental friendly electricity and will save approximately 245,992 t CO₂/a [1].



Figure 1: Vestas V112

The project site is located to the northeast of the existing Lafarge Rashdiya cement plant, and east of the town Gharandil. The project area was selected based on its low intensity of human settlements, proximity to existing transmission infrastructure, expected favorable wind resource, and its low impact on the nature and environment.

Construction of the project is planned to begin in 2013, and will continue for approximately 18 months. The project will operate for 20 years, after which the project will be decommissioned and the installations removed.

Security of supply

When considering the security of energy supply, it is important to consider the following points associated with resource availability:

- © If a resource is rare, its price will continuously increase. Availability and, therefore, costs of a resource depend on its geographic position and its external conditions. Not all technologies are equally suited for all locations;
- © Even abundant resources can become difficult to obtain if the area in which it is sourced becomes politically unstable. Such restrictions will have an impact on the price.

The main three fossil fuels used for electricity generation in Jordan are natural gas (58%), heavy fuel oil (32%), and diesel (10%). Today, renewable energy sources account only for a minimal share of the generated electricity in Jordan.

Jordan has no notable fossil fuel reserves; the only occurrence of a fuel reserve is a natural gas field in Al-Risha in the northeast of the country [2].

These circumstances suggest that in the long term it would be advantageous to become less dependent on oil and gas and instead to increase the electricity production by renewable energies.

Wind – clean energy for a sustainable future

The majority of the international scientific community agrees that man-made climate change is a concern that must be combated by reducing greenhouse gas emissions. In order to meet the future energy demands, the use of renewable energy sources will become increasingly important. The use of renewable energy also reduces dependency on resources and resource-rich countries. Therefore most governments, including Jordan, have implemented policies to address the issue.

As a result many industrialized countries are increasing the use of renewable energies and decreasing the use of power plants burning fossil fuels. The installations of renewable energies have several advantages such as:

- ☉ Reduced GHG emissions;
- ☉ Reliable energy source;
- ☉ Independency in relation to resources;
- ☉ Energy cost reduction in the long term.

Even though energy exchange between different countries is inevitable in the existing regional system, the advantages listed above are regarded as triggers for a change in the worldwide energy supply. Wind energy is a very promising renewable energy source. Therefore the Jordan government supports onshore wind energy projects to develop this technology in the Kingdom. Jordans plan is to install 600 MW wind power by 2015 and 1,000 MW by 2020 [3].

Project site

The project is located in the Governorate of Tafila, east of the town of Gharandil and north of the LaFarge Rashidiya cement plant. The Dana Biosphere Reserve is located south west of the project area, with a distance of approximately 4,300 m between the reserve border and the project site border. The LaFarge Rashidiya cement plant lies in between the project area and the reserve.

The land in the project area is moderately hilly and rocky, with sparse vegetation. Elevation of the project area varies from 1,400 to 1,600 m above sea level.

There is some seasonal grazing activity in the area (sheep, goats) and wheat is grown in the small areas which support agricultural cultivation. There are no permanent dwellings or other structures in the project area that would be affected by the construction or operation of the project.

There are no water sources available at surface level.

The maximum total footprint of the project is approximately 29,000 Dunums, which equates to approximately 480 land parcels. Each turbine requires approximately 1.25 Dunum or about 1,250 m², including crane pad; the actual land area affected by the installation of infrastructure will be a small portion of the total project footprint. The land which is not directly affected by project infrastructure will be left to its original state, allowing for continuation of current land use patterns and minimal disturbance to flora and fauna in the area.

Wind Farm components

The turbine manufacturer for the Tafila wind farm will be Vestas. According to preliminary analysis, the best-suited turbine type for this location is the Vestas V112 with a capacity of 3.075 MW. 38 turbines will be installed in Tafila. Depending on the spatial wind conditions 4 turbines will have a hub height of 84m and 34 turbines will have a hub height of 94m, resulting in a total maximum turbine height of 149.9m.

The turbine locations were identified using a wind flow model of the area. Areas which are not suitable for turbine placement--due to environmental, topographic, geologic, or other issues--were excluded.

Further to the turbines the project will require an electrical substation which serves as the central point for electricity collection and transformation from a medium voltage level (33kV) to 132kV before being injected into the adjacent National Electric Power Company (NEPCO) transmission line. The turbines will transmit electricity to the project substation via underground electrical cables. The cables will be buried at a depth down to 1 m, depending on the soil conditions.

The existing 132kV NEPCO Rashidiya-Al Hasa transmission line runs on a north-south course through the center of the project area. This arrangement will minimize the amount of infrastructure required to connect the project to the NEPCO system, with a corresponding reduction in the environmental impact. In order to connect the proposed substation to the 132kV portion of the substation, approximately 250 meters of overhead cable will be required to be added to the Rashidiya / Al Hasa circuit. One of the existing transmission structures will be removed, and replaced by two new structures to facilitate the connection.

The project will require appropriate roads for access and hauling of WTG during construction and operation. These roads will be made of compacted soil and gravel, and approximately 5 meters wide. After construction these roads will be available for use by locals for agricultural or grazing transportation requirements and will be an improvement for local residents.

For the assembly of turbine components and the operation of a crane for erection of the turbines, a limited amount of flat, compacted ground, about 1.25 Dunum (1,250 m²), will be needed. The area for the crane operation will be cleared of rocks and vegetation, leveled, graveled and compacted to provide a stable base for the crane to operate on.

According to the Power Purchase Agreement (PPA) the wind farm will be equipped with one permanent wind measurement mast in the project area. This tower will be used to verify the wind speeds of the area, and set up a forecast model for the wind farm's generation for NEPCO's dispatch center.

Design optimization

Throughout the development process, the results of the environmental surveys were considered for the wind farm layout, which was continuously adapted and improved to mitigate potential impacts, where possible. The following principles were followed:

- © Avoiding key habitats of flora and fauna;
- © Avoiding of areas with archaeological interest;
- © Avoiding impacts on residents;
- © Complying with the overall project design strategy.

Environmental and social impact

Through early stakeholder consultation the key aspects to be considered and assessed as part of the planning procedure were identified. These aspects are addressed in the ESIA which includes comprehensive reporting on biodiversity, hydrology, geology and hydrogeology, noise, shadow flickering, air quality, landscape and visual impacts, cultural heritage, traffic and transport, as well as socio-economic issues. Independent expert consultants were responsible for measurements, methodology, predictions, impact assessment and mitigation measures. The main conclusions of the ESIA are summarized in the chapters below.

Biodiversity

Independent expert consultants have reviewed the flora, and fauna, with special emphasis on the avifauna. The assessment was conducted based on literature review and field surveys.

The following conclusions have been drawn as a result of these assessments:

- ④ Though the vicinity of the site is rich in resident birds and migrant passerines, few raptors were recorded. The absence of raptors can be explained due to high disturbance from urban expansion, farming, illegal hunting and overgrazing. Records show that more raptors and soaring birds were recorded in Wadi Dana and Fujeij.
- ④ The vegetation on the site is scarce and cannot be regarded as an adequate feeding ground such as the wadis in the vicinity. Therefore the wadis in the surrounding attract more migratory birds especially soaring birds such as eagles and buzzards. Furthermore the marginal vegetation on the project site does not provide good protection possibilities for the fauna and avifauna. Preys do not occupy the site to a great extent and hunting animals are hunting in other regions.
- ④ During the field survey for this biodiversity study, not many migratory birds were flying over the project site. Routes adjacent to the site seem to be the major passage. Feeding and nesting areas for raptors such as Golden Eagle, Black Kite and Common Kestrel, Wheatears and other passerines exist only in very small numbers and are explored only during spring migration.
- ④ Bats were recorded in the past, however the caves that were examined did not show any bat activities. Human persecution and cave burning may be the reason for this.
- ④ One of the recorded mammals is endangered in Jordan. Probably due to disturbance by local farmers and shepherds their number is not high.
- ④ The collision risk calculated for birds is negligible. Depending on the specie, size and the speed of the animal, between 0.79 and 42.28 bird individuals might collide with the rotor and get hit by one of the blades through 20 years of project operation. In addition the total amount of birds passing through the rotor area is regarded to be very low.

Geology, hydrology and hydrogeology

Impacts on the geology and the hydrology by the Tafila wind farm were assessed, showing that negative effects are limited and, if at all, will occur during construction or decommissioning.

These impacts may come along especially with excavation works that disturb the natural soil zones or with an increased vehicle appearance on the site.

An adequate waste management is ensured by the project developer.

The risk of erosion and water run-off, as well as the risk of soil sedimentation in wadis, will be minimized by the usage of drainage pipes.

The wind farm has a planned life span of 20 years. Once the facility has reached the end of its design lifetime, the turbines may be of a status to continue operation as a power generating facility, or the facility may be closed and decommissioned. If decommissioned, all the aboveground components of the wind farm will be removed and the site will be rehabilitated to its original state and will not leave any impacts on the geology or hydrology.

Noise

Noise measurements were performed as required by the Scoping Study. The measured data were presented in the ESIA. Best efforts were made to collect and determine the background noise in the town of Gharandil by measurements in accordance to the Scoping report. Even so it was found that the gathered data are not considered suitable with regard to determining the likely impact of noise from the wind farm on the nearest receptors as noise from extraneous sources (mechanical ventilation and wedding celebrations) resulted in the data collected being too high with respect to actual background noise levels to enable an objective assessment of noise impact to be performed. Thus it was jointly decided by the consultants to follow the simplified approach of modeling the noise from turbines. Subsequent measurements can be undertaken, if required by the MoEnv, in order to derive a more reliable result of background noise levels showing also a correlation with wind speed.

The noise levels predicted at around 35dB(A) and are sufficiently low to enable the attached Simplified Assessment method of noise impact assessment and to get confidence that there is no significant impact on the receptors when the wind farm is under operation.

Due to sufficient distance of the wind turbines to the nearest dwellings, the impact of operational noise of the planned turbines is low and remains below Jordan limits and limits of other international guidelines and regulations.

Shadow flickering

Shadow flicker may occur when the rotating blades of a wind turbine pass through the sun's rays seen from a specific location. This creates a fast-moving shadow with a "flicker" effect, which can be seen inside of homes and other buildings.

The potential shadow flickering was modeled for residential receptors near the site. It was found that some very minor shadow flickering may occur at the closest houses. As local standard do not exist, the German guideline was followed which states that, such exposure on residential properties should not be longer than 30 minutes per day and accumulated exposure should not exceed a total of 30 hours per year. These limits are not exceeded.

Semi-Nomadic people periodically dwell close to or in the project site. To protect them against shadow flickering, information boards will be published within the wind farm site, indicating locations preferably used for dwelling.

Air Quality

To analyze whether the air quality will be influenced negatively by the project a dust measurement was conducted in the vicinity of the Tafila wind farm. This measurement concluded that the project area does not encounter high levels of dust concentrations.

The operation of the wind farm will not cause any generation of dust or other air pollutant material. During construction and decommissioning of the project, especially excavations works that expose soil to the wind and vehicles driving on the gravel roads on the site may generate dust. Furthermore the delivery of light minerals, for instance sand, could also be a source of dust when escaping from vehicle loads in high winds.

As 90 % of airborne pollutants ("dust") come to rest within 100 m of their source and 98% within 250 m, all potential dust receptors near the Tafila wind farm are at least 1 km away from the next potential dust production sites, the significance is considered to be negligible.

Nevertheless, as the project site can be described as desert-like with potential dry strong winds, mitigation measures (such as spraying of dust suppression substances) will be implemented to minimize the project's impact as much as possible.

Landscape and visual impact

A landscape and visual assessment was conducted by the identification of receptors, by the calculation of visibility and by the development of visualisations of the future Tafila wind farm.

Resulting from the topography, in more than 50 % of the areas around the project site the WTG will not be seen. The impacts on villages in the surrounding of the project site were assessed as negligible as the WTG will only partly be seen. The turbines will not be seen as a predominant building from the view of the inhabitants.

The Desert highway, passing the Tafila wind farm in the east in approximately 13 km distance is not influenced by the turbines. The main viewing direction for the drivers is to north/south direction. Furthermore the turbines will rarely be seen from the Highway.

Dana reserve lies on a slope directed from east to west. The WTG will not be visible from the nature reserve.

The visibility from the dwellings around the wind farm depends on the distance. From towns like Tafila the turbines will rarely be seen, whereas from villages close to the wind farm (Gharandil, Lafarge housing area) part of the turbines will be visible.



Figure 2: View of the Wind Farm from Gharandil



Figure 3: View from the Wind Farm from Lafarge Rashidiya Cement Plant

The construction phase of the proposed development is considered to have a minor and not significant effect. The changes that will occur in the landscape will be the appearance of increased human activity together with temporary appearance and movement of large construction vehicles. These activities will

affect a small portion of the overall site leaving the majority of the existing landform, associated vegetation and soil structure unaffected.

Cultural heritage and archaeology

The project area is rich on cultural heritage and archaeological sites. Of special interest were the designated turbine areas and the number of turbines. In order to prevent any negative impacts on the archaeological structures on the site, archaeological experts analyzed each turbine location for ancient constructions. Where historical monuments were found, the locations of the turbines and the roads were revised.

Even though the wind farm is planned in such way that no historical artifacts are impacted, excavation works during the project construction might reveal further archaeological remains. Thus every effort must be made during construction to prevent damages on any findings.

Traffic and transport

During construction and decommissioning of the wind farm, impacts on the traffic are expected. The impacts are likely to cover changes in traffic, changes in road safety and vehicle delay.

Congestion are not considered to have a significant effect as the existing traffic volumes on the road network are very small, and the potential increases during the construction phase are not considered to be significant. It is not possible to quantify the magnitude of impact in relation to wear and tear on the local roads. Nevertheless Vestas is responsible for street repairs, if the damage on roads is caused by Vestas.

During the operation of the wind farm maintenance only small vehicles will attend the site regularly. As this will not be frequently, the impact during operation is regarded to be negligible.

For the delivery of turbines to the site, a route survey was conducted by transport experts of Vestas identifying the preferred route for exceptional load vehicles.

Socio-economics

The Socio-economic assessment revealed that residents living close to the Tafila wind farm mostly support the project and see it as advantage for the region and the people. Even though some ecological doubts were raised during a public consultation agreement on the proposed mitigation is expected. Beneficial effects for local economy and employment are predicted, mainly during the construction but also during the operation phase of the wind farm.

In addition JWPC plans supporting measures for the local economy:

- © Cooperation with RSCN and the implementation of an environmental awareness center at the Dana reserve

- © Documentation and quantification of the wind farm on the local environment, especially the avifauna, by RSCN
- © Visitor information center, staffed by JWPC and RSCN representatives. This center can serve as classroom area for local students.
- © Improvements in local schools and municipality by the installation of high efficiency heating / cooling / lightning, solar rooftop installations, communication equipment, etc., depending on the special needs.

Cumulative effects

Cumulative impacts result by a combination of existing and planned projects and the project under assessment. For the Tafila wind farm no significant cumulative impacts were identified. The only cumulative impact is related to migratory birds. The potential collision risk of birds gets higher the more turbines are built.

Nevertheless it is assumed that the avifauna population will predominantly stay in the Dana nature reserve and the adjacent Wadis and will not fly through the wind farm sites as these areas are more comprehensive feeding and resting grounds.

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