Lekela Egypt

Supplementary ESIA for Lekela BOO Wind Power Plant - at Gulf of Suez

Prepared by:

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Table of Contents

List of Tables

List of Figures

List of Annexes

1. Executive Summary

Lekela completed a full ESIA for a 250MW wind power project in the Gulf of Suez, Egypt, and publicly disclosed it in October 2018. Recently, Lekela was required to review alternative EPC options and is currently considering two approaches. While one design option remains similar to the one currently permitted (70-73 Turbines, rated at 3.6MW), the other would involve utilising 96 turbines rated at 2.6MW. To this end, Lekela commissioned Environics to undertake a supplemental environmental and social impact assessment of the alternative design (2.6MW), in particular to consider potential impacts on avifauna/biodiversity. Lekela aims to finalise on the design in April 2019.

The supplemental assessment included reviewing the potential impacts during the construction and operational phases as well measures to mitigate potential adverse impacts.

The assessment concludes that the change in design would not have a material difference with regard to previously identified impacts of the project including on socio-economic (labour, community effects etc), resource use (water) and emissions generated (waste).

Additionally, an assessment into the potential impacts on avifauna using a Collision Risk Model revealed that the application of the 2.6MW WTG did not lead to a material impact over and above the 3.6MW WTG layout modelled in the original ESIA, despite utilising additional turbines over the same project area.

With regards to barrier effects, Lekela project-specific studies indicated that the impact of barrier effects and disturbance (in isolation from other adjoining projects) will be minimal due to the limited scale of the project area, the lack of local vital habitats for feeding or resting of soaring birds and to some extent the distance of the study site from critical bottle necks and the main migration flyway for soaring birds.

In conclusion it is noted that, contrary to expectations, the use of 96 2.6MW WTGs does not lead to material change on the environmental and social risk profile of the project disclosed in the original ESIA, which assesses the counterfactual risk presented by 70-73 3.6MW WTGs.

Lekela is proceeding with the option of 96 2.6MW turbines for the project.

2. Introduction

The Egyptian government is planning to install 4,300MW of renewable energy over the coming three years, the anticipated capacities will be provided from wind power plant as well as PV installations. As part of these plans, the Egyptian New & Renewable Energy Authority (NREA) is planning to establish a wind power plant complex with a total capacity of approximately 2,150 MW near the Red Sea town of Ras Gharib in the Gulf of Suez.

Lekela Power was prequalified for a 250MW Wind Project from the Egyptian Ministry of Electricity and Renewable Energy to operate within the BOO scheme. Accordingly, Lekela has prepared a full-fledged ESIA study including public consultation and disclosure activities. The ESIA also included detailed description of the bird monitoring campaigns and assessment of the impacts on migratory birds, which is a major potential impact of wind projects. The ESIA was approved by the Egyptian Environmental Affairs Agency (EEAA) in August 2018 (Annex 1). The ESIA included the Collision Risk Modeling (CRM).

As Lekela received various offers, including a 96 turbines layout rated at 2.6MW, it was essential to revise the potential impact assessment to identify the potential alteration of impacts on environmental components including migratory birds as a result of a potential increase in the number of turbines

In this context, Lekela requested Environics to prepare a supplementary ESIA study addressing the impacts of the alternative project design with particular emphasis on impacts on migratory birds.

Figure (1) below shows the modified turbine layout based on 96 turbines rated at 2.6 MW.

Figure (1): Configuration based on 96 turbines rated 2.6 MW

2.1 Objective of the Supplementary ESIA

The objective of the supplementary ESIA is to identify the anticipated incremental impacts on the environment potentially resulting from the alternative project design entailing an increase in the number of turbines.

Moreover, the supplementary ESIA is also intended to satisfy the requirements of EEAA and the international funding institutions in relation to changes in project design.

2.2 Scope of Work

The focus of the Supplementary ESIA is evaluating the project potential environmental impacts resulting from changes to the project layout. The proposed layout comprises 96 turbines rated at 2.6 MW. The supplementary ESIA will address changes in potential impacts during construction and operation stages and will address measures to mitigate potential adverse environmental impacts as relevant. The previous approved ESIA attached in Annex 2 includes full details on the environmental and socio-economic conditions in the project area.

2. Project Description

2.1 Project Location

The project is located at the same site on which Lekela Power is planning to establish a 250 MW wind power plant within the wind complex north of Ras Ghareb where NREA has allocated 328 km^2 for generating electricity from wind power. The project site is located in the Eastern desert by the Red Sea coast, north of the town of Ras Ghareb. The site is serviced by the Ras Ghareb – Zafarana Highway at about 2 km to the East from which it can be accessed as well as the Ras Ghareb – Minya Road to the South. The project area is a desert land and the nearest residential area, the coastal town of Ras Ghareb, is about 28 km to the east of the site. Figure (2) below shows the activities surrounding the proposed location of the wind plant.

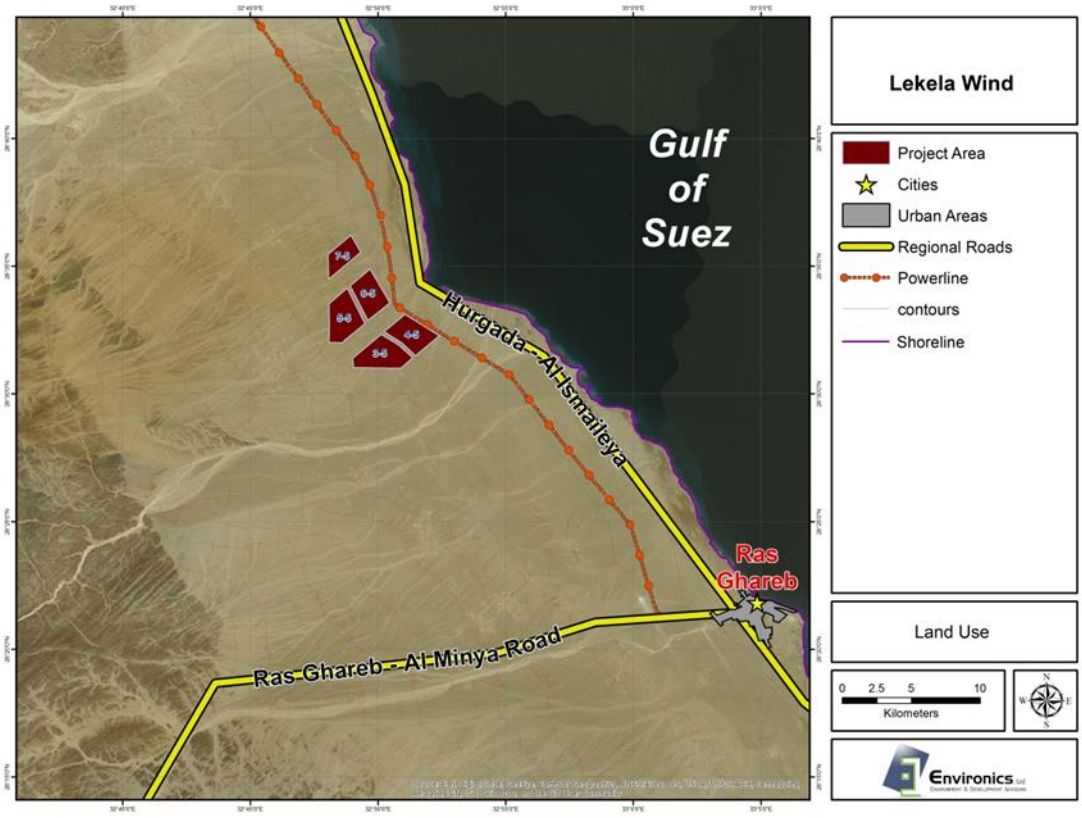

Figure (2): The site, neighboring roads and surrounding activities

The main land uses within the area and their environs are petroleum industry and related infrastructure.

EETC will construct the associated transmission lines to connect Lekela Wind Farm to the Egyptian Electricity Transmission Company (EETC) Ras Ghareb Substation 500/220 kV as shown the Figure (3) below. The OTL route is divided into two main stretches, the first running roughly parallel to the existing Ras Ghareb – Zaafarana highway with an approximate length of 15km comprising approximately 42 towers, while the second stretch runs roughly parallel to the Ras Ghareb – Minya road with an approximate length of 15km comprising 38 towers. The OTL is located in an uninhabited state-owned desert land.,. The ESIA for the transmission line has been prepared by Lekela on behalf of EETC and is currently under review by the Egyptian Environmental Affairs Agency (EEAA).

Figure (3): Route of OTL

2.2 Description of Layout

This section provides a description of the modified project layout and turbine characteristics. The details of other project components are provided in Chapter (3) of the attached detailed ESIA attached in Annex 2.

The wind farm will comprise of 96 independent wind turbine generators (WTGs) rated at 2.6MW each. They are placed over 10 parallel rows and connected using underground medium-voltage cabling.

It should be noted that , increasing the number of turbines will not result in changes to the size or shape of the original buildable area considered for the project nor the project's overall capacity.

2.2.1 Wind turbines

The WTG consists of rotor blades connected to the hub which is connected to a gearbox and generator as shown below.

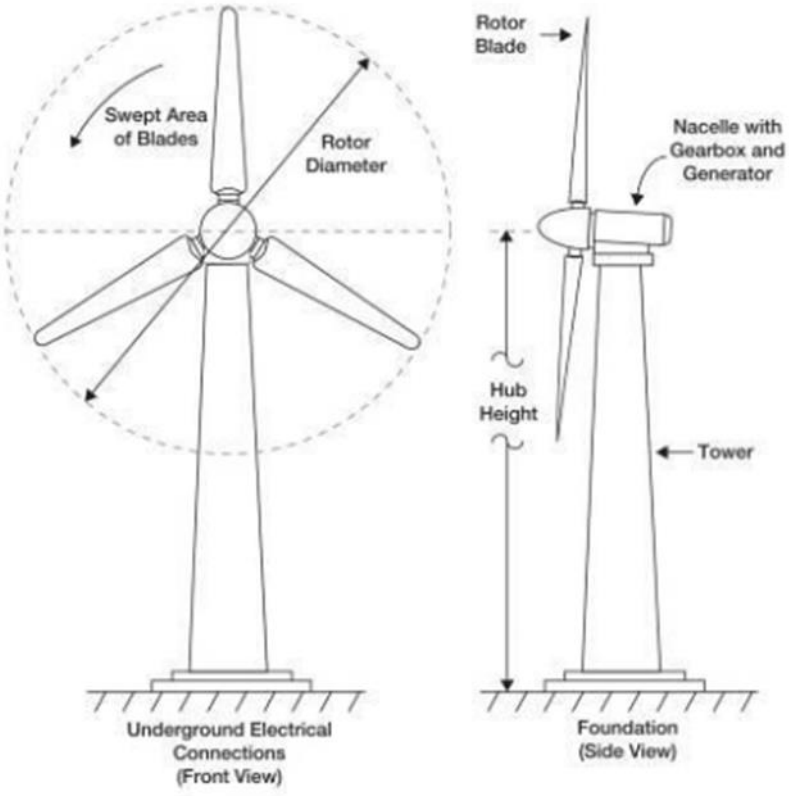

Figure (4): Wind turbine components[1]

[1] Guidelines on the environmental impact assessment for wind farms Belgrade, June 2010. United Nations Development Programme (UNDP) Serbia and Ministry of Environment and Spatial Planning of the Republic of Serbia. https://www.unece.org/fileadmin/DAM/env/eia/documents/EIAguides/Serbia_EIA_windfarms_Jun10_en.pdf

The turbine height will be 120m, the hub height 63m and the rotor diameter 114m. The minimum intra-row separation between turbines is approximately 3.0 rotor diameters (RD). The minimum inter-row separation between adjacent rows of turbines is approximately 6.3 RD.

The Hub Height plus the blade length shall not exceed 120m and will comply with the requirements of the Egyptian Military.

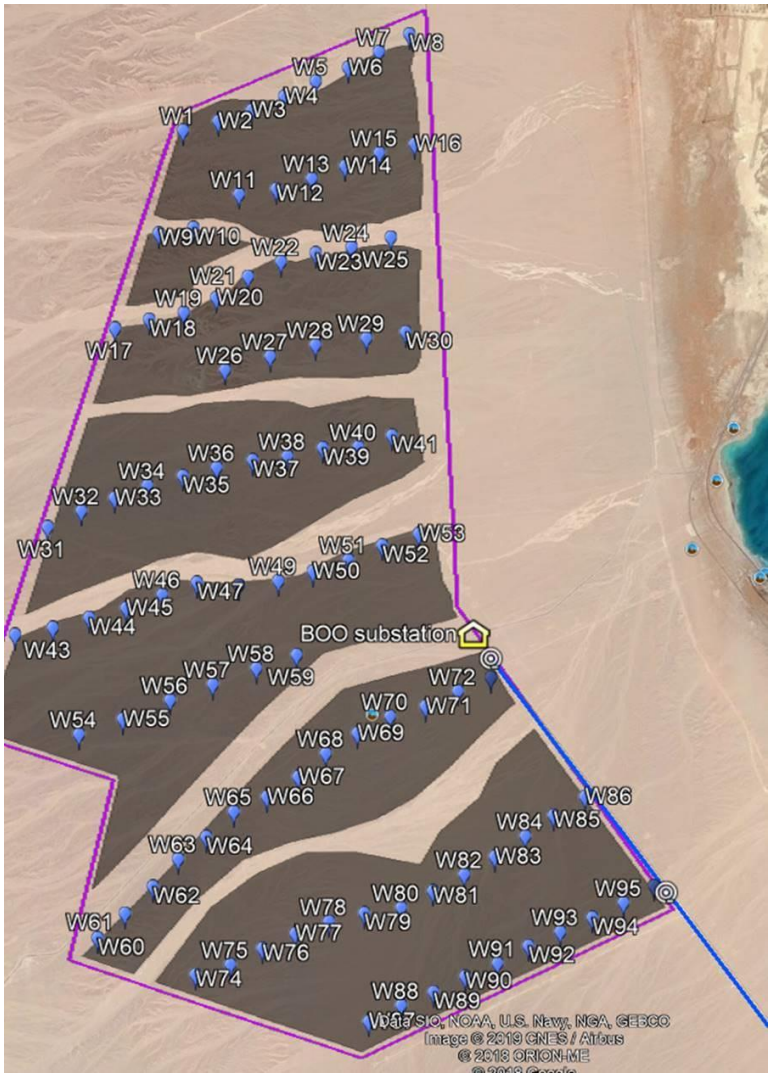

Figure (5): Lekela project layout (96 x 2.6MW)

2.2.2 Electric Equipment and connection to the grid

The WTGs are connected together to form collector circuits that are in turn connected to a new 220kv / MV substation within the site boundary.

From there, EETC will construct a new 220 kV overhead transmission line to connect to a 500kV/ 200kV substation where the voltage is stepped up further and the electricity produced is delivered to EETC Transmission System.

2.3 Construction Activities

The construction activities are identical to those described in the detailed ESIA (Annex 2) n, with two main differences

1. The larger number of turbines entailing foundations, tower erection and turbine/blades installation; and
2. The construction phase is marginally extended to 24 months, as opposed to 22 months

Foundation– Steel fixing stage.

Foundation concrete pour completed and ready for backfilling.

Nacelle Lift

Rotor Lift: crane supporting blade tip until necessary ground clearance is achieved.

Figure (6): Turbine installation process

2.3.1 Main Activities and Schedule

Activities during the construction phase would include:

- Extraction/importation of aggregate for access track, hard-standing and turbine base construction[2];
- Construction of temporary office facilities;
- Construction of access tracks;
- Construction of turbine foundations and crane hard-standings;
- Necessary tests for soil and concrete
- Construction of meteorological masts, substation and O&M building Excavation of trenches and cable laying adjacent to site tracks;
- Connection of collector system cabling;
- Supply and installation of wind turbines;
- Commissioning of site equipment; and
- Site restoration.

2.3.2 Estimated number of the required labor

The direct labour force required for the project during construction will be dependent on the phase of the work but will be up to approximately 300 -350 workers during peak construction phase including skilled and unskilled persons. The company will encourage contractors to hire workers from local communities.

2.3.3 Utility inputs for construction

Water

For concreting works related to the foundations and the substation more water will be required, reflecting the larger number of turbines.
It is likely that there will be a batching plant on site, with water to be provided by tankers.

Table (1) below presents the approximate water consumption per WTG for the different construction activities.

Table (1): Estimated Water consumption[3]

Activity	Maximum water requirement
WTG foundation pouring	50 m^3 per WTG foundation, as it is assumed that the size of the foundation is about 400 m^3
WTG foundation curing	1 m^3 per foundation per day, as it Is assumed that 10 days will be sufficient for foundation curing
WTG components cleaning	2 m^3 per wind turbine

[2] A manoeuvre zone (crane pad or hardstand) is planned to be constructed next to every wind turbine. These are required to place cranes and trailers used to lift and assembly the wind turbine.
The hardstands for the wind turbines will be designed according to the manufacturer specifications, set by the vehicles dimensions, its manoeuvrability and the free area needed for materials storage.

[3] Based on SESA 2017 estimates

2.3.4 Construction Emissions and Wastes

Construction and operations may generate gaseous emissions, liquid effluents, noise and solid waste. The details of the construction and operation emission and waste are provided in the detailed ESIA in Annex (2) of this report.

2.4 Activities during operations

2.4.1 Labour

During operation, permanent employees on site are expected to be approximately 20 workers. While many roles will be of a specialised nature, Lekela aims to employ suitably qualified workers from the local area as a priority. Where possible, training will be provided to enable optimal participation from local communities.

3. Assessment of Incremental Environmental and Social Impacts and Mitigation

3.1 Methodology

This section describes the incremental impacts of the project layout comprising 96 WTGs rated 2.6 MW on the different environmental and social aspects as well as description of additional proposed mitigation measures, where necessary.

An assessment of these impacts and proposed mitigation measures was undertaken and was carried out in three main steps, as follows:

1. Identification of potential incremental impacts
2. Evaluation and assessment of the incremental impacts in terms of their significance
3. Identification/ proposing additional mitigation measures for minimizing the effects of the significant incremental impacts where relevant

3.1.1 Identification of incremental potential environmental and socio-economic impacts

Potential incremental impacts of the proposed project – resulting from a project configuration of 96 WTGs, as opposed to 70-73 WTGs – are outlined in the table on the following page.

Part I of the table describes the different project design options and whether they trigger any impact modification. **Part II** of the table describes the nature of anticipated impacts and their significance and the need to be modified and proposed mitigation measures as appropriate.

3.1.2 Evaluation and Assessment of Impacts

Similar to impact evaluation in the original ESIA, evaluation is based on pre-set criteria including, impact magnitude, duration, planned mitigation measures, regulatory standards and sensitivity of environmental receptors.

I. Project Description

Aspect	Type of modification	Potential Incremental Effect	Notes
Number and capacity of turbines	– About 96 turbines with capacity of 2.6 MW will be installed – Number of turbine rows will be 10 rows	Moderate	The increase in the number of foundations as well as lifting operations would cause additional disturbance to the soil The increase of number of rows would result in additional access roads and thus more compacted soil area. However, the site is located within the vast coastal desert plain ecosystem which is characterized by an almost total absence of vegetation cover and animal life is mainly found in wadis
Number of workers	– no. of workers during construction about 300-350 – no. of workers during operation about 20 instead	Not significant	The incremental increase of number of workers is not expected to result in considerable additional positive impacts.
Construction time schedule	– 24 months	Not significant	
Foundations	– Number of foundations	Not significant	Given the same tip and hub height, rotor diameter and volume of foundations will be similar. Thus, it is not expected that the volume of required concrete and water use per foundation will increase. However, an additional amount of material, including water, as well as excavation will be required to reflect the increase in the number of foundations.

II. Impact Assessment

Aspect	Expected Incremental Impact	Reason for modification	Notes
Positive Impacts			
Employment	None		The number of job opportunities during construction and operation stages have not significantly increased with increasing the number of turbines. Only a few more job opportunities may be created, and for construction jobs over a marginally longer period, however there is no major difference. ***The potential positive impacts as result of the modified design are considered the same***
National energy security	None		The project capacity is the same (250 MW) generating .the same amount of electricity
Reduction of GHG Emissions	None		There are still no greenhouse gases emissions associated with generating electricity from wind energy.
Potential adverse impacts on the environment			
Ambient Air quality	None		Construction activities may result in minor, localized, short term, air quality impacts. Increasing project construction duration to 24 months instead of 22 months would not increase the impacts on air quality. ***The potential impacts as result of the modified design are still considered minor and the same mitigation measure will apply.***
Ambient Noise levels	None		It is not expected that noise from the construction or operation activities would pose impacts on the neighbouring areas (roads or nearby communities) as they are located at significant distances. ***The potential impacts as result of the modified design are still considered minor and the same mitigation measure will apply***
Impact on Soil	None		Generally, the construction and operation activities are unlikely to result in soil contamination that will require future decontamination and clean-up activities. Impacts would potentially result from domestic wastewater management, material and waste storage accidental spills from machinery, and potential spills from the diesel generator and lubricating oils. ***The potential impacts as result of the modified design are still considered to be minor and the same mitigation measure will apply.***

Aspect	Expected Incremental Impact	Reason for modification	Notes
Water consumption	Not significant.		It is not expected that the volume of required concrete and water use per foundation will increase given the same tip and hub heights and same rotor diameter. However, the incremental increase of water consumption for foundations, as result of increasing number of turbines is not considerable over the longer construction period.
Biological environment	Yes	Increasing the number of turbine, and hence the number of rows from 7 rows to 10 rows, may potentially result in increasing the number of required access roads which may potentially reflect on the size of area compacted to construct such roads. This may potentially increase the effect on habitat loss. Local animals might be affected by disturbances during the construction phase. However, disturbance effects are limited to a rather small area. Thus, local animals can find alternative habitats during construction. Moreover, construction works are limited in time and local animals can repopulate the area after construction. In Wadi Hawashiya, however, human activities should be avoided	The site is located within the vast coastal desert plain ecosystem which is characterized by an almost total absence of water and, accordingly, the vegetation cover is very low and animal life is mainly found in wadis, Thus the potential incremental increase of impacts of access roads on the habitat loss is considered minor ***The potential impacts as result of the modified design are minor and the same mitigation measure will apply***
Avifauna	Yes	The impact of the operation phase on the migratory birds is considered potentially significant as a result of collision risk. The increase of number of turbines may result in increase in collision risk.	The potential collision risks as a result of the new layout and turbine design is described in the section below. A Collision Risk Model (CRM) was run for the new design to identify the changes of numbers of potential casualties and the avoidance behaviour. In addition, /alternative mitigation measures will be indicated where necessary
Socio-economic aspects (workplace)	No		Potential impacts during construction could arise from noise, accidental slipping of the workers and hazards from exposure to dust and emissions from material handling. In this context, the potential workplace impacts can be considered moderate ***The potential impacts as result of the modified design are minor and the same mitigation measure will apply***
Impact of the project on the community (workers influx)	No		The expected increase in number of workers during construction is not significant. Thus, disturbance/annoyance potentially caused by the labor influx, will be controlled through a code of conduct integrated in the labor management plan , and a community grievance management system.

Aspect	Expected Incremental Impact	Reason for modification	Notes
			The potential impacts as result of the modified design are minor and the same mitigation measure will apply
Site security	No		***There are no changes in potential impacts as result of the modified design and the same mitigation measure will apply***
Light reflection and shadowing	No		***There are no changes in potential impacts as result of the modified design and the same mitigation measure will apply***
Impact of the project on traffic	No		The incremental impact on traffic as result of increased number of turbines and the construction duration to 24 months instead of 22 months is not significant. ***The same mitigation measures will apply***
Impact of the environment on the project			
Impact of venomous species	No		***No additional impacts are expected as a result of the modification and the same mitigation measure will apply***
Impact of flash flood	No		The flood risk is low as the micro-siting will respect the existing wadi boundaries and installations inside the wadis are avoided. ***No additional impacts are expected as result of the modification and the same mitigation measure will apply***

3.1.3 Scoped out Impacts

The alternative project configuration will not impose any changes to the original design scoped out aspects. These will remain as in the original ESIA presented in Annex (2).

- ***Impacts on "surface water quality", "ground water quality" and "aquatic life"***
  As these have no interactions with the original project as presented in Annex (2), there will be no interaction with the option under investigation

- ***Visual Impact***
  Although the project modification entails an increased number of turbines, there are no receptors or human settlements near the project area. Potential receptors are limited to the transient drivers along the surrounding roads who are used to seeing wind farms that have been expanding along the road from Zaafarana to Hurghada. For these drivers, all existing projects will be of comparable density of the project modified layout, as they use turbines of capacity similar to the alternative configuration. In all cases, the marginal increase, or reduction, of density will be unlikely perceptible from the road.

- ***Impacts on archaeology and cultural heritage***
  No cultural heritage components exist within the project area and in case of unlikely chance find, the appropriate chance find procedures will be implemented.

3.2 Impact Assessment

This section describes the mitigation measures for aspects mainly related to the project design modifications. The detailed impact assessment for all relevant environmental and socio-economic aspects is provided in detail in the ESIA report attached as Annex (2).

3.2.1 Positive Impacts

- ***Employment***

  Although the number of WTG has increased as result of the modified project design, nevertheless, the number of job opportunities during construction and operation stages has not significantly increased. It is estimated that during the construction phase of the project would provide about 300-350 direct job opportunities to the local community. During operation, permanent employees on site are expected to be approximately 15-20.
  The potential positive impacts as result of the project configuration comprising 96 turbines considered the same for the original project as shown in Annex (2).

- ***National energy security***
  As the project's electricity generation remains the same with increased number of WTG, the project contribution to national energy security is unchanged.

- ***Reduction of GHG Emissions***
  This project contribution to minimizing greenhouse gases emissions, particularly CO_2, that would have been generated if the same amount of energy had been generated from conventional fossil fuel fired power plants remains the same as described in Annex (2).

3.2.2 Potential Negative Impacts

After exclusion of the irrelevant impacts and identifying the positive impacts, the remaining "potential negative impacts" were assessed based on the following criteria:

- ***Magnitude*** of the impact.
- ***Duration:*** period of time that impact lasts.
- ***Mitigation measures;*** its availability whether integrated in the project design or implemented as management measures**.**
- ***Adherence to regulatory standards according to Egyptian legal and regulatory framework*** (described in Chapter 2 of the detailed ESIA (Annex 2)).
- ***Public concern*** and perception

3.2.2.1 Impact of the project on the physical environment

- ***Ambient Air quality***
  Construction activities may result in minor, localized, short term, air quality impacts. Increasing project construction duration to 24 months instead of 22 months would not increase the impacts on air quality.

  The potential impacts as result of the modified design are still considered minor and the mitigation measures proposed in Annex (2) will apply.

- ***Ambient Noise levels***
  It is not expected that noise from the construction and operation activities would pose impacts on the neighboring areas (nearest roads or community at distance of more than 25 km)

  The potential impacts as result of the modified design are still considered minor and the mitigation measures proposed in Annex (2) will apply

- ***Soil***
  Despite the increase in number of WTGs, the construction and operation activities are unlikely to result in soil contamination that will require future decontamination and clean-up activities. Impacts would potentially result from domestic wastewater management, material and waste storage accidental spills from machinery, and potential spills from the diesel generator and lubricating oils.

The potential impacts as result of the modified design are still considered moderate and the mitigation measures proposed in Annex (2) will apply.

- ***Water***

  Water consumption during construction for the different construction activities is estimated as follows:
  - WTG foundation pouring: 50 m³ per WTG foundation
  - WTG foundation curing: 10 m³
  - WTG components cleaning before erection: 2 m³ per wind turbine
  - Domestic uses for a peak of 350 person per day, max 17.5 m^3/day

  Water consumption during operation will be primarily due to domestic uses and the estimated water consumption would be in the range of 1 m^3/day (assuming 50 l/person/day - 15-20 person).

  Thus, the impacts of the project on water resources consumption is minor as result of project configuration comprising 96 turbines and the mitigation measures proposed in Annex (2) will apply.

3.2.3 Impacts of the project on the socio-economic aspects

There are no additional impacts expected to occur on the socio-economic aspects as a result of the design of the 96 turbines rated 2.6 MW. The impacts that were previously described in the original ESIA (Annex 2) and the suggested mitigation measures are still applicable.

3.2.4 Impacts of the environment on the project

There are no additional impacts expected to occur on the socio-economic aspects as a result of the design of the 96 turbines rated 2.6 MW. The impacts that were previously described in the original ESIA (Annex 2) and the suggested mitigation measures are still applicable.

3.2.5 Impact on the Biological Environment

Increasing the number of WTGs would result in increasing the number of required access roads which reflects on area compacted to construct such roads. However, increasing the number of WTGs will not require increase of the land area acquired for the project as described in the detailed ESIA (Annex 2), this may potentially increase the effect on habitat loss due to increase the compacted areas to establish access roads.

However, the foot print of a wind farm on its site, given the distances between turbines and rows, does not exceed 3% of the site. The increase of rows, and thus access roads, and foundations, will increase this foot print but will still represent a minor percentage of the site.

Moreover, the site is located within the vast coastal desert plain ecosystem which is characterized by an almost total absence of water and, accordingly, the vegetation cover is very low and animal life is mainly found in wadis. Thus the potential incremental increase of impacts of access roads on the habitat loss is considered minor

Thus, the impacts of the project on biological environment as result of modified design is minor, and the mitigation measures proposed in Annex (2) will apply.

Fauna (excluding avifauna)

The importance of the project sites as a habitat for animals is limited and most species have been recorded from Wadi Hawashiya. There is no construction in Wadi Hawashiya, and other human activities will be avoided.

Scarce local animals in other areas still might be affected by disturbances during the construction phase. However, disturbance effects are temporary and limited to small and distributed areas.

Thus, the impacts of the project on fauna as result of modified design is minor and the mitigation measures proposed in Annex (2) will apply.

Avifauna

- **Assessment for the wider project area**

  The impact of the operation phase on the migratory birds is assessed by RCREEE in a Strategic Impact Assessment for the wider project area including the cumulative impacts on Avifauna (Lahmeyer International and Ecoda, 2017)[4]. The focus here is on the specific Lekela Project, and more specifically on the incremental impact of the alternative project configuration of 96 turbines rated 2.6 MW. The major potential hazards to migrating birds are mortality due to collision as well as barrier effects.

  The Strategic Study indicated that it is very difficult to assess collision risk as well as avoidance behaviour, which might lead to increased energy expenditure caused by a proposed wind power plant. Thus, the impact assessment should be regarded as a qualitative prediction of possible impacts under consideration of the precautionary principle (worst-case-approach), which needs to be specified by further field investigations in bird-wind turbine interactions (e.g. post-construction monitoring) at the western Red Sea coast

  The study also suggests that collisions at wind turbines within the project area during autumn will have lesser impact than during the spring season. High numbers of large soaring birds have been recorded in the project area during spring, including "Endangered" or "Vulnerable" species. Consequently, collision rates leading to additional mortality potentially causing significant population effects for some species cannot be excluded when operating an individual wind farm in the project area. Hence, appropriate mitigation measures and thorough post construction-monitoring are required for each individual wind farm to reduce the risk of collision to an acceptable level.

[4] Lahmeyer International and Ecoda (2017) Strategic and Cumulative Environmental and Social Assessment Active Turbine Management Program (ATMP) for Wind Power Projects in the Gulf of Suez, 2 nd Draft Report (D-5-2), prepared for RCREEE – Regional Centre for Renewable Energies and Energy Efficiency

Based on the Strategic Study's results, it is indicated that an individual wind farm is unlikely to cause significant barrier effects during autumn migration. Barrier effects caused by a single wind farm in the project area are regarded as a moderate impact on migratory soaring birds in spring. Although no further management and mitigation were required except from applying best practice procedures and general mitigation measures, it was subsequently decided to exclude a number of parcels from the original NREA plan for the wind park to create a "safe north-south corridor" for migratory birds.

- **Lekela TBC Cumulative Effects Assessment**

  According with best practice and in order to meet lender biodiversity requirements, Lekela commissioned TBC (The Biodiversity Consultancy) to undertake an analysis of the potential cumulative effects on biodiversity of the proposed Lekela North wind power project. The study's aim was to assess the impact of Lekela's wind project on biodiversity in the context of other known wind farm developments in the area, as well as future plans for wind energy in the Gulf of Suez.

  The analysis helped identify priority Valued Environmental Components (VECs) (IFC 2013), and fatality thresholds that can facilitate an adaptive management mitigation approach for priority bird VECs. The study proposes high-level mitigation and monitoring actions that can be adopted by Lekela to manage biodiversity impacts within the specific project area. Additionally, the study recommends actions that Lekela can undertake or support in collaboration with other developers to ensure that the cumulative effects of additional wind farms in the region are appropriately managed. The revised project design has not impacted either the on-site or the wider regional mitigation recommendations outlined in the cumulative effects assessment.

  The recommendations focus on:

  - On-site mitigation and monitoring methods, to minimise collision risk, validate the effectiveness of proposed mitigation methods, allow estimation of residual impacts and provide information to adapt monitoring and mitigation to prevailing conditions; and,
  - Collaborative efforts with other wind farm entities, to minimise the cumulative effects of all the proposed wind farm developments in the area.

The mitigation measures proposed in the CEA, in addition to the mitigation measures that are discussed later in this report are to be comprehensively listed in the project Biodiversity Action Plan (BAP). This document will hold all contracting parties responsible for meeting the required standards and ensures a comprehensive adaptive avifauna risk-management during construction and operations. Particularly it will outline the approach that the project will take to achieve a no net loss outcome for biodiversity.

- **Collision Risk Assessment of Project Site**

In addition to the Strategic Impact Assessment for the whole wind farms in the area carried out by Lahmeyer International and Ecoda (2017), and Lekela's own CEA, Environics has carried out site specific autumn and spring Collision Risk Assessment for the Lekela project.

The risk analysis conducted, followed the Scottish Natural Heritage (SNH) Collision Risk Model (CRM) (SNH 2000, 2010), which is the standard CRM approach adopted by previous studies conducted in the Gebel El Zeit area. The SNH CRM is one of several approaches that seek to provide an estimate of the potential number of bird collisions likely to occur at a given wind farm. The main source of risk that is considered is that of collision with the moving rotors of wind turbines. However, it is important to point out that CRM results cannot be treated as the sole tool for risk evaluation, but rather as a gauging tool that may provide a basic sense of magnitude of risk that can be anticipated. The empirical results of post-construction monitoring and carcass surveys would provide more factual data that can be used in risk management after wind energy infrastructure is in place.

The methodological steps of the CRM are presented in annex 3.

The different available CRM models tend to be linear in nature and treat migratory birds, more or less, as projectiles that fly through the airspace in straight lines. This does not normally take into account the behavioral and avoidance responses of birds when confronted with the turbines in the field. Studies indicate that behavioral avoidance is quite high in birds, reducing collision potential by up to 99%. To help account for the behavioral avoidance responses by birds, the current CRM model applies two avoidance rates ranging between a conservative 95% avoidance rate and a more realistic avoidance rate of 98%.

The CRM modeling results for the Autumn and the Spring seasons for the original configuration are reported in Annex (2). Modeling was repeated for 2 seasons (Spring and Autumn 2018) for the alternative WTG configuration and to compare with the original configuration. Table (2) summarizes the characteristics of the selected WTG layout and the Spring and Autumn CRM results are presented in tables (3) and (4) below.

Table (2): 2.6 MW turbine configuration

Turbine type	Number of turbines	Rotor diameter m	Max height m	Rotor swept height m	Rotor swept area m2	Total RSA m2	Distance between turbines m	Max chord	Pitch	Rotation period
2.6 MW	96	114	120	5 to 120 m	10207	979872	345	3.984	6	4.6

Table (3): CRM modeling results for Spring 2018

Species	birds at rotor swept height	2.6 MW Rotor swept area / Risk window = 0.2288		
		P collision	95% risk adjusted	98 % risk adjusted
Black Kite	148	0.07	0.59	0.24
Black Stork	74	0.09	0.37	0.15
Booted Eagle	13	0.07	0.05	0.02
Buzzard sp.	9	0.07	0.03	0.01
Crane	18	0.10	0.10	0.04
Eagle sp.	3	0.07	0.01	0.00
Egyptian Vulture	4	0.07	0.02	0.01
Eleonora's Falcon	1	0.06	0.00	0.00
Falcon sp.	2	0.06	0.01	0.00
Harrier sp.	1	0.07	0.00	0.00
Honey Buzzard	830	0.07	3.30	1.32
Kestrel	19	0.07	0.08	0.03
Lesser kestrel	3	0.06	0.01	0.00
Lesser Spotted Eagle	12	0.07	0.05	0.02
Levant Sparrowhawk	1	0.06	0.00	0.00
Long-legged Buzzard	15	0.07	0.06	0.02
Marsh Harrier	11	0.07	0.04	0.02
Montague’s Harrier	1	0.07	0.00	0.00
Pallid Harrier	7	0.06	0.03	0.01
Raptor sp.	59	0.07	0.23	0.09
Short-toed Eagle	33	0.07	0.14	0.06
Sooty Falcon	1	0.06	0.00	0.00
Sparrowawk	1	0.06	0.00	0.00
Spotted Eagle	4	0.07	0.02	0.01
Steppe Buzzard	1180	0.07	4.49	1.80
Steppe Eagle	106	0.07	0.44	0.18
White Pelican	46	0.13	0.33	0.13
White Stork	17599	0.09	90.56	36.22
Totals	**20201**		**100.97**	**40.39**

Table (4): CRM modeling results for Autumn 2018

Species	total birds by species at rotor swept height	2.6 MW Rotor swept area / Risk window = 0.2288				
		P collision	95% risk adjusted	Risk per turbine (96 turbines)	98 % risk adjusted	Risk per turbine (96 turbines)
Black Kite	7	0.07	0.03	0.000	0.0112	0.000
Falcon sp.	2	0.06	0.01	0.000	0.0028	0.000
Harrier sp	5	0.07	0.02	0.000	0.0078	0.000
Hobby	2	0.06	0.01	0.000	0.0026	0.000
Honey Buzzard	1083	0.07	4.31	0.045	1.7221	0.018
Kestrel	13	0.06	0.04	0.000	0.0177	0.000
Marsh Harrier	29	0.07	0.12	0.001	0.0465	0.000
Montague's Harrier	12	0.07	0.05	0.000	0.0183	0.000
Pallid Harrier	14	0.06	0.05	0.001	0.0207	0.000
Red Footed Falcon	1	0.06	0.00	0.000	0.0013	0.000
Sooty Falcon	4	0.06	0.01	0.000	0.0055	0.000
Steppe Buzzard	2	0.07	0.01	0.000	0.0030	0.000
White Pelican	260	0.13	1.87	0.019	0.7481	0.008
White Stork	10601	0.09	54.55	0.568	21.8090	0.227
Totals	**12035**		**61.07**	0.636	**24.42**	0.254

For Autumn season

The autumn CRM modelling results indicated that for the 95% avoidance for the turbine configuration 2.6 MW the estimated collision is about 61 birds of different species. On the other hand, for the 98% avoidance it is about 24 birds.

For Spring season

The spring CRM modelling results for the turbine configuration 2.6 MW show a similar pattern. For the 95% avoidance the estimated collision is about 101 birds and for the 98% avoidance it is about 40 birds.

Barrier effects

Lekela project specific studies indicated that impacts of barrier effects and disturbance will be very minimal due to the limited scale of the project area, the lack of local vital habitats for feeding or resting of soaring birds and to some extent the distance of the study site from critical bottle necks and the main migration flyway for soaring birds..

Conclusion

CRM results cannot be treated as the sole metric for risk evaluation, but rather as a gauging tool that may provide a basic sense of magnitude of risk that can be anticipated. It is worth pointing out that the number of fatalities resulting from the modified design of 96 turbines rated 2.6 MW does not take into consideration any mitigation measures or protection that will be implemented during wind farm operations.

The following paragraphs outline the measures that will be taken to ensure the risks to avifauna are minimised over the lifetime of the project. These are developed from the mitigation proposals included in the original ESIA. The application of these measures is anticipated to result in a material reduction of casualties that were modelled on the basis of unmitigated operations.

- **Mitigation Measures**

The Strategic Impact Assessment carried out by Lahmeyer International and Ecoda (2017), rightly considered shut down as the key mitigation measure. If turbines do not operate during periods of high migratory activity and/or when high conservation status/collision risk susceptible species occur, then collision risk for migratory birds can be minimized. A well designed turbine shutdown programme that achieves this is a principal mitigation measure that can both facilitate effective operation of a large wind project and ensure safeguarding of birds at risk.

In this respect, the Study considered two main approaches for shut down; a fixed shut down programme, and a shut down on demand programme.

Fixed shutdown (FS) programme

This highly precautionary approach shuts down all turbines during peak migration periods. A fixed shutdown programme will incur a substantial loss in wind energy yield.

If applying a FS-programme all turbines of a wind farm shall be stopped during the critical migration period in spring (i.e. March 1st to May 18th) during daytime (i.e. 1.5 hour after sunrise to 1.5 hour before sunset).

Shutdown on-demand (SOD) programme

As data (including that collected by Environics for Lekela site over 6 seasons) indicate clearly that soaring bird migration takes place in peaks, and is not distributed evenly across the migration season. Moreover, over the specific day witnessing a peak, the crossing of birds over the site is not uniform over the day but is rather concentrated in specific hours of the day. With seasonal and daily peaks, the option of a fixed shut down scheme is excluded as it substantially increases the losses in power generated without a reduction in risk of bird collision.

A SOD-programme was regarded as a useful and effective mitigation measure for reducing collision risk for migratory soaring birds at wind turbines.

In a SOD-programme, selected turbines are stopped according to the four criteria listed below. Criteria for shut down should aim at minimizing the risks to birds while at the same time reducing losses of energy yield.

Recent Developments

The SOD is currently evolving to become the dominant operational mitigation measure. It is currently applied in at least three wind farms in Gabal El-Zeit south of the areas where the Lekela project is located and known to have a higher density of migration. In only one of these farms, the SOD is radar aided, while the other two totally rely on observers.

This system has been applied for three seasons to date. The results indicate that the SOD-programme has been an efficient and successful measure leading to a low number of collision casualties (even though a small number of birds collided) and to short periods of shut downs thus maximizing energy generation. The SOD system's operation is incrementally improved through a periodical review of procedures and its performance has witnessed higher levels[5].

1. **Globally threatened species according to the IUCN**
   Turbines shall be shut down whenever a bird or birds of a threatened species are detected migrating through the wind farm area or heading towards it at risky flight altitudes (i.e. within the rotor-swept area).

2. **Flocks with 10 or more large soaring birds (target species)**
   Turbines shall be shut down whenever flocks with 10 or more large soaring birds are detected migrating through the wind farm area or heading towards it at risky flight altitudes.
3. **Imminent high risk of collision**

[5] For example to date (8weeks into Spring 2019) , the two farms of a total of 340 MW in which Environics undertakes the SOD programme, totally relying on observers have seen around 40 shut down with no single bird casualty.

A single turbine or turbines shall be shut down whenever there is an imminent high risk of collision of a large soaring bird (e.g. a bird approaching a turbine at a close distance).

4. Sand storms

Turbines shall be shut down during sand storms whenever criteria 1 and 2 have been verified in the two hours that preceded the sand storm.

Shut down on demand (SOD) will be performed from the start of operation. The criteria for shutting down as they evolve through experience will be used by the Lekela farm. These criteria will be fine-tuned through an adaptive management approach resulting from live bird monitoring and fatality monitoring, and benefiting from the experience obtained during the first seasons.

Adopting a SOD programme with the criteria mentioned above will not differ, in general, according to the capacity and number of turbines. However, if the SOD in Lekela project will not be radar-aided, the only difference might be that more observation points and observers will be needed to effectively cover all turbines of a project site. This, however, will be optimized on site after construction.

- In all cases, an SOD programme should be combined with flight activity and fatality monitoring programmes to assess effectiveness of shutdown and refine its parameters, making it more efficient, including the length of the risk window, which is likely to become much smaller with more available data. This monitoring programme is already agreed with NREA and EEAA and will be implemented through the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) for the whole wind park, including Lekela Project, as part of a collective Active Turbine Monitoring Programme is currently being developed by RCREEE and, in case of radar detection, to be coordinated with the armed forces.

<u>Other Mitigation Measures</u>

Other mitigation measures are identical to those proposed and approved for the project configuration as detailed in the ESIA attached in Annex 2. These include:

- Maintaining the unattractiveness of the site to migrant birds. This is achieved by rigorously banning any type of cultivation, or plantation of green areas in or around the site; prevention of garbage or other solid or liquid waste in or near the site.
- Reducing risks from power lines through installing markers or underground power cables if possible.
- Post-construction monitoring, particularly during the initial stages of operation to verify bird response predictions, and intervene if critical issues arise. This knowledge will be used to refine shutdown and risk management measures that need to be taken, and hence reduce long-term costs. The post construction monitoring effort must include a systematic carcass survey to assess actual mortality during operation.

Annex 2 – Collision Risk Model Methodology

The objective of the CRM is to provide the best possible predictions of the potential number and species of bird casualties due to collision with active rotors at the wind farm, i.e. without mitigation measures (e.g. shutdown).

The SNH (2010) model is composed of two components: Estimate of the number of birds predicted = number flying through rotor (component 1) x probability of a bird flying through rotor swept area being hit (component 2). **(1)**

Component 1 Number of birds in the rotor swept zone

1. The risk window "**W**" is an area that includes the wind turbines and located across the general flight direction of the birds. It was calculated through the following equation:
   W= length of turbine trains x rotor swipe height **(2)**
   The turbine train length was measured from turbine layout maps on Google Earth.
2. The number of birds (n) passing though the risk window per annum was obtained from the field during spring and autumn 2017 and 2018 surveys.
3. The area of the wind farm rotors "**A**" was calculated as follows:
   $\mathbf{A= N\ rotors\ x\ \pi R^2}$ **(3)**
   Where N is the number of rotors and R is the rotor radius.
4. The total rotor area was expressed as a proportion of the risk window (A/W)
   The number of birds flying through rotor (component 1) is then obtained by multiplying number of birds flying through risk window (n) x proportion occupied by rotor area:
   Component 1= n x (A/W) **(4)**

Component 2 Probability risk of collision

Component 2 establishes the probability of birds that are flying through the rotor swept zone being hit. Inputs of for estimating this probability of collision can be divided into two elements, one related to the bird species (its size, wing span and estimated migration speed); the other is related to turbine specifications (rotor length, rotation speed[6], etc.). The probability model takes into account that the bird may be at anywhere within the rotor risk area.

The following are the input parameters related to the turbine model type:

- Number of blades

[6] Scottish Natural History (SNH) (2010). Collision probability spreadsheet. Retrieved from https://www.nature.scot/wind-farm-impacts-birds-calculating-probability-collision

- Maximum chord width of blade
- Pitch
- Rotor diameter
- Rotation speed expressed as rotation period

Relevant bird input parameters are the following:

- Bird length
- Wing span
- Flight style (Flapping vs Gliding)
- Bird Speed

References

Scottish Natural History (SNH) (2010). Collision probability spreadsheet. Retrieved from https://www.nature.scot/wind-farm-impacts-birds-calculating-probability-collision