The Arab Republic of Egypt

FY2021 Ex-Post Evaluation Report of
Japanese ODA Loan Project
"Gulf of El Zayt Wind Power Plant Project"

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0. Summary

The objective of the Project was to increase the power supply and curb fossil fuel use by constructing a new wind power generation facility in the Gulf of El Zayt, which is located on the coast of the Red Sea, Egypt, thereby contributing to the fulfillment of electricity demand, climate change mitigation through the reduction of greenhouse gas (GHG) emissions, and economic and social development. Regarding relevance, this project is "consistent with the development plan" and "consistent with the development needs." Concerning coherence, it is "consistent with Japan's ODA Policy" and "externally coherent." As for "internal coherence," while the completed ODA loan projects and this project are complementary to each other from the perspective of supplying clean energy, no specific cooperation or synergistic effect was observed. Based on the above, relevance and coherence are high. With regard to efficiency, the outputs were mostly as planned, but the project period was slightly longer than the initial plan because: the contractors' pre-qualification examination process and bidding procedure required time due to the Egyptian revolution; the detailed design, confirmation, and customs clearance of the electrical equipment were delayed; and the project had to deal with a contractor's bankruptcy. Nevertheless, the project cost was within the plan, and thus, efficiency is high. Regarding effectiveness and qualitative effect indicators (actual values), targets were met for "capacity factor," "plant availability," "net electrical energy production," and the "net reduction of GHG (CO_2)," while the "outage duration hours due to planned inspection/repair" was generally close to the target. As for "outage duration hours due to mechanical breakdown," the target was not achieved. Although the impact may be limited at the time of the ex-post evaluation, it was confirmed that this project plays a role in revitalizing the economy and improving public welfare through the stable supply of electricity. Therefore, the effectiveness and impacts are high. There seems to be no major concern about the outlook for the sustainability of the effects generated by this project. Therefore, the sustainability of the project effects is very high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location
(Source: JICA)

Developed Wind Power Facility
(Gulf of El Zayt)

1.1 Background

Before the start of this project, as the economy grew rapidly in Egypt, demand for electricity increased at an average annual rate of 7.1% after 1996. The actual electricity reserve rate[1] was low, and the electricity supply and demand were under pressure. Traditionally, most electricity production used oil and natural gas produced domestically. However, it was anticipated that domestic resources alone would not be sufficient to supply electricity and imports of energy resources would increase if the electricity demand were to continue to grow. Therefore, it was feared that energy security and external balance would severely be affected. In addition, awareness of global warming was increasing year by year in Egypt. As it would contribute to the reduction of greenhouse gas emissions and realization of economic development while considering the environment, expectations were on the rise for the development and operation of a wind power generation facility in the Red Sea coastal area, where stable wind direction and speed were predicted throughout the year.

1.2 Project Outline

The objective of this project is to increase the power supply and curb fossil fuel use by constructing a new wind power generation facility in the Gulf of El Zayt, which is located on the coast of the Red Sea, Egypt, thereby contributing to the fulfillment of electricity demand, climate change mitigation through the reduction of greenhouse gas (GHG) emissions, and economic and social development.

[1] Electricity reserve rate = {(power plant capacity - peak-time power supply)/power plant capacity}*100.

Loan Approved Amount/ Disbursed Amount	38,864 million yen/25,243 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 15, 2010/March 30, 2010
Terms and Conditions	Main Contract: Interest Rate 0.3 % Repayment Period 40 years (Grace Period 10 years) Conditions for Procurement General Untied Consulting Services: Interest Rate 0.01% Repayment Period 40 years (Grace Period 10 years) Conditions for Procurement General Untied
Borrower/ Executing Agency(ies)	New and Renewable Energy Authority (hereinafter referred to as "NREA") (guarantor is the government of the Arab Republic of Egypt)/NREA (wind power plant related components), Egyptian Electricity Transmission Company (hereinafter referred to as "EETC") (substation related components)[2]
Project Completion	April 2019
Target Area	Gulf of El Zayt, Red Sea Governorate
Main Contractor(s) (Over 1 billion yen)	Gamesa Eolica SL (Spain)
Main Consultant(s) (Over 100 million yen)	Lahmeyer International GMBH (Germany)/Oriental Consultants (Japan) (JV)
Related Studies (Feasibility Studies, etc.)	- Feasibility Study by JETRO (March 2005) - Special Assistance for Project Formation (SAPROF) by JICA (March 2009)
Related Projects	[ODA Loan Projects] - "Zafarana Wind Power Plant Project" (L/A signed in December 2003) - "Kuraymat Integrated Solar Combined Cycle Power Plant Project" (Phase I: L/A signed in January 2006, Phase II: December 2008) - "Hurghada Photovoltaic Power Plant Project" (L/A signed in February 2016) [Grant Aid Projects] - "Project for Introduction of Clean Energy by Solar Electricity Generation System" (G/A signed in

[2] The project implementation structure was that the NREA being in charge of the construction of wind power generation facility, associated electrical and civil engineering work, and laying of transmission lines from the power generation facility to the nearby substation, while the EETC being charge of installing substation equipment inside the substation to connect the wind power generation facility to the grid.

	February 2010) [Other International Organizations, Aid Agencies] - "Wind power project (200 MW wind power facility)" (joint co-fining by Kreditanstalt für Wiederaufbau (hereinafter referred to as "KfW"), European Investment Bank (hereinafter referred to as "EIB"), European Commission (hereinafter referred to as "EC")) - "Wind power project" (40 MW wind power facility)" (KfW) - "Wind power project" (120 MW wind power facility)" (Fondo para la Internacionalización de la Empresa (hereinafter referred to as "FIEM"[3])" - "Wind power project" (250 MW wind power facility)" (KfW)

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenichi Inazawa, Octavia Japan, Co., Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: September 2021–November 2022

Duration of the Field Study: No international travel was involved, and surveys were conducted remotely using a field survey assistant.

2.3 Constraints during the Evaluation Study

(Remote Field Survey Utilizing a Field Survey Assistant)

Due to COVID-19, the external evaluator did not travel internationally for this study. Using the local survey assistant, the external evaluator conducted the site visits remotely, collecting information/data and conducting interviews with the individuals concerned. The external evaluator analyzed the information collated so as to conduct evaluation analyses and make appropriate judgements.

[3] Spanish government-affiliated fund.

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance/Coherence (Rating: ③[5])

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Egypt

Before the start of this project, the Egyptian government formulated the *Sixth Five-Year Plan* (2007/08–2011/12[6]), stating its policy to add 8,547 MW to the power generation capacity in order to increase the power generation by 9.1% per year. In addition, the government established the Supreme Energy Council, chaired by the prime minister, indicating its policy to reduce dependence on oil and actively develop new and renewable energies. This council also set up a plan to increase the composition of new renewable energy to 20% of the country's total power generation capacity by 2020 (of which 12% would be wind power and 8% hydroelectric power).[7]

At the time of the ex-post evaluation, the government of Egypt has formulated the *Electricity Sector Strategy* through the Egypt Economic Development Conference,[8] in which the government indicated its plan to increase the installed capacity of power generation to 54.5 GW by 2022. In addition, the government established a national agenda called *Egypt's Vision 2030* in February 2016, announcing goals and reform plans for the power sector including renewable energy, with a view to realizing a diverse, competitive and balanced economy. Additionally, the government is also advocating an energy efficiency and diversification strategy centered on renewable energy promotion. Furthermore, the *Integrated Sustainable Energy Strategy to 2035* (hereinafter referred to as "ISES 2035"), announced by the Ministry of Electricity and Renewable Energy (MoERE) in 2015, advocates the establishment of energy security and the promotion of renewable energy by involving all sectors. Table 1 shows the energy composition ratio of Egypt before and after the start of this project. Although the above-mentioned target for the wind power composition (12%) was not reached, the government has indicated its policy to increase the share of renewable energy including wind power, so as to ensure a stable supply of electricity.

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory.
[5] ④: Very High, ③: High, ②: Moderately Low, ①: Low.
[6] Egypt's fiscal year begins in July and ends in June.
[7] Reference information: the total installed capacity of power generation before the start of this project (2006) was 22,227 MW. The composition of the power source was 19,075 MW (85.8%) thermal; 2,847 MW (12.8%) hydraulic; and 305 MW (1.4%) wind—the majority was thermal power generation. With the development of natural gas oil fields in Egypt, the weight of natural gas increased, accounting for 80.3% (source: JICA documents).
[8] It was held in March 2015.

Table 1: Energy Composition Ratio Before and After the Start of This Project

	Thermal	Hydro	Wind and Solar *Note 1	Others *Note 2
Before the Start of This Project (2006)	85.8% (19,075 MW)	12.8% (2,847 MW)	1.4% (305 MW)	-
At the Time of the Ex-Post Evaluation (2021)	86.7% (51,634 MW)	4.8% (2,832 MW)	5.1% (3,016 MW)	3.4% (2,048 MW)

Source: JICA and NREA documents
Note 1: It was only wind power before the start of this project.
Note 2: Power generation by a private sector operator (build, own, operate and transfer (BOOT) method).

Based on the above, the government of Egypt has attached great importance to the promotion of renewable energy, the statement of goals and reforms in the electric power sector, and the establishment of energy security, before the start of this project as well as at the time of the ex-post evaluation. Therefore, it is consistent with the policies and measures stipulated in the national and sector plans.

3.1.1.2 Consistency with the Development Needs of Egypt

Before the start of this project, as the economy grew rapidly in Egypt, demand for electricity increased at an average annual rate of 7.1% after 1996. The actual electricity reserve rate was low, and the electricity supply and demand were under pressure. Traditionally, most electricity production used oil and natural gas produced domestically. However, it was anticipated that domestic resources alone would not be sufficient to supply electricity and imports of energy resources would increase if the electricity demand were to continue to grow. Therefore, it was feared that energy security and external balance would severely be affected. In addition, awareness of global warming was increasing year by year in Egypt, and the Supreme Energy Council was established as mentioned above. At this council, climate change measures such as reducing dependence on oil and actively developing new renewable energy were presented. As it would contribute to the reduction of greenhouse gas emissions and realization of economic development while considering the environment, expectations were on the rise for the development and operation of wind power generation facilities in the Red Sea coastal area, where stable wind direction and speed were predicted throughout the year.[9]

At the time of the ex-post evaluation, the government of Egypt is working to increase its power generation capacity. The government continues to have high expectations for power generation utilizing renewable energy using wind and solar power sources, with the aim of curbing

[9] At the time of the appraisal (2010), wind power generation projects other than this one were already being implemented, such as: a wind power plant facility with an installed capacity of 5.0 MW in the Hurghada area; and one with 425 MW in the Zafarana area. While the government's plan was to operate wind power generation facilities with a total of 545 MW by the end of 2009, expectations for wind power generation projects were even higher in order to balance vigorous power demand and environmental consideration.

greenhouse gas emissions and responding to global warming. According to the above-mentioned ISES 2035, the government aims to increase the share of renewable energy to 20% of the total electricity capacity by 2022 and 42% by 2035.[10] As an average wind speed of 8 to 10 m/sec can be secured on the coast of the Red Sea, wind power generation projects supported by Fondo para la Internacionalización de la Empresa (hereinafter referred to as "FIEM"), KfW, EIB, and EC have been implemented in the Gulf of El Zayt area in addition to this one.[11] Additionally, a project supported by KfW is currently being implemented as of the time of the ex-post evaluation. The total capacity of the projects above is 830 MW,[12] which makes it the largest wind power generation area in the Middle East and Africa. Furthermore, the Egyptian government has had a plan in recent years to promote electricity exports to Europe (Greece, Cyprus, etc.) and neighboring countries (Sudan, Saudi Arabia, etc.).[13]

Based on the above, stabilizing the power supply by increasing power generation capacity has been a major issue for Egypt, both before the start of this project and at the time of the ex-post evaluation. Expectations for renewable energy power generation projects using wind and solar power continue to be high, with a view to curbing greenhouse gas emissions and responding to global warming. Therefore, this project is consistent with the development needs.

3.1.2 Coherence (Rating: ③)

3.1.2.1 Consistency with Japan's ODA Policy

Before the start of this project, Japan announced the *Hatoyama Initiative* (September 2009) with the aim of achieving a "balance between the environment and economy" and contributing to a transition to "low-carbon society" globally. The government indicated its plan to promote energy conservation and clean energy, such as through the introduction of energy infrastructures including low-carbon power supply systems. In addition, the *Medium-Term Strategy for Overseas Economic Cooperation Operations*, formulated by JICA (former JBIC) in April 2005, placed "a foundation for sustainable growth" as one of the priority areas, indicating that it would support the promotion of sustainable growth through the development of economic and social

[10] In addition, as a future energy strategy, it is clearly stated that Egypt will become an energy hub for Europe, Asia and Africa, through the expansion of grid interconnection inside and outside the Middle East Arab region.
[11] The installed capacity is 220 MW. It can be estimated to be approximately 7.3% (= 220 MW / 3,016 MW) of the total installed capacity of renewable energy power generation facilities nationwide, that is, 3,016 MW.
[12] Of the total installed capacity of the renewable energy power generation facilities nationwide (3,016 MW), the wind power generation capacity of the entire Gulf El Zayt area is estimated to be approximately 27.5% (= 830 MW / 3,016 MW).
[13] In 2021, the Egyptian government signed agreements with export destination countries on transmission line connections; electricity exports are expected to increase in the future. One of the factors behind this is that, as will be explained in Section 3.3.2.1 (Intended Impacts) (Figure 4: Changes in Electricity Reserve Rate), the installed capacity of power generation has increased significantly in the last four to five years, and an excess supply capacity has been created. As discussed earlier, the government has also set a goal to raise the share of renewable energy to 42% by 2035. Thus, it is observed that the government will implement measures such as establishing energy source security, raising awareness of global warming, and improving the balance of payments. From that viewpoint, it is anticipated that there will be further expectations in terms of policy and development needs.

infrastructures including electricity, which is essential for the activities of the private sector. Additionally, as part of another priority area, "global issues and peace-building," it was indicated that JICA would actively support the control and reduction of greenhouse gases, in order to address global environmental problems. Furthermore, JICA's *Country Assistance Implementation Policy* formulated in 2005 set economic and social infrastructure development and efforts to address environmental issues as priority areas, based on the fact that Egypt had issues such as sustainable economic growth and environmental conservation.

This project supports the power sector including renewable energy, for the development of Egypt's economic and social infrastructures, and is to contribute to environmental conservation through the development of economic infrastructures. Therefore, it is consistent with Japan's ODA policy.

3.1.2.2 Internal Coherence

The completed ODA loan projects—"Zafarana Wind Power Plant Project" and "Kuraymat Integrated Solar Combined Cycle Power Plant Project"—aimed to increase electricity supply and respond to electricity demand and climate change, which is similar to the objective of this one. Although specific mutual cooperation or synergy was not confirmed during the implementation of this project, the completed projects and this one are complementary to one another, as they all aimed to supply clean energy. Therefore, it can be said that this project contributes to the establishment of national energy security and the promotion of renewable energy.

3.1.2.3 External Coherence

In the Gulf of El Zayt area located on the coast of the Red Sea, wind power generation facilities have been developed with the support of this project, KfW, and FIEM, as well as multiple co-financing donors. Taking advantage of the characteristics of the location where an average wind speed of 8 to 10 m/sec can be secured, this project and other donors' projects collectively generate electricity and contribute to increasing power supply and curbing fossil fuel use through substations. In this sense, cooperation is created. Synergy is also manifested among these projects as they all aim at a stable power supply. In relation to the international framework, this project is in line with sustainable development goals such as: "Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all" and "Goal 13: Take urgent action to combat climate change and its impacts," from the perspective of contributing to global warming mitigation by increasing electricity supply and curbing fossil fuel use.

<Summary of Relevance and Coherence>

This project is "consistent with the development plan" and "consistent with the development needs". Regarding coherence, while "internal coherence" in the form of concrete cooperation or

synergy was not observed, it is "consistent with Japan's ODA policy" and "externally coherent". Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

Table 2 shows the planned and actual outputs of this project.

Table 2: Planned and Actual Outputs of This Project

Plan (at the time of the appraisal: 2010)	Actual (at the time of the ex-post evaluation: 2021–2022)
1) Materials and equipment, civil engineering work, etc. (a) Construction of a new wind power generation facility with a total output of 220 MW (1) Wind power generator (single unit output of 2 MW: 110 sets) (2) Related equipment, such as control monitoring system (3) Electrical work and civil engineering installation work. (b) Expansion of substation facility and interconnection lines The installation of power receiving and transforming equipment such as transformers and switchgears for JICA's project in the substation[14] is covered by the Japanese ODA loan (substation construction and interconnection lines between the substation and the transmission line are not provided for by the ODA loan and are to be financed by KfW and the Egyptian power holdings company (hereinafter referred to as "EEHC")).	1) Materials and equipment, civil engineering work, etc. (a) Construction of a new wind power generation facility with a total output of 220 MW ⇢ Implemented as planned. (b) Expansion of substation facility and interconnection lines ⇢ Some changes were made (construction of the substation by other donors was cancelled, and changed to renewal of an existing substation located near this project's site. Thus, installations of substation equipment and interconnecting lines were added).
2) Consulting services Detailed design, supervising pre-qualification examination (P/Q) and bid documents, facilitating P/Q examination and bid evaluation, assisting contract negotiations between the executing agency and contractors, construction supervision, etc.	2) Consulting services ⇢ Mostly implemented as planned.

Source: JICA documents (at the time of the appraisal), Project Completion Report and answers to the questionnaire (at the time of the ex-post evaluation)

[14] A substation is a facility that aggregates power generated by wind power generators.

The differences between the plans and actual results shown in Table 2 are explained below.

1) Materials and Equipment, Civil Engineering Work, Etc.

(a) Construction of New Wind Power Generation Facility with a Total Output of 220 MW

Implemented as planned.

(b) Expansion of Substation Facility and Interconnection Lines

The substation development plan was reviewed at the time of the detailed design. The plan was changed from the construction of a substation by other donors to the renewal of an existing substation, and as a result, the installation of substation equipment and interconnecting lines were added. In addition, since it was changed to an existing substation renewal, the construction of a building and firewalls became unnecessary. Factors in this were: (1) as the existing substation was located almost in the center of the three wind power generation projects (KfW, JICA, and FIEM), it turned out that expanding the existing substation located in the center of the three wind power plants would be more efficient for transmitting power to the transmission system than constructing a new substation through this project; and (2) the existing substation had space to store the equipment and machinery of this project, and a project cost reduction was expected.

2) Consulting Services

The consulting services were mostly implemented as planned. As will be discussed in Section 3.2.2.2 Project Period, the project period was extended. Along with this, the duration of the consulting services was also expanded.[15]

3.2.2 Project Inputs

3.2.2.1 Project Cost

According to the plan at the time of the appraisal, the total project cost was 66,059 million yen (of which 38,864 million yen was to be covered by the Japanese ODA loan). In reality, the actual cost was 29,065 million yen (of which 25,243 million yen was provided by the Japanese ODA loan), which was within the plan (approximately 44% of the plan). The main reason for the difference is that the Egyptian pound fell sharply against the Japanese yen during the project implementation. The main factors behind the exchange rate fluctuations are that the Central Bank of Egypt introduced a floating exchange rate system in the latter half of 2016, which was followed by economic turmoil. Another reason is that efficient contracting was achieved through

[15] One of the factors behind the extension was, as will be described later in Section 3.3.2.2 Other Positive and Negative Impacts, that the need arose to monitor migratory birds during and after the construction of the wind farm, and that such supervision needed to continue during the warranty period (three years) after the start of service. Particularly for the latter, as will be explained in Section 3.3.1.1 Quantitative Effects (Operation and Effect Indicators) under Effectiveness, the construction supervision consultant's supervision and support were needed since many unplanned outages occurred during the warranty period after the start of service. The consulting services were extended in order to realize the steady operation of the facility, and one can say it was a realistic decision. The cost associated with the extension is not included in the actual amount stated in Section 3.2.2.1 Project Cost, and was borne by the Egyptian side.

competitive tendering for the construction of the wind power generation facility and the procurement of materials and equipment.

3.2.2.2 Project Period

Table 3 shows the initial plan and the actual project period. At the time of the appraisal, the project was planned to run from March 2010 to June 2015 for five years and four months (64 months).[16] In reality, it lasted from March 2010 to April 2019 for nine years and two months (110 months), which was longer than planned (approximately 172% of the planned timeframe). This was mainly because: a) the contractors' pre-qualification examination process and bidding procedure required time; b) the detailed design, confirmation, and custom clearance of electrical equipment (medium voltage switchgear,[17] etc.) also needed time; c) delays were caused by the bankruptcy of a contractor responsible for electrical equipment works and the power generation turbine installation (the main delay was in the delivery of equipment and machinery)[18]; and d) the negotiation between the contractor in charge of wind power generation equipment construction and the New and Renewable Energy Agency (NREA) was lengthened, over an issue of payment in local currency. The extension of the consulting services is as explained above.

Table 3: Initial Plan and Actual Project Period

	Initial Plan	Actual
(Whole Project)	March 2010–June 2015 (64 months)	March 2010–April 2019 (110 months)
1) Selection of Consultant	April 2010–March 2011 (12 months)	September 2010–January 2011 (5 months)
2) Consulting Services	April 2011–June 2015 (51 months)	July 2012–December 2021 (116 months)
3) Procurement and Installation of Materials and Equipment, etc.	July 2012–June 2015 (36 months)	February 2015–April 2019 (51 months)

Source: documents provided by JICA (initial plan), Project Completion Report and answers to the questionnaire (actual)

When discussing the fact that the contractors' pre-qualification examination and bidding processes required time, it is necessary to take into account the political instability and delay in the organizational process due to the Egyptian revolution (Arab Spring) after 2011. The three years and three months (39 months), from January 2011 (when a large-scale anti-government demonstration occurred) to March 2014 (when Prime Minister Mahlab was elected and the new

[16] At the time of the appraisal, the completion time of this project was defined as "at the start of facility operation."
[17] A device that integrates functions for receiving, transforming, distributing and supplying power and has an insulating function so that it can be used safely for a long period of time is called a switchgear.
[18] Although the contractor went bankrupt in 2016, the work was carried out without any problems until the completion of this project.

cabinet was inaugurated after the referendum of the new constitution), is considered a period especially affected by external factors.[19] It is judged to be an unexpected event (an event that was not anticipated at the time of the appraisal, and such a political change has not occurred continuously and frequently).[20] Excluding this period from the project span is considered to be a realistic and accurate judgment. Therefore, although the project was delayed, taking approximately 172% of the plan as discussed above, it is desirable to calculate the actual length as 71 months (= 110 - 39 months) by excluding this period. The actual extent was 71 months compared to the planned 64 months, that is, the project period was approximately 111% of the plan; and therefore, it was slightly longer than the plan.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

Economic Internal Rate of Return (EIRR)

The EIRR was calculated to be 13.89% at the time of the appraisal, considering the reduction in the construction, fuel, operation and maintenance costs of a thermal power plant (alternative power generation facility) and the revenue from emission right sales as "benefits," the project, operation and maintenance costs as "costs," and a project life of 20 years. The EIRR was recalculated at the time of the ex-post evaluation based on the same assumptions as at the time of the appraisal, and the result was 27.5%, higher than what was expected at the time of the appraisal. One of the reasons is that the actual costs of construction and operation/maintenance were lower than the planned amount. (It was particularly affected by the fact that the Egyptian pound fell sharply against the euro during the project implementation, pertaining to some part of the construction and operation/maintenance costs.)

Financial Internal Rate of Return (FIRR)

At the time of the appraisal, the FIRR was calculated to be 7.19%, considering revenues from selling electricity and selling emission credits as "benefits," the project, operation and maintenance cost as "costs," and a project life of 20 years. The FIRR was recalculated at the time of the ex-post evaluation, using the same conditions as at the time of the appraisal, and the result was 14.1%, higher than what was expected at the time of the appraisal. The reasons for this are: a) similar to the above, the actual costs of construction and operation/maintenance were lower than the planned amount; and b) due to inflation, the price of electricity at the time of the ex-post evaluation is higher than what was anticipated at the time of the appraisal, which increased the

[19] Specifically, the consulting service started late; it took time for the Egyptian side to confirm the legal matters concerning the consultant and to issue the letter of credit (L/C), which had a slight impact on the subsequent procurement and installation of materials and equipment.

[20] Reasons for recognizing it as an external factor include "events that do not occur continuously or frequently in the project area" and "events that were not assumed as risks at the time of the appraisal" (Reference: p4 of the *JICA Ex-Post Evaluation Reference 2021*).

revenue from selling electricity.

<Summary of Efficiency>

The outputs of this project were mostly as planned, and the project cost was within the plan. However, the project period was slightly longer than what was initially planned because: the contractors' pre-qualification examination process and bidding procedure required time due to the Egyptian revolution (Arab Spring); the detailed design, confirmation, and customs clearance of the electrical equipment were delayed; and the project had to deal with a contractor's bankruptcy. Therefore, the efficiency of the project is high.

Photo 1: Full View of the Substation (EETC Facility)

Photo 2: Switchgear for Power Distribution (EETC Facility)

3.3 Effectiveness and Impacts[21] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Table 4 shows the quantitative effect indicators of this project (baseline, target and actual values).

[21] When providing the sub-rating, Effectiveness and Impacts are to be considered together.

Table 4: Quantitative Effect Indicators of This Project (Baseline, Target, Actual values)

Indicator	Base-line value	Target value 2017 2 Years After Completion	Actual value		
			2018/2019 Completion Year	2019/2020 1 Year After Completion	**2020/2021** 2 Years After Completion
1) Capacity factor (unit: %) *Note 1	-	45	33.9	38.8	**46.1**
2) Outage duration hours due to mechanical breakdown (unit: hour)	-	18,250	97,342	138,773	**30,264**
3) Outage duration hours due to strong wind, etc. (unit: hour)	-	0	0	0	**0 (1,263.55)**
4) Outage duration hours due to planned inspection/repair (unit: hour)	-	2,920	5,280	2,643	**3,325**
5) Plant availability (unit: %) *Note 2	-	95	98.3	97.6	**98.9**
6) Net electrical energy production (unit: GWh)	-	867	656	749	**892**
7) Net reduction of GHG (CO_2) (unit: ton/CO_2) *Note 3	-	494,000	361,667.9	412,725.5	**490,837.1**

Source: Documents provided by JICA (baseline, target), answers to the questionnaire and Project Completion Report (actual)

Note 1: An indicator to confirm the validity of the operation plan. The calculation is: annual power generation / (rated output x number of hours per year) x 100.

Note 2: An indicator to confirm the validity of the operation plan. The calculation is: (annual operating hours / annual number of hours) x 100.

Note 3: How to calculate the net reduction of GHG (CO_2): based on the power generation composition ratio in Egypt at the time of the appraisal (2010), the CO_2 emissions (estimated value) per power generation amount (GWh) were calculated to be 569.78 tons. By constructing a wind power generation facility that does not consume fossil fuels, an annual power generation of 867 GWh was expected. The reduction of CO_2 emissions was expected by the following calculation: 867 GWh x 569.78 tons / GWh = 494,000 tons per year. At the time of the ex-post evaluation (2021), the NREA estimates CO_2 emissions to be about 551 tons in consideration of the environment surrounding renewable energy in recent years. The actual values in the table are calculated as follows: net electrical energy production (GWh) multiplied by approx. 551 tons.

Seven operation and effect indicators were set at the time of the appraisal. The target value was set for two years after the completion (two years after the facility was put into service). Since the actual completion was in 2019, actual value data were collected for 2020/2021 (actual value of a total of 110 sets that were procured), which is two years after the completion. Below is the analysis of each indicator.

1) Capacity Factor

The actual value has achieved the target. In 2018/2019, it was low because the wind power generation facility was shut down for a certain period as the transformer in the substation (tap

changer that responds to fluctuations in the received voltage) did not sufficiently respond to the voltage rise and fall and the initial adjustment was not perfect, and the contractor struggled to respond and required time. Apart from this, in 2019/2020, the grid voltage after operation was a little unstable, and the capacity factor was a little low due to the decrease in power generation; but in 2020/2021, these issues have been resolved because the transformers are operating stably and are being operated and maintained without delay.

2) Outage Duration Hours due to Mechanical Breakdown

The actual value has not reached the target. This is related to the fact that 1) capacity factor above did not reach the target value and was low, that is, the operation was not stable for a while after the start of service.[22] However, these issues are being resolved, and in 2020/2021, the number decreased significantly compared to the previous year.

3) Outage Duration Hours due to Strong Wind, etc.

The target value was zero (= it would not occur). However, 1,263.55 hours were recorded in 2020/2021. This was not due to natural disasters such as storms. It was because the operation of the power generation facility was voluntarily suspended due to the spread of COVID-19 that year. Pandemics do not occur continuously or frequently; it happened not only in Egypt but on a global scale. It is thus regarded as an external factor that could not be assumed at the time of the appraisal. Therefore, it is not appropriate to analyze the project effect and make a judgment concerning this indicator.

4) Outage Duration Hours due to Planned Inspection/repair

The actual values for each year are generally close to the target value. The outage in 2018/2019 is the result of the fact that many inspections were required for the recovery, relating to the fact that 1) capacity factor above was low, not reaching the target. In 2020/2021, the outage time was longer than expected because the turbine blades (equipment of the power generation turbine) needed to be cleaned and the filters had to be replaced.

5) Plant Availability

Actual values have achieved the target value in each year. According to the NREA, this is due to the fact that there have been no major delays in the preventive maintenance of the wind power generation facilities, the maintenance staff engaged in power generation turbines are working carefully, and the guidance of the construction supervision consultant has been helpful.

[22] As mentioned above, responding to the transformer and initial adjustment required time, which may suggest the unplanned downtime (actual value) was not really a "breakdown." However, outrage duration, including operation failure, is considered "outage duration hours due to mechanical breakdown."

6) Net Electrical Energy Production

The actual values have reached the target. This is related to the fact that "1) capacity factor" was low and did not reach the target, and the operation status become favorable in 2020/2021 (two years after completion), since when the amount of power generation has been on the rise.

7) Net Reduction of GHG (CO_2)

The actual values are close to the targets. At the time of the appraisal, the CO_2 emissions (estimated value) per power generation (GWh) were calculated to be 569.78 tons, based on the power generation composition ratio in Egypt at that time. At the time of the ex-post evaluation, the NREA calculated it to be approximately 551 tons, considering the current environment surrounding renewable energy. It can be said that there is no substantial difference between the CO_2 emissions (estimated value) at the time of the appraisal and the ex-post evaluation. In other words, the reduction is calculated based on the actual value of net electrical energy production, but it can be noted that the value is generally close to the target.

3.3.1.2 Qualitative Effects (Other Effects)

(Increase in Power Supply, Balancing with Curbing Fossil Fuel Use)

In this survey, we requested the NREA to comment on the relationship between the increase in the power supply, control over fossil fuel use (reduction of environmental load) and this project through questionnaires and meetings. However, no case that led to the manifestation of specific effects has been confirmed. Nevertheless, the wind power generation sector has been assisted by this project as well as European countries so far, and there is still plenty of space for the development of wind power generation projects in the future. In the Red Sea coastal area especially, large wind speeds of 8 to 10 m/sec can be obtained throughout the year. Thus, in the future, it is likely that increasing the power supply and curbing fossil fuel use (reducing the environmental load) will attract more attention, with renewable energy becoming more important.

Photo 3: Wind Power Generator

Photo 4: Anemometer

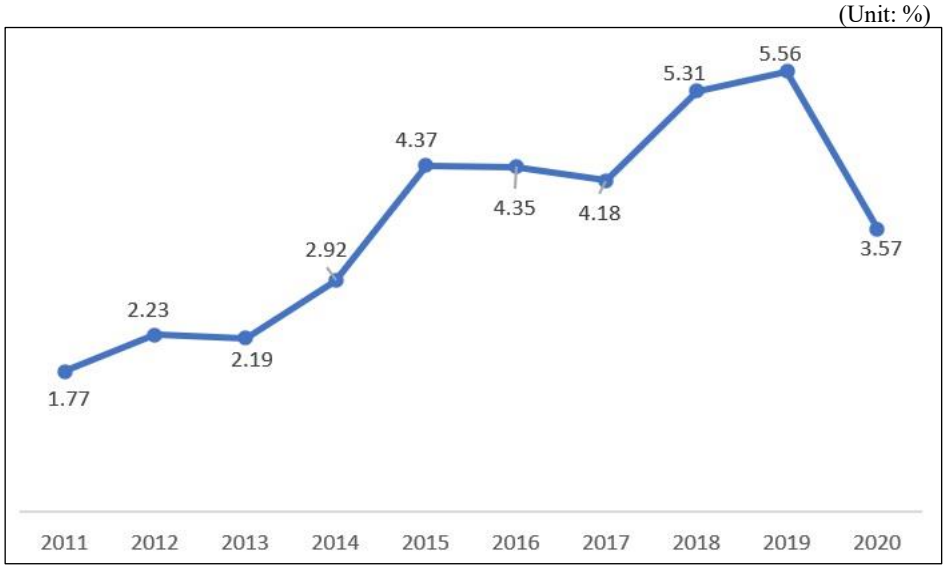
Photo 5: Transformer

3.3.2 Impacts

3.3.2.1 Intended Impacts

1) Contribution to Revitalizing Economic Activities and Improving Public Welfare Through Stable and Efficient Supply of Electricity

Figure 1 shows the national gross domestic product (GDP) growth rate from the start of this project to the time of the ex-post evaluation, while Figure 2 illustrates the changes in population. Similarly, Figure 3 presents the supply-demand balance of electricity, and Figure 4 demonstrates the changes in electricity reserve rates.

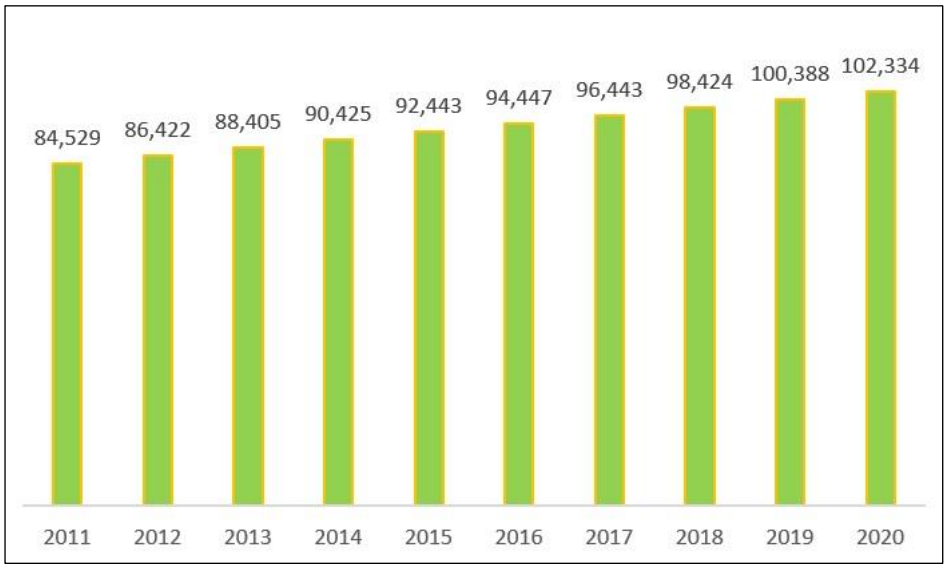


Source: World Bank[23]

Figure 1: Egypt's GDP Growth Rate Trends (2011–2020)

[23] Quote source: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=EG (accessed on December 12, 2021).

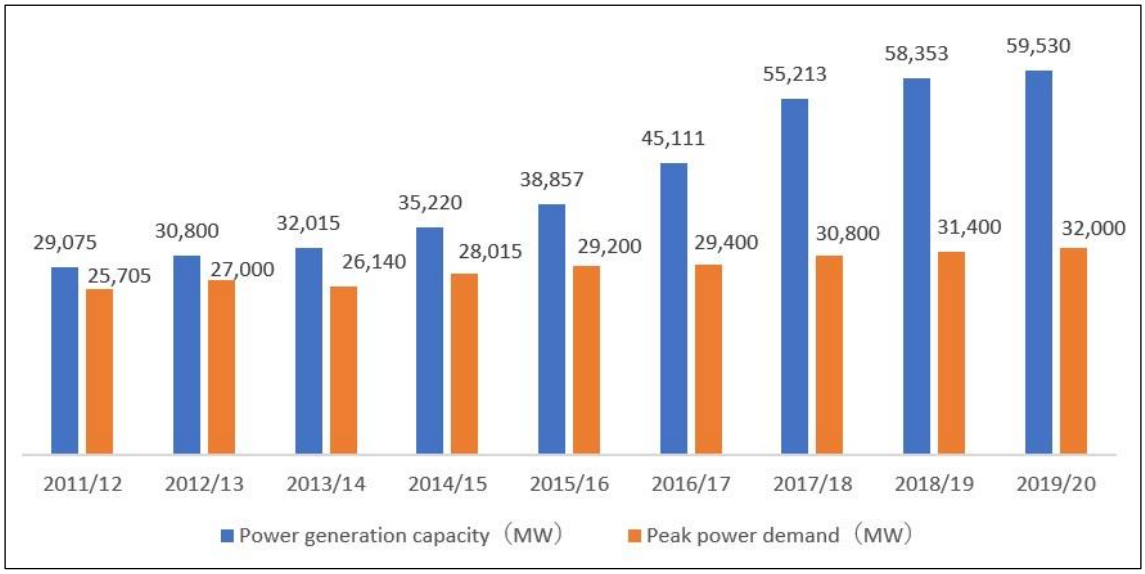
(Unit: thousand)



Source: World Bank[24]

Figure 2: Changes in Egypt's Population (2011–2020)

(Unit: MW)

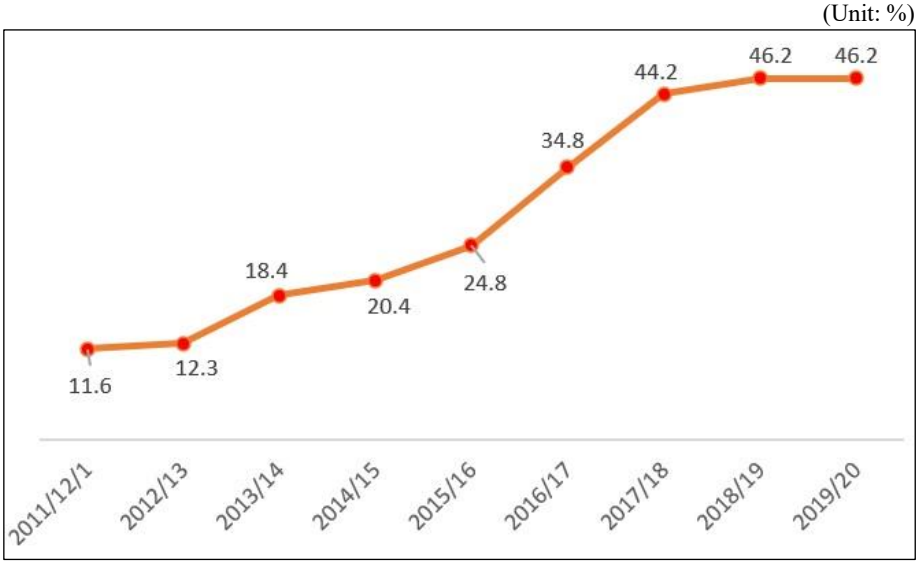


Source: EEHC and NREA

Figure 3: Egypt's Electricity Supply and Demand Balance Trends (2011/12–2019/20)

[24] Quote source: https://data.worldbank.org/indicator/SP.POP.TOTL?locations=EG (accessed on December 12, 2021).

(Unit: %)



Source: EEHC and NREA

Figure 4: Changes in Electricity Reserve Rates (2011/12–2019/20)

Regarding the national GDP trends in Figure 1, the stagnation after 2011 is thought to be the impact of the aftermath of the Egyptian revolution. Although there were signs of recovery after 2015, the GDP of 2020 was lower than the previous year due to the spread of COVID-19. In terms of the changes in population shown in Figure 2, it has been on the rise over the past 10 years. Figure 3 presents the trends of the power supply-demand balance. As mentioned in 3.1.1.1 Consistency with the Development Plan under Relevance, the government has been working to increase the installed capacity of power generation, and it can be observed that power supply and demand are improving gradually. As a result, as can be seen in Figure 4, the electricity reserve rate is on the rise. In an interview with the NREA, comments such as the following were received: "There is a focus on investment in the power sector—the expansion and construction of new power plants are underway in various parts of the country;" "The power supply is stable. Stable electricity supply is the highest priority. It is a source of vitality, improving livelihoods and improving corporate productivity." It can be said that this project plays a role in revitalizing the economy and improving public welfare through the stable supply of electricity.

2) Contribution to Promoting the Development and Utilization of New Renewable Energy Technologies

As mentioned above, this project's installed capacity of wind power generation is 220 MW, which is not large compared to the total power generation capacity of Egypt (59,530 MW). Therefore, it can be said that the impact of this project is limited. On the other hand, from the start of the procurement and installation of materials and equipment (February 2015) to the time of the ex-post evaluation, the country's installed capacity of renewable energy has increased significantly; it has more than quadrupled (700 MW in 2014/2015 ⇢ 3,016 MW in 2019/2020). Egypt's electricity sector accounts for approximately 13% of GDP and has a high degree of socio-

economic contribution. It is thought that the government's continued work on curbing the proportion of thermal power generation that depends on fossil fuel resources such as petroleum and liquefied natural gas (LNG) and developing clean energy will contribute to reducing risks associated with stable power supply while controlling greenhouse gases. Therefore, it can be said that wind power generation that plays a part in establishing clean energy, like this project, will continue to perform an important role in developing new renewable energy technologies and promoting its use.

3.3.2.2 Other Positive and Negative Impacts

1) Impacts on the Natural Environment

This project was classified as Category A[25] as it falls under the vulnerable areas listed in the "Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations" (enacted in April 2002). In addition, the environmental impact assessment (EIA) report for this project was approved by the Egyptian Environment Agency in April 2009.

It was confirmed by questionnaires and interviews with the NREA and the Egyptian Electricity Transmission Company (EETC) and on-site inspections that there was no particular impact on air pollution, water quality, or noise/vibration during the project implementation or after the project was completed. The NREA and the EETC monitored the environment, such as noise and vibration, during building. Even after the conclusion of construction, both organizations are monitoring the environment around the wind power generation facility and the substation by assigning technical staff (four for NREA and two for EETC).

(Mitigating Impacts on Ecosystems: Countermeasures Against Migratory Bird Collisions Around Wind Power Generation Facilities)

Prior to the start of this project, measures against migratory bird collisions had been pointed out among project personnel in the Gulf of El Zayt area. In 2016, when the project was underway, a consultant hired for this project by the JICA Egypt Office pointed out the need for "Shutdown On Demand" (hereinafter referred to as "SOD")—a countermeasure against migratory bird collisions at the project site.[26] For about three years from 2017 to 2020, the NREA started SOD in cooperation with the construction supervision consultant of this project as well as local companies. The dead bodies of 17 migratory birds were found around the wind farm in the fall of 2018, which were possibly due to collisions. As a countermeasure, the consultant recommended

[25] Although this project did not belong to the "affected sector" because resident relocation did not occur and negative impact was not anticipated/estimated to be small, the project site coincided with the flying route of migratory birds including rare species, and thus it was classified as Category A. Another reason is that the environmental impact assessment (EIA) conducted by the Egyptian side also recommended the implementation of risk mitigation measures after the completion of the project to avoid migratory bird collisions.

[26] According to the NREA, one of the reasons why migratory bird countermeasures were requested is that the NREA needed to report on the matter as per the request from the Egyptian Ministry of the Environment and JICA.

to conduct SOD, installing several wind speed measurement poles (masts), positioned wires on overhead lines, and placed marks around the wires to improve visibility, and if a flock of 10 migratory birds was confirmed to exist inside the wind power generation facility area. Since 2020, the NREA has been supervising and monitoring while outsourcing SOD.[27]

Table 5 shows the number of migratory bird collisions (monitoring results) around the wind power generation facility of this project. The fall of 2018 is the record when SOD was started; it can be seen that the number of collisions declined from the fall of 2020 to the fall of 2021. This can be inferred to be the result of a series of efforts.

Table 5: Number of Migratory Bird Collisions Around the Wind Farm (Monitoring Results)[28]

Fall 2018 (3-month record)	Fall 2020 (3-month record)	Fall 2021 (3-month record)
17 birds ⇨	7 birds ⇨	4 birds

Source: NREA documents, Project Completion Report

2) Resettlement and Land Acquisition

In this project, land acquisition and the relocation of residents were not anticipated at the time of planning, and they also did not occur in reality.

3) Gender Equality, Marginalized People, Social Systems and Norms, Human Well-being and Human Rights

It can be said that this project contributes to the improvement of Egypt's economy and welfare, as well as the reduction of GHG (CO_2). Specific examples of the direct impacts of this project in relation to gender, the realization of equality, whether or not equitable social participation is being marginalized, social system norms, and people's well-being could not be confirmed through the questionnaire or interviews. Nevertheless, as Egypt's population is growing and economic revitalization is progressing, it can be said that this project plays a role in benefiting people and businesses widely and equally, increasing the choices for human life, and generating events that lead to happiness.

[27] It is outsourced to a contractor who has specialized knowledge and experience in this field. The duration of the contract is five years.

[28] Migratory bird collisions are more likely to occur in spring and autumn. The main bird species are white stork, great white pelican, and European honey buzzard. As stated in the 2020 monitoring report, about 100,000 migratory birds fly to the area around the project site every three months, and around the generator constructed by this project, about 89,000 birds have been confirmed. According to the NREA, "It is not limited to the site of this project, but it is also occurring at other neighboring project sites. This project does not necessarily present a serious case, and the area south of this project site has higher probability of such collision." In fact, SOD is also implemented at other nearby project sites (wind power generation projects by KfW and FIEM). In addition, as mitigation measures for the natural environment before the start of this project, (1) painting with consideration for visibility, (2) windmill height limitations (110 m or less), (3) securing flight corridors for migratory birds, and (4) restrictions on aviation obstacle lights, etc., were required, and they were implemented through this project.

<Summary of Effectiveness and Impacts>

It can be said that the outcomes and impacts expected from implementing this project were generally achieved as planned and that there is almost no negative impact on society (including human rights and gender equality), environment or economy in the long run. This project has achieved its objectives. Therefore, the effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ④)

3.4.1 Policy and System

In the "Electricity Sector Strategy" (March 2015) announced at the Egypt Economic Development Conference, the government of Egypt is advocating a plan to increase the installed capacity of power generation by 54.5 GW nationwide by 2022. In addition, through the "ISES 2035" announced by the Ministry of Electricity and Renewable Energy (MoERE), the government aims not only to establish energy security but also to increase and promote renewable energy, including the development of wind power generation facilities. This project contributes to the establishment of energy security and to the field of renewable energy, and can be said to be in line with the policies and directions of the Egyptian government even at the time of the ex-post evaluation.[29]

3.4.2 Institutional/Organizational Aspect

The executing agency is the NREA. The NREA is in charge of research and development as well as the promotion of new and renewable energies including wind power, solar power and biomass, and power generation projects using new and renewable energies. The EETC is in charge of operating the substation facilities. The total number of staff at the NREA and the EETC is about 1,000 each.[30]

At the time of the ex-post evaluation, no staff shortage was observed for the operation and maintenance departments of the Gulf of El Zayt wind power plant and substation. Regarding the organization and system as well as the number of operation and maintenance staff, the NREA has signed a consignment contract with a subcontractor (private company),[31] which is carrying out

[29] As discussed in 3.1.1.2 Consistency with the Development Needs under Relevance, in recent years, the government of Egypt has begun to focus on electricity exports to Europe and neighboring countries, in light of the use of renewable energy. It is expected that renewable energy will be more utilized in the future. In other words, the environment surrounding renewable energy is expected to continue to evolve.

[30] Data as of the end of 2021.

[31] The consignment contract came into effect in June 2021. The subcontractor was in charge of maintenance and repair of the wind power generation facility constructed during this project until 2021 when the warranty period expired; and it continued its consignment after that period. Similarly, this subcontractor is also in charge of the operation and maintenance of the KfW project. The contract for this project is eight years, and KfW's wind power generation project is five years. The contracts include provisions to procure and replenish spare parts by the time each contract expires. Conditions such as an extension of the period after the contract expires are also presented.

the operation and maintenance of the wind power generator. The NREA has a total of 13 staff, including two on-site supervisors, six supervisory design engineers, two engineers, and three drivers, while the subcontractor has a total of 11 staff members, including one project manager and 10 engineers. Operations such as cleaning generator turbine blades and switchgears for power generation system distribution, and inspecting power generation cables, are outsourced to external companies under the supervision of the subcontractor.

The NREA and the EETC have a cooperation system for the operation and maintenance of substation facilities. As an example, when a substation under EETC's jurisdiction has a planned maintenance activity, the NREA side slows down the speed of the wind power generator under its jurisdiction and properly communicates with the EETC to prevent problems. There are a total of nine EETC staff members working at the substation, including one on-site supervisor, two supervisory design engineers, four engineers, and two drivers.

Based on the above, it is judged that there is no particular problem in the operation and maintenance system of this project at the time of the ex-post evaluation.

3.4.3 Technical Aspect

Regarding the technical aspect of the operational and maintenance, the Gulf of El Zayt wind farm and the substation have staff with extensive work experience in the right places. Technical staff working at the power plant have 16 years of working experience on average, and those of the substation have about 20 years of working experience. These staff are familiar with the operation and maintenance of wind power generation, legal affairs and contracts, as well as with the operation and maintenance of a high-voltage and medium-pressure substation facility. In addition, the staff of the outsourced company are also experienced and familiar with the supervision work.

At the substation, training is conducted on the operation of facilities and equipment. It has been held every year since 2018 and the EETC field staff participate. On-the-job training (OJT) is provided as needed.

Manuals on system operation and maintenance are available at the power generation facility and the substation. These are referenced and utilized by the staff for their work as needed.

Based on the above, it is judged that the technical level related to the operation and maintenance is sufficient and that there is no problem.

3.4.4 Financial Aspect

Regarding the operation and maintenance budget for this project, essentially all of each year's income and necessary expenses come from the national treasury. Tables 6 and 7 show the

operation and maintenance budgets[32] for the last three years.

Table 6: Operation and Maintenance Budget of the Gulf of El Zayt Wind Power Plant

(Unit: Egyptian pound)

2018/2019	2019/2020	2020/2021
98,331,012	98,331,012	98,331,012

Source: answers to the questionnaire

Table 7: Operation and Maintenance Budget of the Substation

(Unit: Egyptian pound)

2018/2019	2019/2020	2020/2021
N/A	5,600,000	5,600,000

Source: answers to the questionnaire

The NREA commented: "Allocated budget has been stable for the last few years" and "Necessary expenses have been fulfilled." In the future, large-scale maintenance is expected to be carried out for all wind power generators every few years, and the NREA plans to allocate the necessary budget. Table 8 shows the revenue from selling electricity from the Gulf of El Zayt wind farm, which has been on the rise in recent years.[33] From the above, there is considered to be no particular financial problem with the operation and maintenance.

Table 8: Revenue from Selling Electricity from the Gulf of El Zayt Wind Power Plant

(Unit: Egyptian pound)

2018/2019	2019/2020	2020/2021
349,522,650	453,959,000	575,787,540

Source: documents owned by the NREA

3.4.5 Environmental and Social Aspect

No special environmental and social mitigation measures were taken, and no impact is anticipated for the time being. As mentioned above, regarding migratory bird countermeasures, the NREA is taking measures such as SOD to prevent collisions after the completion of construction. Since 2020, SOD has been implemented by an outsourced company, and with thorough supervision and monitoring, the number of collisions decreased between 2020 and the fall of 2021. From the above, it can be said that mitigation measures regarding environmental impacts have been taken and such efforts have been successful.

3.4.6 Preventative Measures to Risk

Before the start of this project, it was anticipated that "the turbine may not operate due to abnormal weather (changes in wind conditions)." According to the NREA, there were no risky

[32] The NREA and the EETC consider the budgets, apply to the Ministry of Finance (MOF) through the Ministry of Electricity and Renewable Energy (MoERE), and have them allocated after the approval procedure. The financial source is the government project budget.

[33] Revenue from selling electricity is also affected by the increase or decrease in the amount of power at the transmission end, which was explained in 3.3.1.1 Quantitative Effects (Operation and Effect Indicators).

abnormal weather or changes in wind conditions during the project implementation. The average wind speed along the Red Sea coast is 8 to 10 m per second, which is a favorable condition for the wind power generation project because wind can be secured at all times. It was also confirmed that there were no risks, external conditions, or events to be controlled during the project implementation.

3.4.7 Status of Operation and Maintenance

The maintenance of the wind power generation facilities that is being carried out includes: daily inspections of facilities and equipment for the purpose of preventing breakdowns and troubles, preventive maintenance every six months, large-scale inspections and maintenance once a year, etc. The generator turbine blades and switchgear for power generation system distribution are also regularly cleaned. At the substation facility, the planned maintenance of transformers and switchgear for distribution as well as the cleaning of materials and equipment installed outside the substation are performed every quarter.

As mentioned above, the NREA and the subcontractor are carrying out the operation and maintenance of the wind power generator based on the subcontracting contract. The cleaning of the generator turbine blades and the switchgear for power generation system distribution as well as the inspection of power generation cables are conducted under the supervision of the contractor. The operation and maintenance of the substation are performed by the EETC.

In terms of spare parts, procurement may take up to several months. However, it was confirmed that there has been no case of insufficient maintenance due to a procurement delay. Regarding the power generation facilities, the basic operation and maintenance policy is to secure spare parts for three years. In relation to the substation, the switchgear and transformers are sufficiently secured. The subcontractor is in charge of procuring and replenishing the spare parts.

A fire accident occurred at the substation on October 27, 2021. The medium voltage switchgear, optical fiber interface, etc., were caught in the fire.[34] The EETC covered the cost and performed the restoration work, which was completed in December of the same year. The EETC replaced the switchgear (60 pieces) in the substation to prevent future fire accidents. Their policy is to conduct preventive maintenance and inspections systematically for the time being (several months).[35]

No issues have been observed in the policy/system, institutional/organizational, technical, financial, and environmental and social aspects, including the current status of operation and

[34] The cause of the fire is unknown.
[35] Specifically, the policy is to manage the oil used for a device at the substation, to measure calibration (e.g., to determine whether the value indicated by the measuring device is correct, it is compared to the value suggested by standard equipment, and if there is any difference, it is corrected), to inspect and check devices in the substation every two years, and to examine and check the circuit breakers every three years.

maintenance. Risks have been well mitigated. Therefore, sustainability of the project effects is very high.

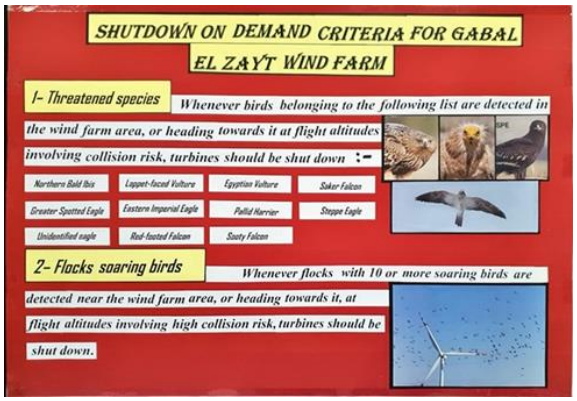


Photo 6: SOD Standards
(Posted Inside the NREA)

Photo 7: Spare Parts Storage Facility

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project was to increase the power supply and curb fossil fuel use by constructing a new wind power generation facility in the Gulf of El Zayt, which is located on the coast of the Red Sea, Egypt, thereby contributing to the fulfillment of electricity demand, climate change mitigation through the reduction of greenhouse gas (GHG) emissions, and economic and social development. Regarding relevance, this project is "consistent with the development plan" and "consistent with the development needs." Concerning coherence, it is "consistent with Japan's ODA Policy" and "externally coherent." As for "internal coherence," while the completed ODA loan project and this project are complementary to each other from the perspective of supplying clean energy, no specific cooperation or synergistic effect was observed. Based on the above, relevance and coherence is high. With regard to efficiency, the outputs were mostly as planned, but the project period was slightly longer than the initial plan because: the contractors' pre-qualification examination process and bidding procedure required time due to the Egyptian revolution; the detailed design, confirmation, and customs clearance of the electrical equipment were delayed; and the project had to deal with a contractor's bankruptcy. Nevertheless, the project cost was within the plan, and thus, efficiency is high. Regarding effectiveness and qualitative effect indicators (actual values), targets were met for "capacity factor," "plant availability," "net electrical energy production," and the "net reduction of GHG (CO_2)," while the "outage duration hours due to planned inspection/repair" was generally close to the target. As for "outage duration hours due to mechanical breakdown," the target was not achieved. Although the impact may be limited at the time of the ex-post evaluation, it was confirmed that this project plays a role in revitalizing the economy and improving public welfare through the stable supply of electricity.

Therefore, the effectiveness and impacts are high. There seems to be no major concern about the outlook for the sustainability of the effects generated by this project. Therefore, the sustainability of the project effects is very high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Efforts to Mitigate Environmental Impacts and Utilization for Similar Projects

During the implementation of this project, the NREA received advice from the construction management consultant and worked on SOD to reduce damage to migratory birds. It can be said that the number of migratory birds colliding with wind power generators has been declining in the last three years due to outsourcing to specialists, supervision and monitoring, etc., having achieved a certain effect. The fact that measures were taken in anticipation of future impacts during the project implementation, rather than after the project was completed, is proof that this project takes the effects on the ecosystem seriously. Such attempts to operate wind power generation while reducing the impacts on the ecosystem can be referred to as a useful example of mitigating environmental impacts for similar future projects (wind power generation projects in coastal areas where migratory birds exist).

Importance of Solidifying the Operation and Maintenance System after the Project is Completed

In this project, the duration of the consulting services was extended until the end of the warranty period, and the contractor continued to play a certain role in the operation and maintenance even after the end of the warranty period by signing a contract with the executing agency. It can be said that attention was paid so as to reduce unplanned outage of the developed wind power generation facility and to enable sufficient operation and maintenance of the facility. As a result, there are no major problems with the operating status at the time of the ex-post evaluation, and even if a sudden accident or failure occurs, there is a system in place to respond immediately. For similar projects in the future, it is worth considering to plan for and establish an operation and maintenance system that is solid even after the project is completed.

5. Non-Score Criteria

5.1. Performance

5.1.1 Objective Perspective

Before the start of this project, a concern about the impact on the ecosystem around the project site was acknowledged by those involved in the project. Migratory birds fly in every spring and autumn, and the possibility of them colliding with wind power generation facilities was anticipated. In 2016, when the project was underway, the construction supervision consultant of this project pointed out the need for migratory bird collision countermeasures, specifically SOD. For approximately three years from 2017 to 2020, the NREA embarked on SOD in collaboration with the consultant and local businesses. Measures were taken, such as installing a wind speed measurement pole (mast), stretching the wire over the overhead line, and installing a mark around the wire to improve visibility. According to the NREA, one of the reasons why they took such countermeasures was that the Egyptian Ministry of the Environment and JICA demanded that the measures be taken and reported on. Such actions were necessary support for the executing agency, and at the same time, show the fact that an appropriate supervision and monitoring system was in place taking changes in the project environment into consideration. In addition, it can be said that this proves communication was maintained and cooperative relationships were established among the project parties.

5.2 Additionality

None.

(end)

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Materials and Equipment, Civil Engineering Work (a) Construction of a new wind power generation facility with a total output of 220 MW (1) Wind power generators (single unit output 2 MW x 110 units) (2) Related equipment/facility such as control monitoring system (3) Electrical work, civil engineering installation work (b) Expansion of substation and transmission lines Installation of power receiving and transforming equipment such as transformers and switchgears covered by JICA project for the substation (the construction of a substation and interconnection lines between the substation and the interconnection line are not covered by Japan's ODA loan (KfW and EEHC are to finance)) 2) Consulting Services Detailed design, pre-qualification examination (P/Q) and confirmation of bid documents, assistance for P/Q examination and bid evaluation, assistance for contract negotiations between the executing agency and contractors, construction supervision, etc.	1) Materials and Equipment, Civil Engineering Work (a) Construction of a new wind power generation facility with a total output of 220 MW → Implemented as planned. (b) Expansion of substation and transmission lines → Some changes were made (the construction of the substation by another donor was cancelled; it was changed to a renewal of an existing substation located near this project's site, based on which substation equipment was installed and interconnection lines were added). 2) Consulting Services →Implemented almost as planned.
2. Project Period	March 2010–June 2015 (64 months)	March 2010–April 2019 (71 months[36])
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency	 38,864 million yen 27,195 million yen	 25,243 million yen 3,822 million yen

[36] As mentioned earlier, the duration of three years and three months (39 months), from January 2011 (when a large-scale anti-government demonstration occurred) to March 2014 (when Prime Minister Mahlab was elected and the new cabinet was inaugurated after the referendum of the new constitution), is considered an external factor for the delay in the start of the consulting services, slowing down the project.

Total ODA Loan Portion Exchange Rate	66,059 million yen (38,864 million yen) 1 USD=90.3 yen, 1 Egyptian pound=17.8 yen (As of December 2009)	29,065 million yen (25,243 million yen) 1 USD=101.24 yen, 1 Egyptian pound=11.7 yen (Average between 2010 and 2019 based on the International Monetary Fund's (IMF) International Financial Statistics (IFS))
4. Final Disbursement	November 2019	