Egypt

Ex-Post Evaluation of Japanese ODA Loan Project

Zafarana Wind Power Plant Project

External Evaluator: Yasuhiro Kawabata, Masami Tomita, Sanshu Engineering Consultant

0. Summary

This project aimed at increasing power supply and reducing the use of fossil fuels, by constructing the 120MW of wind power plant in Zafarana of Egypt, and thereby contributing to reduction of air pollution, amount of greenhouse gas emissions equivalent to the amount when a similar size of a thermal power plant is operated and global warming.

Relevance of this project is high, as the project is consistent with priority areas of Egypt's development plans and Japan's ODA policy, and moreover development needs for the project are high. Actual figures of almost all the operation and effect indicators are higher than approximately 80% of target figures for two years after project completion, and the project contributed to the increase of power supply and reduction of the use of fossil fuels and the amount of greenhouse gas emissions. Thus, effectiveness and impact of the project are high. Sustainability of the project is also high, as no major problem has been observed in institutional, technical and financial aspects of operation and maintenance (O&M) and current O&M status. On the other hand, efficiency of the project is low, as both actual project cost and period largely exceeded planned cost and period.

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

1. Project Description

Project Location

Wind Power Plant Constructed by the Project

1.1 Background

Before the project was implemented, Egypt had been faced with power supply constraints, and there were frequent power cuts during peak time of summer in 2002, which became a social

problem[1]. In order to address the problem, the Egyptian government promoted construction of power plants, particularly of thermal power plants, and also promoted utilization of new and renewable sources of energy, to advance energy saving and environmental protection.

The project site, Zafarana, is an area which is endowed with stable wind speed and direction almost throughout a year and is suitable for wind power generation (the average wind speed from 1991 to 2001 was 9.0 m/sec[2]). Moreover, the availability factor of the existing wind power plants in the area (30MW constructed with assistance from Danish International Development Agency (DANIDA) and 33MW constructed with assistance from Kreditanstalt für Wiederaufbau (KfW)) was as high as 98%[3]. Therefore, this project was implemented in order to increase power supply and reduce air pollution and greenhouse gas emissions through reduction of the use of fossil fuels, by utilizing wind energy.

This project was also approved as a Clean Development Mechanism (CDM) project by the CDM Executive Board of the United Nations in 2007[4]. Japan is obliged to reduce greenhouse gas emissions to a level 6% below 1990 levels during the first commitment period (2008-2012) which was defined in the Kyoto Protocol. However, private enterprises have shown cautious reactions to institutional and commercial risks related to the Kyoto Mechanisms, and thus the amount of private funds available for CDM projects is limited. On the other hand, CDM projects provide developing countries with the secondary benefits such as reduction of air pollution and saving of foreign currencies through slower demand for oil. Moreover, CDM projects compensate low profitability of projects through acquisition of Certified Emission Reductions (CER) credits, which enables proper project operation. Therefore, based on above reasons, this project was implemented as a CDM project[5].

1.2 Project Outline

The objective of this project is to increase power supply and reduce the use of fossil fuels, by constructing the 120MW of wind power plant in Zafarana of Egypt (on the Red Sea coast

---

1 Source: Japan International Cooperation Agency (JICA) appraisal document

2 Source: interviews with the executing agency (New and Renewable Energy Authority: NREA)

3 Source: JICA appraisal document

4 Background of CDM: the United Nations Framework Convention on Climate Change (UNFCCC), which states international efforts to reduce greenhouse gas emissions, was adopted in 1992. Then, the Kyoto Protocol was adopted in 1997, which obliges developed countries to reduce greenhouse gas emissions to certain levels below 1990 levels during the first commitment period (2008-2012), in order to achieve the objective of the convention. Moreover, the Kyoto Mechanisms was established, which allows developed countries to utilize reduced amount of greenhouse gas emissions in other countries in addition to the amount reduced in their own countries, in order for developed countries to achieve numerical targets for emission reduction stated in the Kyoto Protocol. The Kyoto Mechanisms consists of 1) Clean Development Mechanism (CDM), 2) Joint Implementation (JI), and 3) Emissions Trading (ET). CDM, which was adopted in this project, is a mechanism in which developed countries reduce greenhouse gas emissions in developing countries through projects and utilize the reduced amount to achieve their reduction targets in their country.

5 Source: JICA internal document

220km southeast of Cairo), and thereby contributing to reduction of air pollution, amount of greenhouse gas emissions equivalent to the amount when a similar size of a thermal power plant is operated and global warming.

Loan Approved Amount/ Disbursed Amount	13,497 million yen / 13,497 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	October, 2003 / December, 2003
Terms and Conditions	Interest Rate: 0.75% Repayment Period: 40years (Grace Period: 10 years) Conditions for Procurement: General Untied
Borrower / Executing Agency(ies)	New and Renewable Energy Authority: NREA Guarantor: Government of Egypt
Final Disbursement Date	July, 2010
Main Contractor (Over 1 billion yen)	Gamesa Eolica SL (Spain)
Main Consultant (Over 100 million yen)	DECON Deutsche Energie-Consult Ingenieurgesellschaft (Germany) ・ Oriental Consultants (Japan) (JV)
Feasibility Studies, etc.	Japan Consulting Institute (JCI), 1999
Related Projects (if any)	Wind power plants assisted by DANIDA (180MW in total), assisted by KfW (160MW in total), assisted by Spanish government (85MW in total)

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasuhiro Kawabata, Masami Tomita, Sanshu Engineering Consultant

2.2 Duration of Evaluation Study

Duration of the Study: September, 2012 – August, 2013

Duration of the Field Study: December 6 – December 15, 2012, March 14 –March 23, 2013

3. Results of the Evaluation (Overall Rating: B[6])

3.1 Relevance (Rating: ③[7])

3.1.1 Relevance with the Development Plan of Egypt

At the time of project appraisal, Egypt, which was faced with power supply constraints, aimed at increasing power supply comprehensively by 1) effective utilization of resources (water resources and natural gas) and enhancement of efficiency of existing power generation

[6] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[7] ③: High, ② Fair, ① Low

facilities (transition from traditional steam turbine to combined cycle) and 2) energy diversification (hydraulic power, wind power and solar power) through construction of new power generation facilities [8] . The Fifth Five-Year National Development Plan (2002/2003-2006/2007) states that the country would promote utilization of new and renewable sources of energy by implementing solar and wind power projects[9]. Moreover, the Long Term Electric Power Development Plan (2002-2012) states that construction of 11,279MW in total of new power generation facilities was planned, of which 880MW was planned to be covered by new and renewable sources of energy by 2010 (of which, 815MW was planned to be covered by wind power generation)[10].

On the other hand, at the time of ex-post evaluation, the Sixth Five-Year National Development Plan (2007/2008-2011/2012) (Chapter 5) emphasizes utilization of new and renewable sources of energy, and the supply capacity of wind power generation is targeted to be increased to 1,050MW in total during the plan period[11]. Moreover, according to the Energy Sector Development Plan of Egypt (2012/2013 -2016/2017), 13,970MW in total of power-generating capacity is planned to be developed during the plan period, of which 2,850MW is planned to be covered by wind power generation[12].

Therefore, enhancement of power supply capacity and utilization of new and renewable sources of energy including promotion of wind power projects are emphasized in national and sector development plans of Egypt both at the time of project appraisal and ex-post evaluation, and thus the project is consistent with the development plans.

3.1.2 Relevance with the Development Needs of Egypt

At the time of project appraisal, electric power demand in Egypt had been increasing by 5-7% a year since 1995, and it was expected to be tripled in 20 years from 1997[13]. The target figure for the supply reserve margin[14] in the country is set at 15%, however, the margin was expected to decrease to approximately 10% in 2004/05 due to increasing power demand[15]. In August 2002, power demand increased sharply due to heat wave, which caused serious power shortage and periodic power cuts in the country[16]. Therefore, to increase power supply and to reduce environmental burdens were required.

Table 1 shows the transition of total power generation capacity, peak power demand (peak

---

8 Source: JICA appraisal document
9 Source: same as above
10 Source: same as above
11 Source: Egyptian government HP (http://www.mop.gov.eg/english/sixth%20five%20year.html)
12 Source: document provided by Egyptian Electricity Holding Company (EEHC)
13 Source: JICA appraisal document
14 The supply reserve margin = ((total power generation capacity – peak demand) / peak demand) x 100
15 Source: JICA appraisal document
16 Source: same as above

load), and the supply reserve margin in Egypt from the time of project appraisal to ex-post evaluation.

Table 1: Total Power Generation Capacity, Peak Demand, and the Supply Reserve Margin in Egypt

Financial Year	2001/02	2002/03	2003/04	2004/05	2005/06
Peak Power Demand (MW)	13,326	14,401	14,735	15,678	17,300
Total Power Generation Capacity (MW)					
Thermal	13,498	13,498	13,187	13,804	15,438
Hydro	2,745	2,745	2,745	2,783	2,783
Wind	63	63	140	140	183
Solar	0	0	0	0	0
Private Sector	683	1,365	2,048	2,048	2,048
Total	16,989	17,671	18,120	18,775	20,452
Supply Reserve Margin (%)	27	23	23	20	18
Financial Year	2006/07	2007/08	2008/09	2009/10	2010/11
Peak Power Demand (MW)	18,500	19,738	21,330	22,750	23,470
Total Power Generation Capacity (MW)					
Thermal	16,889	17,389	18,230	19,388	21,514
Hydro	2,783	2,842	2,800	2,800	2,800
Wind	225	305	425	490	687
Solar	0	0	0		
Private Sector	2,048	2,048	2,048	2,048	2,048
Total	21,945	22,584	23,503	24,726	27,049
Supply Reserve Margin (%)	19	14	10	9	15

Source: EEHC Annual Report

According to the table above, the actual figures of the supply reserve margin had been above the target (15%) until 2006/07, however, the margin has been below the target since 2007/08, and to increase power supply is still an important issue for the country.

The power plant constructed by the project is connected to the national grid, and electric power has been supplied to the Zafarana area from the national grid since 2003 (previously power was supplied 4 hours a day only from 17:00 to 21:00 using generators). The amount of power sold in the area in 2003 was 136MWh, which increased to 54,360MWh in 2012 by 400 times[17].

Therefore, electric power demand in Egypt has been increasing since the time of project appraisal, and relevance of the project, which aimed at increasing power supply, remains high at the time of ex-post evaluation.

3.1.3 Relevance with Japan's ODA Policy

According to the Country Assistance Policy for Egypt (2002), Japan emphasizes development of economic and social infrastructures and environmental conservation etc. in the country as

[17] Source: document provided by the executing agency (Egyptian Electricity Transmission Company (EETC))

priority areas for assistance[18]. Moreover, the Overseas Economic Cooperation Operation Policy of JICA (former JBIC) emphasizes "infrastructure development for economic growth" and JICA planned to provide assistance for promoting economic growth through development of economic and social infrastructures including electricity. Also, the policy states that JICA actively supports introduction of new and renewable sources of energy including wind power in an effort to solve global issues, and the project was consistent with these policies[19].

This project has been highly relevant with Egypt's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Effectiveness[20] (Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Table 2 shows planned and actual figures of operation and effect indicators for the project.

Table 2: Operation and Effect Indicators for the Project (planned and actual)

Indicator	Planned 2009 (2 years after completion)	Actual 2008[1] (start of operation)	Actual 2009 (project completion)	Actual 2010	Actual 2011 (2 years after completion)	Actual 2012
Maximum Output (MW)	120	85.9	120.7	120.7	120.7	120.7
Utilization Factor (%) [2] (figures in brackets are achievement rates against targets)	40	2.8 (7%)	26.9 (67%)	32.8 (82%)	31.8 (80%)	30.0 (75%)
Unplanned Outage Hours (hours/year) [3]	0	N/A	229	184	165	134
Planned Outage Hours due to inspection& maintenance (per unit) (hours/year) [3]	13	N/A	14	14	14	14
Availability Factor(%) [4] (figures in brackets are achievement rates against targets)	97	N/A	98.4 (101%)	98.9 (102%)	98.7 (102%)	98.6 (102%)
Net Electric Energy Production (GWh/year) [5] (figures in brackets are achievement rates against targets)	415	29.5 (7%)	284.6 (69%)	346.8 (84%)	335.8 (81%)	317.4 (76%)
Amount of Fossil Fuels Saved (ton/year) [6]	N/A	6,000	61,000	75,000	72,000	68,000

Source: Planned: JICA appraisal documents, Actual: Maximum Output / Unplanned Outage Hours / Planned Outage Hours due to Inspection &Maintenance / Net Electric Energy Production: answer to the questionnaire (CMS)

Note 1: Procurements were planned to be implemented by one lot at the time of project appraisal, however, one lot was divided into 11 lots in practice, and the first lot started operation in August 2008.

[18] Source: The Country Assistance Policy for Egypt, Ministry of Foreign Affairs

[19] Source: JICA HP

[20] Sub-rating for Effectiveness is to be put with consideration of Impact

Note 2: Utilization Factor = (Annual Electricity Production (kWh) / (Rated Output (kw) x (Total Hours per Year (H)) x 100

Note 3: Outage hours are the average of each turbine.

Note 4: Availability Factor = (Annual Operation Hours (H) / Total Hours per Year (H)) x 100.
Annual Operation Hours = (Total Hours per Year) – (Outage Hours due to Mechanical Troubles and Natural Disasters etc.)

Note 5: Actual figures of Net Electric Energy Production are the amount of electricity which was received by EETC and certain amount of which was consumed by NREA (NREA is resupplied with electricity from EETC when wind power is not sufficient etc.) While target figures in the project appraisal unlikely took into account the possibility of NREA being resupplied with electricity from EETC, the ex-post evaluation used the most conservative figures as actual figures.

Note 6: Amount of Fossil Fuels Saved = Annual Electricity Production (kWh) x Fuel Consumption Rate (217g/kWh)

When comparing planned and actual figures of two years after project completion, actual figures of the utilization factor and net electric energy production are approximately 80% of planned figures, and actual figures of maximum output and the availability factor slightly exceeds planned figures. Actual figures of planned outage hours due to inspection and maintenance are almost the same as planned figures. According to the executing agency, the reason for actual figures of the utilization factor and net electricity energy production being approximately 20% below planned figures is mainly due to the decrease in the wind speed, as planned figures were calculated based on the wind speed of 9.0 m/sec which was actually measured at the time of project appraisal, however, the wind speed of recent years is approximately 7.5 m/sec. While there was no planned figure for the amount of fossil fuels saved, approximately 60,000 – 75,000 tons seem to have been saved per year.

Table 3 shows the breakdown of unplanned outage hours.

Table 3: Breakdown of Unplanned Outage Hours

(Unit: hours/year)

Year	Mechanical Troubles / Natural Disasters etc.	Others (Due to external factors such as shut down of the national grid etc.)	Total
2009	20,135 (average of 1 turbine: 142)	12,396 (average of 1 turbine: 87)	32,531 (average of 1 turbine: 229)
2010	13,776 (average of 1 turbine: 97)	12,400 (average of 1 turbine: 87)	26,176 (average of 1 turbine: 184)
2011	16,366 (average of 1 turbine: 115)	7,101 (average of 1 turbine: 50)	23,467 (average of 1 turbine: 165)
2012	17,947 (average of 1 turbine: 126)	1,122 (average of 1 turbine: 8)	19,069 (average of 1 turbine: 134)

Source: answer to the questionnaire (CMS)

Unplanned outage hours were targeted as zero hour at the time of project appraisal, however, in the case of zero unplanned outage hours, the availability factor becomes 99.8%, which contradicts with the planned figure of 97%. Moreover, according to the interviews with operation staff of the executing agency and local electricity experts, assuming zero unplanned outage hours due to

mechanical troubles and natural disasters is highly unlikely, and the planned figure for unplanned outage hours set at the time of project appraisal is considered to be unrealistic.

3.3 Impact

3.3.1 Intended Impacts: Reduction of Greenhouse Gas Emissions

Table 4 shows planned and actual figures of avoided CO_2 emission realized by the project.

Table 4: Avoided CO_2 Emission by the Project (Planned and Actual)

(Unit: both planned and actual: ton/year)

Year	Planned	Actual	Achievement Rate
2008	-	16,000	-
2009	233,000	157,000	67%
2010	233,000	191,000	82%
2011	233,000	185,000	79%
2012	233,000	175,000	75%

Source: Calculated by Net Electric Energy Production (MWh) x CO_2 Emission Factor ($0.55tCO_2/MWh$) based on CDM Project Design Document (PDD).

The original target of avoided CO_2 emission was estimated as 270,000 ton per year in the project appraisal[21], however, the net calorific value and the carbon emission factor used in the project appraisal are different from those used in CDM PDD, and thus planned and actual figures cannot be simply compared. Then, the target figure was recalculated using the net calorific value and the carbon emission factor adopted in PDM CDD, which turned out to be 233,000 ton per year. The achievement rate of actual figures against the revised target is approximately 80%. Approximately 180,000 – 190,000 ton of CO_2 emissions seem to have been avoided annually by the project, and it is considered to contribute to reduction of air pollution and global warming.

3.3.2 Other Impacts

3.3.2.1 Benefits for the Project Area and Local People

According to interviews with executing agencies (NREA and EETC), employment in the locality increased during the construction period and after commencement of operation in the power plant.

3.3.2.2 Impacts on the natural environment

Environmental management manuals were prepared by contractors of the project which indicate points to be complied during the construction period and after commencement of operation, and waste management and control of chemical products etc. have been conducted

[21] Source: JICA appraisal document

based on these manuals. According to executing agencies, the results of environmental monitoring were reported to JICA. Moreover, according to interviews with staff of NREA, EETC, the local government (Red Sea Governorate), and Romance Beach Hotel, there was no negative impact on environment due to the project. The contents of the project were construction of a new wind power plant and expansion of the existing substation in the desert area where there is no local residents, and thus there seems to have been no negative environmental impact such as noise problems etc.

3.3.2.3 Land Acquisition and Resettlement

According to executing agencies, there was no resettlement due to the project.

This project has largely achieved its objectives, therefore its effectiveness and impact are high.

3.4 Efficiency (Rating: ①)

3.4.1 Project Outputs

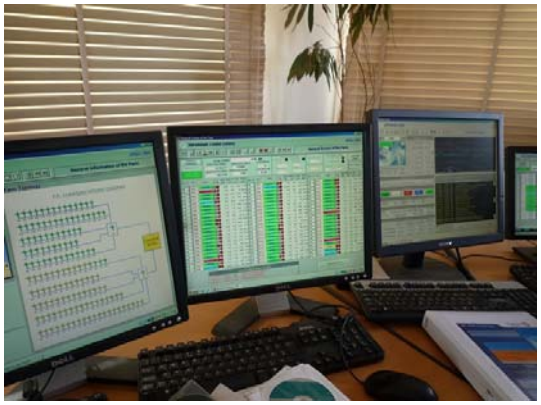
Outputs of the project (planned and actual) are shown below in Table 5. Regarding the wind power plant, while the maximum output of 120MW was planned in the project appraisal, the actual maximum output was 120.7MW, which was slightly higher than the plan, as the output of each turbine turned out to be 850kW for 142 units.

Table 5: Comparison of Outputs (Planned/ Actual)

Item		Planned	Actual
Civil Works	Construction of Wind Power Plant	・ Wind turbine generators (range from 600kW x 200 units to 1,000kW x 120 units), 120MW in total ・ Control monitoring system and other related equipment ・ Electrical works and civil & installation works	・ Almost as planned However, 120.7MW in total (850kW x 142 units)
	Expansion of Substation (not covered by Japan's ODA)	・ Transformers (125MVA x 2 units) and other related equipment ・ Electrical works and civil & installation works	・ As planned
Consulting Service	Contents	・ Conceptual design ・ Preparation of Pre-Qualification (P/Q) documents and bid documents ・ Assistance for evaluation of bids ・ Assistance for contract management ・ Supervision of the civil (construction) works etc.	・ As planned
	Mans-Month	・ International CS: 57M/M ・ Local CS: 119M/M 176M/M in total	・ International CS: 80M/M ・ Local CS: 40M/M 120M/M in total

Source: Planned: JICA appraisal documents, Actual: JICA internal documents and interviews with executing agencies

Substation installed by the project



Control Monitoring System

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned project cost at the time of project appraisal was 18,466 million yen (foreign currency: 13,915 million yen, local currency: 4,551 million yen), of which Japanese ODA Loan portion was 13,497 million yen[22]. Among the above, the planned cost for construction of the wind power plant was 17,927 million yen (foreign currency: 13,497 million yen, local currency: 4,430 million yen), of which Japanese ODA Loan portion was 13,497 million yen. The planned cost for expansion of the existing substation was 539 million yen (foreign currency: 418 million yen, local currency: 121 million yen), and the cost for expansion of the substation was to be covered by EETC budget[23].

On the other hand, the actual project cost was 26,292 million yen (foreign currency: 16,147 million yen, local currency: 10,145 million yen)[24], of which Japanese ODA Loan portion was 13,497 million yen, and it was higher than planned (142% against the plan). Among the above, the actual cost for construction of the wind power plant was 25,644 million yen (foreign currency: 15,693 million yen, local currency: 9,951 million yen), of which Japanese ODA Loan portion was 13,497 million yen. The actual cost for expansion of the existing substation was 648 million yen (foreign currency: 454 million yen, local currency: 194 million yen), and the cost for expansion of the substation was covered by EETC budget.

The reason for the actual cost for construction of the wind power plant exceeding the planned cost was because the actual cost for civil and engineering works largely exceeded the planned cost, while the actual cost for consulting service was almost the half of the planned cost. The reasons for this are the rising price of steel, the fact that the warranty period was extended to

[22] Source: JICA appraisal document

[23] Source: same as above

[24] Calculated by multiplying the actual cost by the average exchange rate of 1EUR=141.56JPY and 1EGP=18.50JPY (the average exchange rate of the Japanese ODA loan disbursement period of December 11, 2003 – July 20, 2010), based on documents provided by executing agencies.

three years after the completion of the last lot for training (OJT) of NREA staff on O&M of the power plant, and fluctuation of exchange rates etc.[25]

3.4.2.2 Project Period

The planned project period at the time of project appraisal was 39 months in total from December 2003 (signing of the loan agreement) to February 2007 (the completion of the project was defined as the completion of civil and engineering works and handing over of the power plant)[26]. On the other hand, the actual project period was 68 months in total from December 2003 (signing of the loan agreement) to July 2009 (completion of civil and engineering works)[27], and it was significantly longer than planned (174% against the plan). The reasons for the actual project period for construction of the wind power plant largely exceeding the planned period are a delay in pre-qualification, the fact that selection of a contractor was delayed due to a long time required for clarification of bidding documents and contract negotiations, the fact that the contact finally became effective in August 2007 while the contract procedure was completed in February 2007, due to a long time required for procedures for advance payment, the commencement of construction works being further delayed until December 2007, and the fact that construction works were stopped for three months due to a long time required for additional payment for higher prices of steel from the contractor to the subcontractor etc.[28] The reason for the actual project period for expansion of the substation exceeding the planned period is because selection of a contractor was delayed due to a delay in preparation of bidding documents, the bidding deadline being extended upon receiving a request from bidders, and a long time required for clarification of bidding documents etc.[29]

Table 6: Comparison of Planned and Actual Project Period for the Wild Power Plant Portion

Content	Planned	Actual
Selection of Consultant	July 2003 – December 2003 (6 months)	September 2003 – May 2004 (9 months)
Conceptual Design	January 2004 – January 2004 (1 month)	November 2004 – November 2004 (1 month)
Procurement of Civil Works	January 2004 – April 2005 (16 months)	January 2005 – February 2007 (26 months)
Civil Works	April 2005 – February 2007 (23 months)	August 2007 – July 2009 (24 months)

Source: Planned: JICA appraisal documents, Actual: answers to the questionnaire

[25] Source: project completion report and JICA internal documents
[26] Source: JICA appraisal document
[27] Source: JICA internal documents and answers to the questionnaire
[28] Source: JICA internal documents and interviews with NREA
[29] Source: interviews with EETC

Table 7: Comparison of Planned and Actual Project Period for the Substation Portion

Content	Planned	Actual
Procurement of Civil Works	May 2003 – August 2003 (4 months)	December 2003 – March 2005 (16 month)
Civil Works	September 2003 – September 2004 (13 months)	March 2005 – May 2006 (15 month)
Testing and Commissioning	October 2004 – November 2004 (1 month)	June 2006 – June 2006 (1 month)

Source: Planned: JICA appraisal documents, Actual: answers to the questionnaire

3.4.3 Results of Calculations of Internal Rates of Return (IRR) (for reference only)

(1) Financial Internal Rate of Return (FIRR)

Results of FIRR calculation at the time of project appraisal and ex-post evaluation are shown below in Table 8. FIRR was calculated using the same conditions as in the project appraisal, based on an assumption that almost the same amount of energy production and electricity price as in 2011 will be kept after 2013 onwards. The actual figure of FIRR is lower than the planned figure, as the actual project cost and O&M cost exceed the planned cost, the actual amount of energy production is a little smaller than the planned amount, the actual amount of subsidy is smaller than the planned amount (in the project appraisal, 50% of the export value – domestic sales value of fuels for power generation saved by the project was allocated as subsidy to be paid from the Ministry of Petroleum to the subsidy fund for renewable energy projects, however, in practice, 0.02LE/kWh is the ceiling for the subsidy) etc.

Table 8: Comparison of FIRR

Time of Calculation	Conditions for Calculation	Result
Project Appraisal (2003)	Cost: investment cost, operation and maintenance cost Benefit: income from energy sales, subsidy Project life: 20 years	1.22%
Ex-Post Evaluation (2012)	Same as above	▲4.40%

Source: Project appraisal: JICA appraisal documents, Ex-post evaluation: calculated based on documents provided by executing agencies

(2) Economic Internal Rate of Return (EIRR)

Results of EIRR calculation at the time of project appraisal and ex-post evaluation are shown below in Table 9. As with FIRR, EIRR was calculated using the same conditions as in the project appraisal, based on an assumption that almost the same amount of energy production and electricity price as in 2011 will be kept after 2013 onwards. While the actual project cost and O&M cost exceed the planned cost and the actual amount of energy production is a little smaller than the planned amount, the border price of electricity and fuel price rose steeply compared with those at the time of project appraisal, which increases the benefit related to the increase of electric power supply

(electricity sales income based on the border price) and the gain from exports of fuels for power generation saved by the project, and consequently, the actual figure of EIRR largely exceeds the planned figure.

Table 9: Comparison of EIRR

Time of Calculation	Conditions for Calculation	Result
Project Appraisal (2003)	Cost: investment cost, operation and maintenance cost Benefit: increase of electric power supply, reduction of CO_2 emission, gain from exports of fuels saved domestically Project life: 20 years	16.90%
Ex-Post Evaluation (2012)	Same as above	31.69%

Source: Project appraisal: JICA appraisal documents, Ex-post evaluation: calculated based on documents provided by executing agencies

The project cost exceeded the plan, while the project period significantly exceeded the plan, therefore efficiency of the project is low.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

Operation and maintenance (O&M) of the wind power plant constructed by the project is conducted by New and Renewable Energy Authority (NREA). The total number of staff in NREA as of 2011/12 is 1,199[30], of which 187 staff work in the Zafarana site, of which 10 engineers and 12 technicians operate and maintain the power plant constructed by the project in two shifts for 12 days each[31].

O&M of the substation added by the project is conducted by Egyptian Electricity Transmission Company (EETC). The total number of staff in EETC as of January 2013 is 33,500[32], of which 32 staff (8 engineers, 11 technicians, 5 workers, 2 drivers, 4 security staff and 2 assistants) operate and maintain the Zafarana substation No.1 added by the project in two shifts for 7days each[33].

Regular inspections are carried out based on maintenance manuals, and the availability factor of the power plant exceeds the target figure of 97%, and thus no major problem is observed regarding the institutional aspect of O&M.

3.5.2 Technical Aspects of Operation and Maintenance

Among 22 staff (engineers and technicians) of NREA responsible for O&M of the wind

30 Source: NREA Annual Report

31 Source: answers to the questionnaire

32 Source: same as above

33 Source: same as above. Among 32 staff in total, 19 staff operate the substation No.1 and 13 staff maintain the substation No. 1 and No. 2.

power plant constructed by the project, all engineers have a bachelor degree of engineering and all technicians have technical diploma[34]. The number of staff with over 10 years of work experience in the electric energy sector is 4, 5 to 10 years is 10, and less than 5 years is 8[35]. Among 22 staff, two staff (the leader of each working shift) had trainings for two weeks in Spain and one week in Egypt, and other staff had OJT for 6 months on average[36]. Maintenance manuals were also prepared.

Among 19 staff (engineers and technicians) of EETC responsible for O&M of the substation added by the project, the number of staff with 25 years of work experience in the electric energy sector is one, 6 to 16 years is 14, and less than 5 years is 4[37]. Trainings on repair and maintenance have been provided for 8 engineers for two weeks and for 8 technicians for 2-3 weeks in EETC's own training center, and maintenance manuals were also prepared[38].

NREA has wealth of experience on wind power generation and EETC has wealth of experience on transformation and transmission of electrical energy, and sufficient number of technical staff is assigned in the field, and no major problem was observed in the site inspection by the evaluator. Therefore, there seems to be no major problem regarding the technical aspect of O&M.

3.5.3 Financial Aspects of Operation and Maintenance

(1) NREA

NREA is an affiliated agency under the Ministry of Electricity and Energy and NREA is not necessarily financially independent, as NREA's revenues and expenditures of each financial year are tied to the national treasury. Table 10 below shows NREA's profit and loss statement (P/L), and while NREA's net income has been in deficit due to a large amount of interest payments related to foreign and domestic loans[39], operating income has been in profit even taking into account depreciation cost. According to the agreement made between the Ministry of Finance, the Ministry of Petroleum and the Ministry of Electricity and Energy in June 2012, it has been determined that the value equivalent to the amount of fuels for power generation (fossil fuels) saved by NREA's projects utilizing new and renewable sources of energy will be allocated to NREA as additional subsidy, which is expected to reduce NREA's deficits largely in the near future[40].

---

34 Source: same as above
35 Source: same as above
36 Source: same as above
37 Source: same as above
38 Source: same as above
39 The capital of foreign and domestic loans does not appear in NREA's P/L, as capital is repaid by the Egyptian government.
40 Source: interviews with executing agency (NREA)

Table 10: Profit and Loss Statement of NREA

(Unit: thousand LE)

	2009/2010	2010/2011	2011/2012
Operating Revenue	**293,274**	**244,033**	**251,755**
Operating Expense	**187,319**	**207,784**	**227,807**
Material Inputs	8,714	8,584	10,237
Service Inputs	7,585	8,047	7,648
Wages	21,931	27,158	34,975
Depreciation	143,332	163,699	174,362
Rent	108	104	102
Others	5,649	192	483
Operating Income	**105,955**	**36,249**	**23,948**
Other Income	**20,120**	**26,633**	**20,128**
Subsidy	19,825	26,633	20,128
Others	295	0	0
Other Expense	**255,221**	**224,069**	**463,123**
Interest	242,406	191,410	427,899
Exchange Loss	0	24,331	35,177
Others	12,815	8,328	47
Net Income	**▲129,146**	**▲161,187**	**▲419,047**

Source: prepared based on documents provided by NREA

Table 11 below shows NREA's balance sheet (B/S). While the net income is in deficit of approximately 400 million LE in 2011/12 due to interest payments, the amount of capital was increased for more than 100 million LE. It is considered that this is due to compensation from the national treasury, as NREA's revenues and expenditures of each financial year are tied to the national treasury, as mentioned above, although details of money transfer is not clear[41]. Accordingly, while NREA's net income was in deficit in 2011/12, the capital-asset ratio is maintained at approximately 13%. While the amount of current liability is more than the amount of current asset, this will not be a major problem, as electricity tariffs are usually to be collected regularly in a short term.

Table 11: Balance Sheet of NREA

(Unit: thousand LE)

	2009/2010	2010/2011	2011/2012
Asset			
Current Asset	578,776	1,544,193	1,933,845
Fixed Asset	7,567,048	8,175,473	8,707,184
Asset Total	**8,145,824**	**9,719,666**	**10,641,029**
Capital/Liability			
Capital	1,298,544	1,264,302	1,381,632
Current Liability	629,040	1,854,734	2,521,893
Fixed Liability	6,218,240	6,600,630	6,737,504
Capital/Liability Total	**8,145,824**	**9,719,666**	**10,641,029**

Source: prepared based on documents provided by NREA

[41] While it cannot be denied that part of NREA's finance has been covered by borrowings, capital is repaid by the Egyptian government and hence the impact on NREA's finance is relatively low.

Regarding O&M cost related to the project, at the time of ex-post evaluation, approximately 690 to 820 thousand LE has been expensed annually for O&M of the wind power plant constructed by the project (labour cost, spare parts, and administration cost etc. for O&M)[42]. This project was completed in July 2009, and three years after project completion (until July 2012) is the warranty period, and defects occurred during the period are fixed by the contractor, and thus the O&M cost at the time of ex-post evaluation is relatively small. However, major repair (replacement of gearbox and generators etc.) is expected after 2015. O&M cost of 2015 is estimated approximately 13,000 thousand LE, which will increase steadily and O&M cost of 2022 is estimated approximately 28,000 thousand LE[43]. According to NREA, major repair for wind power plants is different from the case of gas turbines, where major repair is required for once in several years. Rather, major repair for wind power plants is required every year after several years of project completion, as there are 142 wind turbines.

The table 12 below shows the comparison of sales revenues from and O&M cost of the wind power plant constructed by the project.

Table 12: Sales Revenue from and O&M cost of the Wind Power Plant Constructed by the Project

(Unit: thousand LE)

	2010	2011	2012
O&M Cost	820	690	690
Sales Revenue	49,241	52,379	49,514

Source: O&M Cost: provided by NREA. Sales Revenue: calculated based on the amount of electric energy production provided by NREA and unit price of electricity provided by EETC.

As seen in the table above, O&M cost is sufficiently covered by sales revenues at the time of ex-post evaluation. Assuming that almost the same amount of energy production and electricity price as in 2011 will be kept (= electricity price will not be revised) in the future, O&M cost can still be covered by sales revenues after 2015, when major repair is expected.

Therefore, there seems to be no major problem regarding NREA's financial aspect of O&M.

(2) EETC

EETC, which is responsible for O&M of the substation, is also under the Ministry of Electricity and Energy. According to the P/L of EETC, net income has been in profit

[42] Source: interviews with executing agency (NREA)

[43] Source: same as above

from 2008/09 to 2010/11 as shown in Table 13 below, and there seems to be no major problem regarding the financial aspect of O&M of the facilities provided by the project.

Table 13: Profit and Loss Statement of EETC

(Unit: thousand LE)

	2008/2009	2009/2010	2010/2011
Operating Revenue	**16,816,176**	**18,901,224**	**21,067,838**
Operating Expense	**15,273,171**	**17,435,331**	**19,664,292**
Material Inputs	137,651	114,052	109,730
Wages	911,667	989,033	1,316,163
Depreciation	805,956	818,041	885,866
Purchases for Sale	12,914,615	14,756,800	16,246,692
Others	503,282	757,405	1,105,841
Operating Income	**1,543,005**	**1,465,893**	**1,403,546**
Other Income	**537,326**	**807,537**	**544,911**
Subsidy	306,619	455,127	337,987
Others	230,707	352,410	206,924
Other Expense	**1,398,734**	**1,419,451**	**1,758,156**
Interest	1,372,098	1,391,524	1,723,231
Exchange Loss	26,636	27,927	34,925
Net Income	**681,597**	**853,979**	**190,301**

Source: documents provided by EETC

Regarding O&M cost related to the project, approximately 188 to 213 thousand LE has been expensed annually for O&M (labour cost and spare parts etc. for O&M) at the time ex-post evaluation. O&M cost of the substation added by the project is expected to be sufficiently covered by revenues.

Therefore, there seems to be no major problem regarding EETC's financial aspect of O&M.

3.5.4 Current Status of Operation and Maintenance

Regarding the wind power plant constructed by the project, regular inspection and maintenance are conducted based on a maintenance plan, and inspection of all facilities such as blades, blade bearing, hollow shaft, main shaft, high speed shaft, gearbox, brake, generator, yaw gear, anemometer, tower, cables, etc. of each turbine, lubrication, oil change, and replacement of spare parts etc. are conducted every 6 months[44]. High vibration of a tower due to unbalanced blades and broken main shaft due to cracks (two turbines) were observed during the warranty period, however, both were already fixed[45]. While all the wind turbines are currently functional, there are some defects such as misalignment between gearbox and generator, faulty recharge batteries, high sound in yaw system, and faulty air conditioning unit, etc. in some of the turbines,

[44] Source: documents provided by executing agency (NREA)

[45] Source: interviews with executing agency (NREA)

and the contractor is currently repairing these problems, and thus the whole facilities constructed and procured by the project have not been handed over to NREA[46]. NREA requested third party experts to investigate these problems, and NREA, the contractor and the third party experts are currently discussing how to deal with these problems, and all the facilities constructed and procured by the project will be handed over after all the problems are solved[47]. Therefore, while there are some defects currently, stakeholders including third party experts are dealing with these problems, and thus there seems to be no major problem.

Regarding the substation added by the project, regular inspection and maintenance are conducted based on a maintenance plan, for example, feeder panels and circuit breakers are inspected every 6 months, protection equipment and mechanical parts of transformers are tested every year, mega test of winding resistance transformers is conducted every two years, and calibration of meters is conducted every three years, etc.[48] According to the executing agency, all facilities provided by the project are operational without problems, and no problem was observed in the site inspection by the evaluator.

No major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aimed at increasing power supply and reducing the use of fossil fuels, by constructing the 120MW of wind power plant in Zafarana of Egypt, and thereby contributing to reduction of air pollution, amount of greenhouse gas emissions equivalent to the amount when a similar size of a thermal power plant is operated and global warming.

Relevance of this project is high, as the project is consistent with priority areas of Egypt's development plans and Japan's ODA policy, and moreover development needs for the project are high. Actual figures of almost all the operation and effect indicators are higher than approximately 80% of target figures for two years after project completion, and the project contributed to the increase of power supply and reduction of the use of fossil fuels and the amount of greenhouse gas emissions. Thus, effectiveness and impact of the project are high. Sustainability of the project is also high, as no major problem has been observed in institutional, technical and financial aspects of the operation and maintenance (O&M) and current O&M status. On the other hand, efficiency of the project is low, as both actual project cost and period largely exceeded planned cost and period.

---

[46] Source: same as above

[47] Source: same as above

[48] Source: interviews with executing agency (EETC)

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) In this project, the process for selection of a contractor for the power plant portion was delayed due to delays in P/Q and a long time required for clarification of bidding documents and contract negotiations etc. Then it also took 6 months for the contract to become effective due to a long time required for procedures for advance payment. The process for selection of a contractor for the substation portion was also delayed due to delays in preparation of bidding documents, postponed bidding deadline upon receiving a request from bidders, and a long time required for clarification of bidding documents etc. As a result, the actual project period largely exceeded the planned period. JICA should consider how to deal with these problems during appraisal if there is a risk of delay because executing agencies are unfamiliar with Japanese ODA Loan procedures. For example, the World Bank prepares a procurement assessment report for a new project during appraisal based on the country procurement assessment report, and the Bank assesses executing agencies' capabilities and risks related to procurement, and formulates a detailed project implementation plan based on the report, which could be one of the options for JICA.

(2) There is no explanation on the substation portion or actual figures of operation and effect indicators in the project completion report (PCR) of the project. Also, there are inconsistencies in actual project cost (by category and by year) stated in the PCR. PCR needs to be validated by JICA operating departments to ensure an appropriate implementation of PDCA (Plan-Do-Check-Action) cycles by executing agencies and an effective monitoring of project status and effects by donors.

Column: Clean Development Mechanism (CDM) Project

As explained earlier, this project was approved as a CDM project by the CDM Executive Board of the United Nations in 2007. (1) The process of CDM approval of the project, (2) Issues and obstacles related to the CDM approval, and (3) Merits and demerits derived from the project being approved as a CDM project are explained below.

(1) The process of CDM approval of the project:

1) Preparation of a plan for a CDM project by project stakeholders (JICA and NREA)
2) Approval of the plan by the designated state institution in the investing country (Japan) and in the host country (Egypt)
3) Validation of the CDM project by the Designated Operational Entity (DOE: the third party entrusted by the CDM Executive Board)
4) Registration of the CDM project by the CDM Executive Board (if DOE judged that it is appropriate to approve the project as a CDM project)
5) Project implementation and monitoring (monitoring of emissions reductions by the executing agency)
6) Verification and certification of Certified Emissions Reductions (CER) by DOE
7) Issuance and distribution of CER credits by the CDM Executive Board to the executing agency

(Source: JICA internal documents and interviews with NREA)

(2) Issues and obstacles related to the CDM approval:

According to NREA, issues and obstacles are that the CDM approval procedure was complicated and difficult, and rules and regulations of the procedure were revised often, and that DOE responsible for verification of CER was inexperienced and their performance was low, etc. DOE is to be selected through a competitive bidding by an executing agency from the list of 44 organizations provided by the CDM Executive Board. NREA selected 9 organizations from 44 organizations and conducted the competitive bidding, however, only one organization bid for the project, and thus NREA made a contract with the organization. However, there were several problems such as frequent changes of contact persons, slow response, and submission of reports being delayed etc. As explained below, NREA applied for CDM approval of three wind power generation projects after this project, and the CDM approval procedure of the DANIDA-assisted project, in which other DOE was involved, was completed in one year, on the other hand, the procedure for this project took three years.

Another issue regarding the CDM approval was that an executing agency is required to prove additionality of the project (the fact that the project could not be implemented other than as a CDM project), and this was also very difficult, according to NREA. Particularly, as part of discussion on additionality, it was stated in the Marrakesh agreements of 2001 that “public funding for CDM projects from Parties included in Annex 1 is not to result in the diversion of official development assistance (ODA)”, and NGOs raised issues including that if the diversion of ODA for projects that produce CER is allowed, it will give incentives to prioritize such projects for financing. A considerable time seems to have been spent to solve the issue, and it seems to have been cleared according to the reasons below;

- While the Marrakesh agreements state that it cannot be the diversion of ODA, it does not state that ODA cannot be used for CDM projects;

- ODA from KfW was used for the wind power plant project in Essaouira of Morocco, which was approved by the CDM Executive Board;
- The Egyptian government selects projects which have higher priorities based on its national development plans, policies and development needs, and requests the Japanese government to provide ODA loans, and there is no fact that financing was ever provided to a sector with low priorities;
- According to the verification tool for additionality adopted by the CDM Executive Board, the profitability of the project is low and there exist barriers to investment, which assures additionality, and revenues from CER credits will complement the low profitability and promote appropriate project implementation and operation.

(3) Merits and demerits derived from the project being approved as a CDM project:

According to NREA, this project enabled technological transfer related to CDM and NREA was able to become familiar with CDM approval procedures through the experience. After the CDM approval of this project, NREA applied for CDM approvals of three wind power generation projects (those assisted by KfW, DANIDA and Spanish government) from 2010 to 2011, and all of them were approved. Moreover, while CER of this project is currently being verified and CER credits have not yet been distributed, they will be issued and distributed from 2013, which will complement the low profitability of the project to some extent. According to NREA, there is no demerit related to the CDM approval of this project.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	**Wind Power Plant Portion** ・ Wind turbine generators (range from 600kW x 200 units to 1,000kW x 120 units), 120MW in total ・ Control monitoring system and other related equipment ・ Electrical works and civil & installation works **Expansion of Substation Portion** ・ Transformers (125MVA x 2 units) and other related equipment ・ Electrical works and civil & installation works	**Wind Power Plant Portion** ・ Almost as planned However, 120.7MW in total (850kW x 142 units) **Expansion of Substation Portion** ・ As planned
2. Project Period	December 2003 – February 2007 (39 months)	December 2003 – July 2009 (68 months)
3. Project Cost Amount paid in Foreign currency	13,915 million yen	16,147 million yen
Amount paid in Local currency	4,551 million yen	10,145 million yen
	(224 million LE)	(548 million LE)
Total	18,466 million yen	26,292 million yen
Japanese ODA loan portion	13,497 million yen	13,497 million yen
Exchange rate	1 USD = 119.46 yen = 5.89LE (As of May 2003)	1 EUR = 141.56 yen 1 LE = 18.5 yen (Average between December 2003 and July 2010)