Japanese ODA Loan

Ex-Ante Evaluation (for Japanese ODA Loan)

1. Name of the Project

Country:	Arab Republic of Egypt
Project:	Hurghada Photovoltaic Power Plant Project
Loan Agreement:	February 29, 2016
Loan Amount:	11,214 million yen
Borrower:	New and Renewable Energy Authority (NREA)

2. Background and the Necessity of the Project

(1) Current State and Issues of the Electricity Sector in Egypt

Egypt currently depends greatly on thermal power for power generation with hydropower accounting for 9% of its total power sources, thermal power for 89%, and renewable energy for 2%, but since the Arab Spring in 2011, the country has not made much progress in oil and natural gas development due to the deterioration of the investment environment, and there are frequent power failures partly because of lack of natural gas, the principal fuel for thermal power generation. The peak load in Egypt has grown by 6.0% annually (average growth rate for the decade up to FY2013/2014), higher than the annual economic growth rate of 4.4% (average growth rate for real GDP during the same period), and in particular, the nighttime electricity demand has remained high. The installed capacity of power generation in FY2013/2014 was 32,015MW, but the peak load in FY2017/2018 is expected to be 32,951MW, exceeding the current power supply capacity. Increasing the installed capacity of power generation to meet electricity demand is an urgent issue to be addressed.

In order to meet rapidly growing electricity demand, the Ministry of Electricity and Renewable Energy plans to increase the installed capacity of power generation in addition to taking measures such as encouraging further investments in gas field development. In particular, the Egyptian government aims to reduce domestic oil and natural gas consumption and instead develop power sources with less environmental impacts. With the installed capacity of power generation using renewable energy (excluding hydropower) standing at 570MW in FY2013/14, the government plans to build power plants capable of generating about 8,400MW of electricity by 2020. Of this, about 2,400MW are expected to come from photovoltaic power plants.

(2) Development Policies for the Electricity Sector in Egypt and the Priority of the Project

In order to achieve this goal, the Egyptian government plans to build power plants, including the Hurghada Photovoltaic Power Plant, and in addition, with the enactment of the Presidential Decree-Law regarding the Stimulation of Producing Electricity from Renewable Energy Sources in December 2014, it introduced a feed-in tariff (FIT) system to facilitate the development of renewable energy through private investments. There is growing concern among government officials, on the other hand, that an increase in the usage of unstable renewable energy as power sources destabilizes the network voltage. By supporting in constructing the Hurghada Photovoltaic Power Plant and its storage battery facilities, this JICA project aims to contribute to increasing the installed capacity of power generation while encouraging the development of renewable energy. Furthermore, it aims to contribute to stabilizing output power from photovoltaic modules through trial introduction of storage

battery systems and to making the network voltage stable and supplying electricity during the nighttime in the project areas. For these reasons, it agrees with Egypt's policies and challenges.

(3) Japan and JICA's Policy and Operations in the Electricity Sector

Under the development goal of "Improving the investment and business environment" in the Japanese government's priority aid area for Egypt, "Sustainable economic growth and creation of employment," JICA has up to now supported the construction of power plants, including the Zafarana Wind Power Plant, Gulf of El Zayt Wind Power Plant, and Kuraymat Integrated Solar Combined Cycle Power Plant, in accordance with its program "Introduction of new and renewable energy and promotion of energy conservation". The present project, aimed at developing photovoltaic power plants, is in agreement with these policies.

(4) Other Donors' Activity

The United Arab Emirates constructed a 10MW photovoltaic power plant in Siwa Oasis of northwestern Egypt, and the power plant started operation in March 2015. The French Development Agency (AFD) is building a 20MW photovoltaic power plant in Komombo City of southern Egypt. Germany's KfW Group is helping formulate a renewable energy master plan.

(5) Necessity of the Project

This project is consistent with Egypt's development policy and goals as well as Japan's and JICA's priority aid areas. As a Special Terms for Economic Partnership (STEP) project, it is also expected to introduce on a trial basis storage battery facilities that make the most of Japan's technology, thus contributing to exports of infrastructure systems from Japan. Therefore, it is highly necessary and appropriate for JICA to support implementation of this project.

3. Project Description

(1) Project Objective

The objective of this project is to construct a 20MW photovoltaic power plant and related facilities at the Hurghada Wind Power Plant, which is located 15 km northwest of Hurghada City on the coast of the Red Sea, in order to increase power supply, stabilize the network, and encourage use of renewable energy, thus contributing to promoting social and economic development and mitigating climate change.

(2) Project Site/Target Area

On the compound of Hurghada Wind Power Plant located 15 km northwest of Hurghada City in the Governorate of the Red Sea

(3) Project Components

1) Construction of a photovoltaic power plant (output: 20MW) and storage battery facilities (capacity: 30MWh), installation of Power Conditioning Systems (PCS) and an

Energy Management System (EMS), and laying of cables up to the Central Hurghada Substation
2) Expansion of the Central Hurghada Substation to which the photovoltaic power plant is connected and connection of cables in the substation
3) Consulting services (such as assistance in bidding, supervision of construction, training)

(4) Estimated Project Cost (Loan Amount)

13,645 million Yen (Loan Amount: 11,214 million Yen)

(5) Schedule

From February 2016 to September 2021 (68 months); the project will be completed when the facilities come into service (September 2019)

(6) Project Implementation Structure

1) Borrower: New and Renewable Energy Authority (NREA)
2) Guarantor: Government of the Arab Republic of Egypt
3) Executing Agency: New and Renewable Energy Authority (NREA) and the Egyptian Electricity Transmission Company (EETC)
4) Operation and Maintenance System
NREA will carry out the portion of the project that is covered by yen loan. EETC will be responsible for expanding the central Hurghada substation and connecting cables in the substation, two of the project components that are not covered by yen loan.

(7) Environmental and Social Consideration/Poverty Reduction/Social Development

1) Environmental and Social Consideration
   (1) Category: C
   (2) Reason for Categorization: The sectors and characteristics of this project do not fall into any of the sensitive sectors, characteristics, and areas listed in the JICA Guidelines for Environmental and Social Considerations, which were published in April 2010, and the project is considered to have minimal or little adverse impact on the environment and society.
2) Promotion of Poverty Reduction: None
3) Promotion of Social Development: None

(8) Collaboration with Other Donors: None

(9) Other Important Issues

1) As a STEP project, this project is expected to make the most of Japan's technology as follows:
   (1) Storage batteries with a long life that enable stabilization of the network voltage in the project area and power supply at night when electricity demand is high
   (2) High-efficiency Power Conditioning System (PCS) with a function of stabilizing the network voltage through reactive power control
   (3) Energy Management System (EMS) that provides integrated control over PCS for photovoltaic modules and for storage battery

2) This project, aimed at increasing power supply and encouraging use of renewable energy through construction of a photovoltaic power plant, will contribute to reduction in greenhouse gas (GHG) emissions. In terms of the estimated amount of GHG gas emissions reduced, it is expected to mitigate global warming by approximately 16,660 tons/year-CO2.

4. Targeted Outcomes

(1) Quantitative Effects

1) Performance Indicators (Operation and Effect Indicator)

Indicator	Baseline (Actual Value in 2015)	Target (2021) [Expected value 2 years after project completion]
Electric energy supply by photovoltaic modules (MWh/year)	--	30,589
Net electric energy supply in nighttime by storage battery (MWh/year)	--	8,400 (28MWh x 300 days)
Unplanned outage hours (due to equipment outage) (hours/year)	--	10
Planned maintenance outage hours (each piece of equipment) (hours/year)	--	72
Maximum output power in daytime (photovoltaic modules only) (MW)	--	20
Maximum output power in nighttime (storage batteries only) (MW)	--	6

(2) Qualitative Effects

Stabilization of the network voltage, improvement of the living environment, and promotion of economic development in the project area

(3) Internal Rate of Return

Based on the assumptions listed below, the economic internal rate of return (EIRR) for this project is expected to be 6.47%.

[EIRR]
Cost: Project cost (excluding taxes) and operation and maintenance cost
Benefit: Reduction in the amount of fossil fuel used and increase in its export as a result due to the introduction of photovoltaic power generation and storage batteries, and sales of emissions rights
Project Life: 25 years
The financial internal rate of return (FIRR) cannot be calculated because the unit price of

electricity sold using storage batteries is not decided.

5. External Factors and Risk Control

None

6. Lessons Learned from Past Projects

(1) Lessons Learned from Similar Projects

JICA's "Report on Investigations (project research) of Challenges in and Possibilities of Regional Electrification Using Photovoltaic Power Generation Projects" (2005) and the like indicate that how to maintain storage batteries often becomes an issue to be addressed. In particular, it is necessary to pay attention to the concern that end-of-life (lead storage) batteries may be left as they are, causing environmental pollution.

(2) Application of the lessons learned to this project

This project plans to monitor the charging status of storage batteries and detect troubles in the batteries early by introducing storage batteries with battery management units. At the same time, it plans to procure storage batteries after confirming the battery disposal methods used in Egypt at the time of the detailed design.

7. Plan for Future Evaluation

(1) Indicators to be Used

Electric energy supply by photovoltaic modules (MWh/year), Net electric energy supply in nighttime by storage battery (MWh/year), Unplanned outage hours (due to equipment outage) (hours/year), Planned maintenance outage hours (each piece of equipment) (hours/year), Maximum output power in daytime (photovoltaic modules only) (MW), Maximum output power in nighttime (MW), and internal rate of return

(2) Timing

Two years after the project is completed