Ex-Ante Project Evaluation (for Japanese ODA Loan)

1. Name of the Project

Country: The People's Republic of Bangladesh
Project: Matarbari Ultra Super Critical Coal-Fired Power Project (II)
Loan Agreement: June 29, 2016
Loan Amount: 37,821 million Yen
Borrower: The Government of the People's Republic of Bangladesh

2. Background and Necessity of the Project

(1) Current State and Issues of the Power Sector in Bangladesh

In the People's Republic of Bangladesh, electric power supply is not keeping up with its increasing demand because of the industrialization and the rapidly growing economy of recent years. As of 2015, the potential demand is 9,000 MW, however, the actual performance of maximum power supply is 8,177 MW (Bangladesh Power Development Board: BPDP), leaving the supply capacity being 90 % of its demand.

Whereas the power demand is estimated to increase at 9.3 % per annum over the next decade, the output of domestic natural gas shall decline with 2016 as its peak. The gas-fired power plants, which account for approximately 60 % of the total capacity of electric power facilities, depend on the domestic natural gas as its energy source. Therefore, it is a pressing task to increase the power supply as well as diversify the energy sources.

(2) Development Policies for the Power Sector in Bangladesh and the Priority of the Project

In The Seventh Five Year Plan (FY 2016/17 - 2020/21), which is regarded as the top-ranked plan of the national development strategy, the power sector is positioned as one of the most important sectors in the country which is aiming to attain middle income country status by 2021. Also, Power System Master Plan 2010 stated that coal is the most important primary energy, and to use the imported coal as the base power source for the electric demand which is going to be nearly 34,000 MW by 2030. The plan counts the construction of high-efficacy ultra super critical coal-fired power plants as a hot issue.

Matarbari Ultra Super Critical Coal-Fired Power Project (hereinafter referred to as "the Project") is one of the highly-prioritized projects under the direct supervision of the Prime Minister as an infrastructure-improvement project to meet the rapidly increasing power demand in the country as well as to diversify energy sources.

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

The acceleration of the economic growth is raised as one of the priority fields in the Country Assistance Policy for Bangladesh (June 2012), and the shortage of power is considered to be the biggest bottle neck of the economic development. Also, JICA Country Analysis Paper for Bangladesh (April 2013) analyzes that "stable power supply" is a task to be done with priority, and the Project corresponds these policies and analyses. JICA provided an ODA loan in FY 2014 for the phase 1 of this project. Other major assistances provided in the

power-sector thus far are as follows.

- ODA loan: New Haripur Power Plant Development Project (FY 2007, FY 2008), Bheramara Combined Cycle Power Plant Development Project (FY 2010, FY 2013), National Power Transmission Network Development Project (FY 2013), Renewable Energy Development Project (FY 2013) etc.
- Technical Cooperation: Dispatch of Power Sector Adviser (FY 2004 - present), Strengthening Management and Performance Standards in Power Sector of Bangladesh through Promotion of TQM (FY 2006-2009), Master Plan Study on Coal Power Development in Bangladesh (FY 2009-2010) etc.

(4) Other Donors' Activity

The World Bank is providing supports for; the improvement of core transmission network, the development assistance loans for power sector, the formulation of the plans for financial reform and restructuring of power sector, and the construction of gas-fired power plants etc. The Asian Development Bank is providing supports for; the improvement of management efficiency of BPDP, the establishment of Bangladesh Energy Regulatory Commission (BERC), and the construction of gas-fired power plants.

(5) Necessity of the Project

Providing supports to this Project corresponds to the policy and analysis of the Government of Japan and JICA. Also, the Government of Bangladesh is placing emphasis on the importance of construction of high-efficiency coal-fired power plants, where imported coals are utilized, as a measure to provide stable power supply that can cope with the rapidly increasing power demand as well as the needs for the diversification of energy sources. Thus, necessity of JICA to assist the Project is high.

3. Project Description

(1) Project Objective

The objective of the Project is to meet the increasing electricity demand and mitigating greenhouse gas emissions by constructing an ultra super critical coal-fired power plant (rated output: 1,200 MW (600 MW × 2)) in Matarbari area, Chittagong Division in southeastern Bangladesh, thereby contributing to the revitalization of the nationwide economic development and mitigation of climate change.

(2) Project Site / Target Area

Cox's Bazar District and Chittagong District in Chittagong Division

(3) Project Components

a) Ultra Super Critical Coal-Fired Power Plant (600MW x 2)
   Port and harbor to unload coals (Maximum water depth of approximately 18.5m)
b) Transmission lines (approximately 92km with 400kV, towers etc.)
c) Access roads (bridge: approximately 640m, construction of new roads: approximately 10km maintenance and repair of existing roads: approximately 33km etc.)
d) Electrification of the surrounding areas (Transmission line of 132 kV: approximately

25km, Substation with 132/33kV and 33/11kV, Distribution facilities with 33/11/6.35/0.4kV)

e) Procurement of equipment and materials (Large-sized vehicles, measuring instruments, equipment for disaster prevention etc.)

f) Consulting services (detailed design, tender assistance, construction supervision etc.)

(4) Estimated Project Cost (Loan Amount)

706,705 million Yen (Loan Amount: 569,660 million Yen / Loan Amount in this phase: 37,821 million Yen)

(5) Schedule

June 2014 - September 2028 (172 months in total). The Project will be completed when the service of the facilities commences (June 2024).

(6) Project Implementation Structure

1) Borrower: The Government of the People's Republic of Bangladesh

2) Executing Agencies: Coal Power Generation Company Bangladesh Limited (CPGCBL), Power Grid Company of Bangladesh Limited (PGCB), Roads and Highways Department (RHD)

3) Operation and Maintenance System: CPGCBL, PGCB and RHD will carry out the operation and maintenance of this project, and also Bangladesh Water Development Board (BWDB) will be in charge of the dikes which form a part of access roads.

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

1) Environmental and Social Consideration

① Category: A

② Reason for Categorization

This Project applies to the sector of thermal power plant stated in the Japan International Cooperation Agency (JICA) Guidelines for Environmental and Social Considerations (April 2010).

③ Environmental Permit

The Environmental Impact Assessment (hereinafter, referred to as "EIA") regarding the construction/maintenance of the power plant, port and harbor was approved by Department of Environment (hereinafter called "DOE") in October 2013, and the EIA for the construction/maintenance of transmission lines and access roads was approved in November of the same year. As concerns the routes of transmission lines which were changed afterward, the EIA report for "Dhaka-Chittagong Main Power Grid Strengthening Project" covers them and this EIA is anticipated to be approved by DOE in August 2016. As for the construction of access roads (approximately 6.5 km) newly added to the project scope by the appraisal of this phase, a new EIA report was prepared and approved by DOE in January 2016. The EIA for the electrification of the surrounding areas (the construction of transmission line network) was approved by DOE in October 2015. Although the scale of dredging is becoming larger in the project of port and harbor as the plans of sea route change, neither amendment nor addition to the EIA are required according to the domestic

legislation in Bangladesh.

④ Anti-Pollution Measures

By adopting the flue-gas desulfurization (FGD) equipment with seawater process and the low nitrogen oxide (NOx) combustion method, both sulfur oxide (SOx) and NOx within the exhaust gas emitted from the power plant of this Project are expected to meet the Bangladeshi and international standard (The Environmental, Health, and Safety (EHS) Guidelines by International Finance Corporation (IFC)). Likewise, concentration of SOx and NOx in the atmosphere is expected to meet the Bangladeshi and EHS standard as well. As for the dust (Particle Pollution: PM), it will meet the standard of EHS guidelines, however, the estimated upper value of the PM 10 concentration (42.4 - 62.4μg/m3, annual value) resulted to be the only value that exceeds the standard of Bangladesh. This is thought to be because of the concentration before the implementation of this Project (42 - 62μg/m3), and the influence of this Project itself is estimated to be merely 0.4μg/m3. The influence of PM shall be minimized by adopting a high stack (275m) and an electric dust collector. Seawater is used as cooling water in this Project, however the impact on the ecosystem is not foreseen because the standard of Bangladesh for the industrial wastewater (below 40℃) shall be strictly obeyed, keeping the elevation of water temperature within 7℃ at the time of discharge compared to the time of intake. The noise impacts will not exceed the standard of both Bangladeshi and EHS guidelines during the construction as well as after the commencement of service. The dredged soil is anticipated to increase as the plans of sea route change, but a part of the dredged soil shall be used as embankment after the treatment of the cementitious, and the rest of the soil shall be appropriately treated in the designated muck disposal sites.

⑤ Natural Environment

The target area of this Project is not in or around the area, such as national parks, subject to be influenced by the Project. Sonadia Island, designated as “Ecologically Critical Area” by the Government of Bangladesh, is located approximately 15 km south of the project site. The impact on Sonadia Island, however, is not foreseen because the environmental mitigation policy, written in the measure against pollution, has been implemented and air pollution and water contamination will remain limited. Since the creatures in the ocean often move and migrate, in case scarce species are witnessed some measures shall be taken such as reducing the noise and vibration as well as adjusting the brightness of the light which will be cast on the surface of the ocean and the surrounding areas associated with the construction works. Also, the workers are forbidden to collect, capture or hunt scarce species and their eggs.

⑥ Social Environment

The size of the land that is to be acquired for the power plant / port and harbor is approximately 475 ha, and these areas are used as salt fields in the dry season and as shrimp farms in the rainy season. In addition to the 20 households (16 out of 20 are illegal residents) who need to move because of the power plant / port and harbor, 2,031 people are

the target of this land acquisition and it is verified that it will affect 1,102 people's source of income (the number of people to be affected remains the same since the time of the first phase appraisal of the Project). The land acquisition for the construction and maintenance/repair of access roads is to be 35.71 ha (23.86 ha out of this was added after the first phase appraisal of the Project due to widen the existing roads) and this involves resettlement of approximately 20 unofficial residents. There will be no land acquisition needed for the construction of transmission lines as well as the electrification of surrounding areas since the properties owned by either implementing agencies or the government will be used (At the time of the first phase appraisal of the Project, land acquisition of 0.13 ha was planned in order to build a substation, however, this acquisition became no longer necessary as the construction of this substation turned to be exempted from this Project). The transmission lines came to be connected to the substation constructed in the Dhaka-Chittagong Main Power Grid Strengthening Project. As concerns the compensation for the land acquisition/resettlement of residents/loss on assets and the cost of living, procedures are going forward in the component of power plant / port and harbor based on the JICA Guidelines for Environmental and Social Considerations along with the domestic procedures of Bangladesh and the Resettlement Action Plan (RAP). For the access road, which requires land acquisition as well as residents resettlement in the second phase of this Project, a revised RAP shall be prepared at the stage of making detailed design. When the meetings were held with local stakeholders for each project component when preparing the EIA report and RAP (at the time of the first phase appraisal); no opposing opinions was raised on this Project, yet some requests were made for the proper environmental management and the infrastructure development in the surrounding areas. The implementing agencies responded that they shall take the proper measures to the opinions and requests, and the understanding of the attendees was obtained. The meeting with local stakeholders concerning the access road is to be held after the revised RAP is prepared.

⑦ Other / Monitoring

As for the resettlement of the residents, internal monitoring will be carried out by the implementing agency, and external monitoring by the third-party. As for the environment, the implementing agency and the contractor will monitor the air, water quality and noises during the construction. After the commencement of the service, the implementing agency will keep monitoring them.

2) Promotion of Poverty Reduction

① Electrification of the surrounding areas

Improve the electric facilities in the surrounding areas of the power plant, and implement the electrification of the 4,000 households in Matarbari/Dalgata areas.

② Improvement of the basic infrastructure for the workers

The improvement of the basic infrastructure for daily life is going to be carried out with the fund of the Government of Bangladesh for the workers involved in this Project. The

public facilities which will be built as a part of this infrastructure improvement, such as hospitals and schools, can also be used by the local residents of these areas.

③ Budget allocation in proportion as power generation amount

The Matarbari power plant is in the target area of the Social Development Fund whose establishment was approved by the Government of Bangladesh in November 2012, and 0.03 Taka per 1kWh of electricity sales shall be saved into the above-mentioned fund. The budget shall be allocated from this fund to the administrative bodies in the Matarbari area, and this budget is allowed to be used only for the purposes that contribute to the improvement of living environment.

3) Promotion of Social Development

Measures against HIV/AIDS shall be taken by the implementing agency as well as the contractor for the workers employed during the construction period as a part of the package for the construction of the power plant/port and harbor, transmission lines and the access roads of this Project. Also, male and female interview, gender-balanced stakeholder meetings have been conducted on environmental and social consideration during the preparatory survey. Therefore, it is categorized as gender mainstreaming needs assessment and analyses project.

(8) Other Important Issues: N/A

4. Target Outcomes

(1) Quantitative Effects

1) Performance Indicators (Operation and Effect Indicator)

Indicators		Unit	Target (2026) [Effective value 2 years after project completion]
[Operation Indicators]			
Power Plant			
Maximum output		MW	1,200
Utilization ratio		%	80
Operation rate		%	85
Auxiliary power ratio		%	6.48
Gross thermal efficiency		%	41.29
Unit downtime(*)	Human errors	hours / year	0
	Mechanical troubles	hours / year	218
	Regular Inspections	hours / year	1,096
Suspension frequency of the unit operation(*)		times / year	10
Transmission Lines			
Transmission loss rate		%	0.4
Ports and Harbors			
Berth operation rate		%	60
Total cargo volume		1,000 tons / year	4,000
Volume of dredged soil		Cubic meter / year	360,000
[Operation and Effect Indicators]			
Net electric energy production		GWh / year	7,865
CO_2 emission(*)		1,000 tons / year	3,416
NO_X emission(*)		1,000 tons / year	6.1
SO_X emission(*)		1,000 tons / year	10.9

Dust emission(*)	1,000 tons / year	0.7
Fuel consumption(*)	1,000 tons / year	1,863

(*) Per Unit

2) Internal Rate of Return

Based on the conditions stated below, the Economic Internal Rate of Return (EIRR) was calculated as 14.84%. As for the Financial Internal Rate of Return (FIRR), the component of generation turned to be 2.07% and the component of transmission turned to be 12.88%*.

EIRR:

Cost: Project cost (excluding tax), Fuel cost, Maintenance and operation cost

Benefit: Difference with the electricity generated with oil

Project Life: 25 years

FIRR:

(Component of Generation)

Cost: Project cost, Fuel cost, Maintenance and operation cost, Tax, Discount rate

Benefit: Sales revenue of electric power (PPA: Power Purchase Agreement)

Project Life: 25 years

(Component of Transmission)*

Cost: Project cost, Fuel cost, Maintenance and operation cost, Tax, Discount rate

Benefit: Power transmission fees, Residual value at the end of project life

Project Life: 25 years

* In the Dhaka-Chittagong Main Power Grid Strengthening Project, the FIRR of the whole Dhaka-Matarbari transmission project is calculated including the components of the Project.

(2) Qualitative Effects

Revitalization of the nationwide economic development and mitigation of climate change

5. External Factors and Risk Control

N/A

6. Lessons Learned from Past Projects

(1) Lessons Learned from Past Projects

The ex-post evaluation of Mombasa Diesel Generating Power Plant Project in Kenya demonstrates that appropriate supports from the manufacturers enhance the sustainability of power plants projects.

(2) Application of Lessons Learned to the Project

As this is the first technology, which is introduced to Bangladesh, this Project aims to build and establish the maintenance and operation system with the technology transfer through consulting services and the Long Term Service Agreement by manufacturers. Also the management system of the implementing agency shall be strengthened by the organization-reinforcement consultant that is to be employed in this Project.

7. Plan for Future Evaluation

(1) Indicators to be Used

1) Maximum output (MW/ year), Utilization ratio (%), Operation rate (%), Auxiliary power ratio (%), Gross thermal efficiency (%), Unit downtime (human errors, mechanical troubles, regular inspections) (hours/ year), Suspension frequency of the unit operation (times / year), Transmission loss (%), Fuel consumption (1,000 tons / year), CO_2 emission (1,000 tons / year), Transmission loss rate (%), Berth operation rate (%), Total cargo volume (1,000 tons / year), Volume of dredged soil (cubic meter/ year), Net electric energy production (GWh/ year), CO_2 emission (1,000 tons / year), NO_X emission (1,000 tons / year), SO_X emission (1,000 tons / year), Dust emission (1,000 tons / year), Fuel consumption (1,000 tons / year)

2) Economic Internal Rate of Return: EIRR (%), Financial Internal Rate of Return: FIRR (%)

(2) Timing: Two years after the completion of the Project