### 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 (III)

Loan Agreement: June 29, 2017

Loan Amount: 10,745 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 has not kept up with the increasing demand resulting from the country's industrialization and rapid economic growth in recent years. As of 2015, the potential demand was 9,000 MW, but the actual maximum power supply was 8,177 MW (Bangladesh Power Development Board: BPDP), which means that the supply capacity is 90% of demand.

Although the power demand is estimated to increase by 9.3 % per annum over the next decade, the output of domestic natural gas will decline following its peak in 2016. Gas-fired power plants, which account for approximately 60% of the total capacity of electric power facilities, depend on domestic natural gas as its energy source. Therefore, an increase in its power supply and diversification of its energy sources are urgently required.

(2) Development Policies for the Power Sector in Bangladesh and the Priority of the Project In the 7th Five-Year Plan (FY2016/17–FY2020/21), 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 Bangladesh, which aims to attain middle income country status by 2021. Also, the 2010 Power System Master Plan stated that coal is the most important primary energy and that imported coal should be used as the base power source for the country's electric demand, which will 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.

The Matarbari Ultra Super Critical Coal-Fired Power Project (hereinafter referred to as "the Project") is a highly-prioritized project being carried out under the direct supervision of the Prime Minister as an infrastructure improvement project that is intended to meet the country's rapidly increasing power demand as well as to diversify its energy sources.

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

The acceleration of economic growth has been raised as a priority field in the Country Assistance Policy for Bangladesh (June 2012), and the shortage of power is considered to be the biggest bottleneck in the economic development. Also, the JICA Country Analysis Paper for Bangladesh (April 2013) describes securing a "stable power supply" as a priority task, and

the Project is in line with these policies and the analysis. The major forms of assistance provided in the power-sector thus far are as follows.

- Loan: New Haripur Power Plant Development Project (FY2007–FY2008), Bheramara Combined Cycle Power Plant Development Project (FY2010–FY2013), National Power Transmission Network Development Project (FY2013), Renewable Energy Development Project (FY2013), etc.
- Technical Cooperation: Dispatch of Power Sector Adviser (FY2004–present),
  Strengthening Management and Performance Standards in Power Sector of Bangladesh through Promotion of TQM (FY2006–FY2009), Master Plan Study on Coal Power Development in Bangladesh (FY2009–FY2010), etc.

# (4) Other Donors' Activity

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

# (5) Necessity of the Project

The provision of support for this Project is in line with the policies and the analysis of the Government of Japan and JICA. Also, the Government of Bangladesh is placing emphasis on the need to construct high-efficiency coal-fired power plants, which use imported coal, as a measure to provide a stable power supply that will be able to cope with the rapidly increasing power demand as well as the need for a diversification of energy sources. Therefore, the necessity for JICA to support the Project is substantial.

### 3. Project Description

(1) Project Objective

The objective of the Project is to meet the increasing electricity demand and achieve stable power supply in Bangladesh, by constructing an ultra super critical coal-fired power plant in Matarbari area, thereby contributing to nationwide economic development and improvement of living standard.

(2) Project Site / Target AreaCox's Bazar District and Chittagong District in Chittagong Division

(3) Project Components

1) Ultra Super Critical Coal-Fired Power Plant (600 MW x 2)

Port and harbor to unload coals (Maximum water depth of approximately 18.5 m)

- 2) Transmission lines (approximately 92 km with 400 kV, towers etc.)
- 3) Access roads (bridge: approximately 675 m, construction of new roads: approximately8.5 km, repair of existing roads: approximately 34.5 km etc.)
- 4) Electrification of the surrounding areas (Transmission line of 132 kV: approximately 25 km, Substation with 132/33 kV and 33/11 kV, Distribution facilities with 33/11/6.35/ 0.4 kV)
- 5) Procurement of equipment and materials (Large-sized vehicles, measuring instruments, equipment for disaster prevention etc.)
- 6) Consulting services (detailed design, tender assistance, construction supervision etc.)

(4) Estimated Project Cost (Loan Amount)

700,369 million Yen (Loan Amount in this phase: 10,745 million Yen)

### (5) Schedule

June 2014 - July 2027 (146 months in total). The Project will be completed when the facilities are put in place (January 2024).

# (6) Project Implementation Structure

- 1) Borrower: The Government of the People's Republic of Bangladesh
- 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 (EIA) reports were approved by the Department of Environment of Bangladesh (DOE) for the construction and improvement of the power station and port/harbor in October 2013 and for the construction and improvement of power transmission lines and access roads in November 2013. Subsequent changes to power transmission line routes were included in preparing an EIA report for the Dhaka-Chittagong Main Power Grid Strengthening Project, and approved by DOE in June 2016. An updated addition to access road construction will most likely be approved by DOE in December 2017 following a scheduled update of the relevant EIA report. There are arrangements for JICA to be kept abreast of the progress on updating the access roads. The EIA for the rural electrification (power transmission/distribution grid construction) component of the Project received DOE approval in October 2015.

(4) Anti-Pollution Measures:

The Project will incorporate seawater-based flue gas desulfurization equipment and a low-NOx combustion system and thereby expects to meet the criteria for both sulfur oxide (SOx) and nitrogen oxide (NOx) exhausts from power stations in accordance with applicable domestic and international regulations (IFC Environmental, Health, and Safety Guidelines). The projected power station is expected to meet both national and EHS Guidelines standards for atmospheric concentrations. In terms of smoke dust (particulate matter) pollution, the power station conforms to the EHS Guidelines. Meanwhile, the estimated (annual)  $PM_{10}$  concentration level (42.4 to 62.4  $\mu$ g/m<sup>3</sup>) in emissions from the power station exceeds the upper limit of Bangladesh's prescribed range-this was the only exception in which the plant missed the threshold. However, this very likely reflected the impact of the pre-implementation concentration level (42 to 62  $\mu$ g/m<sup>3</sup>) and the Project presumably contributed an insignificant 0.4  $\mu$ g/m<sup>3</sup>. The plant will be equipped with a tall stack (275 m) and electrical dust collectors to minimize the effects of the PM. The Project uses seawater as a coolant. By controlling the temperature of the water at discharge to within 7°C above the temperature at intake, the plant will comply with the national standard (less than 40°C). Therefore, no negative impact is expected on the ecological system. The power station is expected to meet both national and EHS Guidelines noise standards during construction and while in service.

**(5)** Natural Environment:

The target area does not apply to a vulnerable area, such as national park, or its surrounding. About 15 km south of the site lies Sonadia Island, which is designated as an Ecologically Critical Area by the government of Bangladesh. However, as the mitigation measures noted in Anti-Pollution Measures will be taken, the effects of air pollution, water contamination, etc., will be limited, so no negative impact is expected on the island. To keep breeding sea turtles out of harm's way, necessary measures will be taken during their egg-laying season, including dimming the intensity of light sources illuminated on the sea surface or the surrounding area during construction and limiting noise and vibration. Project workers will be banned from gathering, harvesting, or hunting spoon-billed sandpipers and other rare species, or their eggs.

6 Social Environment:

The size of land to be acquired for constructing the power station and port/harbor is about 475 ha. The site under consideration is used as a salt farm in the dry season and as a shrimp farm during the rainy season. The number of residents whose livelihoods, etc., will be adversely affected by the construction and improvement of the power station and port/harbor totals 2,647. Out of these affected residents, 1,077 are subject to involuntary relocation (of which there are 16 illegally domiciled families). Work is in progress to determine the size of land to be acquired for the construction and repair/renovation of access roads; as well as the number of affected residents; the number of relocated residents; and the number of illegally domiciled residents in each of the aforementioned two groups as part of the ongoing process of updating the Relocation Assistance Program (RAP) to accommodate the completed detailed design. The updated RAP is scheduled to be finalized in September 2017 at the latest after discussions with local stakeholders. The power transmission grid construction and rural electrification components will be used on land belonging to the executing agency and to the government, so no land acquisition is required. Incidentally, it has been determined that this portion of power transmission lines will be connected to the substation constructed in the Dhaka-Chittagong Main Power Grid Strengthening Project. Compensation claims will be granted with the submission of an RAP prepared in accordance with the JICA Guidelines for Environmental and Social Considerations and Bangladesh's applicable procedures for the acquisition of land, relocation of residents, and compensation for lost assets and affected livelihoods. In discussions held with local stakeholders, no objections to the Project were raised by participants; meanwhile, requests were expressed to properly manage the environment and to develop the infrastructure in the surrounding regions. The executing agency indicated a willingness to act appropriately on such requests, and obtained understanding from the participants.

⑦ Other/Monitoring:

The relocation of local residents and the rehabilitation of affected livelihoods will be monitored on an ongoing basis, internally by the executing agency and externally by third-party institutions. In this project, the monitoring of the environment during construction will be done by the executing agency and contractors, while the monitoring of air quality, water quality, water temperature, noise, etc., after the commencement of service will be done by the executing agency.

#### 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 1 kWh 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) Collaboration with Other Donors: None

### 4. Targeted Outcomes

### (1) Quantitative Effects

1) Performance Indicators (Operation and Effect Indicators)

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Indicator		Unit	Target (2026) Expected value 2 years after project completion
[Operation Indi	cators		
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 <sup>(*)</sup>	Human errors	hours / year	0
	Mechanical troubles	hours / year	218
	Regular Inspections	hours / year	1,096
Suspension frequency of the unit		times / year	10
operation <sup>(*)</sup>			
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
$CO_2 \text{ emission}^{(*)}$		1,000 tons / year	6,832
$NO_X emission^{(*)}$		1,000 tons / year	6.1
$SO_X emission^{(*)}$		1,000 tons / year	10.9
Dust emission <sup>(*)</sup>		1,000 tons / year	0.7
Fuel consumption <sup>(*)</sup>		1,000 tons / year	1,863

(\*) Per Unit

### 2) Internal Rate of Return

According to the following preconditions, the Project's Economic Internal Rate of Return (EIRR) will be 16.1%. The Financial Internal Rate of Return (FIRR) will be 2.3% for the component of generation and 11.7% for the component of transmission.

# [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

- 1) Possible delays arising from natural disasters, such as cyclones.
- 2) An inability to sign power purchase agreements would pose a risk to the financial viability of the executing agency.

# 6. Lessons Learned from Past Projects

(1) Lessons Learned from Past Projects

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

# (2) Application of Lessons Learned to the Project

As this is the first technology to be introduced in Bangladesh, the Project aims to build and establish a maintenance and operation system by means of a technology transfer through consulting services and a Long Term Service Agreement by manufacturers. Also, the management system of the implementing agency shall be strengthened by the organization reinforcement consultant to be employed in the 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<sub>2</sub> 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<sub>2</sub> emission (1,000 tons / year ), NO<sub>X</sub> emission (1,000 tons / year ), SO<sub>X</sub> 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