Japanese ODA Loan

Ex-Ante evaluation

1. Project

Country: People's Republic of Bangladesh
Name of the Project: Matarbari Ultra Super Critical Coal-Fired Power Project (I)
Loan Agreement: June 16, 2014
Loan Amount: 41.498 billion yen
Borrower: The Government of the People's Republic of Bangladesh

2. Background and Necessity of the Project

(1) Current Status and Issues in the Power Sector in Bangladesh

Bangladesh suffers from insufficient power supply to meet the increasing power demand which itself is a result of improved electrification rates and industrialization in the wake of the country's rapid economic growth in recent years. As of March 2014, the power supply meets only 80 percent of the potential demand estimated as 9,268 megawatts and the maximum power supply was 6,887 megawatts. The power demand is expected to continue increasing over the next decade by 10 percent per year over the next decade. Although 70 percent of the power generation is currently operated by gas-fired plants using domestic natural gas, domestic natural gas will face depletion in the near future. Therefore, Bangladesh needs to seek other energy resources that are more sustainable than natural gas in order to ensure a stable power supply. To meet the future power demand, Bangladesh has started a long-term power development plan based on coal power plants using imported coal as a primary power source.

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

The 6th Five-Year Plan (2011/2012-2015/2016) as the nation's top-ranked plan of the National Development Strategy defines power sector as a key infrastructure for economic growth with reduction of poverty. The government also defined the Power System Master Plan 2010 as an important development policy in the power sector and has reached the conclusion that coal is the most important primary energy source. Based on this conclusion, the government announced the construction of an ultra super critical coal-fired power plant capable of extremely high generating efficiency through the use of imported coal. With its construction, the country is looking to satisfy its predicted power demand, which is expected to rise to 34,000 MW by 2030.

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

In the JICA Country Analytical Work for Bangladesh (April 2013), "economic infrastructure improvement" is defined as a priority issue, and within this scope, " development of new power generation to minimize the gap between power supply and demand, while supporting high-efficiency thermal power generation using coal as an

alternative power source from natural gas" is identified as a priority issue. Accelerating inclusive economic growth is also identified as a priority area in Japan's Country Assistance Program for Bangladesh (June 2012). As such, this project is consistent with Japan and JICA's aid policies. Major support provided to the country's power sector is listed below:

- Loan assistance projects: New Haripur Power Plant Development Project (2007, 2009), Bheramara Combined Cycle Power Plant Development Project (2013), National Power Transmission Network Development Project (2013), Renewable Energy Development Project (2013), and others.
- Technical Cooperation projects: Dispatching Power Sector Adviser (2004–present), Total Quality Management Training (2007), Master Plan Study on Coal Power Development in Bangladesh (2009), and others.

(4) Other Donors' Activity

The World Bank supports power grid transmission improvement project, Sector loan for supporting energy sector development, restructure and rehabilitation for the financial affairs in the energy sector, construction of gas-fired power plants, and more. The Asian Development Bank (ADB) supports enhancement of operational efficiency at the Bangladesh Power Development Board (BPDB), establishment of the Bangladesh Energy Regulatory Commission, construction of gas-fired power plants, and more.

(5) Necessity of the Project

As noted above, this project is consistent with Japan and JICA's aid policies, and is also consistent with the Bangladesh government's policy, since the necessity of constructing a high-efficiency coal-fired power plant using imported coal is listed in government policy as a response to surging power demand and as a measure to stabilize the power supply. Accordingly, the necessity and relevancy to implement of this project are high.

3. Project Description

(1) Project Objectives

This project aims to construct a highly-efficient ultra super critical coal-fired power plant (rated output: 1,200 MW (600 MW × 2) in Matarbari District, Chittagong Division in southeastern Bangladesh, and thereby respond to surging power demand in the country and mitigate greenhouse gas emissions. This will contribute to the revitalization of the state economy as a whole while helping to limit climate change.

(2) Project Site/Target Area

Chittagong Division, Cox Bazar District

(3) Project Components

1) Ultra super critical coal-fired power plant (1,200 MW (600 MW × 2)), deep-water port for carrying in coal (maximum water depth: 15.8 m)

2) Power grid (400kV power grid: 61 km, steel tower, reinforcing transformer stations, etc.)
3) Access roads (bridge: 640 m, new roads: 1.2 km, and rehabilitation of existing roads: 35 km)
4) Rural Electrification (132-kV power grid: 25 km and distributing substation)
5) Procurement of equipment (large vehicles for maintaining the power station, devices and equipment for disaster prevention, etc.)
6) Consulting services (e.g. detailed designs, bidding assitance, and supervision of construction)

(4) Total Project Cost
449.925 billion yen (including Yen Loan Amount: 41.498 billion yen)

(5) Project Implementation Schedule
From June 2014 to December 2025 (total of 137 months). The project will be completed when all the facilities start operation (December 2022).

(6) Project Implementation Structure
1) Borrower: The Government of the People's Republic of Bangladesh
2) Executing Agency: Coal Power Generation Company Bangladesh Limited (CPGCBL) Power Grid Company of Bangladesh Limited (PGCB) Roads and Highways Department (RHD)
3) Operation and Maintenance System: The same as the executing agency above.

(7) Environmental and Social Considerations, Poverty Reduction, and Social Development
1) Environmental and Social Considerations
i. Category: A
ii. Reason for Categorization: Project is classified as an environmental category 'A' project, due to the extent of the Project and complexity of environmental and social issues associated with construction of the coal power plant, port facility, transmission line, and access road.
iii. Environmental Permit: The Environmental Impact Assessment (EIA) Report for the Project was approved by the Department of Environment of Bangladesh for construction and improvement of power stations, ports, and harbors in October 2013 as well as for construction and improvement of power grids and access roads in November 2013.
iv. Anti-Pollution Measures: Exhaust gas from the power station is expected to satisfy both domestic and international Environmental, Health, and Safety Guidelines (EHS))standard values for sulfur oxides (SOx) and nitrogen oxides (NOx) by using flue gas desulfurization equipment that employs seawater and a low-NOx combustion system. The power station is also expected to satisfy domestic and international Environmental,

Health, and Safety Guidelines (EHS) standard values for atmospheric concentration. For smoke dust (particle pollution (PM)), the power station conforms to the requirements of the Environmental, Health, and Safety Guidelines (EHS). However, the estimated PM10 concentration (annual figure: 42.(4)–62.(4) μg/m^3) of the power station exceeds the upper value of Bangladesh's standards. This is because the figure is affected by the concentration before the project inauguration (42–62 μg/m3). The contribution of this project is thought to be insignificant--only 0.4 μg/m^3. The effects of the PM can be minimized by using a tall stack (275 m) and electrical dust collectors. This project uses seawater as a coolant. By limiting the increase in drainage temperature to 7°C or less over the temperature of the intake water, the plant will comply with national standards (less than 40°C). Thus the negative impact on the ecological system is expected to be minimal. The power station is also expected to satisfy domestic and international Environmental, Health, and Safety Guidelines (EHS) standard values for noise during construction and after starting use.

v. Natural Environment: The Project site is not located in or around sensitive areas such as national parks. Located 15 km south of the project site is Sonadia Island, which is designated as an Ecologically Critical Area by the Bangladeshi government. Despite its location, the impact of air and water quality deterioration will be limited due to measures taken (see above), and thus the negative impact on Sonadia Island is expected to be minimal. In this regard, however, marine animals often move around or migrate. Therefore, if rare species are observed visually, necessary measures such as adjusting the intensity of light sources on the sea surface or the surrounding area during construction or limiting noise or vibration should be taken. In addition, laborers will be prohibited from collecting, catching, or hunt rare species and/or their eggs.

vi. Social Environment: The necessary land acquisition for constructing the power station, ports, or harbors is about 475 ha. The area is used as a salt farm in the dry season and a shrimp farm during the rainy season. It has been confirmed that twenty families (including 16 families illegally residing) must be relocated, and another 1,000 people's livelihoods are expected to be affected. Compensation related to land acquisition, resident relocation, lost assets, or livelihoods are to be provided in line with domestic procedures and the Relocation Assistance Program (RAP). Although land must be acquired for power transmission wires and access roads (about 0.13 ha and 3.1 ha respectively), no resident transfers are required. Land acquisition and compensation are to be provided in line

with domestic procedures and the RAP. No objection from participants was heard at the on-site stakeholder discussion held for each project component; however, appropriate environmental management and surrounding infrastructure development were requested. The executing agency indicated that they would respond to feedback and requests appropriately and obtain consent from participants.

vii. Other/Monitoring: The relocation process for local residents will be monitored by external experts as well as by the executing agency. The environment will be monitored by the executing agency and contractors while construction is underway and by the executing agency for air, water pollution, and noise after service starts.

2) Promotion of Poverty Reduction: The homes of about 4,000 families (approximately 20,000 persons) living near the power station will electrified.

3) Promotion of Social Development (e.g. Gender Perspective, Measures to Prevent Infectious Diseases Including AIDS, Participatory Development, Consideration for the Handicapped, etc.): The project will involve HIV/AIDS prevention activities for construction workers, in collaboration with consultants.

(8) Collaboration with Other Schemes and Donors: N/A

(9) Other Important Issues:

This is an unprecedented project for constructing an ultra super critical coal-fired power station. Incorporating highly efficient super critical power generation technology, the new power station will reduce emissions by about 400,000 tons/year (converted to CO_2) compared to other subcritical pressure coal-fired power stations of same size, and thus contributes to mitigating climate change.

4. Project Benefits

(1) Quantitative benefits

1) Evaluation Indicators (Operation and Effect Indicator)

Indicators		Unit	Target (2027) five years after completion
Operational index			
Power station			
Maximum output		MW	1,200
Utilization ratio		%	80
Operation rate		%	85
Auxiliary power ratio		%	6.48
Gross thermal efficiency		%	41.29
Unit down time*	Human error	Hours/year	0
	Machine failure	Hours/year	218
	Periodic inspections	Hours/year	1,096
Number of times unit operation suspended*		times/year	10
Electric power cables			
Transmission loss rate		%	0.4

Ports and harbors		
Berth operation rate	%	60
Total cargo volume	1,000 tons/year	4,000
Dredged volume	Cubic meters/year	360,000
Operation and Effect Indicators		
Transmission end electrical energy	GWh/year	7,865
CO_2 emissions*	1,000 tons/year	3,416
NO_X emissions*	1,000 tons/year	6.1
SO_X emissions*	1,000 tons/year	10.9
Dust emissions*	1,000 tons/year	0.7
Fuel consumption*	1,000 tons/year	1,863

Note: per unit

2) Internal Rate of Return (IRR)

Based on the conditions below, the Economic Internal Rate of Return (EIRR) of this project was calculated as 19.63%, while Financial Internal Rate of Return (FIRR) was 2.43% and the power transmission component was 16.85%.

EIRR:

Cost: Project costs, fuel costs, and maintenance costs

Benefits: Balance with petroleum power generated

Project Life: 25 years

FIRR:

(Power generating component)

Cost: Project costs, fuel costs, maintenance costs, taxes, and discounts

Benefits: Revenue from sales of electric power (Power Purchase Agreement, PPA)

Project Life: 25 years

(Power transmission component)

Cost: Project costs, fuel costs, maintenance costs, taxes, and discounts

Benefits: Power transmission fees, residual value when completing project life

Project Life: 25 years

(2) Qualitative benefits

Revitalization of Bangladesh's economy as a whole and mitigation of climate change

5. External Risk Factors and Risk Control

Delays in civil engineering work due to natural disasters such as cyclones and conclusion of PPA to ensure the financial viability of the executing agency.

6. Evaluation Results and Lessons Learned from Past Projects

(1) Evaluation results of similar projects

The ex-post evaluation results for Kenya's Mombasa Diesel Generating Power Plant Project demonstrate that appropriate supports from manufacturers can significantly improve the sustainability of power generation projects.

(2) Lessons for the Project

This project aims to establish a stable maintenance and control system by transferring technology through consultants and establishing long-term service agreements with manufacturers. In addition, the internal control systems of the executing agency will be reinforced by organizational capacity improvement consultants hired separately through the project.

7. Plans for Future Evaluation

(1) Indicators for Future Evaluation:

1) Maximum output (MW)
2) Utilization ratio (%)
3) Operation rate (%)
4) Auxiliary power ratio (%)
5) Gross thermal efficiency (%)
6) Unit downtime
   - Human error (hours/year)
   - Machine failures (hours/year)
   - Periodic inspections (hours/year)
7) Number of times unit operation suspended (times/year)
8) Transmission loss rate (%)
9) Berth operation rate (%)
10) Total cargo volume (1,000 tons/year)
11) Dredged volume (cubic meters/year)
12) Transmission end electrical energy (GWh/year)
13) CO_2 emissions (1,000 tons/year)
14) NO_x emissions (1,000 tons/year)
15) SO_x emissions (1,000 tons/year)
16) Dist emissions (1,000 tons/year)
17) Fuel consumption (1,000 tons/year)
18) Economic Internal Rate of Return (EIRR) (%)
19) Financial Internal Rate of Return (FIRR) (%)

(2) Timing of Next Evaluation: Two years after completion