CLIMATE RISK ASSESSMENT AND MANAGEMENT REPORT

I. Basic Project Information

Project Title: Rupsha 800-Megawatt Combined Cycle Power Plant
Project Budget: $1,140 million
Locations: Khulna City, Khalishpur Upazila, Khulna District, and South-Western Bangladesh
Sector: Energy
Theme: Power generation and transmission, and gas distribution
Brief Description: The project targets improving energy security in Bangladesh. It will increase availability of efficient and cleaner energy by developing a state-of-the-art power plant with 800-megawatt (MW) generation capacity using the most efficient power generation technology. The project also envisages the construction of associated natural gas supply and power transmission infrastructure facilities, as well as strengthening of the institutional capacity and overall business process of the project's executing agency, North-West Power Generation Company Limited, to efficiently plan and operate power plants.

II. Summary of Climate Risk Screening and Assessment

Bangladesh is the most vulnerable and at-risk country in the world to climate change. The majority of climate change projections for Bangladesh suggest that the average temperature in the country is likely to increase by 1°C by 2030, 1.4°C by 2050, and 2.4°C by 2100 against the baseline period (1960–1990), and sea levels are expected to rise by between 0.8 meter (m) and 1.5 m by the end of this century and up to 2 meters higher under extreme warming scenarios. The proposed Rupsha 800 MW Project, like other power plants, is located in riverside and prone to sea level rise, flooding and storm surge. Also, increase temperature will decrease plant efficiencies, increases transmission system losses and poses risk to stability of the power supply.

A. Sensitivity of project component(s) to climate/weather conditions and sea level

Project components	*Sensitivity to climate/weather conditions and sea level*
1. Rupsha 800-Megawatt Combined Cycle Power Plant 2. Gas Distribution Pipeline 3. Power Transmission Interconnection 4. Capacity Strengthening of North-West Power Generation Company Limited	1. Power plant is vulnerable to temperature increase, heavy precipitation, drought, sea level rise, and extreme weather conditions due to its location, fresh cooling water requirement, and efficiency change by heat. 2. Gas distribution pipeline is installed underground thus, its sensitivity is low. 3. Power transmission line is affected by temperature increase, and extreme weather conditions which lead to system losses and frequent maintenance and repair. 4. Capacity strengthening is not considered for the climate change risk screening and assessment.

B. Climate Risk Screening

Risk topic	Description of the risk
1. Rising temperatures	• The majority of climate change projections for Bangladesh suggest that the average temperature in the country is likely to increase by 1°C by 2030, 1.4°C by 2050 and 2.4°C by 2,100 against the baseline period (1960–1990). The highest temperature rise is projected to occur in the month of February (>2.72°C), and the lowest rise is projected for the month of August (<2.06°C).
2. Changes in precipitation and sea level	• Increased temperature will lead to reduction in plant efficiencies and generation output, and thermal expansion of power lines, thus the amount of power that can be securely transported will decrease.

3. Extreme weather events (floods and cyclones)	• The modeling suggests that Bangladesh will experience an increase in rainfall during the monsoon season and a decline in rainfall during the winter months–with annual precipitation projected to increase by 70 millimeters, which represents a 3.9% increase over the baseline period. • Intergovernmental Panel on Climate Change (2007) projects a rise in sea level ranging between 18 and 59 centimeters by 2100. Sea levels could rise by between 0.8 m and 1.5 m in Bangladesh by the end of this century and up to 2.0 m higher under extreme warming scenarios. • Exposed to high rainfall pattern change, low seasonal water availability and drought with sea level rise will lead to a reduction in plant efficiencies and generation capacity due to saline intrusion. Inundation with saline or brackish water can impact transmission towers by contributing to corrosion of tower footings. • It is likely that climate change increases frequency and magnitude of extreme weather events in Bangladesh. • The extreme weather events will lead to disruptions in power generation and transmission infrastructures due to flooding and cyclones. • Frequent maintenance and repair is required, and this will increase operational costs.
Climate Risk Classification: Medium	
C. Climate risk assessment	
The combined cycle power plant (CCPP), transmission lines, and gas distribution pipes would be affected by the climate change, and particularly CCPP would be vulnerable to high temperature, seasonal rainfall change, and extreme events such as floods and cyclones. The location of the CCPP may also be sensitive to flooding that can result to erosion and scouring of foundation base, and submergence of equipment. The rating of each risk is assessed as below: Temperature Increase: Minor • Higher temperature leads to minor loss in cooling capacity and increases in operational costs. Changes in precipitation and sea level: Moderate • Change in seasonal water availability leads to minor disruptions to cooling and increases treatment costs. • Sea level rise, in combination with heavy rainfall events, is expected to contribute to moderate infrastructure damage and loss of service. • Damage is recoverable by maintenance and minor repair. Extreme weather events: Major • An increase in frequency and intensity of extreme events may incur extensive infrastructure damage and disruptions to power generation and supply. • Risk reduction via structural adaptation measures is required.	

III. Climate Risk Management Response within the Project

The following climate change adaptation measures are recommended to mitigate the risks and considered in the project design: Temperature increase • Consider extreme temperature scenarios to accommodate higher mean air and water temperatures and reduce exposure to extreme heat.

- Design, engineer, and construct structures suited for rising temperatures and heat waves.
- Develop best operating practices for equipment at high temperatures.

Changes in precipitation and sea level

- Elevate critical infrastructure and equipment, enhance levees and flood control structures.
- Improve water use efficiencies, water recapture, storage and re-use technologies.
- Diversification of water supply technologies, including water supply augmentation, alternative water sources and the potential to use saline waters for cooling.

Extreme weather events

- Update siting, design and operational plans to account for flooding and storm surge and reduce risk via structural adaptation measures, including elevation of critical infrastructure and equipment, enhance levees and flood control structures.
- Protect above ground ancillary facilities with river levees, flood control structures, riverbank protection works and riparian buffer plantings.

Prepare emergency response plans and early warning systems to account for higher frequency of intense storms, floods and cyclones.

The robust designs together with adaptive management practices will be necessary in managing climate risks and adaptation for the project. As the CCPP component is under the highest risk among four project outputs, the investment for climate change adaptation is also focused on the CCPP rather than transmission interconnection and gas pipeline infrastructures. The climate adaptation finance is calculated based on the incremental cost of the adaptation activities, which is the cost associated with the elements of project design that address climate-related risks and vulnerabilities in comparison with a project design that does not address them.

The project adopts a closed-loop cooling tower instead of one through release considering lack of water resource which is worsen by the climate change. The cost difference between cooling tower and one through release system is counted as adaptation finance. In addition, the project includes demineralized water treatment system as the sea level rise causes saline water interruption to the river which is source of the cooling water. The demineralized treatment facility is required to secure water resources preparing for sea level rise which is also worsen by the climate change, thus the cost for this equipment is incremental and counted as adaptation finance. The total leveling height of the CCPP project site is 5.5m, and the average flood level on and around the site is 2.95m, so 2.55m is additional leveling. Among 2.55m, 0.4m is buffer under the current condition, so the cost for rest of 2.15m (after rounding up 2.2m) is considered as adaptation finance. The unit cost to incorporate emergency and protection system is U$64.58/$m^2$ and the system can cover 21.04 ha which is slightly larger than the CCPP project site. In total, the adaptation finance of the project is estimated as $41.13 million of which $25.08 million is counted as ADB's adaptation finance considering ADB's OCR (regular loan) is covering 61% of the relevant costs. The rest is financed by IDB and the government. Table 1 outlines a range of climate adaptation measures with their costs to improve the climate resiliency of the project.

Table 1. Indicative Cost of Climate Change Adaptation Measures

Items	Linked Adaptation Measures	Adaptation Finance ($ million)	ADB's Adaptation Finance ($ million)	Remarks for Adaptation Finance
Closed-loop cooling tower	Water use efficiency and reuse	4.34	2.64	Cost difference between one-through system and cooling tower for CCPP
Demineralized water treatment system (reverse osmosis)	Alternative water resources	21.75	13.27	Entire cost for desalination of intake water
River bank protection and leveling	Waterproofing and elevation of critical infrastructure	1.45	0.88	Cost for additional 2.2 meters among total leveling height
Auxiliaries system	Emergency protection system	13.59	8.29	Based on unit cost for the emergency system $64.58/$m^2$
Total		**41.13**	**25.08**	

ADB = Asian Development Bank, ft^2 = square feet, CCPP = combined cycle power plant.
Source: ADB's assessment and estimates.

The project will utilize advanced technology in the power transmission component, which will be designed to have efficient high temperature and low sag aluminum conductor composite core. The cost of the transmission line is $27.49 million and $23.2 million is allocated to ADB OCR. As per the Guidance Note on Counting Climate Finance in Energy (5 January 2017), a default value of 40% is used for calculation and $9.28 million is considered to be ADB's climate mitigation finance due to efficiency improvement and loss reduction. The project is also constructing gas pipeline to deliver natural gas to the existing 225 MW Khulna power plant which is currently operating on high speed diesel. Natural gas will be used to operate the power plant (Khulna power plant is designed as dual fuel power plant) replacing high speed diesel. This offset component is also counted as climate change mitigation finance. The cost of the gas pipeline is $6.14 million and $5 million is allocated to ADB OCR which is counted as ADB's climate mitigation finance. Table 2 outlines climate mitigation elements with their costs and ADB's mitigation finance amount.

Table 2. Indicative Cost of Climate Change Mitigation Measures

Items	Mitigation	Mitigation Finance ($ million)	ADB's Mitigation Finance ($ million)
230 kV power transmission lines to evacuate generated electricity	Application of efficient HTLS, AAAC conductors.	23.2	9.28
Gas pipeline to existing Khulna 225 MW Power Plant	Change fuel from HSD to LNG	6.14	5.00
Total		**29.34**	**14.28**

AAAC = aluminum conductor composite core, ADB = Asian Development Bank, kV= kilovolt, LNG = liquefied natural gas, HSD = high-speed diesel, HTLS = high temperature and low sag, MW = megawatt.
Source: ADB's assessment and estimates.