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Report No: PAD1422

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED CREDIT

IN THE AMOUNT OF SDR 155.4 MILLION
(US$ 217 MILLION EQUIVALENT)

TO THE

PEOPLE'S REPUBLIC OF BANGLADESH

FOR THE

GHORASHAL UNIT 4 REPOWERING PROJECT

November 30, 2015

Energy & Extractives
SOUTH ASIA

CURRENCY EQUIVALENTS

(Exchange Rate Effective {31st October 2015})

Currency Unit	=	BDT
BDT 77.9647	=	US$1
US$1.39687000	=	SDR 1

FISCAL YEAR
July 1 – June 30

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
BPDB	Bangladesh Power Development Board
CBA	Collective Bargaining Agent
CCGT	Combined Cycle Gas Turbine
EPC	Engineering, Procurement & Commissioning
EIA	Environment Impact Assessment
ERR	Economic rate of Return
ESM	Environment and Social Management
HFO	Heavy Fuel Oil
GDP	Gross Domestic Product
GOB	Government of Bangladesh
GHG	Greenhouse Gas
GNI	Gross National Income
GPS	Ghorashal Power Station
GWh	Giga watt hour
GT	Gas Turbine
GHG	Gas Turbine Generator
GPS	Ghorashal Power Station
HRSG	Heat Recovery Steam Generator
IDA	International Development Association
IPP	Independent Procurement Panel
LTSA	Long Term Service Contract
NIS	National Integrity Strategy
PSMP	Power Sector Master Plan
MMCFD	Million Cubic Feet Per Day
MPEMR	Ministry of Power, Energy, and Mineral Resources
NDT	Non-Destructive Test
OE	Owner's Engineer
OEM	Original Equipment Manufacturer
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PGCB	Power Grid Corporation of Bangladesh
PMB	Plant Management Board
PMU	Project Management Unit
REB	Rural Electrification Board
RLA	Residual Life Assessment
RMS	Regulatory Metering Station
SBU	Strategic Business Unit
SCD	Systematic Diagnostic Dialogue
ST	Steam Turbine
SFYP	Sixth Five Year Plan
WTP	Willingness to Pay

Regional Vice President:	Annette Dixon
Acting Country Director:	Martin Rama
Senior Global Practice Director:	Anita Marangoly George
Practice Manager:	Julia Bucknall
Task Team Leader(s):	Mohammad Anis, Ashok Sarkar

BANGLADESH
GHORASHAL UNIT 4 REPOWERING PROJECT

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PAD DATA SHEET

Bangladesh

Bangladesh Ghorashal Unit 4 Repowering Project (P128012)

PROJECT APPRAISAL DOCUMENT

SOUTH ASIA

0000009260

Report No.: PAD1422

Basic Information		
Project ID P128012	EA Category A - Full Assessment	Team Leader(s) Mohammad Anis, Ashok Sarkar
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ] Financial Intermediaries [ ] Series of Projects [ ]	
Project Implementation Start Date 01-Mar-2016	Project Implementation End Date 31-Mar-2021	
Expected Effectiveness Date 01-Mar-2016	Expected Closing Date 31-Mar-2022	
Joint IFC No		

Practice Manager	Senior Global Practice Director	Acting Country Director	Regional Vice President
Julia Bucknall	Anita Marangoly George	Martin Rama	Annette Dixon

Borrower: People's Republic of Bangladesh

Responsible Agency: Bangladesh Power Development Board

Contact:	Khandker Maksudul Hasan	Title:	Chairman
Telephone No.:	880-2-9556832	Email:	chairman@bpdb.gov.bd;

Project Financing Data(in USD Million)					
[ ]	Loan	[ ]	IDA Grant	[ ]	Guarantee
[X]	Credit	[ ]	Grant	[ ]	Other

Total Project Cost:	263.00	Total Bank Financing:	217.00
Financing Gap:	0.00		

Financing Source	**Amount**

BORROWER/RECIPIENT	46.00
International Development Association (IDA)	217.00
Total	263.00

Expected Disbursements (in USD Million)

FY	2016	2017	2018	2019	2020	2021	2022	0000	0000	0000
Annual	20.00	80.00	52.00	20.00	20.00	10.00	15.00	0.00	0.00	0.00
Cumulative	20.00	100.00	152.00	172.00	192.00	202.00	217.00	0.00	0.00	0.00

Institutional Data

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Cross Cutting Topics

[X] Climate Change
[ ] Fragile, Conflict & Violence
[ ] Gender
[ ] Jobs
[ ] Public Private Partnership

Sectors / Climate Change

Sector (Maximum 5 and total % must equal 100)

Major Sector	Sector	%	Adaptation Co-benefits %	Mitigation Co-benefits %
Energy and mining	Energy efficiency in Heat and Power	50		100
Energy and mining	Thermal Power Generation	50		
Total		100		

☐ I certify that there is no Adaptation and Mitigation Climate Change Co-benefits information applicable to this project.

Themes

Theme (Maximum 5 and total % must equal 100)

Major theme	Theme	%
Financial and private sector development	Infrastructure services for private sector development	100
Total		100

Proposed Development Objective(s)
The proposed development objective of the Project is to increase generation capacity and efficiency of the targeted power plant.

Components	
Component Name	**Cost (USD Millions)**
Component 1: Re-powering of the Target Unit	255.00
Component 2: Technical Assistance for Institutional Strengthening Support	8.00

Systematic Operations Risk- Rating Tool (SORT)	
Risk Category	**Rating**
1. Political and Governance	High
2. Macroeconomic	Moderate
3. Sector Strategies and Policies	Moderate
4. Technical Design of Project or Program	Moderate
5. Institutional Capacity for Implementation and Sustainability	Substantial
6. Fiduciary	High
7. Environment and Social	Moderate
8. Stakeholders	Low
9. Other	
OVERALL	Substantial

Compliance		
Policy		
Does the project depart from the CAS in content or in other significant respects?	Yes [ ]	No [X]
Does the project require any waivers of Bank policies?	Yes [ ]	No [X]
Have these been approved by Bank management?	Yes [ ]	No [X]
Is approval for any policy waiver sought from the Board?	Yes [ ]	No [X]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X]	No [ ]

Safeguard Policies Triggered by the Project	**Yes**	**No**
Environmental Assessment OP/BP 4.01	**X**	
Natural Habitats OP/BP 4.04		**X**
Forests OP/BP 4.36		**X**
Pest Management OP 4.09		**X**
Physical Cultural Resources OP/BP 4.11		**X**

Indigenous Peoples OP/BP 4.10		**X**
Involuntary Resettlement OP/BP 4.12		**X**
Safety of Dams OP/BP 4.37		**X**
Projects on International Waterways OP/BP 7.50		**X**
Projects in Disputed Areas OP/BP 7.60		**X**

Legal Covenants

Name	**Recurrent**	**Due Date**	**Frequency**
Project Steering Committee		28-Feb-2016	

Description of Covenant

The Recipient shall establish and thereafter maintain throughout the period of Project implementation, a Project Steering Committee within MoPEMR with a mandate, composition and resources satisfactory to the Association.

Name	**Recurrent**	**Due Date**	**Frequency**
Project Management Unit staff		28-Feb-2016	

Description of Covenant

The Recipient, through BPDB, shall appoint to the PMU and thereafter maintain throughout the period of Project implementation, under terms of reference satisfactory to the Association, an environmental safeguards specialist and a financial management specialist.

Name	**Recurrent**	**Due Date**	**Frequency**
Owner’s Engineer		30-Apr-2016	

Description of Covenant

The Recipient, through BPDB, shall contract under ToR satisfactory to the Association, an Owner’s Engineer to provide implementation support and supervision services to the PMU for the construction and commissioning, design and engineering, and environmental and social safeguards management of the Ghorashal Unit 4 Power Plant.

Name	**Recurrent**	**Due Date**	**Frequency**
Independent Procurement Panel	**X**		Yearly

Description of Covenant

The Recipient shall maintain throughout the procurement process of Engineering, Procurement and Commissioning (EPC) contract as specified in the Procurement Plan, a panel of international procurement experts with qualifications, experience and ToR satisfactory to the Association, which shall be authorized and empowered, on behalf of the Recipient, to carry out the procurement of said contracts.

Name	**Recurrent**	**Due Date**	**Frequency**
Independent Procurement Expert	**X**		Yearly

Description of Covenant

Prior to the procurement of those contracts for goods, works and/or services specified in the Procurement Plan, including the contract for the services of an Owner’s Engineer, the Recipient shall appoint and

thereafter maintain throughout the procurement period of said contracts, an independent procurement expert with qualifications, experience and ToR satisfactory to the Association.

Name	Recurrent	Due Date	Frequency
Long Term Service Agreement (LTSA)		30-Jun-2019	

Description of Covenant

The Recipient, through BPDB, shall enter into a LTSA under terms and conditions satisfactory to the Association, with the OEM (or an equivalent qualified supplier, acceptable to the Association) of the gas turbine of the Ghorashal Unit 4 Power Plant that is constructed and installed under Part 1(a) of the Project, to ensure that said gas turbine is adequately serviced and maintained.

Name	Recurrent	Due Date	Frequency
Internal Audits		30-Jun-2017	

Description of Covenant

The Recipient shall appoint and thereafter maintain throughout the period of Project implementation, under terms of reference of satisfactory to the Association, an independent firm to assist the PMU with the conduct of internal audits of Project activities.

Conditions

Source Of Fund	Name	Type

Description of Condition

Team Composition

Bank Staff

Name	Role	Title	Specialization	Unit
Mohammad Anis	Team Leader (ADM Responsible)	Senior Energy Specialist	Team Leader	GEEDR
Ashok Sarkar	Team Leader	Senior Energy Specialist	co-Team Leader	GEEDR
Tanvir Hossain	Procurement Specialist	Senior Procurement Specialist	Procurement	GGODR
Mohammad Reaz Uddin Chowdhury	Financial Management Specialist	Financial Management Specialist	Fiduciary	GGODR
Dr. M. Khaliquzzaman	Safeguards Specialist	Consultant	Environment Safeguard	GEN06
Hisham A. Abdo Kahin	Counsel	Lead Counsel	Legal	LEGES
Maya Sheli Port	Counsel	E T Consultant	Legal	LEGES
Md. Iqbal	Team Member	Senior Energy Specialist	Technical	GEEDR

Md. Tafazzal Hossain	Team Member	Program Assistant	Program Assistant	SACBD
Mohammad Saqib	Team Member	Senior Energy Specialist	Economic Analysis	GEEDR
Qingtao Yang	Team Member	E T Temporary	Program Assistant	GEEDR
Sabah Moyeen	Safeguards Specialist	Senior Social Development Specialist	Social Safeguard	GSURR
Satish Kumar Shivakumar	Team Member	Finance Officer	Loan	WFALN
Shakil Ahmed Ferdausi	Safeguards Specialist	Senior Environmental Specialist	Environment Safeguard	GENDR
Sheoli Pargal	Team Member	Lead Energy Economist	Adviser	GEEDR
Yusuf Salauddin	Team Member	Consultant	Technical	GEEDR

Extended Team

Name	Title	Office Phone	Location

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
Bangladesh	Dhaka	Narsingdi	**X**		

Consultants (Will be disclosed in the Monthly Operational Summary)

Consultants Required?	Consultants will be required

I. STRATEGIC CONTEXT

A. Country Context

1. Bangladesh's economy has performed well over the past decade. Its Gross Domestic Product (GDP) growth has risen by one percentage point per decade, from an average of 3.7 percent per annum in the 1980s to over 6% since 2010 and this sustained growth was achieved despite the adverse impacts of the global recession, oil price rise, unrest in the Middle East (an important source of healthy remittance inflow) and local natural disasters. Bangladesh has very recently moved up to lower-middle income status from low income group. The country not only maintained the minimum requirement of the per capita income in the past consecutive three years, but also achieved a phenomenal rise in the Gross National Income (GNI) in the just concluded financial year. The country's per capita income soared at $1,314 at the end of FY15 when it was $1,190 in FY14 and $1,154 in FY13. This economic growth has largely been dependent on a reliable and affordable supply of electricity. Bangladesh's economy could have performed much better if the energy infrastructure had developed in line with the economic demands.

2. A majority of manufacturing and service firms in Bangladesh identify shortage of reliable electricity as the most important constraint to smooth operation and expansion of their business. In the 'Doing Business Report' (2014) prepared by the World Bank, Bangladesh was ranked the lowest out of 189 economies on the 'Getting Electricity' indicator. About 62% of the population has access to electricity. While access in urban areas is close to complete coverage, only about 42% of rural households have access to electricity. In addition, the large gap between demand and power supply results in frequent outages and load shedding. Electricity supply is constrained because of several reasons, most important of which are limited investment in new base-load generation capacity and inadequate fuel supply.

3. Per capita consumption of electricity in the country is only 371 kwh/year which is one of the lowest in the world and lower than most of the South Asian countries. Current installed generation capacity in Bangladesh is 11,680 MW, while available capacity is 7,800 MW. The highest demand served in the country in 2015 was 8,177 MW. On average, over 1,000 MW of load shedding was experienced in the summer of 2014. Electricity demand is projected to grow by more than 10 percent per annum over the medium term. To address the current and future shortages, the power sector master plan 2010 (PSMP), which is currently being revised) suggested for the addition of 30,000 MW of capacity by 2030 at an estimated cost of $59 billion.

B. Sectoral and Institutional Context

4. In the context of severe power shortages throughout the country, the Government of Bangladesh (GOB) had developed an ambitious generation expansion plan that envisages adding 11,500 MW to the national grid by the year 2018. However, implementation of this target within the timeline has faced huge challenges to the Government as they are already behind schedule in some of the planned activities. As part of the plan, a number of large gas-fired/dual fuel power plants (around 1,500 MW capacity) and several large coal fired plants based on imported coal (around 4,000 MW capacity) were awarded to the private sector but only 310 MW capacity[1] has so far been added to the grid because of delay in reaching financial closures. As an interim measure, GOB had contracted about 2,400 MW of rental and quick rental plants (for 3-5 year terms) that are running on expensive liquid fuel. Due to the failure in adding base load generation in the last few years, the government had to renew most of these rental contracts for another term.

5. About 62% of the power generation in Bangladesh is based on natural gas, whilst 30% of the generation is from imported liquid fuels (diesel/HFO), 2% from hydro-generation, 2% from coal and 4% through

[1] Summit Meghnaghat II Power Plant

power import from India. Although Bangladesh is rich in natural gas reserves, current gas production of 2,500 mmcfd is about 600 mmcfd below demand due to a low level of exploration work and inadequate gas transmission systems. Availability of gas through further gas exploration works will likely to take longer time. On the other hand, the country's huge coal reserves remain unutilized as the Government is yet to finalize the coal policy to make way for domestic coal extraction.

6. In the present generation mix, about 42% of the total installed capacity is owned by the Bangladesh Power Development Board (BPDB). Private Power Producers (rentals and IPPs) account for 43% of installed capacity, 4% of the capacity is being imported and the rest is held by corporations owned by the State. Most of BPDB's generation fleet has not been modernized and as a result, the average efficiency of these plants is around 30%. This contrasts starkly with the modern gas-based combined cycle power plant efficiencies of 60%. Of particular concern are the approximately 2,100 MW of gas-fired steam cycle plants, which operate at about 30% efficiency. In line with the apparent shortages in natural gas production, improving the efficiency of the gas based power plants and prioritizing gas supply for higher efficient power plants have become critical in order to improve the effectiveness of gas utilization in the power sector.

7. Although the Government has managed to reduce power shortages during summer and the irrigation season through the expensive rental and quick rental plants in the last four years or so, they are aggravating the deteriorating financial position of the power sector because of its dependency on huge subsidy for payments to these private generators. There has been significant increase in the budgetary transfer from the year 2009 to 2012 since the introduction of liquid fueled power plants. In 2012, the budgetary transfer amount was US$840 million. The annual budgetary transfer had gone down to US$ 584 million in FY13 due to tariff adjustments in phases since February 2011. It again went up to US$800 million in FY14 and US$1 billion in FY15. This deficit will not go down further unless the contracts of the short term rentals are terminated and replaced by low cost base load power plants. In the long run, it is expected that the bulk and retail tariffs will continue to increase and generation costs will decline with the commissioning of the large power plants (including conversion of the existing steam plants to combined cycle) permitting the retirement of the costly liquid fuel plants.

8. The power sector is organized under the Ministry of Power, Energy, and Mineral Resource (MPEMR). Since independence in 1971, the Bangladesh Power Development Board (BPDB) under MPEMR had been the single entity in the power sector to generate, transmit and distribute electricity. In 1977, the Rural Electrification Board (REB) was formed to build and operate electricity distribution in rural areas using a rural electric cooperative model. Bank's support to BPDB started in 1979 and continued in three independent operations covering public sector generation, system loss improvement in transmission and distribution and strengthening of BPDB's organizational and institutional performance. The last operation was closed in 1999 and since then Bank has no direct engagement with BPDB. While the generation project (Ashuganj) with BPDB (completed in 1988) went well, the development objectives of the other two operations with BPDB could not be achieved successfully. This was primarily due to the inappropriate institutional structure and ingrained weaknesses of the parastatal system. BPDB did not perform well in those operations as demonstrated by high level system loss and accounts receivables. In this context, IDA (together with other sector donors) had maintained a continuing dialogue with GOB on the need to introduce fundamental reforms to unbundle and introduce substantial private sector participation in the sector.

9. The 1996 power sector reform policy set in motion a sector unbundling process which created a series of corporate entities. In this process, the Power Grid Company of Bangladesh (PGCB) was established to manage the country's power transmission assets. Gas Transmission Company Limited (GTCL) was formed with the objective of establishing a balanced and reliable gas transmission networks in the country. Separate

power distribution companies were also created[2] with few of them yet to be fully corporatized (SZPDC, CZPDC and NWPDC). On the generation side, the Ashuganj Power Station Company (APSCL), Electricity Generation Company (EGCB) and Northwest Power Generation Company (NWPGCL) have been created as part of the unbundling process with BPDB still retaining some generation and distribution assets under its balance sheet.

10. Although the policy reforms in the electricity sector started in the late 1990s with the unbundling of the vertical integrated utility, further reforms and unbundling have not moved much in the last five to six years due to strong resistances from the collective bargaining agents (CBA). Recently, GOB has reinitiated its efforts to corporatize the remaining distribution and generation assets of BPDB providing multiple timelines but such efforts have yet to produce any result.

11. As an alternative to corporatization, BPDB management is more inclined towards implementing Strategic Business Units (SBUs) under the BPDB corporate umbrella. Each SBU is expected to operate quasi-independently, with its own board and management structure, separate accounts, a performance based system, etc. In support of this initiative, GOB had issued a notice forming separate boards of each of these SBUs. Although delayed, functionalization of Ghorashal Power Station (GPS) as Strategic Business Unit (SBU) has been started since July 1, 2015. The Official order has been issued for the Chief Engineer at Ghorashal Power Station to become the SBU Chief Executive Officer (CEO). The proposal of delegation of financial power to SBU has also been passed by the BPDB Board. A draft Power Purchase Agreement (PPA) with BPDB is being developed. These are good steps towards achieving the operational efficiency of the SBU.

12. The proposed Project is for repowering of one of the four 210 MW gas-fired steam units at GPS by adding one gas turbine and generator (GTG), and a heat recovery steam generator (HRSG) to produce and feed steam into the existing steam turbine (ST) unit, for an upgraded total capacity of about 400 MW.

C. Higher Level Objectives to which the Project Contributes

13. The proposed Project is consistent with the Government of Bangladesh's power sector strategy to improve the efficiency of the existing plants that are using scarce natural gas inefficiently and to quickly add new power generation capacity to address the country's severe power shortages. The Systematic Country Diagnostic (SCD[3]) for Bangladesh recognizes that a shortage of power is a key constraint to growth and poverty reduction in the country. The forthcoming FY16 Country Partnership Framework (CPF), which is anchored in the SCD, identifies energy as a transformational priority.

14. The proposed Project would reduce carbon dioxide (CO2) emissions[4] and is therefore well aligned with the Government's PSMP, which aims to realize a low carbon society by introducing high efficient power supply and low CO2 emission technology. It is also consistent with the Bank's strategic focus on mitigating climate change impacts and with the Energy Sector Directions Paper (2013) which emphasizes energy efficiency improvements as one of its strategic pillars. This proposed project design also contributes to Bangladesh program goals of enhancing transparency and accountability.

[2] These include Dhaka Power Distribution Company (DPDC), Dhaka Electricity Supply Company (DESCO), West Zone Power Distribution Company (WZPDC), South Zone Power Distribution Company (SZPDC), Central Zone Power Distribution Company (CZPDC) and Northwest Zone Distribution Company (NWPDC).
[3] October 25, 2015
[4] An estimated net reduction of 0.3 million tons of CO_2 over the plant's 20 year life.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

15. The proposed development objective of the Project is to increase generation capacity and efficiency of the targeted power plant.

B. Project Beneficiaries

16. The direct beneficiaries of the proposed project are: (i) the households and businesses having access to the national grid and (ii) the local population who will benefit from enhanced environmental practices. The country is experiencing significant demand growth for electricity estimated at an annual rate of 10%. The national electricity access rate is at 62% implying that the outcomes of the project will be realized within the urban populations where it will boost the formal and informal sectors in industry, agriculture, and in so doing contribute to employment creation and increased GDP growth. Additionally, the quality of social services especially schools and hospitals will improve with access to stable and affordable electricity supply. However, it will be difficult to credibly measure or estimate the percentage of population that would be benefitted directly from this particular plant as it all goes to the national grid.

C. PDO Level Results Indicators

17. Results Indicators of the project are below:
    a) Generation capacity constructed under the project measured by MW
    b) Projected lifetime fuel savings measured in Petajoules (PJ)
    c) Overall Efficiency of the unit measured in percentage (%)

III. PROJECT DESCRIPTION

A. Project Components

18. Since the steam power plants can remain operational for many decades, it is an attractive proposition for older plants to be repowered to significantly improve their efficiency and generate higher capacity of power with increased operating flexibility. It is not uncommon for a 25-year-old gas-based steam power plant to remain operational for an additional 20 to 30 years through conversion into a modern combined cycle plant[5]. Such conversion technology can be a better alternative to a new, green-field combined cycle power plant for a country like Bangladesh considering the current gas availability constraints in the country for which the Government's focus is shifting from gas-based towards coal- based generation, and the cost of green-field combined cycle power plant could be prohibitive. GOB has, thus, accorded top priority to improving the efficiency and availability of the existing gas-based steam power plant units. The same is also reflected in the road map of PSMP.

19. The proposed project would repower[6] one of the four 210 MW gas-fired steam units at Ghorashal power station(GPS) by adding one gas turbine and generator (GTG), and a heat recovery steam generator (HRSG) to produce and feed steam into the existing steam turbine (ST) unit, for an upgraded total capacity of about

[5] Modern Power Systems, August 2002

[6] **Repowering** involves replacement of the existing boiler with a new gas turbine and heat recovery steam generator (HRSG). The waste heat from the hot exhaust of the gas turbines will help produce useful steam through the HRSG. The steam generated in the HRSG will be used to drive the existing steam turbine-generator. While repowering may involve rehabilitation, it primarily refers to the addition of new equipment to the existing unit.

400 MW. The existing boiler that uses gas to produce steam for the existing ST will be dismantled. The targeted unit for repowering has been identified through a feasibility study (completed in July 2012 by a consulting firm engaged through a Bank TA). This targeted steam unit is currently generating 170MW and the overall efficiency of the unit is around 30%, using 49 mmcfd of gas. As the feasibility study indicates, the proposed Project would increase the overall efficiency of the identified unit to 54% and the generation output will also be more than doubled with only 18% increase in gas requirement. Consequently, specific fuel consumption (per GWh) would be reduced by 44%, which would also lead to lower specific GHG emissions. The proposed Project will also allow operational flexibility for BPDB as it will be designed to operate the new gas turbine and existing steam plant independently from each other through a bypass stack. To minimize disruption in power availability from the existing Unit during the construction period, the existing ST will be shut down only after the installation and commissioning of the GTG and HRSG so that the plant can run on simple cycle (ST only) mode until that period.

20. **Component 1: Re-powering of the Target Unit (Total US$255 million; IDA US$210 million):** This component would finance all the required plant equipment and auxiliaries, design and installations services for the full repowering of Unit 4. The major plant equipment include a new Gas Turbine and Generator (GTG), a Heat Recovery Steam Generator (HRSG), Distributed Control System (DCS), gas booster compressor, main stack, bypass stack and all other associated ancillary equipment. The works would include complete overhauling of the existing ST generator, replacement and modernization of the existing auxiliaries, rehabilitation and modernization of existing cooling towers and workshop buildings, construction of a regulatory metering station (RMS), dismantling of the existing boiler, and construction of residential and non-residential buildings. The component will not cover works on the existing steam turbine as it is undergoing major maintenance prior to this proposed project, including repair and/or replacement of key turbine parts. The Government contribution will cover: taxes and duties associated with goods, works, and services; project operating costs and interest during construction; and residential and non-residential buildings at GPS. Detailed scope of works is in the Annex 2.

21. The proposed project will not require any investment in transmission capacity, as the enhanced generation from the GTG can be met through existing spare transmission capacity available at Ghorashal. Over the longer term, ADB is leading a consortium to fund a national transmission network development project (to be implemented by PGCB) that would cover the enhanced transmission requirement in the entire region, including Ghorashal, when all of the 210MW units at Ghorashal Power Plant would be repowered.

22. **Component 2: Technical Assistance for Institutional Strengthening Support (Total US$8 million; IDA US$7 million):** This component would finance an Owner's Engineer (implementation support consultant) for the Project to bolster project governance while ensuring effective management, monitoring and quality assurance of the design, engineering and construction and the initial operation of the repowered plant. This component would also focus on capacity building and institutional support to operate the plant effectively and efficiently as well as support BPDB to help strengthen its technical and managerial capacity to plan, develop and operate its generation portfolio. The TA will also be used to hire individual consultants to support PMU and GPS that would include areas of environmental and financial management and other areas as needed in addition to help automate BPDB's financial reporting system. The training plan would also cover training related to fraud and corruption risks and preventive measures that can be implemented and annual forensic auditing of project accounts. This component would also support the implementation of the Governance and Accountability Action Plan (See Annex 6). Honoraria and taxes associated with training and services will be borne by the Government.

B. Project Financing

23. The cost of the project, including taxes, is estimated to be US$263 million, of which the proposed IDA financing is US$217 million. Counterpart financing will cover taxes and duties associated with goods, civil

works, training and services; project operating costs, including honoraria; and construction of residential and non-residential buildings at GPS. The Development Project Proposal (DPP) of the project has clearly listed taxes, duties, operating costs, honoraria and these additional civil works under the GOB financing source. An overall cost breakdown is provided in the table below and details of IDA funded activities are in Annex 2.

Table: Breakdown of Project Cost

US$ million

Project Components	Project cost	IDA Financing	% Financing
1. Repowering of the Plant (~400 MW)	255.0	210.0	82
2. Technical Assistance (consulting services and training)	8.0	7.0	88
Total Financing Required	263.0	217.0	83

C. Lessons Learned and Reflected in the Project Design

24. The design of the proposed project was based on the feasibility study carried out in 2012 which was further confirmed through a Residual Life Analysis (RLA) on the targeted, existing unit. The key lessons learned for the project is from BPDB's experience with Unit 3 repowering project. BPDB has already signed contract for similar repowering project of Unit 3 at GPS for which financing closure is yet to be reached. MIGA management is considering to support this project by providing guarantee to HSBC's commercial loan. Due to the restrictive qualification criteria and the technical requirement, that project ended up with single responsive bid. The design of the proposed project has removed those limitations to allow wider participation and with more clarity on the project's scope. It is expected that the proposed project will demonstrate the feasibility of repowering of gas-based steam plants which could be replicated to an estimated 2,000 MW.

25. Also, during the start of the regular maintenance works of the Unit 4 this year and when the whole unit was opened, the implementing agency had sent out an open invitation to the interested bidders to inspect the unit by their experts and fourteen (14) companies (GT manufacturers as well as EPC contractors) visited the site and inspected the unit. Some of their inputs from that process have also been taken into consideration in the project design.

26. The Project will also be a vehicle to work on furthering the Bank's dialogue on improving the overall governance in the energy sector, through close interaction with the relevant authorities on good practice procurement processes for large contracts during the preparation as well as the implementation of the Project. To that end, the Government of Bangladesh had agreed to an independent procurement panel for this project acceptable to the Bank. Input from the Bank's Integrity Vice Presidency's (INT) has also been taken into consideration in designing the modality of the independent procurement panel. A panel of international experts (procurement as well as technical) has been hired by the Government to evaluate the bids of the project independently. BPDB has also formed a separate evaluation committee for hiring Owner's Engineer (OE) with one international procurement expert as an independent member in the committee.

D. Alternatives Considered:

27. Alternatives to the proposed repowering project have been analyzed. The 'no project' alternative can be dismissed as being un-realistic as Bangladesh will continue to build additional generation plants to meet its growing electricity demand and to eliminate its current power shortages. Indeed until such time as power shortages are completely eliminated and demand fully met, the incremental generation from the project would primarily serve to reduce these shortages. Out of the several available options of repowering

technology, the full repowering is the end result of a comprehensive analysis of all the alternatives including full repowering, hybrid and mini-hybrid. Hybrid options will have much lower efficiencies of 41-43% compared to 54% for full repowering. Also, capital cost per additional MW output for the hybrid and mini hybrid is more than full-repowering. Therefore, among the repowering options, full repowering of Unit 4 has the lowest levelized cost. Furthermore, another advantage of full repowering is the maximum possible capacity addition of the existing unit compared to other hybrid and mini hybrid options that will maximize its net present value.

28. On the other hand, with respect to new built CCGT plant at existing location, the ranking of the Full Repowering option, would depend on number of other factors and parameters including discount rate, cost of gas and the disruption to power generation during construction for new built option. The residual life assessment (RLA) report had also investigated the foundations of the existing steam turbine and had concluded that re-use of the foundation in case of a complete new steam turbine would be feasible only after redesign and adaptation of the foundation, which would probably result in a forced stop period of the adjacent machineries to prevent trips or damages during operation. Therefore the consultant did not recommend this option.

29. Among the next best alternative generation options to the proposed project at Ghorashal is a base-load green-field CCGT plant at a new location. In addition, new generation using coal-based steam turbine ST-USC is considered as another alternative despite having relatively longer construction period. In this category, the economic benefits of repowering or new built option are derived from the avoided cost of generation from existing Unit 4 assuming that (in the absence of the project) Unit 4 will continue to supply power for at least 10 years[7] and incremental generation to be met through selected alternatives – CCGT (at a new location) or ST-USC. Economic results are all in favor of repowering under varying assumptions. All of these alternatives have been evaluated in detail in Annex 5.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

30. The Government will have the overall responsibility for project management and coordination through its Power Division at MoPEMR. BPDB will be responsible for the implementation of the project through a PMU at GPS. Although the institutional capacity of BPDB at the corporate level has improved over time, its capacity at the plant level has been weak and all procedures are managed centrally from BPDB headquarter at present. GPS is now being implemented as Strategic Business Unit (SBU) where day to day operations of the plant will be managed by the Plant Management Board (PMB) that would include senior staff of operations, maintenance and finance. A Project Steering Committee (PSC) will provide the operational platform for overall guidance, policy advice, coordination of the project activities, and address interagency issues.

31. **Project Steering Committee**. The PSC will be chaired by the Secretary, Power Division of MoPEMR and will comprise, among others, representatives of the Ministry of Finance, Ministry of Planning, BPDB and other stakeholders (including the power transmission and gas supply authorities) .The Project Director (PD) of the PMU will act as the secretary of the PSC.

32. **Project Management Unit**. BPDB has formed a project management unit (PMU). No later than the end of February 2016, the PMU will be expanded to include one Financial Management specialist and an Environmental focal point who may be assigned from Ghorashal O&M team. The PMU has actively

[7] In practice this could be more than 10 years because Unit 4 will continue to operate till more efficient surplus capacity is available in the system or is retired for technical reasons.

participated in the preparation of bidding document for the design, supply, installation and commissioning of the power plant and will be responsible for the supervision of construction of the power plant. The Owner's Engineer (OE), whose hiring process has already started, will support PMU in implementation of the EPC contract. The OE will directly report to the PMU. The process of hiring OE has already started to ensure OE is on board by the time EPC contractor mobilizes.

33. During implementation, the OE will certify EPC's invoices and participate in progress review and coordination meetings. The PMU will closely coordinate with the SBU on logistics, security, and site hand over etc. A representative from the Ghorashal SBU will participate in the coordination meetings that will be arranged by the PMU. After completion of the power plant installation works, commissioning and start up phases will start. At this point, the PMU will form a commissioning team comprising engineers of the Ghorashal SBU. The team will participate in the commissioning works. The team will work together with the OE, EPC and PMU during the commissioning and hand over phases. Upon achievement of the commercial operations date (COD), the power plant will be handed over to the SBU that will assume operation and maintenance responsibilities of the power.

B. Results Monitoring and Evaluation

34. The monitoring of the project will be done in two phases. In first phase, the focus will be firmly on efficient and timely implementation of the physical infrastructure, with due regard, of course, for quality assurance of design, engineering, supply and construction. Once the plant comes into operation, there will be regular operational reports from GPS concerning the output of the plant. IDA will also monitor the progress of the implementation of the SBU at Ghorashal. Specific results indicators have been agreed with the implementing agency for this project, and progress against planned results targets (Annex 1) and agreed governance actions (Annex 6) will be regularly monitored and reported on to IDA. In addition, the PMO will continue to monitor the performance of the BPDB through a set of Key Performance Indicators (KPI) established for public sector entities, and the Ministry will monitor GPS's operational performance.

C. Sustainability

35. GOB's commitment to the project and its objectives is strong as the project is viewed as necessary to improve the efficiency of the existing plant as well as increase the power availability in a sustainable manner. The repowering technology can deliver the anticipated efficiency and output over the remaining economic life of the plant. An Owners Engineer will be hired to supervise the implementation of the project and support GPS to develop the adequate technical capacity to operate and maintain the plant. A Long term Service Agreement (LTSA) will be signed by BPDB with the Original Equipment Manufacturer (OEM) of the Gas Turbine operation (after the EPC warranty period is completed) to ensure the asset created through this project is adequately serviced/maintained. With GPS being converted to SBU, the plant is expected to be managed better compared to the current state. Power Purchase Agreement (PPA) is being drafted and GPS will sign this PPA with BPDB soon. The financial analysis shows that the project will be able to generate adequate funds to cover the annual operating costs (O&M and fuel costs).

36. The Government has assured IDA of continuing with the current gas allocation to Unit 4 and any incremental requirement of gas after repowering to achieve the maximum benefits from the project. To that end, the Government is also committed to retire unit 1 and 2 (that are most inefficient) which would release additional gas and would suffice any incremental requirement for Unit 4.

V. KEY RISKS

A. Risks Ratings Summary Table

Risk Category	Rating
1 Political and Governance	H
2 Macroeconomics	M
3 Sector strategies and policies	M
4 Technical design of project & program	M
5 Institutional capacity for implementation and sustainability	S
6 Fiduciary	H
7 Environment and social	M
8 Stakeholders	L
9 Other	–
Overall	S

B. Overall Risk Rating and Explanation of Key Risks

37. The overall risk rating of the project is 'Substantial' due to the high governance and fiduciary risks involved in the project and the substantial institutional capacity risks.

38. Since the implementing agency BPDB has not been engaged with any Bank funded project for more than a decade, there is a lack of familiarity within BPDB in terms of Bank fiduciary and safeguard requirements. To mitigate this risk, fiduciary and safeguard consultants will be recruited to strengthen the BPDB PMU team in these specialized areas. Procurement risks are expected to be largely mitigated by BPDB having hired an independent procurement panel (IPP) to review draft bid documents, evaluate bids received, and recommend contract award. Input from the Bank's Integrity Vice Presidency (INT) has been taken into consideration in designing the independent procurement panel.

39. Repowering projects are often considered to carry substantial design risks when the condition of the steam turbine is not known. In the case of the proposed Ghorashal 4 Project, this design risk has been minimized through the RLA testing and recommendations on the major work and replacements in the RLA and feasibility reports. In addition, the technical scope of the project was finalized with the O&M staff of the GPS, separating the activities being carried out under the current maintenance works on unit 4 and well-reviewed by an experienced technical consultant from the Bank side as well as the international technical experts who are the members of the independent evaluation committee.

40. BPDB will be managing multiple turbine projects at the Ghorashal station, which will require strong contract management and coordination skills to avoid delays in completion of contracts and poor quality of works. These contract management risks will be mitigated through appointment of owner's engineer by the time the EPC contractor mobilizes. BPDB will also prepare a detailed activity schedule for parallel activities at GPS to map out in advance coordination needs and appropriate sequencing. Additional institutional risks are related to the establishment of a new Ghorashal Power Station Strategic Business Unit (GPS) to manage the power plant once construction is completed. GPS may have weak management capacity in its initial years, as the internal governance structure is institutionalized and staff come on board. TA support will be provided to the BPDB and to the GPS to facilitate roll-out of the SBU reforms, including actions to enhance transparency and good governance in accordance with the NIS, APAs, and the GAAP.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

41. The Project would provide much needed 3,000 GWh annually in the shortest possible timeframe. The economic analysis shows the repowering option to be cost-effective for several reasons: (i) it would not require any major additional infrastructure cost associated with fuel supply and connection to the grid; for a new green-field project, these costs could be quite substantial and have longer gestation period; (ii) overall efficiency will be increased from 30% to 54% reducing the gas requirement from 12.0 to 6.7 Mmcf per GWh; (iii) it will extend the life of the existing unit and will improve the plant load factor which will further reduce the cost per kWh; (iv) the adjacent Units can continue to operate while the work is going on in Unit 4; this, however, will not be the case for a new built option at the existing location which requires piling work to strengthen the foundation to support the new turbine design and according to RLA report this cannot be done without disrupting the power generation from two adjacent units of 210 MW each (operating at 170MW each) resulting in increased power outages, and an estimated loss of generation of 1,748 GWh per year[8]. The estimated financial capital cost is US$ 270 million, while the economic capital cost (excluding taxes, price contingencies and interest during construction) is US$225 million[9], about 30% less than estimated costs of US$ 326 million for a new-built project at existing location for same capacity. Using these parameters, the economic returns of the project is determined to be significantly higher than the hurdle rate of 12%.

42. Although the efficiency of a new built CCGT at same location (59%) is more than the full repowering (54%) but on the other hand its cost per MW (US$ 816/kW) is about 45% higher than full repowering (US$ 561/kW). Therefore, advantage of the repowering option is its low capital cost whereas new built will have lower operating/fuel cost because of higher efficiency.

43. **Economic Returns** – The results of economic analysis summarized in Table below show that repowering option is a least cost option when compared against relevant alternatives - either CCGT (new built at existing location or green-field at a new location) or a steam turbine (coal-based). The baseline economic return of Full Repowering option against the avoided cost of a green-field CCGT, is 24 percent ERR (and NPV US$147 million) compared to 10 percent ERR (and NPV negative US$ 78 million) for a new built option[10].

44. The above estimates for new built option accounts for the loss of generation from two adjacent units in year two of construction resulting in unmet demand that will cost US$ 254 million when valued at cost of diesel self-generation (at current prices) net of cost of supply. With increase in natural gas prices (linked to crude oil prices), NPV for new built option would increase at a higher rate compared to repowering. For example at crude oil price of US$ 129/bbl both repowering and new built will have an NPV of US$ 216 million. However, it is unlikely that the crude oil prices will reach to that level in the near future. When the benefit of avoided GHG emissions are included in the economic flows, the ERR increases to 26 percent (NPV US$163 million) for repowering and 11 percent (NPV negative US$41 million) for new built option. The difference in NPVs has reduced after accounting for emissions because new built has higher efficiency and therefore lower cost from emissions. The payback period is short – the hurdle rate of 12 percent is crossed in year 8 (or 5th year of full CC operation) for repowering. Similarly, when evaluated against ST-USC (coal), again the NPV and ERR for repowering is more than for the new built option. In case of ST-

[8] 170 MW x 2 units x 66.7% plant factor x 8,760 hours per year x (1 – 12% T&D losses) / 1000 = 1,748 GWh

[9] This number has been used for the economic analysis; although the IDA amount requested for Board approval for this component is lower (US$210 mill) based on the higher offer received through actual bid submission.

[10] In case the lowest bidder is evaluated as a winner, the ERR would be about 30% excluding environmental benefits which is more favorable than the current estimates.

USC, as an alternate NPV would become positive for new built option if emissions costs are added.

Table: **NPV (US$ million) and Economic Rate of Return (%) for Base Case Scenarios**

	Without Emissions Cost			With Emissions Cost		
	CCGT – LNG	ST – Coal	GE – HSD	CCGT – LNG	ST – Coal	GE – HSD
Full Repowering Option						
NPV	147	0	1,037	163	258	1,251
ERR	24	12	62	26	33	69
New Built Option						
NPV	-78	-241	874	-41	61	1,127
ERR	10	-2	29	11	14	33

45. Against the no-project alternative, the ERR for repowering is significantly higher at 62 percent (NPV US$ 1,037 million) because diesel based self-generation incurs significantly higher cost. The environmental cost is also higher accounting for a larger share of the total benefits, compared to gas-CCGT generation because the avoided emissions are based on oil. The ERR including avoided environmental costs is 69 percent (NPV US$1,251 million). The corresponding ERR and NPV for new built option are 29% (US$ 874 million) and 33% (US$1,127 million) for with and without emissions costs respectively.

46. The sensitivity analysis shows the returns to be remarkably robust against unfavorable outcomes: for example, the switching value for gas supply is 21mmcfd i.e. two-third of the current supply. Construction costs could be 83 percent higher and the construction delays resulting in a postponement of revenue stream could continue for 6 years before the ERR falls to the hurdle rate.

47. The robustness of economic returns is also tested in a scenario analysis, in which the outcome of plausible worst case is examined. The worst case scenario combines pessimistic assumptions for all of the main risk factors – 10% cost overrun associated with one year delay in operation 25% additional downtime in year 2 and gas supply reduced to 80% of the requirement. The analysis shows that economic return does not fall below the hurdle rate. Similarly changing the analytical assumptions in favor of new built option: reducing the discount rate to 10%, increasing cost of gas to 90% parity to crude oil price, reducing WTP to 25 US¢/kWh (by excluding capacity cost of diesel generation), life of new built unit extended from 25 to 35 years and plant factor for repowered unit reduced from 85% to 75% NPV for repowering (US$138 million, ERR: 22%) would still be higher than new-built option (US$ 80 million, ERR 12%). And if emissions costs are added the difference in NPVs reduces (because of higher efficiency of new built unit) but would still be higher for repowering option (US$ 157 million for repowering vs. US$ 122 million for new built). Therefore, repowering project has been selected as it gives higher NPV under varying assumptions.

48. In terms of GHG emissions from the project, since the project is displacing inefficient generation from the existing unit with very low efficiency of 30%, it would result in net reduction of 0.3 million tons of CO_2 over its 20 years life.

B. Technical

49. Ghorashal is the largest power station in the country with a current nameplate capacity of 950 MW[11] (including other two 55MW steam units). The turbine manufacturer of these units is LMZ (Russian) and

[11] Nameplate capacity reflects the output of the units when they were new. As a power plant ages, it is common to 'de-rate' its capacity to show its actual output. A new green-field project is being built at Ghorashal with a capacity of 335MW.

LMZ machines are very robust. The identified steam turbine unit (Unit 4) at Ghorashal for the proposed project was installed in 1989. The feasibility study carried out in 2012 had confirmed that there are good prospects for cost effective refurbishment and upgrade of this unit that can increase its useful life to another 25 years once repowered. Incorporating these machines into a new combined cycle configuration is a challenging exercise, although international experience has demonstrated its practicality (See Annex 2 for repowering reference) and benefits of such conversions.

50. For such investments, it is difficult to assess the full scope of works required to design the detailed technical specifications without a visual inspection of the unit and study based on available O&M data. This would require understanding the inside condition of the machine in order to avoid future surprises when the steam turbine is dismantled during implementation. This was of particular concern for the targeted unit at Ghorashal on which major overhauling had been performed only once in 2001 (after running about 12 years since its initial commissioning in 1989). Consequently, during the machine shut down in February 2015 for maintenance works on the steam turbine of unit 4, a Residual Life Assessment (RLA) was carried out on the targeted unit; RLA consultants witnessed the testing (non-destructive testing) carried out by the maintenance vendor.

51. After analyzing the various RLA tests reports and visual inspections of the inside condition of the machine, the consulting firm has confirmed that the current Steam Turbine (Unit 4) has a long remaining life and is fit for operation in the intended repowering project. They have also recommended that the Unit be overhauled after every 50,000 operating hours. The report also assessed the option of replacing the existing unit by a new ST unit and opined that this can only be realistic after redesign and adaptations of the foundation which would involve piling works at the existing turbine hall. These adaptations of the foundation would result in a forced stop period of the adjacent Units to prevent trips or damages during operation. Accordingly, BPDB has not preferred this option. A detailed economic analysis of both the options are explained in Annex 5.

52. The project would be built at the existing land and most of the existing civil structures would be retained. That itself would reduce construction cost by 10 per cent as compared with new construction at a green-field site. While some of the existing auxiliary equipment would be re-used with some modification and refurbishment, some others also will be completely replaced. The repowering of the facility will not only help achieve reduction of capital cost expenditures and operation and maintenance (O&M) cost, but also reduction in emissions and other discharges.

C. Financial Management

53. A FM capacity assessment was carried out to evaluate the overall FM environment prevalent in the country and within the implementing agency. The assessment looked at the prevailing risks at the implementing agency level and also identified the FM arrangements that will be needed to meet the fiduciary requirements in accordance with institutional requirement of the World Bank. Fiduciary risk mitigation measures were also agreed with the agency along with a time bound FM action plan (Annex 3). In absence of a robust accounting software there is a risk to account for the project expenses timely and accurately so that a reliable financial report can be generated as or when needed. Also, there is an inadequate number of internal audit staffing within the organization and they lack in modern audit tools and techniques.

54. The following arrangements will govern the project financial arrangements: (a) a FM Specialist in BPDB, with terms of reference (ToR) agreed with the Bank, will be recruited by February 2016 or project effectiveness and will be retained for the project duration; (c) all payments will be made directly by the PD from the PIU using the banking system (or petty cash expenditures following Recipient guidelines); no payments are anticipated to be handled through the regional offices; (d) the accounting system of the BPDB will be used for accounting and reporting of the project expenditures; however, an off the shelf accounting

software will be purchased before project effectiveness and installed for the project purposes only until the BPDB accounting system becomes fully operational; (e) Interim Unaudited Financial Reports (IUFR) will be prepared and submitted to the Bank within 45 days from the close of each calendar quarter although disbursement will be made on traditional transactions basis (f) the annual external audit of this project will be carried out by BPDB's private audit firm under agreed terms of reference, and the final report will be submitted to the World Bank within six months from the close of a financial year; (g) retroactive financing facility will be available for the eligible expenditures incurred (mobilization advances and consultant's payments) on or after December 01, 2015 and before the financing agreement is signed; and (g) Two internal audits will be carried out in the whole life of the project, first one will be due before the mid-term review and other will be carried out one year before the closing of the project. The Internal audit will be carried out by an independent audit firm (along with the BPDB's internal audit team as a capacity building initiative) on the basis of ToR and selection process acceptable to the Bank and should cover from the date retroactive financing is effective.

D. Procurement

55. BPDB's assessed procurement capacity in International Competitive Bidding requirement for such high value contracts is weak. Also there is lack of understanding of Bank's procurement processes due to a long period of disengagement with Bank financed projects in BPDB. As part of the overall procurement risk mitigation framework, GoB had agreed to safeguard the key procurement package of the project – "*Design, Supply, Installation and Commissioning for Repowering of Unit-4 Ghorashal Power Station*" by appointing an Independent Procurement Panel (IPP) comprising 4 (four) members with international experience. The overarching objective of IPP function would be to safeguard the procurement process from the risks of external influence on procurement decision, breach of confidentiality, delay in contract award, risk profile of the probable bidders etc. among others. This would also ensure that the bidding process is followed with full integrity and thoroughness, following appropriate guidelines. This procurement panel would be authorized and empowered, on behalf of the recipient, to conduct the key procurement activity under the project.

56. The specific objective of the Independent Procurement Panel (IPP) is to independently conduct the selected procurement activities of a high value procurement package for one Engineering, Procurement and Construction (EPC) contractor for the proposed project. The procurement would be done following the International Competitive Bidding (ICB) method in accordance with the Guidelines of Procurement of Goods, Works, and Non-Consulting Services (January 2011 and revised July 2014).

57. The Power Cell has hired these IPP members consisting of highly experienced individual consultants with sound knowledge and expertise of international procurement practices used for the procurement of goods, works, and consultant's services, using World Bank or other similar development partners' Procurement Guidelines. The cost towards employment of the IPP will be financed from TA component of another Bank financed project.

58. BPDB has also formed a separate evaluation committee for hiring Owner's Engineer (OE) with one international procurement expert as an independent member in the committee. The international procurement expert is already hired by the Power Cell.

E. Social (including Safeguards)

59. All the project activities to be funded under this proposed project will be carried out within the Ghorashal Power Plant. There is no land acquisition, displacement of people or adverse impacts on livelihoods arising from the project activities. There are no indigenous people in the project area.

60. PGCB is implementing a national 'Power System Expansion and Efficiency Improvement Investment Program (Tranche 2)' that would cover the enhanced transmission requirement in the region including Ghorashal when all of the four 210MW units at Ghorashal Power Plant would be repowered. The PGCB project is being funded by a joint consortium of ADB, IDB and EIB. Although PGCB's transmission expansion project will help handle increased transmission requirements at Ghorashal over the long term, in the short term there is currently spare transmission capacity available at the site as none of the existing units at Ghorashal are operating at their full capacity. This means that even without the PGCB project, BPDB could ensure sufficient transmission capacity for the repowered Ghorashal Power Plant being proposed for IDA financing. Therefore, the PGCB project is not considered necessary to achieve the objective of the proposed IDA-financed project and is not a linked project for the purposes of paragraph 4 of OP 4.12.

F. Environment (including Safeguards)

61. The proposed project is classified as a "Category A" project, due to the complexity of environmental issues associated with project activities involving major civil works by repowering and decommissioning of existing boilers. The project is located in a 40-year old industrial complex with seven power plants in operation, therefore the repowering of the project will not impact the natural habitats. Similarly, no forestry related issue is involved. Therefore, apart from the umbrella policy of "OP/BP 4.01: Environmental Assessment", no other environmental safeguard policies have been triggered for this project. In addition to the compliance of the World Bank safeguard policies, the project will also comply with all environmental legislation of the Government of Bangladesh. The relevant Environmental, Health and Safety Guidelines 2007 and Environmental, Health, and Safety Guidelines for Thermal Power Plants, 2008 of the World Bank Group will also be applicable to the project.

62. BPDB has prepared an Environmental Impact Assessment (EIA) report with input from a local consulting firm with international consultants in the team. The EIA has also been reviewed by an International Adviser appointed by the Government. The EIA has been prepared based on the: (i) reviewing of the environmental and social policy requirement of the World Bank and the requirement of the national legislation; (ii) identification of activities during boiler decommissioning, plant construction and operation that may impact the environment (iii) assessment of environmental and social impact (both quantitative and qualitative) of project activities (iv) analysis of project alternatives; (v) stakeholders consultations during project preparation; and (v) implementation arrangement and capacity building needs for environmental management. The EIA has 5 volumes. These are: Executive Summary (Volume 1); EIA Report (Volume 2); Boiler Decommissioning Plan (Volume 3); Occupational Health, Safety and Environment Plan (Volume 4) and Emergency Response (Volume 5).

63. Environmental Management Plan (EMP) has been prepared for different phases for the mitigation and monitoring of activities involved. The EMP implementation during the construction phase measures will be included the bidding document and the cost of EMP implementation will form a part of the project cost. The EIA includes environmental monitoring programs for both construction and operation phases. The implementation of the mitigation measures, including environmental, health and safety obligations during construction, will be monitored in accordance with a program of monitoring. A Risk Assessment and Management Plan has also been prepared to account for specific hazards during boiler decommissioning and natural gas leakage. Further to that, the winning EPC Contractor will submit a Boiler Decommissioning Action Plan based on terms and conditions provided in Volume 3: Boiler Decommissioning Plan and a Construction Environmental Action Plan based on the EIA and the offered plant and equipment, construction method and work schedule. The EAP will be approved by BPDB and the Bank before the commencement of the work.

64. The environmental impact assessment showed that there will be some marked benefits as a result of this project and adoption of a closed-cycle cooling system. Environmental benefits will come from the

reduction of CO and GHG emissions in the air, decrease in thermal effluent discharged into the Sitalakhya River, lesser extraction of cooling water from Sitalakhya River. The overall positive impact of the project during operation is the augmentation of the generation capacity of the electricity, higher efficiency and improving the socio-economic condition and lifestyle of the country's population. Some additional details of the Environmental Assessment have been provided in the Annex 3. An economic cost-benefit analysis has also been performed encompassing all associated costs and environmental benefits of the proposed project and it was shown that the project is economically viable.

65. The draft Final EIA document and Executive Summary with EMP in Bengali has been disclosed both in the BPDB website www.**bpdb**.gov.**bd** on July 23, 2015 and the Bank's Infoshop on July 24, 2015 for public comments. The hard copies of the above document have also been made available in BPDB offices fulfilling World Bank Disclosure requirements. A national level workshop on the EIA was held on September 12, 2015.

66. The PMU of BPDB will be in charge of implementing the EMP. Although BPDB has not implemented any recent project with the World Bank, it has undertaken projects funded by external development partners that require management of environmental issues. BPDB is aware of the Bank requirement of environmental and social assessment of the project. However, BPDB currently has rudimentary institutional capacity for environmental management. In order to augment capacity of BPDB in the environmental management areas, the project will provide necessary Technical Assistance by financing an Owner's Engineer (implementation support consultant).

67. PMU will recruit an Owner's Engineer for supervision of implementation of boiler decommissioning, supervision of EPC contractor involved in design. Engineering, manufacturing and supply, civil works, erection of turbine and HRSG, including supervision and implementation of EMP. The Owner's Engineer will consist of an environmental unit with 1 international specialist (part time, 50% during construction period) and 2 national environmental specialist (full time). Besides internal monitoring and evaluation by the PMU/BPDB for environmental management and monitoring, independent external monitors will be retained by BPDB, to undertake monitoring of all safeguard compliance and effects.

G. World Bank Grievance Redress

68. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit www.worldbank.org/grs. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

Annex 1: Results Framework and Monitoring

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

Project Development Objectives												
The development objective of the Project is to increase generation capacity and efficiency of the targeted power plant.												
.												
Project Development Objective Indicators												
				Cumulative Target Values							**Data Source/**	**Responsibility for**
Indicator Name	Core	**Unit of Measure**	**Baseline**	**YR1**	**YR2**	**YR3**	**YR4**	**YR5**	**YR6**	**Frequency**	**Methodology**	**Data Collection**
Generation capacity constructed under the project	Y	MW	170	170	170	235	400	400	400	Quarterly	BPDB MIS Report and Project Progress report	BPDB
Projected lifetime fuel savings	Y	PJ	0				303	303	303	Quarterly	BPDB MIS Report and Project Progress report	BPDB
Overall Efficiency of the unit measured in %		%	30%	30%	30%	34%	54%	54%	54%	Quarterly	BPDB MIS Report and Project Progress report	BPDB
Intermediate Results Indicators												
Indicator Name	Core	Unit of Measure	Baseline	YR1	YR2	YR3	YR4	YR5	YR6	Frequency	Methodology	Data Collection

Commissioning of Gas Turbine completed		Text	Not Commissioned		GT commissioned	GT operation started				Quarterly	BPDB MIS Report and Project Progress report	BPDB
Overhauling of existing Steam Turbine Generator completed		Text	Not overhauled		HRSG installed	STG overhauled; Boiler dismantled	CC operation started			Quarterly	BPDB MIS Report and Project Progress report	BPDB
Strategic Business Unit (SBU) fully functional		Text	Partially functional: Bank account opened; financial power delegated; KPIs signed	PPA signed	Functional	Functional	Functional	Functional	Functional	Quarterly	BPDB MIS Report and Project Progress report	BPDB
Environment and Social Management Unit operational at Ghorashal		Text	Not operational	Focal point assigned	Focal point assigned	Focal point assigned	ESM Unit operational	ESM Unit operational	ESM Unit operational	Quarterly	BPDB MIS Report and Project Progress report	BPDB
GHG emissions		CO2 tons/	673	673	673	593	374	374	374	Quarterly	BPDB MIS Report and Project Progress report	BPDB

Annex 2: Detailed Project Description

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

1. **Project Background:** Currently, the generation capacity of Bangladesh is inadequate, gas availability is limited and the steam power plants are not efficient enough. In order to increase generation and improve efficiency of the existing power plants, GOB prioritized the repowering projects and requested the Bank to support their strategy.

2. **Repowering** is defined as complete replacement of the original boiler with a combination of one or more gas turbines (GT) and heat-recovery steam generators (HRSG), and is widely used with very old plants with boilers at the end of their life-time. In most cases, repowering projects include the modernization of the steam turbine and I&C. For economic reasons, it is recommended that the original capability of the Steam Turbine (ST) and the associated BOP systems (transformer, cooling systems etc.) are utilized as much as possible. The available HRSG steam defines the achievable ST output within narrow limitations. As a rule of thumb, the thermal cycle of the repowered unit targets approx. 70-80% of the rated steam turbine output in order to achieve a reasonable amount of steam flow through the HP section of the steam turbine.

3. The fact that Bangladesh has a fleet of gas-fired steam power plants which went into commercial operation more than 20 years ago and major equipment of these plants exceeded or is close to their design lifetime even more supports the idea of repowering. The levers to fulfill the goal of modernization and repowering to increase the economics and dispatch ability of existing power assets are:

- Increase of efficiency and power output
- Extension of lifetime
- Increase of availability and reliability and reduction of O&M costs
- Increase of operational flexibility
- Reduction of specific emissions.

4. **The Ghorashal Power Station** consists of 6 gas fuelled boiler/ steam turbine installations. The units 1 and 2 are the first build installations (in the seventies), producing maximum 48 MW each (design value 55 MW) and are no subject for this project. The units #3, #4, #5 and #6 have the same size and have 210 MW maximum design capacity each. To investigate the possibilities of these installations to Combined Cycle Power Plants, GOB through Power Cell had appointed a consultant to carry out a feasibility study and the report was finalized in September 2012 identifying Unit 4 as the most potential for repowering.

5. **Project Activities:** The component 1 of the project would finance all the required plant equipment, design and installations services for the full repowering of unit 4. The major plant equipment include a new Gas Turbine and Generator (GTG), a Heat Recovery Steam Generator (HRSG), Distributed Control System (DCS), gas booster compressor, main stack, bypass stack and all other associated ancillary equipment. The works would include complete overhauling of the existing ST generator, replacement and modernization of the existing auxiliaries, rehabilitation and modernization of existing cooling towers and workshop buildings, construction of a regulatory metering station (RMS), dismantling of the existing boiler, and construction of residential and non-residential buildings. The component will not cover works on the existing steam turbine as it is undergoing major maintenance prior to this proposed project, including repair and/or replacement of key turbine parts. The Government contribution will cover: taxes and duties associated with goods, works, and services; project operating costs and interest during construction; and residential and non-residential buildings at GPS. The tentative detail project cost of this component is given

below:

Table 2: Estimated Project Cost of Repowering Component (in USD mill)		
Description		**Cost**
Plant and Equipment		**151**
1	New Gas Turbine with Generator	65
2	New HRSG	25
3	New excitation system for STG	2
4	Full and complete overhaul of the generator of the steam turbine	8
5	GT Step up Transformer	5
6	Station Service Switch gear (40 MVA capacity)	5
7	Communication System	2
8	Renew of MV, LV, Switchgear, control and cables	5
9	Central DC power source with UPS having double charger for the Unit 4	2
10	Complete Replacement of piping, valves, pumps, instrumentation, etc. BOP (Balance of Plant).	5
11	Gas boosters, associated equipment including piping to connect to RMS	10
12	Main stack	1
13	Bypass Stack	2
14	The new DCS system.	2
15	Hookup and cables to connect to new GIS S/S	1
16	Workshop facilities (Mechanical/Electrical/I&C)	2
17	Emergency Diesel Generator (2MW) set	2
18	Boiler Dismantling and removal	3
19	Mandatory Spare parts	5
Common Mechanical Works at GPS		**11**
20	Fire Fighting System (FFS) in the whole Ghorashal Power Plant hub should be installed.	2
21	Central compressed air plant	1
22	New Demi water plant	4
23	Common Hydrogen plant	1
24	Closed Cooling Water (CCW) system	2
25	Central Air Conditioning system covering control room, relay room, computer room, etc	1
Design Services		5
Installation (Erection & Commissioning) and other Services		**33**
Total		**200**
Contingency (Physical 2% and Price 3%)		10
Taxes & duties on the goods and works, Project's operating cost and additional civil works and interest during construction (IDC)		45
Total Estimated Cost for Component 1		**255**

6. No gas transmission pipeline will be required. However, a Regulatory Metering Station (RMS) within the GPS boundary will be constructed under this project.

7. **Technical Assistance (TA) component** (Component 2) would finance an Owner's Engineer (implementation support consultant) for the Project to bolster project governance while ensuring effective management of the construction and initial operation of the new power plant. This component would also focus on capacity building and institutional support to the power plant to help establish the technical and institutional capacity to operate the plant effectively and efficiently in addition to help automate its financial reporting system; and capacity and institutional support to BPDB to help strengthen technical and managerial capacity to plan, develop and operate its generation portfolio. The TA will also be used to hire individual consultants to support PMU that would include areas of environmental and financial management. The training plan would also cover training related to fraud and corruption risks and preventive measures that can be implemented and annual forensic auditing of project accounts. The total cost of this component has been estimated at US$ 8.0 million including taxes, of which the IDA share is estimated at US$ 7 million. IDA will not finance salary, allowances, or honoraria associated with this component.

8. The primary reason for choosing Unit 4 was that the boiler of Unit 4 was not in good condition. The boiler had the following problems: boiler tubes panels in poor shape, condenser tubes leakages, forced draft fan vibrations, cracks in foundations, leakages in the sealing of air heaters. The study included technical as well as financial assessment of repowering of existing 210 MW (Unit 4) and installing a new gas fired combined cycle power plant unit. The Bangladesh Power Development Board (BPDB) supported by the feasibility study and decided that unit 4 would be viable for full repowering it to a Combined Cycle Power Plant (CCPP). This would increase the efficiency of the plant considerably (from about 30% to over 54%).

9. The feasibility study assessed the condition of the Units of Ghorashal Power Station on the basis of available historical data and discussion with the O&M staff. With the help of obtained data, the technical specifications of the 210 MW steam turbine units were assessed and their capability in a combined cycle mode of operation after repowering and accordingly the report concluded that the repowering of Unit 4 is technically and economically more feasible than doing a new combined cycle power plant. Table 1 provides a comparison of cost of repowering of unit 4 with new CC plants and few recently awarded new CC projects in the public sector:

Table 1: Comparison with New Combined Cycle Project

	From Feasibility Study				
Description	Unit 4 Ghorashal	New CC Triple Pr	Siddhirganj (IDA)	Ashuganj (MIGA)	Haripur (JICA)
Total Plant Output (in MW)	404	393	335	373	412
Augmented output in excess of current capacity (170MW)	234	-	-	-	
Total Project cost (in million)	264	407	340	328	378
Per MW cost ($million/MW)	0.63	1.04	1.01	0.88	0.92

10. It is difficult to assess the full scope of works required to design the detailed technical specification of any repowering project only through visual inspection of the unit and study based on available O&M data. This would require understanding the inside condition of the machine in order to avoid future surprises when the steam turbine and generator is dismantled during implementation. This was of particular concern for the targeted unit at Ghorashal which had performed major overhauling only once in 2001 (after running

about 12 years since initial commissioning in 1989). This called for a condition assessment report/RLA to be carried out on the targeted unit.

11. A condition assessment/RLA has been carried out on the steam turbine, generator, auxiliaries and foundations of Unit #4 in February 2015 when BPDB opened the turbine and generator on unit 4 for maintenance. This condition assessment was supported by NDT inspections, carried out by OJSC Power Machine (maintenance contractor), and witnessed and reviewed by DNV GL, the same feasibility consultants.

12. After analyzing the various tests reports and visual inspections of the inside condition of the machine, the consultants recommended that the Steam Turbine has a longer life and is fit for operation in the intended Re-Powering Project. However, in order to achieve that, periodic maintenance and major Overhauling as per manufacturer guideline is required after every 50,000 operating hours. Generator was suggested to be overhauled and the auxiliaries replaced and/or refurbished.

13. The RLA report also investigated the foundations of the existing steam turbine and they concluded that re-use of the existing steam turbine with slightly different load is acceptable. However, steam turbine efficiency will be not optimal if adaption and optimization is required for the steam turbine. Re-use the foundation in case of a complete new steam turbine is expected to be realistic after redesign and adaptations of the foundation. These adaptions of the foundation table will probably result in a forced stop period of the adjacent machineries to prevent trips or damages during operation. Therefore the consultant did not recommend for this option.

14. The outline of the repowering activities would be as follows:

- Erection, commissioning of the gas turbine
- Establish and commission the grid connection of the gas turbine generator
- Erect and commission all the required auxiliaries
- Upon the gas turbine producing reliable power, it will be operated in the Simple Cycle Mode and the existing boiler and steam turbine will be shut down
- The existing boiler will then be demolished while the remaining overhauling work on the steam turbine generator and will be completed
- The HRSG will be erected and commissioned and finally, after all other upgrading work has been completed, the Combined Cycle Power Plant will be commissioned.
- Time for completion of commissioning activities is 540 days for Simple Cycle Operation and 900 Days for Combined Cycle Operation (including 540 days of SC operation).

15. Currently, Ghorashal is receiving over 231 mmcfd of gas for all its plants in the premises. This includes two rental plants which are utilizing gas allocated for Unit 6 which is sitting idle since 2010. The contracts of these plants are expected to be retired soon and therefore the gas availability for BPDB plants at Ghorashal will further be increased. This would support the additional gas needs of the repowered plants. The government is committed to discontinue the operation of old inefficient plants (2X55 MW) at Ghorashal for operating the efficient repowered plants, if need be. The gas supplier, TITAS recognizes Ghorashal as a strategic generation hub for BPDB and is also committed to provide necessary support to Ghorashal by supplying required gas that will be required for the increased capacity after repowering. BPDB has confirmed its commitment to ensure availability of incremental gas needed for Unit 4 during the project Appraisal mission.

16. The repowered Ghorashal Unit 4 will be operated by BPDB and availability of experienced operating personnel in the Ghorashal plant is adequate. Training of BPDB personnel in the operation of the repowered unit shall be carried out by the EPC contractor and has been included in the scope of work of the project.

In addition, BPDB will enter into a long term maintenance contract with a contractor for the maintenance of the gas turbine generator. LTSA cost will not be covered under the IDA loan.

17. The identified steam turbine unit at Ghorashal was installed in 1989. They are very robust machines, and the feasibility study has confirmed that there are good prospects for cost effective refurbishment and upgrade of this unit that can increase its useful life to another 25 years once repowered. Incorporating these machines into a new combined cycle configuration is a challenging exercise, although international experience has demonstrated its practicality. The following references are known for full repowering:

Singapore: Senoko plant, consisting of three 120 MWe oil-fired steam units, was commissioned in 1975. A repowering project, the first of its kind in Singapore, converted these units into three 360 MWe combined-cycle plants, through the addition of three GT26 Alstom gas turbines and associated heat recovery steam generators.

Japan: Tokyo Electric Power Company completed the repowering of its No.6 plant in the Goi Thermal Power Station by remodeling it into a full-fired heat recovery combined cycle. This was the first application of this technology in a Japanese electricity power station. The plant was commissioned in June 1994. The capacity of the plant increased to 476 MW by adding a 126 MW gas turbine generator.

South Carolina, USA: South Carolina Electric & Gas Co. repowered its Urquhart Station in Beach Island in 2002. Units 1 and 2, with 75 MW steam turbines, were repowered according the full repowering concept with a GE 7FA gas turbine with HRSG each. Plant output increased from 250 MW to 550 MW.

Florida, USA: Unit 2 of the Arvah B. Hopkins Station in Tallahassee, Florida, was a 230 MW gas/oil-fired conventional steam plant. In the first phase of repowering, it was repowered with a GE 9F gas turbine with Nooter/Eriksen HRSG and the power output increased to 300 MW. The plant went in operation in 2008, but is designed in such way that when additional capacity is needed in the future, another gas turbine and HRSG can be placed.

Netherlands: The Claus C power plant is providing an additional highly flexible plant by replacing the old gas-fired boiler of Claus B by three new GT26 gas turbines. This has increased the power output to approximately 1,300 MW from 640 MW while substantially reducing CO2 emissions by 40%. The efficiency improved form 38% to above 58%.

Mexico: Comisión Federal de la Electricidad of Mexico is repowering the Manzanillo Thermoelectric site. Two conventional boilers running on fuel oil are replaced by six gas fired GE 7FA gas turbines. Plant power output will increase from 600 MW to 1500 MW and expected efficiency improvement is 50%. Full plant is expected to be running by the summer of 2012.

Italy: Enel repowered its Rossano Calabro power plant in Italy in 1997. Four conventional units of each 310 MW are repowered with four 114 MW MS 9001 E Nuovo Pignone gas turbines and Ansaldo HRSGs.

Belgium: Electrabel repowered the conventional coal plant in Amercouer in Belgium with a 283 MW GE 9FB gas turbines with 3p HRSGs in 2009. The power output increased from 130 MW to 420 MW, efficiency increased from 38% to 58%. Also a new steam turbine was designed for optimal process conditions. The steam turbine is placed on the existing steam turbine foundation.

Rhode Island, USA: New England Power Company and Narragansett Electric Company repowered its Manchester Street station in Rhode Island in 1995. Three Siemens V84.2 GTs with HRSGs are placed. The plant's capacity tripled to 489 MW and the heat rate improved about 25%.

New Jersey, USA: Public Service Electric and Gas Company repowered its Bergen station in Ridgefield, New Jersey in the beginning of the 1990's. Four Siemens V84.2 GTs with HRSGs repowered one of the existing 285 MW gas/oil-fired steam units. The new net combined-cycle generating capacity is 650 MW.

Florida, USA: Florida Power & Light Company repowered its Lauderdale station in Fort Lauderdale in the early 1990's. Four Westinghouse 501F GTs in a combined-cycle repowering replaced two existing 125 MW gas-fired units. Net capacity increased from 274 to 846 MW and heat rate improved significantly. The little-used peaking unit turned into a heavily used base load plant.

Minneapolis, USA: The Riverside plant in Minneapolis, operated by Xcel Energy, consisted of two operating steam turbine generators (units 7 and 8) supplied from three coal-fired boilers (units 6, 7 and 8). Steam turbine 7 had a nominal capacity of 165 MW and received steam from boilers 6 and 7. Unit 8 had a capacity of 221 MW. The three coal fired boilers are replaced by two gas fired GE 7FA gas turbines and two-pressure HRSGs. Plant output increased to 486 MW. The repowered plant went in operation in 2009.

Finland: Mussalo No. 2 station Finland is repowered with a 60 MW Siemens V64.3 gas turbine with HRSG. The existing boiler and steam turbine stay in operation.

In addition, there are several plants in Netherlands, USA and Mexico that have been repowered through other available repowering options**.**

Annex 3: Implementation Arrangements

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

Project Institutional and Implementation Arrangements

1. BPDB will be the implementing agency for the project. It will be responsible for project administration; procurement; financial management and disbursement; environmental, social impact assessment, management and related compliances; and monitoring. A Ghorashal Strategic Business Unit (SBU) has been formed and taken over charge. It will be responsible to operate and maintain the assets of Ghorashal Power Plant complex. A SBU Board has been formed that will take all policy and operational decisions of the Ghorashal Power Plant Complex. It is comprised of seven members and Chairman of BPDB will act as Chairman of SBU Board. A Plant Management Board (PMB) is also established at working level that will look after the day-to-day operations of the Ghorashal Power Complex. . The CEO of Ghorashal Power Plant complex will lead the PMB. PMB will report to the SBU Board. BPDB has recently approved a delegation of financial authority for the SBU Board (up to five crore taka). BPDB will contract an EPC contractor to implement the Unit 4 repowering contract at Ghorashal. The BPDB will, in consultation with GPS, will carry out the other procurement of the project including capacity building activities.

Project administration mechanisms

2. The project will be implemented between January 2016 and December 2021. This will comprise of a design cum construction phase which is expected to be over in December 2018, followed by an operational phase when the SBU will operate and maintain the Repowered Ghorashal Unit-4 and start selling electricity to off-taker, BPDB. In the beginning of project implementation, which will start with construction of the Repowered power plant, the project will receive support of a global Owner's Engineer (OE). The OE will provide construction supervision support for the Repowered Combined Cycle Power Plant. This service will essentially include design & engineering; and technical, construction and commissioning support during construction, commissioning and handing over of the power plant to Ghorashal SBU. In the second phase, the capacity building activities will continue and the Ghorashal SBU will continuously acquire financial and technical strengths to establish itself as a power generation utility. It will receive further technical support based on demand.

Financial Management, Disbursements and Procurement

3. **Fiduciary Capacity:** Assesses fiduciary capacity of BPDB is weak and associated fiduciary risk is "High". The assessed capacity of procurement and financial management is described below.

4. **Planning and Budgeting:** Overall risk rating is considered Low for planning and budgeting. A budget will be maintained for the entire term of the project, and detailed budgets for each fiscal year will also be produced to provide a framework for financial management purposes. The annual budget will be prepared on the basis of the procurement plan and any other relevant annual work plans. These budgets will be monitored periodically to ensure actual expenditures are in line with the budgets, and to provide input for necessary revisions.

5. Procurement planning is not much of a challenge due to only a few number of packages to be financed by the project. A procurement plan would cover one large EPC contractor procurement, Consultancy Service for Owner's Engineer and several individual consultant and small value services. A procurement plan covering all major procurement packages has been prepared.

6. **Internal Control:**

a. Filing and Record-Keeping: PMU under BPDB will preserve all accounting records and these records must be made readily available on request for audit/investigation/review by Government and the Bank. All project related documents must be filed separately to facilitate internal and external audits, as well as fiduciary reviews may be carried out by the Bank. The project will maintain assets tracking system for ensuring annual physical verification and reporting on assets procured under the project.

b. Manual of Accounting System and Delegation of Financial Power: BPDB has it's "manual of accounting system' which was developed in the year 1975 and then revised in the year 1981. Though the manual has not been updated since then, separate circulars were issued in order to effect new rules and regulations of BPDB. These circulars have not been kept in one place therefore it was agreed that all the circulars will be added to bind together with the existing manual so that it may work as a ready reference for the accounting and finance staffs. According to the delegation of financial power of BPDB, development project directors are entitled to approve any financial transactions.

c. Financial Management System for the project only: A modern accounting system will be established under the project for whole BPDB accounting and reporting purposes, which will take a considerable amount of time to get ready for use. In the meantime, in order for BPDB to maintain its accounting and reporting for the project expenses, an off the shelf accounting software will be procured under the project. This software will be used to account for project expenses only until the SBU wide accounting software is established and implemented as part of this project.

d. Payments: All project payments will be made by the PD in the PMU using the banking system (except for small petty cash payments). Retroactive financing facility will be available for the eligible expenditures incurred (mobilization advances and consultant's payments) on or after December 01, 2015 and before the financing agreement is signed;

e. Internal Audit: Under the Member (Finance) of the board, there is a Director responsible for carrying out the Internal Audit Function of the entity. However, it was noted that there is capacity constraint in performing the IA function in compliance with international standards. The project will look into ways to provide support to the Internal Audit Department, especially through training. However, an accounting firm will need to be hired by the project to conduct Internal audit of the project once at the end of 2nd year of implementation and another just one year before the closure of the project. ToR of the internal audit will be prepared by the project as soon as the project declared effective and same will be shared with the Bank for its concurrence. Procurement of the IA service may be considered as Prior Review contracts due to its technicality. The key internal audit function will be (a) ascertaining whether the system of internal checks and controls operating within the organization for preventing errors and fraud and corruption is effective in design as well as in operation. (b) ascertaining reliability of accounting and other records as well as seeing that accounting methods provide the information necessary for preparation of correct financial statements (c) ascertaining the extent to which the project entity's assets are safeguarded from any unauthorized use or loses (D) Ascertaining whether administrative and financial regulations of the government and instructions issued by the Treasury as well as donors legal requirement are followed.

7. **Oversight Arrangements**

a. External Audit: The annual accounts of the BPDB is audited by a private audit firm as per statutory requirement. It was agreed that the project audit will also be covered by the same audit, provided the TOR is expanded to reflect this. It was agreed that necessary changes in the ToR will be made before the close of each financial year. Annual audit report will be submitted to the Bank by December 31 each year which will be monitored and tracked in the Bank system. The Ministry neither has a pending audit report nor any material audit observations unresolved.

b. Audit Committee and Audit observation resolution mechanism**:** There is no audit committee at the BPDB which is essential to advice and monitor management action on audit and its resolution in a timely manner. Options will be explored for forming such audit committee at the entity level (BPDB or SBU) once the proposed organizational structure of SBU is finalized. In the meantime, it was agreed that a team will be established at the PMU level to respond to audit issues and facilitate settlement in a systematic manner. The team will comprise PD, Director Accounts and Director Audit of BPDB under an agreed TOR. The senior most in terms of position will head the team which will meet on a quarterly basis and provide update to the Bank. It was agreed that the project will share the TOR and communicate the formation of the team within three months of project effectiveness

8. **Procurement complaints.** A written procedure for Procurement Complaint Handling system would be established to manage complaints, including a database for recording, monitoring, and following up on all procurement activities. The Bank must be notified of any complaints to ensure transparency in the resolution process.

Procurement Considerations in the Fiduciary Assessment

9. **General:** Under the project, estimated US$210 million is allocated for one EPC contract for Ghorashal Unit 4 Repowering. Remaining IDA allocation would be used for the service assignment of Owner's Engineer, and for consulting services of individuals and firms. Procurement will be carried out in accordance with the Bank's 'Guidelines: Procurement of Goods, Works, and Non-Consulting Services under IBRD Loans and IDA Credits & Grants,' dated January 2011 and revised on July 2014 (Procurement Guidelines); 'Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits & Grants by World Bank Borrowers,' dated January 2011 and revised on July 2014 (Consultant Guidelines); the World Bank Guidelines on Preventing and Combating Fraud and Corruption in Projects finances by IBRD Loans and IDA Credits and Grants, dates October 15, 2006, and revised in January 2011 and July 2014, and the specific provisions stipulated in the Financing Agreement. A General Procurement Notice for all major procurement to be financed by the proposed project has been published on the Bank's external website and United Nations Development Business.

10. **Procurement Risk Mitigation Measure:** As part of the overall procurement risk mitigation framework, Government of Bangladesh (GoB) agreed to safeguard the procurement activity for EPC contract by appointing an Independent Procurement Panel (IPP). The GOB would authorize and empower the Independent Procurement Panel to act on behalf of the BPDB in conducting the evaluation process, including receipt, opening, and evaluation of bids. The approval process will follow the rules of business of BPDB and the Delegation of Financial Powers for Development Projects in Bangladesh. The overarching objective of IPP function would be to safeguard the procurement process from the risks of external influence on procurement decision, breach of confidentiality, delay in contract award, risk profile of the probable bidders etc. among others. This would also ensure that the bidding process is followed with full integrity and thoroughness, following appropriate guidelines.

11. The specific objective of the Independent Procurement Panel (IPP) is to independently conduct the selected procurement activity of the high value procurement package for one Engineering, Procurement and Construction (EPC) contractor for the proposed Project. The procurement would be done following the International Competitive Bidding (ICB) method in accordance with the Guidelines Procurement of Goods, Works, and Non-Consulting Services (January 2011 revised July 2014).

12. **Modality of the IPP Function:** The IPP has been established under the project, comprising four consultants with international experience. The Power Cell has hired the panel members consisting of highly experienced individual consultants with sound knowledge and expertise of international procurement practices used for the procurement of goods, works, and consultant's services, using World Bank or other similar development partners' Procurement Guidelines. The cost towards employment of the IPP is financed from a Technical Assistance supported by the Bank. Majority of the IPP function will be dedicated to all-encompassing activities required for bid evaluation of procurement of one EPC contractor following the applicable Procurement Guidelines of the World Bank. The functional modality of the Procurement Panel is as follows:

i) International Procurement expert of the procurement panel would act as Chairperson and would represent the panel. The Chairperson will be responsible for all communication with the BPDB and the bidders/consultants.

ii) The panel will be responsible for preparing the customized format of bid evaluation report acceptable to Bank.

iii) The panel members shall be members of the bid opening committee. The bids shall be opened and initialed, and minutes issued, by the panel members in the bid opening session. From the bid opening until the completed bid evaluation report along with recommendations for award of contract is formally handed over by the procurement panel to the BPDB for approval, BPDB shall not have access to bid information. The panel will not be guided in anyway by the provisions of the Public Procurement Act or Rules (PPA/PPR), but shall be guided solely by the provisions of the Bank's Procurement and Consultants Guidelines.

(i) The BPDB would arrange a secured office room for the Procurement Panel members on a full-time basis at a specified office location (very similar to sequestering). This room will remain accessible to panel members only. The office would be fully equipped with computers, photocopier, scanner, internet connection and double key locker/ cabinet to store the bids/ proposals. The panel members would not be allowed to carry bids or copies outside of the specified office location (venue of evaluation) until the evaluation is complete; report is signed and delivered to the PD in a sealed envelope. IPP Members will coordinate with each other to consolidate their reviews and submit a consolidate bid evaluation report.

iv) Only the panel shall be responsible for bid evaluation, seek clarification and conduct due diligence as required for proper bid evaluation.

v) The IPP will be responsible to prepare a complaint handling mechanism known to the bidders and the protocol for communication with bidders to respond to queries during bid evaluation including arranging reply from bidders' references.

vi) In the course of bid evaluation, if complaints are received by the BPDB and/or by the Bank, the panel members shall review the complaints, form an opinion on the complaint and inform the Bank

whether further action is required on the complaint. The panel members shall carry out the bid opening and bid evaluation task by themselves, without delegating it in whole or in part to any other official/ staff/ person in any circumstance without prior approval of the Bank.

vii) Time is of essence for procurement activities as outlined above and to be performed by the IPP. In this respect the IPP will be timely contracted by the Power Cell under Ministry of Power who will ensure provision of necessary logistics and other administrative support to the IPP and who will oversee timely completion of its tasks as well as its independence in performing its work;

viii) Upon receipt of the evaluation report from the panel Chair, the PD will submit the recommendation to the BPDB Board for approval in a sealed envelope without any tier in between. The BPDB Board will approve the bid evaluation report along with the award recommendations. The PD will send the approved recommendation to the Bank for review and non-objection. After receiving Bank's non-objection, the PD will take necessary approvals in accordance with the GoB's delegation of authority.

ix) The PD will take necessary steps for issuing notification of award and contract signing.

13. **Procurement of goods and works.** Except as otherwise agreed in the procurement plan, the procurement of goods and works will follow ICB procedures. The procurement of goods and works having an estimated value less than the ceiling stipulated in the procurement plan may follow National Competitive Bidding (NCB) and National Shopping procedures. Direct Contracting may be allowed under special circumstances, with prior approval of the Bank. NCB contracting will be carried out under the Bank's Procurement Guidelines, following procedures from the Open Tendering Method of the PPA 2006 (including first amendment to the PPA 2009) and the PPR 2008 (as amended in 2009), using standard bidding documents that are satisfactory to the Bank. For the purpose of NCB contracting, the following shall apply: (a) post-bidding negotiations shall not be allowed with the lowest evaluated or any other bidder; (b) bids should be submitted and opened in public in one location immediately after the deadline for submission; (c) lottery in the award of contracts shall not be allowed; (d) bidders' qualification/experience requirements shall be mandatory; (e) bids shall not be invited on the basis of percentage above or below the estimated cost, and contract awards shall be based on the lowest evaluated bid price of compliant bid from eligible and qualified bidder; and (f) single-stage two-envelope procurement shall not be allowed.

14. **Procurement of non-consulting services.** Except as otherwise agreed in the procurement plan, procurement of non-consulting services will follow ICB procedures. Procurement of non-consulting services having an estimated value less than the ceiling stipulated in the procurement plan may follow NCB procedures.

15. **Selection and employment of consultants**. The following methods will apply for selection of consultants: Quality and Cost-Based Selection (QCBS), Quality-Based selection (QBS), Fixed Budget Selection (FBS), Consultants' Qualification (CQ), Least-Cost Selection (LCS), and Single-Source Selection. Single-Source Selection consultants may be allowed under special circumstances with prior approval of the Bank. Short lists of consultants for services estimated to cost less than US$500,000 equivalent per contract may be composed entirely of national consultants. The procurement plan will specify the circumstances and threshold under which specific methods will be applicable.

16. To minimize other procurement associated risks, the following measures have been agreed upon with the government:

a) A market survey of the available bidders for the scope of work has been already done by an independent consultant;

b) BPDB arranged site inspection of the Steam Turbine during its overhaul through an open invitation to prospective bidders. The invitation to site inspection was published in the UNDB and local newspaper. Fourteen (14) potential bidders including some of the major EPC contractors and Turbine Manufacturers visited the site and attended wrap up meeting of invitation to site inspection.

c) The bidders would be required to disclose their relationship with employer's staff/ contractors/ agents etc.

17. **Review by IDA of procurement decisions.** The review by IDA of procurement decisions and selection of consultants will be governed by Appendix 1 of the Bank's Procurement Guidelines. For each contract to be financed by credit, the threshold for prior-review requirements and post-review contracts will be identified in the procurement plan.

18. **Post review.** For compliance with the Bank's procurement procedures, the Bank will carry out sample post review of contracts that are not prior-reviewed by the Bank. Procurement post reviews will be done on an annual basis depending on the number of post-review contracts.

Financial Management Considerations in the Fiduciary Assessment

19. **Staffing:** PD of the project will have financial power to approve financial transactions of the project. However, an Assistant Director (AD) from finance department of BPDB will be deputed to help PD on financial management issues including 2 other accounting staffs. PD also works as the drawing and disbursement officer of the project. However, BPDB will hire a professionally qualified accountant from the Market as Financial Management Specialist to help the project in terms of accounting, auditing and financial reporting. BPDB has already deputed an accounting staff to the PMU from the office of the financial controller.

20. **Disbursements:** It was agreed that the project would start with transaction based disbursements and may convert to IUFR based disbursement when the project demonstrate capacity to prepare reliable and timely financial reports during implementation. For the project as a whole, the Bank will finance the goods, works and services/training contracts net of taxes. The tax components for all expenses and the operating expenses of the project will be funded by GOB and funds for the same will be routed through the respective implementing entity through normal budgetary channels.

21. Under this Project, the Bank will not finance salaries/operational costs of any nature for the implementing agency nor sitting allowances or honoraria. Only the capital components will be financed by the Bank. For each of the contracts, Bank funds will be transferred directly to the contractors. Direct payments will be made by the Bank to the contractor's banker on obtaining approvals with required documentation from the respective implementing agencies. These funds will not be routed through the implementing entities. Special Commitment and Reimbursement may also be used as a disbursement method, if required.

22. **Accounting and Financial Reporting:** The project will provide quarterly unaudited financial reports (IUFR) within 45 days from the end of each quarter as per the reporting format acceptable to the Association.

23. **Capacity building through establishment of Accounting and Asset Management System and training:** The financial statements are prepared using spreadsheet while books of accounts are maintained manually. Manual book keeping and reporting inherently has several shortcomings including risks of errors and omissions. The accounting and Asset management software is one of the high priorities to the

Management of BPDB in order to keep records of all transactions and inventories and prepare an accurate and timely financial statement automatically. It was agreed that accounting and asset management system will be established under the project for whole BPDB. The management of BPDB agreed that a technical committee will be formed at HQ level to support the implementation of the system. Initially an assessment of the current system will be carried out by a consultant in order to design the desired software in consultation with BPDB 'technical team' and also the consultant shall prepare the technical specification of the system in order for tendering purposes. ToR of the consultant shall be prepared by BPDB and share the same with the Bank for its concurrence. Further, the consultancy service may be considered as "Prior review" contract from the banks perspective due to its technical importance.

24. A training needs assessment will be carried out by BPDB in order to identify accounting, finance and auditing staffs for necessary training which may include obtaining certifications at different level.

25. **Agreed FM Action Plan:**

SL	Actions	Responsibility	Timeline
1	Preparation of ToR for the "*Accounting System Consultant (ASC)*" firm and share the same with the Bank for its concurrence	BPDB/WB	November 30, 2015
2	Sharing the Evaluation Committee Report of ASC for the Bank's concurrence	BPDB	January 31, 2016
3	Completion of hiring process of Accounting System Consultant	BPDB	February 15, 2016
4	Deputation of Assistant Director-Accounts and 2-3 accounting staff	BPDB	February 28, 2016
5	Preparation and sending the ToR of FM consultant (FMC) to the Bank for its concurrence	BPDB/WB	November 30, 2015
6	Sharing the Evaluation Committee Report of FMC for the Bank's concurrence	BPDB	January 15, 2016
7	Completion of hiring process of FMC	BPDB	February 28, 2016
08	Procurement of off the shelf accounting software	BPDB	January 31, 2016
09	Establishment of Audit Committee	BPDB	March 31, 2016
10	Preparation of ToR of Internal Audit Firm and sharing the same with IDA	BPDB/WB	June 30, 2017
11	Sharing the Evaluation Committee Report of IA firm for the Bank's concurrence	BPDB	December 31, 2016
12	Submission of External Audit Report	BPDB	Annually, by December 31
13	Submission of Internal Audit Reports	BPDB	June 30, 2017 and June 30, 2019
14	Preparation and submission of IUFRs	BPDB	Quarterly
15	Submission of Withdrawal Applications	BPDB	Monthly

Environmental and Social (including safeguards)

26. The proposed Project is a repowering of 210MW gas-fired steam power unit to a ~400MW combined cycle power unit by installing one heat recovery steam generator (HRSG), one heavy duty gas turbine (GT) for indoor installation and retrofitting/refurbishing the existing steam turbine (ST). About 67.3 Million Standard Cubic Feet per Day (MMSCFD) Natural gas for the proposed gas turbine and supplementary firing will be supplied by Titas gas transmission and Distribution Company through the existing gas network and

the proposed Regulating Metering Station (RMS). Surface water from the Shitalakhya River will be used for condenser cooling and other purposes. A closed cycle cooling using cooling towers is being considered because of its beneficial impact on the environment. Generated Power of gas turbine will be evacuated through the proposed 230kV Gas Insulated System (GIS) switchyard and that of steam turbine will be evacuated through Bay no. 6 of the existing 230 kV Air Insulated System (AIS) switchyard.

27. Project activities include: (a) decommissioning of existing boiler; and (b) full Repowering of Unit #4. The main activities of decommission of boilers are dismantling of: Heavy oiler drum, Economizer, Water tubes, Steam pipes, Forced draft (FD), Induced draft (ID) & recirculating Fans, Chimney, Air ducts, etc., Insulation sheets and material, and demolishing of the foundations. On the other hand, main activities related to full repowering are: commissioning of Gas Turbine, construction of HRSG, rehabilitation of Steam Turbine, replacement work of existing old control system of Steam Turbine Generator (STG) and interfacing of control system, interfacing of control system of the combined cycle power plant, and commissioning of HRSG & STG.

28. **Applicable Environmental Category and Safeguard Policies.** The project is classified as a "Category A" project, due to the complexity of environmental issues associated with project activities involving major civil works by repowering and decommissioning of existing boilers. The project is located in a 40-year old industrial complex with seven power plants in operation, therefore natural habitats will not be impacted and no forestry issues are involved. All project activities will be carried out within the boundary of the industrial complex. Therefore, apart from the umbrella policy of "OP/BP 4.01: Environmental Assessment", no other environmental safeguard policies have been triggered for this project. As per OP 4.01, carrying out environmental assessment (EA) is the responsibility of the implementing agency (BPDB). In addition to the compliance of the World Bank safeguard policies, the project will also comply with all environmental legislation of the Government of Bangladesh particularly the provisions of Environmental Conservation Act (ECA) 1995 (and its amendments), and applicable Environmental Conservation Rules (ECR) 1997. The relevant Environmental, Health and Safety Guidelines 2007 and Environmental, Health, and Safety Guidelines for Thermal Power Plants, 2008 of the World Bank Group will also be applicable to the project. Moreover, since the scope of work will include handling of hazardous materials such as Asbestos during boiler decommissioning, World Bank Asbestos Guidance Notes (2009) and other international best practices for Asbestos handling will also be applicable.

29. **Approach to Address Environmental Safeguard Issues.** The proposed project will be financed by the World Bank and the Government of Bangladesh. The Environment Impact Assessment (EIA) of the project will require fulfilling the policies and legislative requirement of the World Bank and the Government. BPDB has prepared an EIA report with input from reputable international consultants. The EIA has been prepared based on: (i) reviewing the environmental and social policy requirement of the World Bank and the requirement of the national legislation; (ii) screening of Impacts and Prioritization; (iii) conducting expert Consultations with Scientific and Professional Community and focus group discussions in project area, public consultation with affected population, local government bodies, public representatives, NGOs and business communities (iv) Prediction of impacts/risks and preparation of mitigation/enhancement measures by field investigation, data analysis, and mathematical modeling, (v) assessing the implementation arrangement and capacity building needs for environmental management.

30. **Environment Impact.** The repowering project activities will have diversified impacts on the environment and socio-economy with various natures and magnitudes. Among the impacts from the proposed activities, some are temporary in nature and limited to pre-construction and construction period, and others are permanent in nature during the operation period. Based on the experience of other similar power generation projects, many of the environmental issues are mainstreamed in the project design (e.g., minimize NOx emission by using low NOx burner, lower the relative water requirement for condenser cooling and minimize thermal plume using closed-cycle cooling, decrease specific-relative fuel

requirement, etc.). Generation of hazardous waste (~50 tonnes of Asbestos containing material) during decommissioning of existing boiler, Inhalation of airborne asbestos fiber during boiler decommissioning activities, elevated noise level from the operation of heavy equipment, felling of trees during site preparation, and labor camp induced sanitation and social stress are the significant impacts of the construction works. Around 30 numbers of small wooden tree and bushes will be cut. However, the impact will be short-term in nature as those habitats are likely to be restored in course of time as a result of the proposed plantation program. Simulation of air quality parameters using emissions from the proposed and surrounding power plants show that the repowering project will have a beneficial impact of decreasing the NO_2 concentration in the ambient air (with marginal decreases of CO and particulate matter).

31. A cumulative impact assessment including all emission sources around the power plant within a 50kmx50 km grid showed that predicted maximum ground level concentrations of NO_2, $PM_{2.5}$ and PM_{10} exceed the Bangladesh standards and WHO guidelines. The high predicted NO_2 concentrations are due primarily to the Aggreko Power plant – which has stacks of insufficient height to adequately disperse emissions. The high $PM_{2.5}$ and PM_{10} concentrations are primarily caused by heavily congested roads and highways and occur far from the project site (28 km away). Due to repowering of unit-4, there will be significant reduction in emissions from the baseline for the Ghorashal power station. After repowering, the modeling result shows that NO_x, $PM_{2.5}$ and PM_{10} emissions from GPS Unit -4 will decrease by 810 tons/yr (13%), 113 tons/yr (41%) and 62 tons/yr (23%), respectively. Noise modeling showed that the operation of the power plant will alter the existing noise environment with several selected receptors experiencing noise in excess of the national standards. However, with appropriate mitigation measures (suggested in the EMP) the adverse effect of noise can be minimized/eliminated. Water quality prediction using a mixing zone model showed that due to repowering (i.e. conversion to a closed cycle cooling from an open-cycle cooling system) there will also be a reduction in the extent of thermal plume in Sitalakhya river that is currently being generated by the GPS units. Reduction in thermal plume in Shitalakhya River may facilitate in restoring habitats of fish species and generating habitat for others aquatic organisms along with benthic habitats. It is expected that due to repowering of Unit 4 there will be a major change in water requirements from Sitalakhya River for the plant. The current water requirement for the cooling water system for unit-4 is 7.6389 m^3/s which will be reduced to 0.38194 m^3/s as a result of conversion to a closed cycle cooling. Hydrazine, a toxic substance currently used for deoxygenation of water will be eliminated in the new plant.

32. The benefits of the repowering project was also assessed in terms of the reduction of greenhouse gases. It is estimated that 1,439,264 ton/yr of CO_2 emission generates from the baseline scenario (steam cycle) and 901,868 ton/y of CO_2 emission produced from the repowering case for the equal amount of power (412 MW), respectively. The net CO_2 emission benefit is estimated as 537,396 ton/y and a total of 13,434,904 ton in the entire project life (25 years). The overall positive impact of the project during operation is the augmentation of the generation capacity of the electricity and improving the socio-economic condition and lifestyle of the country's population.

33. **Environmental Management Plan:** Environmental Management Plan (EMP) has been prepared for different phases for the mitigation and monitoring of activities involved. The Environmental Management Plan (EMP) includes several plans for implementing mitigation and enhancement measures, emergency response, occupational health and safety, and Environmental Code of Practices. Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental Code of Practices (ECP), and Contractor's good practices during project implementation. On the other hand, impacts and risks which are critical or major will be mitigated or prevented by adopting certain mitigation measures discussed in the EMP. The contractors need to prepare site specific construction management plans to address various environmental issues and to demonstrate the manner in which the Contractor will comply with the requirements of ECPs and EMP. It will be reviewed and approved by BPDB before implementation of construction works. One of the major components of the proposed repowering is decommissioning of the existing boiler. Since Asbestos Containing Materials (ACM) are available in the insulation material of the

boiler and associated steam pipelines, the environmental safeguard including control of asbestos contamination has to be ensured. A detail Plan of boiler decommissioning, asbestos handling and safety operation has been prepared and provided in the Boiler Decommissioning Plan. The general principle on which the boiler decommissioning plan is based on is safe disposal of asbestos containing material and safety procedures while handling asbestos. An Emergency Response Plan (ERP) is prepared which outlines the framework of Emergency Response Strategy which will be followed by the contractor's, operation and maintenance staffs of BPDB during decommissioning, construction, and erection and operation and maintenance phases. A Risk Assessment and Management Plan has also been prepared to account for specific hazards during boiler decommissioning and natural gas leakage. Further to that, the winning Erection, Procurement and Commissioning (EPC) Contractor will submit a Boiler Decommissioning Action Plan based on terms and conditions provided in Volume 3: Boiler Decommissioning Plan and a Construction Environmental Action Plan based on the EIA and the offered plant and equipment, construction method and work schedule. The EAP will be approved by BPDB and the WB before the commencement of the work.

34. In order to make the Contractors fully aware of the implications of the EMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in the EIA as well as World Bank Group's General Environmental Health and Safety Guidelines. The Contractor must be made accountable through contract documents for the obligations regarding the environmental and social components of the project.

35. **Borrower's capacity on environmental safeguard.** The Project Management Unit (PMU) of Bangladesh Power Development Board (BPDB) will be in charge of implementing the Environmental Management Plan. Although BPDB has not implemented any recent project with the World Bank, it has undertaken projects funded by external development partners that require management of environmental issues. BPDB is fully aware about the Bank requirement of environmental and social assessment of the project. However, BPDB currently has only a rudimentary institutional capacity for environmental management. Presently, the Ghorashal Power Station has four circles which are Operation, Mechanical Maintenance, Electrical Maintenance and Civil. Currently there is no dedicated Environment, Health, and Safety (EHS) Circle to address environmental management and occupational health and safety issues. GPS has no staff with previous experience in implementing environmental management and monitoring plan. A proposal has been made to create an EHS and Utility Services (EHSUS) Circle headed by a manager and two deputy managers, one for environment and one for health and safety. One EHS consultant is also proposed under the manager of this circle to advise the circle on environmental, health, and safety issues.

36. Members of the EHSUS Circle responsible for supervision of environmental mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, participatory approach and occupational health and safety. The contractor will also be required to provide environmental and health and safety trainings to its staff, to ensure effective implementation of the EMP. Budgetary allocations have been made for training and capacity building of PMU and GPS staff.

37. In order to augment capacity of BPDB in the environmental management areas, the project will provide necessary Technical Assistance by financing an Owner's Engineer (implementation support consultant). PMU will recruit an Owner's Engineer for supervision of implementation of boiler decommissioning, supervision of EPC contractor involved in civil works, erection of turbine and HRSG, including supervision and implementation of EMP. The Owner's Engineer will consist of an environmental unit with 1 international specialist (part time, 50% during construction period) and 2 national environmental specialist (full time). Besides internal monitoring and evaluation by the PMU/BPDB for environmental management and monitoring, independent external monitors will be retained by BPDB, to undertake monitoring of all safeguard compliance and effects monitoring components.

38. **Grievance Redress:** A project level grievance redress committee (GRC) will be established for the project with the Manager of EHSU Circle as the convener and Ward Councilor as the member secretary. The other members of the Committee could be the representatives of the community, OE, contractors plus any other major stakeholder group. The claims and complaints will need to be brought to the attention of the Ward Councilor. They will then forward grievances to the higher levels of authorities as desired.

39. **Public Consultation:** Public consultation has been carried out adequately at the early stages of the EA process through informal discussions, focus group discussions and expert interviews. The local people stated that they have no objection about the proposed project and stated that it will bring immense benefit both for the local and national level by means of electricity generation. During the consultations, the affected people and the local communities expressed support for the Project as they saw the benefit to the community as well as in country. A follow on public consultation on the draft ESIA has also been organized in September 12, 2015.

40. **Disclosure.** The Final EIA document and Executive Summary with EMP in Bengali has been disclosed both in the BPDB website www.**bpdb**.gov.**bd** on July 23, 2015 and the Bank's Infoshop on July 24, 2015 for public comments. The hard copies of the above document have also been made available in BPDB offices fulfilling World Bank Disclosure requirements. The national workshop on EIA was held on September 12, 2015.

Monitoring & Evaluation

41. The monitoring of the project will be done in two phases. In first phase, the focus will be firmly on efficient and timely implementation of the physical infrastructure, with due regard, of course, for review, monitoring and quality assurance of design, engineering, supply and construction works. In the second phase, once the repowered plant comes into operation, there will be regular operational reports from GPS concerning the output and other key parameters of the plant operation. In addition, IDA will also monitor the progress of the implementation of SBU process and associated developments at GPS. Finally, GOB has been monitoring the performance of the public sector entities through a set of Key Performance Indicators (KPI) and GPS's operational performance is already being monitored by the Ministry.

42. The specific results indicators have been agreed with the implementing agency for this project and the progress according to the Results Framework and Monitoring table (Annex 1) will be part of the monitoring process. As described earlier, the results indicators of the project are: (i) Generation capacity constructed under the project measured by MW; (ii) Projected lifetime fuel savings measured in PJ; and (iii) Overall Efficiency of the unit measured in percentage (%). The BPDB MIS Report and the Project Progress Reports, to be provided on a quarterly basis, will include these result parameters. The monitoring and evaluation capacity of BPDB will be bolstered through the appointment of Owner's Engineer under the project. [12]

[12] The process of hiring Owners Engineer has already started to ensure that Owner's Engineer is on board by the time the EPC contractor mobilizes. Bank will also appoint an individual consultant to continuously monitor independently the progress of the EPC contract implementation.

Annex 4: Implementation Support Plan

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

Strategy and Approach for Implementation Support

1. The Implementation Support Plan (ISP) will include technical, fiduciary and environmental support to the client and this would be reviewed regularly and revised as and when required during the implementation. The implementation support will be provided through at least two implementation support missions in a year and through continuous exchange of correspondence and regular communication. The project's main activity i.e. EPC bidding is at advanced stage and the Bank has already provided significant technical support in preparing the bid documents for the work.

2. The project does not involve much procurement during implementation. The requirement will be for the consultancy services only. The support from the Bank would be to review procurement documents and provide timely no-objection. The support would also include providing detailed guidance on the Bank's Procurement Guidelines to the project staff/consultants, reviewing of contract management activities; and identifying the capacity building/training need for project staff and officials of power utilities/ departments on procurement processing and providing training if required.

3. Implementation Support will review the project's financial management system, including but not limited to, accounting, reporting, and internal controls. The Bank safeguards specialists in the team will supervise various activities to ensure full compliance with the Bank's operational policies / procedures related to environment and social safeguards aspects.

Implementation Support Plan

4. Members of the implementation support team will be based in the Dhaka country office, including Task Team Leader, technical, procurement, financial management, and safeguards specialists, which would facilitate timely, efficient, and effective implementation support to the client. A Mid Term Review (MTR) would be conducted once the project is around half way in project implementation/loan tenure to review the progress and assess the need for any mid-course correction.

5. The main focus of implementation support is summarized below:

Time	Focus	Skills Needed	Resource Estimate	Partner Role
Start-72 months	Implementation of Investment Component A	Task Team Leader Technical Specialist Procurement Specialist Environment Specialist Financial Management Specialist Social Development Specialist	50 SW 30 SW 20 SW 10 SW 10 SW 5 SW	
	Implementation of Institutional Strengthening Component B	Task Team Leader	15 SW	
	Fiduciary and Safeguards		10 SW	

Annex 5: Economic Analysis

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

1. This section presents an economic evaluation of the proposed repowering option for Ghorashal Unit 4, considering its cost effectiveness vis-à-vis the relevant alternatives, including a completely new project at existing site (referred as new built option in this analysis) and comparing the discounted costs and benefits to arrive at the Net Present Value (NPV) and Economic Rate of Return (ERR)[13]. The economic evaluation also presents a sensitivity analysis for key variables and a worst case scenario.

2. Although generation capacity in Bangladesh has doubled from about 6 giga-watt (GW) to over 12 GW in just five years since 2010, the sector continues to experience major peak and energy shortages. Power Sector Master Plan-2010 (PSMP) projects peak demand to reach 17GW by 2020 and to over 33 GW by 2030. In addition to acute peak shortages, Bangladesh's power system also suffers from inadequate fuel supply to support base load generation. The repowering of Unit 4 would lead to improved energy efficiency as well as more electricity being generated due to increased capacity and higher plant load factor. The project will also extend the life of the existing unit. The analysis shows that, under the current circumstances, repowering is the best option to mitigate the power and energy shortfall in the shortest possible time-frame. It is the least cost option and gives high economic returns.

3. The proposed project would repower 210 MW gas-fired steam (single cycle) Unit 4 (currently generating 170 MW due to deration) at Ghorashal Power Station (GPS) by adding one gas turbine and generator (GTG) and a heat recovery steam generator (HRSG) to produce steam for the existing steam turbine (ST) unit, for an upgraded combined cycle total capacity of about 400MW.

Other Associated Infrastructure

4. **Transmission Infrastructure.** There is currently spare transmission capacity available at the site to handle the increased transmission demands of proposed project investments, as none of the existing units at Ghorashal are operating at their full capacity because of the lower load factor and deration of the existing units. To cope with long term needs (i.e., when all 4 units at GPS are expected to be repowered), Power Grid Company Bangladesh (PGCB) has started the process of hiring a developer to construct a new 230kV GIS substation and transmission line to meet the additional transmission requirements. Financing for GIS substation has already been committed by Asian Development Bank. Transmission cost that can be assigned to GPS Unit 4 would be significantly less than alternative green-field projects at another location and therefore cost and benefit analysis at generation level gives a conservative estimate.

5. **Gas Infrastructure.** The relevant alternatives to the proposed repowering option fall into four categories: (i) no project option; (ii) re-powering projects other than Unit 4; (iii) Options for Unit 4 - full repowering, hybrid, mini hybrid, or new built; and (iv) alternative generation options (coal, oil, gas, nuclear).

6. **No Project Option (counterfactual or do nothing scenario).** The 'no project' alternative can be dismissed as being un-realistic, because Bangladesh will in fact continue to build additional generation plants for the grid to meet its growing electricity demand and to eliminate its current power shortages. Indeed until such time as power shortages are completely eliminated and demand fully met, the incremental

[13] The economic analysis rests largely on detailed project report (September 2012) and Residual Life Assessment report (June 2015) prepared by the consultants (M/s KEMA International B.V., The Netherlands, in association with M/s Altlanta Enterprise Limited, Bangladesh) for the Ministry of Power, Energy & Mineral Resources, Government of Bangladesh.

generation from the project would primarily serve to reduce these shortages – the benefits of which are largely the same as that of the no-project counterfactual i.e. substituting grid electricity for diesel self-generation and kerosene for lighting.

7. **Repowering projects other than Unit 4.** Several repowering/conversion projects (about 640 MW) have been identified including replacement of Sylhet 150 MW, Shahjibazar 70 MW and Baghabari 100 MW with combined cycle plants but their preparation is not as advanced as Ghorashal Unit 3 and 4. The financing of Unit 3 which is currently under consideration by MIGA guarantees, and of Unit 4 by IDA financing, will pave the way to replicate the potential for repowering other simple cycle gas-based generation capacity in a sequenced manner, thus minimizing disruption to the existing power being supplied from these Units.

8. **Options for Unit 4.** The full repowering is the end result of a comprehensive analysis of all the alternatives including full repowering, hybrid, mini hybrid[14] and new built combined cycle plant at the existing location. Hybrid options will have much lower efficiencies of 41-43% compared to 54% for full repowering. Also, capital cost per additional MW output for the hybrid and mini hybrid is more than full-repowering. Therefore, among the repowering options, full repowering of Unit 4 has the lowest levelized cost. Furthermore, another advantage of full repowering is the maximum possible capacity addition of the existing unit compared to other hybrid and mini hybrid options that will maximize its net present value. As shown in Table 1, among the options for Unit 4, full repowering entails the lowest levelized cost due to highest efficiency and lowest per MW cost. Its NPV is also highest because maximum generation is possible at the lowest cost. On the other hand, with respect to new built (CCGT at existing location) the ranking of the Full Repowering option, would depend on number of other factors and parameters including discount rate, cost of gas and the disruption to power generation during construction for new built option. All of these factors have been evaluated further, in detail in this Annex.

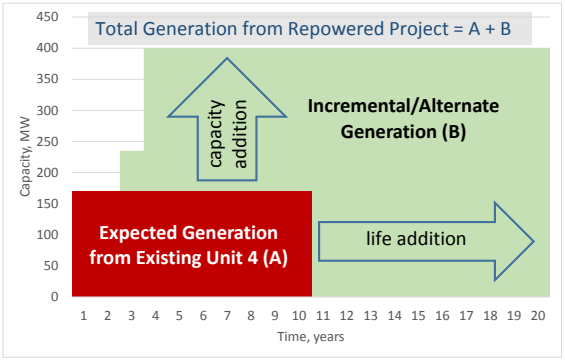
Table1: NPV for Hybrid Vs. Full Repowering Option

			Existing Unit	Hybrid	Mini	Full Repowering
Assumptions	Plant Output	MW	170	266	291	404
	Plant Factor	%	70%	85%	85%	85%
	Efficiency	%	30%	43%	41%	54%
	Expected Life	years	10	20	20	20
	Expected Generation	GWh	1,042	1,981	2,167	3,008
	Investment Cost (2012 Design Report)	$ million	-	145	141	264
	Cost of Fuel	$/mmbtu	6.00	6.00	6.00	6.00
Calculations	Capacity Payment	US¢/kWh	-	0.98	0.87	1.17
	O&M Payment (Assuming no variation)	"	0.20	0.20	0.20	0.20
	Energy Payment	"	6.82	4.76	4.99	3.79
	Total Levelized Cost	"	7.02	5.94	6.06	5.17
	Estimated Net Present Value at USc 10/kWh	US$ Mln.	$191	$684	$726	$1,238
	Estimated Net Present Value at USc 6/kWh	"	($66)	$10	($12)	$214

[14] For hybrid repowering the original boiler and steam cycle remain in operation and a new gas turbine with HRSG is to be installed. For full repowering the existing boiler will also be replaced. In case of mini hybrid, the condensate flow is to be preheated additionally by bleed steam from the steam turbine.

9. **Alternative Generation Options.** Among the next best alternative generation options to the proposed project at Ghorashal (either repowering or a new built) is a base-load green-field CCGT plant at a new location. In addition, new generation using coal-based steam turbine ST-USC, is another option that despite having relatively longer construction period is also considered as one of the alternatives. In this category, the economic benefits of repowering or new built option are derived from the avoided cost of generation from existing Unit 4 assuming that (in the absence of the project) Unit 4 will continue to supply power for at least 10 years[15] and incremental generation to be met through selected alternatives – CCGT (at a new location) or ST-USC. This methodology is elaborated in Figure 1 where total generation from repowered or new-built option is equal to the sum of shaded areas representing generation from existing Unit 'A' and next best alternative 'B'.

Figure 1: Capacity and Life Addition



10. For no project alternative, the economic returns are dependent upon the avoided cost of self-generation assumed to be Gas Engine (GE) running on diesel. The economic analysis measures the benefits based on avoided capacity and energy cost converted to levelized cost per unit. Key assumptions are described below.

Project Costs & Key Assumptions

11. Total cost of the proposed full repowering project (Unit 4) is estimated to be US$ 270 million, including physical (2% of base cost) and price contingencies (weighted average assuming 2% dollar inflation per annum), taxes/duties (15% of base cost) and interest during construction (equal to 0.75% service charge on IDA credit disbursed at the rate of 20, 50 and 30 percent in year 1, 2 and 3 respectively). The economic cost after subtracting price contingencies, taxes and IDC is about US$ 225 million[16].

12. **Capital and O&M Cost.** Key inputs (project life, cost, efficiency, etc.) to estimate cost of generation for ST-USC, CCGT and GE are taken from the PSMP-2010. Investment costs have been adjusted to 2015 as base year assuming 2% dollar inflation rate per annum. Key inputs for repowering and new built at existing location of Unit 4 are based on the design report and residual life assessment study (RLA). Levelized costs are calculated at 12% discount rate over plants' respective lives[17]. A plant factor of 85% is assumed except for gas engine which has a lower plant factor of 20% to cover only the period of outages for self-generation. The cost assumptions are summarized in Table 2.

Table 2: Cost Assumptions for Various Generation Sources (Base Case)

		Greenfield Project				**Project at Existing Location of Unit 4**		
		ST USC	CCGT Dual Fired		GE	Existing	Repowering	New built
Fuel		*Coal*	*Fuel Oil*	*Gas*	*HSD*	*Gas*	*Gas*	*Gas*
Investment	US$/kW	1,731	1,060	1,060	649	Nil	561	816
Project Life	Years	30	25	25	15	10	20	25
Plant Factor		85%	85%	85%	20%	67%	85%	85%
Efficiency		45%	55%	59%	34%	30%	54%	59%

[15] Unit 4 will continue to operate till there is surplus capacity or is retired for technical reasons. Therefore, Unit 4 is expected to remain in operation for at least 10 years.

[16] This number has been used for the economic analysis; although the IDA amount requested for Board approval for this component is lower (US$210 mill) based on the higher offer received through actual bid submission.

[17] A 12% real discount rate is consistent with government policy and BPDB practice to evaluate power projects. Same discount rate has been assumed for appraisal of other Bank financed energy sector projects in Bangladesh e.g. Siddhirganj Peaking Power Project (2008) and Rural Electrification Transmission and Distribution Project (2014).

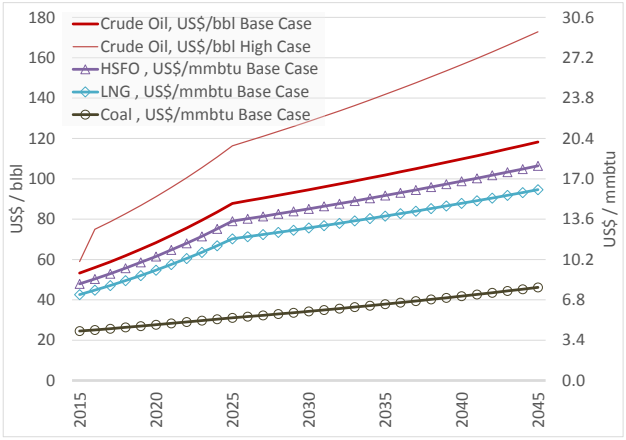
Fixed O&M	$/kW/yr	59	29	29	18	29	29	29
Variable O&M	US¢/kWh	0.33	0.17	0.17	0.19	0.25	0.17	0.17

13. **Conservative Assumptions:** Even though the green-field projects (ST-USC and CCGT) at new locations would have longer gestation period because of land availability, site preparation and infrastructure development issues, for a conservative estimate it is assumed to be made available within the same time frame. Furthermore, additional infrastructure costs associated with green-field project (for supply of fuel and connection to the grid, etc.) have been ignored.

14. Limited availability of suitable sites for the green-field projects are expected to pose significant challenges, delays and higher costs. Therefore, a project at an existing location (either repowering or new built) because of available infrastructure and quick implementation is expected to have higher economic returns compared to a green-field project at a new location using same technology.

15. **Fuel Prices.** Fuel price is an important consideration for the choice between full repowering and new built at existing location – higher fuel input price will favor new built because of its higher efficiency. Price of liquid fuels and LNG can be directly linked to international crude oil prices. World Bank Commodity Price Forecast of April 2015 (adjusted to 2014 cost) shows average crude oil price (of Brent, WTI and Dubai Crude in real terms) to increase from US$ 53/bbl in 2015 to US$ 88/bbl by 2025 at annual average increase of 5%. For the base case scenario, it is assumed that after 2025 real crude oil prices will increase at 1.5% per annum. The US Energy Information Administration Short-term outlook (March 2015) predicts higher crude oil price for Brent – US$59/bbl and US$75/bbl in 2015 and 2016 respectively. These values have been assumed for the high price scenario and projected to increase at 5% till 2025 and at 2% thereafter. Fuel prices in Bangladesh are not marked to market e.g. retail price for HSD is Tk 68/liter (~$23/mmbtu) since 2013 and Fuel Oil is at Tk 60/liter (US$20-21/mmbtu) since 2011. This means that government either provides net subsidies when actual cost is high or imposes taxes/higher return when costs are low. These prices are quite high compared to current crude oil price of US$ 60/bbl (~US$ 10/mmbtu). For economic analysis, price of fuel oil and diesel delivered at plant and/or to consumer for self-generation is assumed to be 90% and 120% of crude oil price in energy terms respectively. Current price of gas for power at Taka 79.82 per Mcf (equivalent to US$ 1.08/mmbtu) is below its economic value or opportunity cost. Therefore, relevant economic gas price could be the price of imported LNG (for short- to medium-term) and price offered for new on- and off-shore discoveries (for medium- to long-term). In the absence of actual reference data or price formula the LNG is also assumed to be linked to crude oil prices and, at 80% parity, would be cheaper than Fuel Oil. The delivered price of gas from new on- and off-shore discoveries are expected to be in the range of US$ 5 – 8 per mmbtu (net of taxes, royalties and other charges). At crude oil price of US$ 60/bbl this is about 50-78 percent of crude oil price. Therefore, (economic) gas price at 80% parity to crude oil price is on the higher side and therefore, used as a conservative estimate to evaluate repowering vs. new built at existing location. Coal prices delivered at plant are assumed to be 1.5 times Australian FOB Coal price forecast given in WB commodity prices April 2015 – projected to increase at 2% from US$ 62/mt in 2015. Based on these assumptions price of coal delivered at plant gate is less than half of imported natural gas. Fuel price forecasts are given in Figure 2.

Figure 2: Fuel Prices Forecast



16. **Incremental Benefits.** The relevant measure of incremental benefits is the willingness to pay (WTP). The estimated cost for diesel generation assumed for non-grid electricity or self-generation can be used as

a proxy for WTP. This cost would not be applied to the total generation but to the electricity sold at the consumer level i.e. net of transmission and distribution losses assumed to be 12% based on actual performance. Furthermore T&D cost of US¢ 0.51/kWh has been added to estimate total cost of supply for comparison with cost of self-generation. Based on the given assumptions including diesel price at 120% of crude oil, cost of diesel self-generation starts at about US¢ 14/kWh and increases at the rate of 1-3% to reach about US¢ 22/kWh towards the end of the project life. At current price of diesel, the cost of generation is estimated to be around US¢ 30/kWh. Therefore, incremental benefits measured at WTP between US¢ 14-22 per kWh are on the conservative side.

17. **Accounting for GHG Emissions.** The direct emissions from combustion of fossil fuels are the most relevant for thermal power generation projects[18]. Default emission factors (TCO_2 per TeraJoule) for various fuels are taken from Intergovernmental Panel on Climate Change (IPCC) guidelines 2006. These emission factors were converted into per kWh on the basis of plant efficiencies. Social Cost of Carbon is according to the World Bank guidelines (2014), with base case starting at US$30 per metric tonne in 2015 and increasing to US$80 per metric tonne in real terms by 2050. The low, base and high scenarios are presented in Table 3.

Table 3: Social value of carbon, US$ per metric tonne of CO_2

	2015	*2020*	*2030*	*2040*	*2050*
Low	15	20	30	40	50
Base	30	35	50	65	80
High	50	60	90	120	150

18. In the absence of this project the same quantity of electricity will be generated using a combination of (a) existing inefficient unit (without rehabilitation) over its remaining expected life of 10 years and (b) balance is assumed (as a conservative case) to be supplied through a new green-field gas CCGT which, because of higher efficiency and same fuel, will have lower per unit emissions than the repowered unit. Since the project is displacing inefficient generation from the existing unit with very low efficiency of 30% it would result in net reduction of 0.3 million tons of CO_2 over its 20 years life. Net emissions calculation is given in Table 4.

Table 4: Generation Emissions, tons of CO_2

	Baseline	Project	Net
Upstream	0	0	0
Generation (Combustion)	Existing (for 9,933GWh): 6,686,594 New Plant (for 53,083GWh): 18,169,787	24,544,444	(311,937)
Downstream	0	0	0
Total Emissions	(for 63,016GWh) 24,856,381	24,544,444	(311,937)

19. Reduction in GHG emissions in the case of non-project counter-factual (GE with diesel) are estimated to be about 19 million tons of CO_2. The reduction is much higher than in the gas CCGT alternative because: (i) self-generation is based on liquid fuels which have higher carbon emissions per unit of heat value; and (ii) the efficiency of self-generation is lower than in a highly efficient CCGT. The emission factor for small

[18] The magnitude of upstream and downstream emissions is expected to be relatively small, and would be about the same as baseline. Net impact is likely to be insignificant and therefore upstream and downstream emissions have not been calculated.

diesel self-generation units is 785gm/kWh as opposed to 342gm/kWh for gas CCGT using default emission factors for combustion (diesel: 74.1 t CO_2 per terajoule and gas: 56.1 tCO_2 per terajoule) and efficiency of 34% for diesel Gas Engine and 59% for gas CCGT.

20. Based on the above assumptions, the costs of generation excluding and including emissions are compared in Figure 3 and 4 respectively. At current prices, CCGT- LNG is the least cost option. In future, economic price of gas is expected to increase at a higher rate (due to its linkage to crude oil prices) compared to steady increase in price of coal which makes ST-USC the cheapest option without accounting for cost of emissions. If emission costs are added CCGT-LNG would have the lowest cost throughout the projection period. Therefore, non-incremental benefits of the repowering project are calculated based on CCGT-LNG as well as ST-USC (Coal) as alternatives to help assess project sensitivities.

Figure 3: Excluding Cost of Emissions

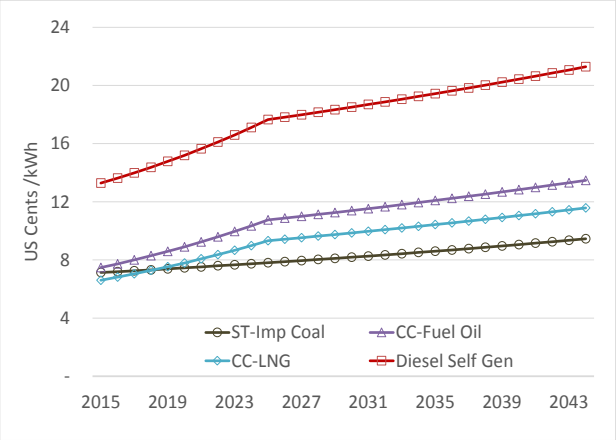
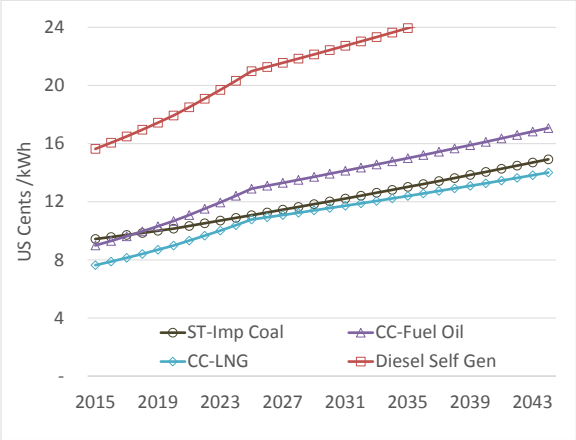


Figure 4: Including Cost of Emissions



Project's Cost Effectiveness

21. The purpose of this section is to analyze whether repowering of Unit 4 is the least cost option for Bangladesh when compared against other alternatives including a new built option at existing site. Table 5 compares ERR and NPV of the two options against green-field CCGT-LNG (with and without environmental benefits) and ST-USC (coal) with environmental benefits for the base case and by changing the key underlying assumptions. Base case scenarios for full repowering and new built option for Unit 4 against green-field CCGT-LNG are presented in Tables 9 and 10 respectively at the end of this section.

22. **Repowering Vs. New Built CCGT at same location:** The efficiency of a new built CCGT at same location (59%) is more than the full repowering (54%) but on the other hand its cost per MW (US$ 816/kW) is about 45% higher than full repowering (US$ 561/kW). Therefore, advantage of the repowering option is its low capital cost whereas new built will have lower operating/fuel cost because of higher efficiency. Also, project life of the repowered unit (20 years) is assumed to be 5 years less than new built. As benefits of the new built will accrue during its operating or later years, a lower price of gas and higher discount rate will favor full-repowering option and vice versa. The differential increases in favor of full repowering as discount rate increases or cost of gas decreases. The choice between repowering over new built is driven by an important fact that there would be the loss of power from adjacent Units during the construction phase if a new built option is adopted. This issue is further discussed in point 'c' below. Key factors affecting the decision between repowering and new built, even with assumptions on the conservative side, are briefly discussed below.

a. Consistent with the government/BPDB policy and other World Bank financed energy sector projects a traditional discount rate of 12% is selected for the base case. A lower discount rate would benefit the new built option and therefore, to be on the conservative side, a discount rate of 10% is used for sensitivity analysis (Table 5, Column 'a').

b. Economic price of gas is assumed to be price of re-gasified imported LNG which is expected to be cheaper than fuel oil generally valued at 80-90% of crude oil price. Base case economic price of gas is assumed to be 80% parity to crude oil. A higher gas price will benefit the new built option and therefore, to be on the conservative side, for sensitivity analysis gas price has been increased to 90% parity with crude oil price (Table 5, Column 'b').

c. From the RLA report it is evident that for new built option the adjacent Units will not be producing electricity during one year of construction period. The freed gas, however, cannot be diverted to other plants or captive use because of physical and contractual limitation. Therefore, under the new built option electricity supply is likely to be reduced by 1,700 GWh for one year, resulting in outages and an unmet demand. Cost of unmet demand could be in the range of what consumers are currently paying for the electricity (e.g. US¢ 9-10/kWh for industrial consumers) and their willingness to pay. Current consumer tariffs are highly subsidized and are also based on subsidized gas prices. Whereas, cost of diesel generation incurred by many consumers in case of outages can be used as a proxy for willingness to pay. At current cost of diesel in Bangladesh (Tk 68/liter or US$ 23/mmbtu, the variable cost of generation including fuel cost is about US¢ 24.6/kWh and levelized capacity charge is about US¢ 6.9/kWh for a total cost of US¢ 31.5, rounded down to US¢ 30/kWh[19]. If one excludes the capacity cost (assuming that to be a sunk cost) then fuel and operating cost of self-generation is about US¢ 25/kWh taken for sensitivity analysis (Table 5, Column 'c'). On the other hand, there will be savings due to avoided cost of electricity supply estimated to be about USc 11.71/kWh including fuel, operation & maintenance and transmission & distribution.

d. A new built plant is perceived to have longer life and better reliability/availability. In present value terms, the later years (15 and beyond) would have minimal impact on ERR and NPV and therefore further reducing the life of the repowered unit from 20 to 15 years or increasing the life of the new built from 25 to 35 years would reduce the ERR and NPV only marginally (Table 5, Column 'd').

e. The base case assumes similar reliability/availability over the expected lives of the two options. This can be assured by a guarantee from the EPC contractor and thereby risk of reduced reliability and availability for a repowered project can be mitigated to a large extent. For the purpose of analysis, this risk can be analyzed by being on the conservative side, by lowering the plant load factor for repowered unit from 85% to 75% while keeping the new built option at the same level (Table 5, Column 'e').

23. Assuming all factors in sensitivity analyses, in favor of new built option: discount rate: 10%; Cost of LNG: 90% parity to crude oil price; WTP: 25 US¢/kWh; reduced plant load factor for repowering and increasing the life of the new built by 10 years (Table 5, Column 'f')- the calculated NPV and ERR for the repowering option (US$ 138 million, ERR: 22%) would still be higher than the new-built option (US$ 80 million, ERR 12%) when evaluated against CCGT -LNG. Repowering has higher emissions cost compared to new built option because of the difference in the efficiencies but this does not change the ranking as NPV of repowering option (US$ 157 million) is still more than new built option (US$ 122 million) when avoided emissions costs are considered. Also, when evaluated against ST-USC option (including avoided emissions cost) repowering again has higher NPV and ERR. Therefore, repowering project should be selected as it gives higher NPV compared to new built option under varying assumptions.

[19] For comparison, in PSMP 2006 cost of energy not served was assumed to be US¢ 43/kWh when diesel prices were at US¢ 0.50/liter. Since then diesel prices have increased to US¢ 0.87/liter and therefore US¢ 30/kWh as cost of energy not served seems reasonable.

24. New Built could have been a better option if it does not cause any disruption to power generation during the construction period (of one year) from adjacent Units at GPS, estimated to cost US$ 254 million in present value terms based on the difference between cost of supply (US¢ 11.71/kWh[20]) and willingness-to-pay (US¢ 30/kWh).

Table 5: New Built Vs. Repowering - NPV (US$ million) and ERR (%) Under Various Scenarios

	Base Case		(a) Discount Rate = 10%		(b) Cost of gas = 90% parity to crude oil price		(c) WTP = US¢25/kWh		(d) New Built Life = 35 years		(e) Repowered Unit Plant Factor = 75% (Year 4 onwards)		(f) All scenarios combined	
Against CCGT excluding Environmental Benefits														
Repowering	147	24%	156	22%	157	25%	147	24%	147	24%	118	22%	138	22%
New Built	-78	10%	-56	9%	-39	11%	-8	12%	-65	10%	-78	10%	80	12%
Against CCGT including Environmental Benefits														
Repowering	163	26%	172	24%	173	27%	163	26%	163	26%	136	24%	157	24%
New Built	-41	11%	-13	10%	-1	12%	29	13%	-28	11%	-41	11%	122	14%
Against ST-USC including Environmental Benefits														
Repowering	258	33%	254	30%	160	29%	258	33%	258	33%	218	31%	112	23%
New Built	61	14%	76	12%	-16	11%	130	16%	81	14%	61	14%	61	12%

25. **Repowering Project with respect to other Alternatives.** As summarized in Table 6, base case economic rate of return for full-repowering option exceeds the 12% hurdle rate against selected alternatives. When evaluated against ST USC (coal), all benefits are due to avoided emissions. In case of CCGT-LNG (after including environmental benefits) net present value of the benefits increases by only 11% from US$ 147 million to US$ 163 million. When assessed against no project alternative (diesel based self-generation), the economic returns of repowering are even more significantly higher – ERR 62%, NPV US$ 1,037 million plus US$ 214 for environmental benefits. Therefore, the Repowering option is a least cost solution to meet the generation requirement particularly in a deficit scenario.

Table 6: Summary of Economic Returns against selected alternatives for (Base Case)

	ST - Imported Coal	CCGT – LNG	Self-Generation – HSD
Excluding Environmental Benefits			
NPV, US$ million	0	147	1,037
IRR, %	12%	24%	62%
Including Environmental Benefits			
NPV, US$ million	258	163	1,251
IRR, %	33%	26%	69%

Project's Viability

26. This section analyzes the risk factors that could adversely affect project's ERR to show whether project remains viable with respect to changes in the underlying assumptions and other factors. These are:

27. **Construction cost overruns.** The risk of cost overrun for a repowering project is expected to be minimal. Furthermore, most of the reasons for cost overruns would be same as for other alternative thermal options and therefore relative benefit of the project are expected to remain the same. The switching value

[20] US¢ 11.71 is the estimated cost of generation at economic price of gas adjusted for T&D losses plus T&D cost.

(i.e. the value at which the ERR falls to the hurdle rate of 12%) excluding environmental benefits is $411 million in case of CCGT-LNG (about 1.8 times the baseline economic cost of $224 million) and US$551 (almost 2.5 times increase) in case of ST-USC with environmental benefits. Cost overruns of this magnitude with respect to other thermal alternatives must be considered extremely unlikely. In all eventualities, project returns are expected to remain robust particularly when environmental benefits of the project are also added.

28. **Construction/Operational delays.** Related to construction cost overruns are the risks of construction delays. Depending on the nature of the delay, these may be highly correlated. And if these delays occur after a significant portion of the investment cost has been spent, economic returns will also fall. On the other hand, where these delays occur at the beginning of the project, before significant expenditure is incurred, the effect on the project ERR is minimal. Assuming that the bulk of the construction expenditure has been incurred, but operation is prevented (e.g., due to gas supply issue or transmission constraints) making capital investment stand idle, with no economic benefits realized, the switching value under such a worst case scenario is 6 and 8 years for with and without environmental benefits respectively when valued using CCGT-LNG and 8 years for ST-coal with environmental benefits. This much delay in commercial operation date (after all investment has been incurred) seems extremely unlikely because this gives ample time to resolve any associated technical, commercial or operational issues. However, as mentioned earlier the main benefit against ST are the avoided emission cost and including those benefits a delay of 7 years to commence operation after major equipment and installation costs have been incurred would reduce ERR to 12%. Any foreseeable delay in start of generation after project has been completed, therefore, would not make the project unviable.

29. **Remaining life of the existing unit.** The main reason why economic returns are robust with respect to cost overrun and construction delay is the high avoided cost of generation from the existing unit. Despite higher cost Unit 4 will continue to operate in its current state till there is surplus capacity in the system or is retired for technical reasons. In economic terms also, it makes sense to operate the plant as cost of energy not served (estimated around US¢ 0.30/kWh) far exceeds Unit 4 cost of generation. Even in an unconstrained scenario, with respect to supply of fuel and availability of finances, moving from current deficit to a surplus situation would take at least 5 years. For sensitivity analysis, therefore, remaining useful life of the existing unit has been reduced to 5 years. As a result, ERR (with and without environmental benefits) falls to 17% against LNG-CCGT and to 26% against ST-USC (with environmental benefits)[21].

30. **World Oil Prices.** Change in price of crude oil will not change relative benefits of the project with respect to new CCGT or Diesel self-generation. However, if the crude oil price increases (high price scenario) while coal prices follow the same trend, generation from ST-coal would become much cheaper than the gas based plants including repowered unit giving net economic loss of US$ 275 million, loss reduces to US$ 17 million when emission costs are added. The main benefit of the project is realized by displacing generation from the existing inefficient unit. The ERR of the project (including emissions cost) by year 10 is 21% due to avoided generation cost of the existing unit and then starts to decline when evaluated exclusively against ST-coal which at higher crude price scenario becomes a much cheaper option. The ERR can be maintained during these first 7 years of full operation because it is also displacing electricity from an inefficient existing unit also valued at higher crude (and thus gas) price. The returns decline after year 10 because after year 10 costs are compared against coal based generation only which is much cheaper compared to high crude oil price scenario. At crude oil price of US$ 115/bbl the ERR in year 10 falls to the hurdle rate of 12%. Therefore, if the crude oil price increases at a higher rate than anticipated and coal prices remain stable as forecasted economic returns of the project would diminish drastically. However, it is unprecedented that crude oil prices will immediately increase to US$ 115/bbl. Secondly, by the time it happens project would have recovered its economic cost. It is also unlikely that high crude oil prices will not have any influence on prices of substitute fuels including coal. Therefore, it is reasonable to

[21] Zero remaining life of the existing unit would imply a complete new built project.

conclude that economic returns of the project are secured with respect to change in oil prices.

31. **Willingness to pay**. The economic returns against the no project alternative are dependent upon the avoided costs of self-generation assumed to be single cycle gas engines running on HSD. This analysis assumes both HSD and natural gas prices to be linked to crude oil price at 120% and 80% parity respectively. The economic return of the project will decline as the gap narrows. Even if HSD price is equal to 80% of crude oil price in energy units (that is same as gas price) the ERR (without environmental benefits) would fall from 81% to 62% but is still above the hurdle rate of 12%. Historically gas prices have remained below that of liquid fuels and therefore with respect to willingness to pay the returns of the project are robust. Hurdle rate of 12% is reached at WTP equal to US¢ 9.5/kWh which is significantly below the price paid by even many industrial and other consumers.

32. **Cost of Carbon.** Main benefits of the project are derived from avoided emissions from coal for ST-USC as alternate. Assuming a low path for social cost of carbon, ERR with environmental benefits reduces from 33% to 27%. As ERR of the project without environmental benefits is about 12% reducing the social cost of carbon to zero would not make the project unviable.

33. **Downtime.** The repowering project is expected to have minimum possible disruption to generation from existing unit during the construction phase. The increase in downtime during construction will tend to increase the outages the cost of which should be evaluated at cost to the economy of energy not served assumed to be US¢ 30/kWh (as described above) adjusted for avoided cost of supply estimated around 11.71 US¢/kWh. Extended downtime will reduce the plant load factor. Therefore, reducing the plant factor for Year 2 by half will reduce the ERR of the project from 24% to 16% (CCGT without emissions) and from 26% to 18% (with emissions). In case there is no generation in year 2 ERR would fall to 11% (without emissions) and to 12% (with emissions). If plant factor for both year 2 and 3 is halved than ERR would decline to 17% and 19% with and without emissions respectively. The results show that the returns are very sensitive to extended downtime.

34. **Gas Availability.** If gas availability becomes an issue it will be common to new built, CCGT-LNG as well as the repowering project. Therefore, the sensitivity is done against ST-Coal. Presently about 33mcfd gas (standardized at 949 btu/scf) is being supplied to the existing unit. Repowering will increase the gas requirement to 54 mmcfd. Assuming that gas supply does not increase from the current level of 33 mmcfd, the ERR of the project would decline from 33% to 24% including cost of emissions. The switching value for gas supply is 14 mmcfd implying that even if gas supply is reduced to less than half of the current volume the project would remain viable.

35. **Risk assessment.** The switching value analysis by changing one variable at a time shows that the project is robust to the major risk factors, and to the main input assumptions. This however provides no insight about the outcome of the project when more than one input assumption combines unfavorably. For the risk assessment, plausible worst case scenario is constructed that combine unfavorable outcomes across the range of variables identified above– 10% cost overrun associated with one year delay in operation and 25% additional downtime in year 2 and gas supply reduced to 80% of the requirement affecting the plant factor. Results of risk assessment show the economic returns against green-field CCGT would remain above the hurdle rate (IRR is 13% and 15% with and without environmental benefits) by combining plausible unfavorable outcomes.

Project's financial analysis

36. The project's financial impact on consumers, BPDB and sector is analyzed by estimating its levelized cost. The levelized tariff is based on the following set of assumption and is subject to change depending upon these parameters.

a. Though IDA credit is available to BD on concessional terms for this project, Weighted Average Cost of Capital assuming 75% debt at commercial rate of 6% and 25% equity at 10% cost of equity is estimated to be around 7% (nominal terms). The real discount rate net of 2% annual inflation would be 5%.

b. The current price of gas (Taka 79.82/Mcf or ~US$ 1.08/mmbtu) is taken for the base year and is increased at the rate of inflation.

37. Based on the above assumptions the levelized cost of generation (ignoring capacity charge) from the existing unit 4 is about US¢ 2.18/kwh in nominal terms (US¢ 1.98/kWh in real terms). The levelized cost of the repowered project is about US¢ 2.51/kWh in nominal terms (US¢ 2.04/kWh in real terms). The levelized cost for repowered unit appears more because of two reasons – (i) capacity charge for existing unit (if any) has been ignored; (ii) gas is valued at a much lower cost. For comparison if gas is valued at US$ 6/mmbtu (as shown in Table 7) the levelized cost of generation of repowered unit would be about 30% less than the cost of the existing unit. The gas price is kept at the current level to estimate the financial impact of the project on overall power sector.

38. The weighted average cost of gross generation in Bangladesh in FY15 was about Taka 6.34/kWh (or US¢ 8.15/kWh). Therefore, the project is expected to not only increase the supply but would reduce the average cost of generation. Assuming that the cost and supply structure remains the same as of FY15 at commissioning repowering project will add 4% to supply and will reduce the power sector's financial deficit by 7% per annum on average over its life. The figures are given in Table 8.

Table 7: Levelized Cost Comparison (Real Terms)

	Current Gas Prices (US$ 1.08/MMbtu)		Gas Price = US$ 6/mmbtu	
	Existing Unit	Repowered Unit	Existing Unit	Repowered Unit
Capacity Charge	-	0.66	-	0.66
Fixed O&M	0.50	0.40	0.50	0.40
Variable O&M	0.25	0.25	0.25	0.25
Fuel Cost	1.23	0.73	6.82	4.05
Total	**1.98**	**2.04**	**7.57**	**5.35**

Table 8: Project's impact on the Sector

	FY 15 Estimated	Increased supply with repowering	Percentage Change
Total Generation (MkWh)	44,599	46,570	4.4%
Energy Available at Bulk Level	43,261	45,173	4.4%
Fuel Cost (Million Taka)	157,091	157,824	0.5%
Non Fuel Cost (Million Taka)	125,553	127,994	1.9%
Total Generation Cost (Million Taka)	282,644	285,819	1.1%
Per Unit Supply Cost (Tk/kWh)	6.53	6.33	-3.2%
Tariff (Tk/kWh)	4.70	4.70	0.0%
Energy Sales (Million Taka)	203,327	212,313	4.4%
Loss/Gain (Million Taka)	-79,317	-73,506	-7.3%
Share of Gas in Generation Mix	67.7%	69.0%	
Gas Volume (mmcfd)	820	841	2.6%

39. Table 9: Economic Returns of Repowered Unit against CCGT-LNG as an alternative (Base Case)

	Existing Unit 4										Repowered Unit										Incremental Cost Vs. Generation						Environmental Benefits			
Year	Net Capacity	Plant Factor	Generation	Efficiency	Fuel Consumed	Emissions	Fuel Cost	Var O&M	Fixed O&M	Total Cost	Capital Cost	Net Capacity	Plant Factor	Generation	Efficiency	Fuel Consumed	Emissions	Fuel Cost	Var O&M	Fixed O&M	Total Cost	Alt Gen: CC-LNG	Emissions	Avoided Cost	Incremental Cost	Net Benefit	IRR	Net Emissions	Environmental Benefit	Total	IRR
	MW	*%*	*GWh*	*%*	*mmcfd*	*$MTCO_2$*	*US$ Mln*					*MW*	*%*	*GWh*	*%*	*mmcfd*	*$MTCO_2$*	*US$ Mln*				*GWh*	*$MTCO_2$*		*US$ mln*		*%*	*$MTCO_2$*	*US$ mln*	*US$ mln*	*%*
1	170	67%	993	30%	33	0.7	86	2	5	93	45	170	67%	993	30%	33	0.7	86	2	5	138	-	-	-	45	(45)		-	-	(45)	
2	170	67%	993	30%	33	0.7	90	2	5	98	112	170	67%	993	30%	33	0.7	90	2	5	210	-	-	-	112	(112)		-	-	(112)	
3	170	67%	993	30%	33	0.7	95	2	5	103	67	235	85%	1,742	34%	50	1.0	147	4	7	226	748	0.3	54	123	(69)		0.1	(4)	(72)	
4	170	67%	993	30%	33	0.7	100	2	5	107	0	400	85%	2,964	54%	54	1.1	166	5	12	182	1,971	0.7	148	75	73	-47%	(0.2)	8	81	-45%
5	170	67%	993	30%	33	0.7	105	2	5	112	0	400	85%	2,964	54%	54	1.1	174	5	12	191	1,971	0.7	154	78	75	-16%	(0.2)	8	83	-13%
6	170	67%	993	30%	33	0.7	111	2	5	118	0	400	85%	2,964	54%	54	1.1	183	5	12	200	1,971	0.7	159	82	77	0%	(0.2)	9	86	3%
7	170	67%	993	30%	33	0.7	116	2	5	124	0	400	85%	2,964	54%	54	1.1	193	5	12	209	1,971	0.7	165	86	79	9%	(0.2)	9	88	12%
8	170	67%	993	30%	33	0.7	122	2	5	129	0	400	85%	2,964	54%	54	1.1	202	5	12	219	1,971	0.7	171	90	81	15%	(0.2)	9	90	18%
9	170	67%	993	30%	33	0.7	128	2	5	136	0	400	85%	2,964	54%	54	1.1	213	5	12	229	1,971	0.7	177	94	83	19%	(0.2)	10	93	21%
10	170	67%	993	30%	33	0.7	135	2	5	142	0	400	85%	2,964	54%	54	1.1	224	5	12	240	1,971	0.7	184	98	86	21%	(0.2)	10	96	24%
11	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	227	5	12	244	2,964	1.0	279	244	36	22%	0.1	(4)	32	25%
12	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	230	5	12	247	2,964	1.0	282	247	35	23%	0.1	(4)	31	25%
13	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	234	5	12	251	2,964	1.0	286	251	35	23%	0.1	(4)	31	25%
14	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	237	5	12	254	2,964	1.0	289	254	35	23%	0.1	(5)	30	26%
15	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	241	5	12	258	2,964	1.0	292	258	34	24%	0.1	(5)	30	26%
16	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	245	5	12	261	2,964	1.0	295	261	34	24%	0.1	(5)	29	26%
17	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	248	5	12	265	2,964	1.0	299	265	34	24%	0.1	(5)	29	26%
18	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	252	5	12	269	2,964	1.0	302	269	34	24%	0.1	(5)	28	26%
19	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	256	5	12	272	2,964	1.0	306	272	33	24%	0.1	(5)	28	26%
20	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	260	5	12	276	2,964	1.0	309	276	33	24%	0.1	(5)	27	26%
21	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	263	5	12	280	2,964	1.0	313	280	33	24%	0.1	(6)	27	26%
22	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	267	5	12	284	2,964	1.0	316	284	32	24%	0.1	(6)	27	26%
23	0	0%	-	0%	-	-	-	-	-	-	0	400	85%	2,964	54%	54	1.1	271	5	12	288	2,964	1.0	320	288	32	24%	0.1	(6)	26	26%
Total			9,933			6.7					224			63,016			25						18					(0)			
NPV			5,612				587	14	28	629	177			18,679				1,371	34	75	1,657	13,066		1,175	1,028	**147**			16	**163**	

Annex 6: Governance and Accountability Action Plan (GAAP)

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

1. The Government recognizes that corruption has emerged as a major deterrent against growth and development in the country, and is inhibiting the achievement of the commitment. Improving governance and fighting corruption are part of the government's development agenda set forth in the Sixth Five Year Plan (SFYP). This approach towards combating corruption is similar to the Bank's continued mission of promoting sustainable growth and reducing poverty. The GAAP for this project contributes to these efforts by outlining a framework for actions, institutional arrangements, and additional specific measures to minimize governance and corruption risks in the project. The GAAP has been designed to reflect the specific responsibilities of the implementing agency and the Bank to facilitate effective and appropriate use of the funds for the project, preclude the incidence of corruption, and enhance good governance.

2. **National Integrity Strategy (NIS):** The NIS of the government is a comprehensive framework aimed at increasing the level of independence to perform, accountability, efficiency, transparency and effectiveness of state and non-state institutions in a sustained manner over a period of time. There are many points of convergence between the goals of the National Integrity Strategy (NIS) and the objectives of the GAAP. BPDB will develop key GAAP action plan for the project that will identify the major governance risks and measures to mitigate them. Some of the activities BPDB has initiated to functionalize SBU and engaging independent procurement panel for evaluation bids under the project would contribute to such NIS/GAAP framework. The GAAP will include activities for Right to Information (RTI) compliance, grievance mechanism, and citizen engagement/beneficiary feedback applicable for the proposed project.

Governance and Corruption Risks:

3. The governance and corruption risks for the proposed project fall into **three** major categories: (a) institutional risks; (b) procurement risks; and (c) contract execution risks.

a. **Institutional risks**. The BPDB is in the process of managing an internal institutional reform, involving the creation of decentralized, autonomous business units, of which the GPS is one. This process involves setting up new governance structures, putting in place management systems, and dealing with personnel issues, all of which is challenging and takes time to put in place. Systems for provision of information to the public and handling complaints or feedback from third parties on performance are also needed and are in the process of development.

b. **Procurement risks**. A substantial amount of the project cost will be managed through fairly large works contracts which present significant procurement risks. Possible risks include collusion among the bidders, fraudulent documents, and corrupt practices between the winning bidder and the approving authority. Conflicts of interest may present a serious problem, most notably through relationships with government officials, whether direct or indirect, including through companies and/or relatives of officials.

c. **Contract management risks**. In the past, BPDB has shown weaknesses related to contract management. There is a risk of collusion between contractors, engineers in the field, and the PMU, including, but not limited to, aspects related to quality assurance, extension of time, variations to contracts, and price adjustments.

Monitoring and Bank Supervision

4. The GAAP will be monitored regularly through indicators and reflected in progress reports by the

implementing agency as well as in the Bank's implementation supervision reports and aide memoires for supervision missions. The GAAP matrix will be used widely for monitoring purposes. Any 'early warning' indicators of governance and accountability risks will be monitored regularly so that corrective measures can be carried out promptly. The GAAP will be adjusted as necessary during implementation to reflect governance issues which may emerge and/or to add actions.

Table: Matrix of Action

Issues/Risks/ Objective	Actions	Agency Responsible	Timeline	Early Warning Indicators to Trigger Additional Action
Institutional Risks				
Need to **strengthen capacity** to handle large-volume procurement, FM, contract management, communications, and monitoring functions	Establish the PMU with internally or externally hired staff or individual consultants.	BPDB	Key staff recruited within 3–6 months of project's effectiveness	Delays in conduct of procurement, execution of contracts, processing of payments, and filing reports
	Regular board meetings of SBU to identify issues that are affecting implementation	GPS	At least once in every alternate months	
	Establish complaints mechanism for the project, using multiple methods including information and communication technology tools.	BPDB	By March 31, 2016.	Nature and frequency of complaints Complaints not acted upon
Need for proactive provision of **information** and enhanced transparency	Establish website for proactive disclosure of information in accordance with the RTI Act.	BPDB	By June 30, 2016	Information Officer not appointed
	Post documents required by the RTI Act on a regular basis		Continuous	Required documents not posted
	Respond to RTI requests on a timely basis		Continuous	
Procurement Risks				
Reduce risk of corruption in **procurement**	Enforce ICB procurement guidelines for documentation, timelines, and transparency.	BPDB	Ongoing	Procurement red flags in ex ante and ex post review; inconsistencies with 'need to
	Appoint an independent procurement panel for large	BPDB	Ongoing	

	contract and hire independent procurement expert for OE evaluation or any other key contract packages			know' principles in procurement mapping; evidence of unauthorized access to information; Panel members not recruited.
Potential for or reduce risk of **conflict of interest** among participants in procurement	Declarations of no conflict of interest by members of procurement panel and bidders Require bidders' statements concerning agents and other possible connections to persons involved with procurement	GPS GPS	Panel members before start of evaluation; bidders at submission At bidding stage	
Contract Execution and Project Management Risks				
Avoid collusion of parties involved and ensure transparent management of contracts	Engage Owner's Engineer for supervision of contracts Engage third-party monitoring agent to perform oversight function.	GPS BPDB	Start of Contract Execution By June 2016 and once a year thereafter	Monitoring reports identify anomalies

Annex 7: Systematic Operational Risk Rating Tool (SORT)

BANGLADESH: GHORASHAL UNIT 4 REPOWERING PROJECT

1. The following matrix describes the rationale for the proposed rating for each risk and the mitigation plans.

1. Political and Governance	**Rating**	**High**
Description	**Risk Management**	
Governance risks are related to: (a) Uncertainties due to strikes may disrupt project activities. (b) Weak legal framework for corporate governance and public sector regulation, contributes to poor performance by public entities. (c) The Right to Information Act 2009 has experienced a slow roll-out, due to poor records management and weak public sector capacity, contributing to low public awareness.	The following are considered for risk mitigation: (a) Coordination with the Home Ministry and local authorities to ensure security as may be needed. (b) The BPDB and GPS will implement their annual performance agreements and NIS actions to enhance corporate governance and entity performance which will be monitored in the context of GAAP. (c) The Project will emphasize information dissemination and transparency through disclosure of project documents according to the Bank's Policy on Access to Information and the GoB's Right to Information Act.	
2. Macroeconomic	**Rating**	**Moderate**
Description	**Risk Management**	
(a) Macroeconomic policies in Bangladesh are generally considered to be well managed, as reflected in the sustained GDP growth rates and low fiscal deficits over the past decade. Revenue mobilization is poor due to the small tax base covered, and productivity of public investments could be enhanced.	(a) The Bank is supporting interventions in an on-going project (VAT modernization) and providing advisory services to improve revenue mobilization, public financial management, and quality of investment, *inter alia*.	
3. Sector strategies and policies	**Rating**	**Moderate**
Description	**Risk Management**	
(a) Weakness in implementation of sector policies	(a) Sustained engagement in capacity building and development of the information database.	
4. Technical design of project or program	**Rating**	**Moderate**
Description	**Risk Management**	
(a) The technical design risk is considered moderate, as the 25 year old turbine was opened up to verify the inside condition of the machine and prepare for conversion with new equipment.	(a) Residual Life Assessment (RLA) testing was carried out on the turbine, and the RLA report made recommendations on the major works and replacements needed. This data was used in preparing the bid documents. In addition, BPDB staff, an experienced technical consultant, and members of the Independent Procurement Panel also contributed their expertise to finalizing the technical scope of the project.	

5. Institutional capacity for implementation and sustainability	Rating	Substantial
Description	**Risk Management**	
(a) BPDB is not familiar with Bank procedures as it has been more than a decade since it implemented a WB-funded project. (b) BPDB will be managing multiple turbine projects at the Ghorashal station, which will require strong contract management and coordination skills to avoid delays in completion of contracts and poor quality of works. (c) The Board has recently formed a Ghorashal Strategic Business Unit (GPS) to manage the power plant once construction is completed. GPS may have weak management capacity in its initial years, as the internal governance structure is institutionalized and staff come on board.	(a) Consultants familiar with Bank procedures in the fiduciary and safeguards areas will be hired to complement BPDB PMU staff. (b) Contract management risks will be mitigated through appointment of owner's engineer by the time the EPC contractor mobilizes. BPDB will also prepare a detailed activity schedule for parallel activities at GPS to map out in advance coordination needs and appropriate sequencing. (c) TA support will be provided to the BPDB and to the GPS to facilitate roll-out of the SBU reforms, including actions to enhance transparency and good governance in accordance with the NIS, APAs, and the GAAP.	
6. Fiduciary	**Rating**	**High**
Description	**Risk Management**	
(a) Procurement experience with large infrastructure projects in Bangladesh shows that large contracts are subject to delays and potential interference at many stages in the contract evaluation and award process. (b) Financial management capacity and the internal audit function of BPDB needs to be strengthened to encompass review of systems and internal controls in the entity and projects.	(a) To address these procurement risks, an independent procurement panel (IPP) of international experts was hired by BPDB to contribute to bid document preparation, to carry out the bid evaluation, and to recommend contract award for the major turbine contract. (b) This risk will be addressed through implementation of the BPDB's restructuring plan, including the creation of separate accounts for the SBUs, and the hiring of FM specialists for the BPDB PMU/GPS. An external entity to assist BPDB with its internal audit functions is also planned.	
7. Environment and social	**Rating**	**Moderate**
Description	**Risk Management**	
(a) BPDB currently has only a rudimentary institutional capacity for environmental management. Currently there is no dedicated Environment, Health, and Safety (EHS) Circle to address environmental management and occupational health and safety issues. GPS has no staff with previous experience in implementing environmental management and monitoring plan. (b) Generation of hazardous waste during decommissioning of existing boiler, Inhalation of airborne asbestos fiber during boiler decommissioning activities, elevated noise level from the operation of	(a) A proposal has been made to create an EHS and Utility Services (EHSUS) Circle headed by a manager and two deputy managers, one for environment and one for health and safety. One EHS consultant is also proposed under the manager of this circle to advise the circle on environmental, health, and safety issues. (b) A detailed Plan of boiler decommissioning, asbestos handling and safety operation has been prepared and provided in the Boiler Decommissioning Plan. The general principle on which the boiler decommissioning plan is	

heavy equipment, felling of trees during site preparation, and labor camp induced sanitation and social stress are the significant risks during the construction works. (c) Long-term water availability for the current cooling system may be an issue.	based is safe disposal of asbestos containing material and safety procedures while handling asbestos. (c) Renovation and modernization of the existing closed cooling system is part of the scope of the project.
8. Stakeholders	**Rating** **Low**
Description	**Risk Management**
(a) Several commercial and development partners are simultaneously engaged in different investment projects at the GPS. Coordination and sequencing of their activities could be a challenge, leading to friction among the various partners and with BPDB.	(a) This stakeholder risk is considered low, as BPDB is preparing a detailed activity schedule for parallel activities at GPS that will map out in advance coordination needs and appropriate sequencing to follow.
9. Overall	**Rating** **Substantial**
Description	**Risk Management**
The overall risk of the project is pertains to the high governance and fiduciary risks involved in the project and the substantial institutional capacity risks.	Fiduciary and safeguard consultants will be recruited to strengthen the BPDB PMU in these specialized areas. Procurement risks are expected to be largely mitigated by BPDB having hired an independent procurement panel (IPP) to review draft bid documents, evaluate bids received, and recommend contract award. To mitigate the capacity risks, Owner's Engineer would also be hired in supervising the project implementation.