ECONOMIC ANALYSIS

A. Background

1. The South Asia Subregional Economic Cooperation (SASEC) Second Bangladesh–India Electrical Grid Interconnection Project will increase the transmission capacity for power flows between eastern India and western Bangladesh from 500 megawatts (MW) to 1,000 MW. The first interconnection has been operational since 2013 and power flows have helped alleviate the persistent power deficit in Bangladesh and support economic growth. Transmission interconnectivity helps countries to effectively manage power surpluses shortages, displace more expensive fuel sources, support recovery after outages, and contribute to improved power system efficiency.

2. The Bangladesh economy has grown by more than 6% a year since 2006,[1] and the country requires a rapid increase in its energy supply to sustain growth. Although effective generation capacity has increased from 5,166 MW in 2009 to 10,817 MW in January 2015,[2] it has not met the energy demand. There are power outages, and in the fiscal year 2014, the maximum load shedding amounted to 932 MW, against a peak demand of 7356 MW.[3]

3. A study on power shortages in Bangladesh estimated that an increase in energy supply of 1 gigawatt-hour (GWh) generates an economic output ranging from Tk46 million[4] to Tk107 million (at constant 1996 prices).[5] A 2001–2003 study of the economic impact of outages in Bangladesh shows that losses resulting from unscheduled supply interruptions are almost three times greater than for scheduled supply interruptions.[6] Augmentation of the Bangladesh–India transmission link by 500 MW will improve the supply and help to partly alleviate these concerns.

B. Least Cost Analysis

4. In May 2015, natural gas and heavy furnace oil (HFO) contributed about 63% and 21% of power generation capacity while power imports contributed 4.5%. In terms of the annual energy supply in fiscal year 2014, natural gas, HFO and imports contributed 71.1%, 16.2%, and 5.6% respectively. Among renewable energy sources in Bangladesh, the potential for hydropower and wind energy is limited while solar power is largely untapped. **Table 1** indicates the average cost of generation.

Table 1: Unit Cost of Electricity Generation in Bangladesh in Tk/KWh

Source	BPDB Plants	Rental Plants	Public Plants	IPP
Hydro	1.49			
Wind	25.45			
Gas	2.07	4.21	2.10	2.18
Coal	6.30			
HFO	17.86	16.46		18.69
Diesel	37.35	24.76	28.24	

BPDB=Bangladesh Power Development Board, HFO = heavy furnace oil, IPP = independent power plants.
Source: Annual Report. 2014. Bangladesh Power Development Board. Dhaka.

[1] Bangladesh Bank. 2014. *Annual Reports*. Dhaka.
[2] Bangladesh Power Development Board. *Key Statistics.* (http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5&Itemid=6)
[3] Bangladesh Power Development Board. 2015. *Annual Report 2013-14*. Dhaka.
[4] Tk: Bangladeshi Taka.
[5] M. Mujeri and T. Chowdhury. 2013. *Quick Rental Power Plants in Bangladesh: An Economic Appraisal.* Dhaka: Bangladesh Institute of Development Studies.
[6] P. Wijayatunga and M. Jayalath. 2008. Economic Impact of Electricity Supply Interruptions on the Industrial Sector of Bangladesh. Energy for Sustainable Development XII (4).

5. Hydropower is the most economical source followed by gas-based generation. While the potential for further augmentation of hydropower is limited, the shortage of domestic gas has constrained gas based power generation with the government forced to allocate gas to some sectors at the expense of other sectors. Electricity utilities resort to load shedding while industrial consumers switch to captive generation based on diesel. Also, gas based generation is less costly for utilities because domestic gas is priced significantly below international gas prices. Combined with the economic cost of limited gas availability and power outages, the total economic cost of gas-based generation is greater than the financial cost in Table 1. The next lowest-cost source of electricity is domestic coal. While Bangladesh has sizable coal reserves, there is only one currently operational coal mine, thus limiting supply. The country's only coal-based power plant (250 MW) faces fuel shortages due to constraints in domestic coal production. Access to domestic coal reserves is poor and likely to have safeguard concerns in densely populated Bangladesh; further development of coal fields will take time. Therefore, domestic coal based generation is a long-term prospect, and the Government has initiated a generation program based on imported coal with plans for 7,295 MW of imported-coal fired plants. Coal-fired generation is expected to cost about Tk8.04/ kilowatt-hour (kWh) at current prices.[7]

6. HFO, diesel, solar and wind-based generation have the highest costs, above Tk15/KWh in 2014 prices. In comparison, in 2014, power imports from the Power Trading Corporation India and the trading arm of the National Thermal Power Corporation cost Tk6.59/KWh and Tk3.82/KWh respectively. Recent long-term power bids in India in fiscal year 2015 had winning bids at INR4.98/KWh (about Tk6.21/kWh equivalent) and INR4.1/KWh (about Tk5.11/kWh equivalent). Under these circumstances, power imports from India offer a feasible and least-cost solution to meet growing power requirements in Bangladesh.

C. Methodology and Major Assumptions

7. **Methodology.** The economic evaluation of the project was carried out in accordance with Asian Development Bank's (ADB) guidelines.[8] The evaluation has been tested for sensitivity to changes in the basic parameters. The economic analysis and financial analysis are consistent in their assumptions.

8. **Demand and Supply forecasts.** Demand projections (in megawatts) are largely in line with the Power System Master Plan 2010 demand projections, and based on data from Power Grid Company of Bangladesh (PGCB), the analysis assumes a load factor of 60% in the Bangladesh power system.

9. PGCB's expansion plan estimates an addition of over 19,000 MW of generation capacity by 2022. Given current trends with project development, a conservative assessment of meeting this capacity addition target by 2027 is considered for the purpose of the economic model. Beyond 2027, the pace of capacity addition would pick up as new technology plants start operating and would be in line to meet long-term capacity addition targets for 2040 and later. Information on the retirement of existing plants has been considered based on PGCB data. Utilization factors for generation plants are assumed to gradually increase as new technology base-load power projects enter start production. Supply from the new transmission line has been taken separately to estimate its impact on incremental and non-incremental consumption. A distribution loss of 11.9% has been assumed in line with its value in fiscal year 2014. Demand

[7] Estimate based on discussions with coal projects under development in Bangladesh.
[8] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.

and supply projections have been divided into peak and off-peak periods for two seasons (summer and winter). Data for each month of 2014 was analyzed to estimate the relative seasonal, peak and off-peak values, which were used for the projections.

10. **Cost-Benefit Analysis.** The costs and benefits of the cross-border transmission project proposal have been estimated by comparing the with- and without-project scenarios. In the without-project scenario, the amount of energy equivalent to that of the proposed transmission line is supplied within Bangladesh.

11. **Investment costs.** All costs and benefits have been expressed in constant 2015 prices. Domestic price numeraire has been used. Tradable inputs are converted into domestic equivalents using an estimated shadow exchange rate factor (SERF) of 1.003[9] after factoring in the impact of trade taxes. Project costs include investment and maintenance costs of the transmission line and annual payments to the Indian entities for delivery of power to Bangladesh. While economic capital costs and operation and maintenance costs are taken from the financial model, with appropriate adjustments to remove taxes and price contingencies, the cost of power purchases from India is considered on the basis of electricity market reports for 2015.[10] Costs are divided into tradables, non-tradables, fuel, skilled and unskilled domestic labor, and skilled and unskilled foreign labor based on reasonable assumptions about their proportion in total cost. A shadow wage rate factor (SWRF) of 0.75[11] is used for unskilled labor and 1 for skilled labor. In case of foreign labor, the SWRF has been multiplied by the SERF to obtain the appropriate conversion factor. In line with the financial analysis, the residual value of the investment is taken as nil. The expansion of the transmission and distribution infrastructure will continue regardless of the proposed project, and the costs are included in the present analysis.

12. **Investment benefits.** Total benefits from the project to Bangladesh accrue through the (i) non-incremental benefits from direct resource cost savings (RCSs) in the domestic economy; and (ii) incremental benefits to new customers and additional domestic consumption demand by existing customers as a result of additional supply during certain periods. Incremental benefits have been computed by estimating the area under the demand curve, assuming a price elasticity of -0.43, in line with references for developing countries in Asia.[12] This simplifying assumption has been made in the absence of specific price elasticity estimates for Bangladesh.

13. Non-incremental benefits have been computed by assuming the new supply will replace HFO–based quick rental plants in the short run, till 2020; imported LNG based plants from 2021 till 2024; and imported coal-based generation from 2025 onwards. Resource cost savings have accordingly been computed by taking average generation costs from the considered fuel sources in 2014 with appropriate adjustment based on change in corresponding average international fuel prices between 2014 and 2015.[13] RCS assumptions are conservative considering that a significant portion of RCSs can be furnace oil or diesel-based captive generation for large industrial consumers.

---

[9] Computed from actual trade data for 2008–2014. The computed SERF matches its value in ADB. 2011. *Report and Recommendation of the President to the Board of Directors*: *Proposed Loan to Bangladesh for the Second Chittagong Hill Tracts Rural Development Project in Bangladesh* Manila. (Loan 42248).

[10] Business Standard. 2015. *Andhra power purchase sees toned down rates*. Hyderabad.

[11] Based on an analysis of approved projects including the Second Chittagong Hill Tracts Rural Development Project (footnote 8, above) and ADB. 2015. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to Bangladesh for Third Primary Education Development Project – Additional Financing.* Manila.

[12] ADB 2013. *Cost−Benefit Analysis for Development: A Practical Guide.* Manila. pp. 318, para 2.

[13] Bangladesh Power Development Board. 2014. *Annual Report.* Dhaka.

14. When reviewed from a Bangladesh–India sub-region perspective, economic benefits can accrue through two streams (i) net resource cost savings in the region where power is transmitted, given the relatively low-cost of generation in India as compared to Bangladesh; and (ii) utilization of power surpluses in the eastern region of India. The latest available forecast for 2016 for India estimates a power surplus for eastern India.[14]

15. In India, the Central Electricity Authority reported a country wide installed capacity of 274,817 MW as of June 2015 against a peak demand of 143,550 MW. In 2014, India announced a new program to complete capacity addition of 175,000 MW of renewable energy generation capacity by 2022 in addition to plans for conventional power plants. India expects to add about 88,000 MW of conventional power capacity for the period from 2012–2017 of which over 54,000 MW has been completed as of 2015. For about 46,000 MW of power generation capacity in India, there are concerns about debt servicing for a variety of reasons under existing contracts including absence or restrictions on long term power purchase arrangements with off-takers given the financial position and slowdown in demand growth of off-takers, fuel availability and transmission constraints.[15] Diversification of risk through entering into multiple off-taker contracts and bidding in the market will improve off-take and debt servicing capacity. Seven electricity traders and generators from India submitted bids to sell 250 MW of power as of July 2015 to BPDB. Availability of 500 MW of power generation capacity in India to export to Bangladesh in the medium to long term is therefore not unjustified. For the purpose of regional analysis, the power purchase cost for Bangladesh is taken at Tk6.21/kWh. Other cost and benefit parameters remain unchanged from the country analysis.

D. Calculation of Economic Internal Rate of Return

16. Consistent with the financial analysis, the economic evaluation is based on a plant economic life of 25 years. Detailed cost–benefit calculations show that the project can be expected to deliver reasonable economic benefits, with an estimated economic internal rate of return (EIRR) of 21.6% **(Table 2)**. When benefits from the project to the Bangladesh–India sub-region are considered, the EIRR rises to 26.7%.

Table 2: Economic Internal Rate of Return

	Benefits (in Tk million)			Costs (in Tk million)				Net Benefits
Year	Incremental - Supply	Non-incremental Supply	Total Benefits	Capital	O&M	Power Purchase	Total Cost	
2015				1,072			1,072	(1,072)
2016				4,755			4,755	(4,755)
2017				6,202			6,202	(6,202)
2018	11,975	14,178	26,153		46	23,610	23,656	2,497
2019	12,965	14,883	27,847		46	25,206	25,252	2,596
2020	9,218	20,794	30,011		45	25,275	25,320	4,691
2021	12,244	13,639	25,883		45	25,206	25,250	632
2022	61	29,169	29,230		44	25,206	25,250	3,980
2023		29,245	29,245		43	25,206	25,249	3,996
2024		29,325	29,325		43	25,275	25,318	4,007
2025		27,925	27,925		42	25,206	25,248	2,677
2026		27,925	27,925		42	25,206	25,248	2,677
2027		27,925	27,925		41	25,206	25,247	2,678

[14] Eastern Regional Power Committee. 2015. *Meeting on Load Generation Balance Report for 2016*. Kolkata.
[15] CRISIL. *Power Sector Rating Report.* 2015. Mumbai.

Year	Benefits (in Tk million) Incremental - Supply	Non-incremental Supply	Total Benefits	Costs (in Tk million) Capital	O&M	Power Purchase	Total Cost	Net Benefits
2028		28,002	28,002		41	25,275	25,316	2,686
2029		27,925	27,925		40	25,206	25,246	2,679
2030		27,925	27,925		40	25,206	25,246	2,679
2031		27,925	27,925		39	25,206	25,245	2,680
2032		28,002	28,002		39	25,275	25,314	2,688
2033		27,925	27,925		39	25,206	25,244	2,681
2034		27,925	27,925		38	25,206	25,244	2,681
2035		27,925	27,925		38	25,206	25,244	2,682
2036		28,002	28,002		37	25,275	25,312	2,690
2037		27,925	27,925		37	25,206	25,243	2,683
2038		27,925	27,925		36	25,206	25,242	2,683
2039		27,925	27,925		36	25,206	25,242	2,683
2040		28,002	28,002		35	25,275	25,310	2,691
2041		27,925	27,925		35	25,206	25,241	2,684
2042		27,925	27,925		35	25,206	25,241	2,685
2043		27,925	27,925		17	25,206	25,222	2,703
EIRR(%)								**21.56**

( ) = negative; EIRR = economic internal rate of return; O&M = operation and maintenance.
Source: Government of Bangladesh approved project proposal in 2015 and Asian Development Bank estimates.

17. **Sensitivity analysis.** The evaluation tested the sensitivity of the EIRR to a series of identified risks. These include (i) a 10% increase in project costs; (ii) a 10 % increase in operation and maintenance costs; (iii) a 5% increase in power procurement cost; (iv) a delay of 6 months in commissioning; (v) a 10% reduction in the supply of 500 MW of power; and (vi) a combination of the above **(Table 3)**. EIRR remains above the threshold of 12% for variations in the underlying parameters. Switching values indicate the percentage change in underlying parameter that reduces EIRR to its threshold value of 12%. The project remains economically viable even when the project cost is doubled or when the line is loaded to less than 50% of its capacity. EIRR is most sensitive to increase in power cost and increase in project cost.

Table 3: Sensitivity Analysis

Scenarios	Variation	EIRR (%)	Switching Values (%)
1. Base Case		21.56	
2. Increase in Project Cost	10%	19.73	79.50
3. Increase in O&M Cost	10%	21.53	3041.00
4. Increase in Power Procurement Cost	5%	12.33	5.15
5. Delay in Commissioning	6 months	20.85	
6. Reduction in Power Supply	10%	19.24	66.60
7. Combined effect (2,3, 5 & 6)		15.32	

EIRR = economic internal rate of return; O&M = operation and maintenance.
Source: Government of Bangladesh approved project proposal in 2015 and Asian Development Bank estimates.

E. Conclusion

18. Cost benefit calculations show the project is expected to deliver significant economic benefits. The EIRR is estimated to be 21.6% when sub-regional benefits are excluded from consideration, and 26.7% when sub-regional benefits are included. The EIRR is above the threshold in both cases and is also resilient to significant variations in underlying parameters. The results show the investment is economically viable and sustainable.