Economic and Financial Analysis

I. Economic Analysis

A. Background

1. The Bangladesh–India Electrical Grid Interconnection Project will allow an exchange of power between the two countries. It will initially facilitate the transmission of 500 MW of power from India to meet existing and future demand in Bangladesh. The economic analysis of the investment proposal for the cross border transmission network was carried out in accordance with ADB's *Guidelines for Economic Analysis of Projects*.

B. Economic Rationale of the Project

2. Energy cooperation among South Asian Association for Regional Cooperation (SAARC) countries was first discussed at the fifth SAARC summit in 1990. The concept of an "energy ring" was agreed at the 13th summit in 2005 in Dhaka to promote trading in electricity, gas, and oil among SAARC member countries. The economic rationale for this initiative was the efficient use of energy resources and the provision of a platform for power trading. The SAARC countries are net importers of fossil fuels including coal, oil, and oil products from outside the region and considerable benefits could be derived from tapping hydropower potential in Bhutan, India, and Nepal and from utilizing the differing seasonal load characteristics of the countries in the region. Regional interconnectivity could help countries to manage power shortages, avoid power outages, and improve system-wide efficiency. Currently, India imports power from Bhutan and exports power to Nepal. Technical studies are underway on the feasibility of grid interconnections between India and Sri Lanka. The proposed electrical grid interconnection project between India and Bangladesh will provide a successful example of power trading between two countries in the region, contribute to meeting the goal of providing power to all as well as bring economic benefits to the region.

C. Demand–Supply Situation in Bangladesh

3. The Bangladesh economy has grown by nearly 6% a year since 2005 and it is faces rapidly growing energy needs to sustain its growth particularly in the industrial sector. Inadequate generation capacity addition and fuel shortages have resulted in electricity sales in Bangladesh growing by only about 7% per annum since 1990. In response, the government has decided to develop 9400 MW of power capacity by the end of 2015 to meet its existing and future demand requirements. However this generation capacity addition will take time and the current power shortages require immediate solutions. The electrical grid interconnection facility between India and Bangladesh will partially alleviate the current power crisis. The facility will eventually be able to transmit up to 1000 MW[1] of power. The proposed project would facilitate imports of cheap and reliable power from India for use in Bangladesh. A significant part of the demand in Bangladesh can be attributed to the industrial sector (responsible for 45% of power usage) and the residential sector (responsible for 41% of power usage).

[1] The interconnection will be able to carry up to 1000 MW of power when the substation capacity is increased from 500 MW to 1000 MW.

D. Least-Cost Analysis

4. About 85% of electricity in Bangladesh is produced from gas-based power plants. Coal, hydropower, heavy fuel oil (HFO), and diesel are the other sources of energy for power generation. Inadequate investment in upstream gas field development in recent years has resulted in a shortage of gas for the industrial sector and for electricity generation. This has constrained power generation, with electricity utilities resorting to load shedding while industrial consumers have been using captive generation facilities that require diesel. As an immediate measure to reduce gas shortage, the government has decided not to provide assured gas supply to a number of new power projects and has asked promoters to develop these projects on a dual fuel model (to be run on diesel or HFO).

5. Table 1 indicates the cost of power generation using various fuels in Bangladesh.[2]

Table 1: Least-Cost Analysis of Electricity Generation in Bangladesh

Fuel Source	Economic Generation Cost Per Unit Tk/kWh
Gas	4.2
Coal (local)	3.7
Coal (Imported)	5.4
HFO	12.1
Diesel	25.2
Hydropower	1.4

HFO= heavy fuel oil; kWh= kilo watt hour

6. While, hydropower is the most economic source of electricity in Bangladesh, its potential is limited. Except for few small-scale hydropower projects, there is hardly any untapped hydropower. The next low-cost source of electricity is coal followed by gas, HFO, and finally diesel. As indicated above, a further expansion of gas-based power generation is not feasible in the near future given inadequate gas production. Gas is being used for transportation, industries (mainly fertilizer), and domestic purposes. Given the severity of power shortages, the government has decided to cut down the gas supply to some sectors, such as fertilizer production, and it has limited the supply of gas to the power sector. Under such circumstances, local gas, although the least-cost option, will not provide an immediate solution to the current power crisis. While Bangladesh has sizable coal reserves in the north-west region, currently only one coal-based power plant is operating and it has been facing fuel shortages given constraints in coal production. The development of domestic coal fields will take time and will require significant investment. Imported coal-based power generally costs about Tk 5.4/kwh ($0.077) at current coal prices. In the current situation, power imports from India[3] are expected to be the most feasible least-cost way of overcoming existing power shortages in Bangladesh.

E. Economic Feasibility

7. All costs have been expressed in constant 2010 prices. The domestic price numerator has been used and tradable inputs were valued at their border price equivalent value (BPEV) and

[2] Except for the imported coal, the unit costs are based on actual data.

[3] Power from India is expected to be priced at a tariff of approximate 4.6 Taka/unit escalated at 2% per annum.

converted using an estimated standard exchange rate factor (SERF) of Tk 1.47 per rupee. For the Bangladesh part of the interconnection facility, an economic conversion factor for labor cost (0.97) was considered. The capital costs include physical contingencies, but exclude taxes, price contingencies, and financial charges during construction. For the Indian part, a standard conversion factor of 0.97 has been used to convert financial costs and benefits into economic values.

8. An economic lifespan of 30 years was assumed in the analysis and a standard 12% discount rate was used to calculate the net present value (NPV). Capital costs were spread over the first 3 years at the rate of 20% for year 1, 50% for year 2, and 30% for year 3. The capacity utilization of the transmission lines was assumed to be 80% in estimating the quantity of power transmitted. A 4% loss level was considered over the interconnection facility.

9. The incremental costs and benefits of the cross-border transmission project proposal were estimated by comparing the "with project" and the "without project" scenarios. Under the "without project scenario," it is assumed that the equivalent amount of energy is generated within Bangladesh. The most likely source of energy for power generation in the base case was taken to be imported coal, given the shortfalls in gas and domestic coal for power production. During sensitivity analysis, replacement by a more expensive source (HFO) was considered for the "without project" scenario. The interconnection's feasibility has been assessed from the perspective of both Bangladesh and the region in the following sections. Generally, the systems or time-slice approach is used in estimating the economic internal rate of return (EIRR) of transmission projects. However, in this case, since the interconnection is similar to a dedicated line used to evacuate power from a designated plant, the project has be analyzed as a single project, avoiding the systems or time-slice approach.

F. Economic Feasibility: Bangladesh Project

10. The project costs include investment and maintenance costs of the Bangladesh transmission line, cost of other associated facilities, and annual payments made to the Indian power authority to purchase power. The data used for analysis were extracted from publicly available sources. No environmental or social benefits or costs were quantified or used in the economic feasibility analysis.

11. There are two approaches to estimating benefits. The first is to consider resource cost savings and the second is to use avoided outage costs and other parameters. In the base case, the resource cost savings were used to estimate the benefits. The resource cost savings were based on the assumption that imported coal would be used to generate power in the absence of the project.

12. It is assumed that the Government of India would supply coal-based power from the NTPC plant at Farakka in West Bengal through its trading agency NTPC Vidyut Vyapar Nigam (NVVN). The power would be sold to Bangladesh at NTPC's bus bar at a price determined by India's Central Electricity Regulatory Commission (CERC). For 2010, CERC has determined the power sale price from this power plant to be Rs2.93 per kWh, which is expected to increase by 2% per annum. In addition, NVVN will charge Rs0.07 per kWh as trading margin. Thus the net base cost of power in fiscal year 2010 for Bangladesh would be Rs3.00 per kWh. In addition, transmission losses of 4% would be borne by Bangladesh. Standard power sector return to investment margins are already considered in the tariff of Rs3.00 per kWh used for the economic analysis.

13. The results of the economic analysis indicate that, even with conservative assumptions in the base case, the project will still have a high EIRR of 27%, together with a Tk11,935 million NPV. This indicates that the project is economically viable under conservative assumptions.

14. A sensitivity analysis indicates that computing benefits based on a replacement of HFO-based generation, the use of outage costs and willingness to pay (WTP) provide a higher EIRR. In the sensitivity analysis, an outage cost of $0.34 per kWh for the industrial sector was used while the existing tariff for household, agriculture, and commercial sectors was considered the lower bound of the willingness to pay (WTP). The weighted average WTP in Western Bangladesh is Tk5.78 per kWh, based on the weighted average usage by consumer segments. The project is quite sensitive to cost escalations; a 15% cost increase will provide a negative net present value (NPV). However, this magnitude of cost escalation is unlikely. A delay in the benefits stream by 1 year after the civil works makes the project economically unattractive. Therefore, it is important to make sure all the agreements and institutional arrangements are ready by the time the civil works are finished so power flow can begin immediately. The project provides an acceptable EIRR even if 250MW is supplied at the current proposed rates. Overall, the analysis shows that project is economically viable and it provides stable benefits under variety of risks.

G. Economic Feasibility: Regional Project

15. For the regional analysis, the following costs were considered:

(i) Indian transmission line investment and operation and maintenance costs,
(ii) Indian generation costs, and
(iii) investment and operation and maintenance costs of the Bangladesh transmission line and cost of other associated facilities

16. In this analysis, the capital cost of generation is an important issue. Capital investments in Indian generation were regarded as sunk costs. Based on this assumption, only the recurrent costs of energy generation were considered in the analysis. Another important issue is the opportunity cost of power in India. If India or the eastern grid of India faces power cuts, the export of power to Bangladesh has an opportunity cost for India. However, given the likelihood of of surplus power in the eastern grid and India's planned generation capacity expansion of 60,000 MW between 2007 and 2012 and 100,000 MW between 2012 and 2017, this was not considered an issue. The regional project is economically feasible with an EIRR of 31% and a net present value (NPV) of Tk16,806 million. This base case is founded on conservative assumptions, but even with such assumptions, the results indicate the project is economically viable.

17. The project is economically stable for most relevant risk factors. Sensitivity analysis indicates that computing benefits based on substitution by HFO-based generation or by using a combination of outage costs for industrial consumers and willingness to pay (WTP) for other consumer categories provides for a higher EIRR. Sensitivity analysis with cost escalation shows that the project is sensitive to cost. An increase of 15% in all costs (capital, operation and maintenance, and power generation) will make the project economically unviable. However, as the bulk of the cost of the overall project comes from the cost of generation that would be tied up using a power purchase agreement, a substantial cost escalation is unlikely.

18. Implementation delays will also make the project economically unviable. After construction of the transmission lines, if power is not transmitted for 2 years, the NPV will be negative and the EIRR will be less than 12%. Even a 1-year delay will result a drastic reduction in net benefits. Therefore, adopting the power purchase agreement and allowing the power to flow soon after the construction of the infrastructure is imperative. As part of sensitivity analysis, 50% capacity utilization of the transmission facilities was also considered and results show that, even with 50% utilization, the EIRR is greater than 12%. The base case of the regional project provides a slightly higher EIRR than that for the Bangladesh project. This is partly because of the NVVN margin of Rs. 0.07/unit, which is added as a cost to the Bangladesh side. Moreover, an additional 4% transmission loss from the purchased power increases the cost of the Bangladesh project. However, the difference in the EIRR between the regional and the Bangladesh projects is marginal.

H. Conclusions

19. The economic analysis was conducted using reasonable assumptions. The economic feasibility of the project was assessed from the perspective of Bangladesh as well as the region. Results show the proposed project is economically viable from both these perspectives. The analyses clearly demonstrate that the proposed investments are economically efficient. The EIRR of the project from the Bangladesh side is marginally lower than that of the regional project due to the NVVN trading margin and transmission losses in Bangladesh. The current commitment of India is to provide 250 MW of power; the remaining 250 MW has to be purchased from the power market in India. In light of this uncertainty, sensitivity analysis considered use of 50% capacity. The results show that even at that capacity the project provides an acceptable EIRR. This illustrates that the project is economically feasible even under adverse circumstances. The rest of the sensitivity analysis shows that project returns are quite stable with reference to the relevant risk factors. A delay in the benefit flow can make the project economically unattractive. It is important to make sure that the institutional arrangements particularly the power purchase agreement are signed as soon as possible so that there are no delays in the flow of power.

II. Financial Analysis

A. Introduction

20. The financial analysis of the proposed Bangladesh India Electrical Grid Interconnection Project was carried out in accordance with ADB's *Financial Management and Analysis of Projects*.[4] All financial costs and benefits are expressed in constant 2010 prices. Cost streams used for financial internal rate of return (FIRR) determination, i.e., capital investment and operation and maintenance costs, reflect the costs of delivering the estimated benefits. The revenue accruing to the executing agency based on transmission tariffs was used to estimate the financial benefits.

B. Methodology and Major Assumptions

21. The weighted average cost of capital (WACC) of Power Grid Company of Bangladesh Limited (PGCB) was compared with the FIRR to ascertain the financial viability of the project. The

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[4] ADB. 2005. *Financial Management and Analysis of Projects*. Manila.

sensitivity of the FIRR to adverse movements in the underlying assumptions was also assessed. Based on this analysis, the Project is assessed to be financially viable.

22. Financial viability was examined by comparing the incremental costs and benefits of the "with project" and "without project" scenarios. Incremental costs include the investment costs and operating costs associated with the project. The investment costs include the civil works, electrical and mechanical work, land acquisition and development, and resettlement for the project in Bangladesh. Interest during construction and price contingencies were excluded. Operating costs have been considered at 2.5% of project cost in the first year of operation. The incremental benefits to the project company would arise from the revenue approved by Bangladesh Energy Regulatory Commission (BERC) based on its transmission tariff regulations. The project is assumed to have a 30-year economic life.

23. Energy flows were computed based on an annual project utilization of 80%. Income tax was assumed to be 27.5% (as for publicly traded companies). A straight line depreciation rate of 3.15% was assumed based on the draft transmission tariff regulations. A working capital requirement of 2 months of operating costs was assumed in accordance with draft tariff regulations. The free cash flow stream is converted to real terms by adjusting for domestic inflation, assumed to be 7.2% for the purpose of financial analysis. BERC tariff regulations, once gazetted in 2010, would allow PGCB to recover operating costs and an approved return on capital. It is expected that a transmission tariff of Tk0.3/unit would be adopted by 2012 when the project is operational and would be readjusted by BERC periodically in accordance with tariff regulations.[5]

C. Calculation of Weighted Average Cost of Capital

24. To compute the weighted average cost of capital **(**WACC), the financing sources were assumed to comprise equity and debt contributions to the project and the loans from ADB. The cost of equity was assumed to be 15%, based on the government's long-term bond rate and a margin for the sector. The analysis assumed that the ADB loan was extended to the government and re-lent to PGCB in Bangladesh taka at an interest rate of 5.5%. The loan tenure was assumed to be 32 years, including an 8-year grace period. The cost of government debt is taken at 5.5%. The foreign inflation rate was assumed to be 0.5% and the domestic inflation rate to be 7.2%. Table 2 shows that the average WACC is 2.9%.

Table 2: Weighted Average Cost of Capital

Item	Amount ($ million)	Weighting (%)	Nominal Cost (%)	Corporate Tax Rate (%)	Tax Adjusted Nominal Cost (%)	Inflation Rate (%)	Real cost	Weighted components of WACC
Foreign loans	94.5	67%	5.5%	37.5%	3.44%	0.5%	2.9%	2.0%
GOB loan contribution	18.5	13%	5.5%	37.5%	3.44%	7.2%	(3.5%)	(0.5%)

[5] Tariff re-adjustment of 10% per annum based on development project proposal inputs submitted to the Planning Commission in May 2010.

Equity contribution	27.8	20%	15.0%	0.0%	15.00%	7.2%	7.3%	1.4%
Total	**140.9**	**100%**						**2.9%**

ADB = Asian Development Bank, GOB = Government of Bangladesh, WACC = weighted average cost of capital.

Source: ADB estimates.

D. Calculation of Financial Internal Rate of Return

25. The FIRR is calculated at 6.0% over a period of 30 years. The rates for the individual projects compare favorably with the estimated WACC at 2.9%, substantiating the financial viability of the project.

E. Risk Assessment and Sensitivity Analyses

26. **External risks.** The BERC announced its draft transmission tariff regulations in 2008 after consultations with various stakeholders. Tariff-related risk for the project will be considered mitigated once the BERC tariff regulations are gazetted and PGCB is in a position to recover its operating costs and return on capital. The typical geopolitical risks present for projects in Bangladesh would apply.

27. **Project-specific risks.** Financial risks for project include the following: (i) an increase in the price of civil works and equipment, (ii) delays in project implementation, and (iii) lack of access to necessary counterpart funds. These risks are considered low since (i) the cost estimates are based on recent tenders received during the preparation of the detailed project report by the joint technical team[6] and bids have been received for the transmission line package, (ii) PGCB's implementation capacity has been demonstrated in recent project implementation of ADB loans; and (iii) the government has been releasing funds for other ADB projects in a timely manner. A reduction in the flow of power over the project could have a detrimental impact on the FIRR as indicated in the sensitivity analysis. Given that demand is expected to grow and power shortages in Bangladesh are expected to continue, it is unlikely that Bangladesh will not require power flows from India through the project. Further, Bangladesh is expected to enter into power purchase agreements with suppliers in India to utilize the full capacity of the project.

28. **Sensitivity analysis**. Analysis was carried out to examine the sensitivity of the FIRR and the financial net present value to adverse changes in key variables. The variables considered for the sensitivity analyses are a 20% increase in capital costs, a 20% increase in operation and maintenance costs, and a 10% reduction in power flows over the line. The project is most sensitive to capital cost overruns and a reduction in power flows. If a capital cost overrun occurs, the BERC can be expected to consider the cost overrun for inclusion in PGCB tariff determination if the costs were prudently incurred or as a result of factors outside PGCB's control. Further, a transition from an energy flow tariff structure to a capacity-based tariff structure (more appropriate for transmission utilities) is expected to be pursued under the sector dialogue between ADB and the government. This would reduce the risk of a reduction in power flows for PGCB.

[6] The joint technical team consisting of representatives from India and Bangladesh prepared the detailed project report that was referred to in the preparation of the detailed project proposal in May 2010.