ECONOMIC ANALYSIS

1. The Assam Power Sector Investment Program is a proposed multitranche financing facility (MFF) to fund power generation and distribution expansion and efficiency improvement projects in the state of Assam, India. The main investment program objectives are to achieve increased adequacy and efficiency of Assam's power system.

2. Tranche 1 of the MFF concerns the replacement of four aged gas turbines at Assam's Lakwa Power Station with reciprocating gas engines. The gas turbines, which have a total installed capacity of 60 megawatts (MW), are at the end of their economic lives, are expensive to operate because they consume significantly more gas than modern generating equipment. Economic benefits will accrue from this investment primarily as a consequence of reduced fuel used by new generators to produce the same amount of power.

3. Economic analysis to determine the economic viability of tranche 1 is to
   (i) validate electricity demand and supply projections,
   (ii) ensure that tranche 1 represents the least-cost alternative,
   (iii) undertake cost–benefit analysis of the proposed investment, and
   (iv) identify the distribution of project costs and benefits among key stakeholders.

A. Economic Assessment

4. **Economic rationale.** Currently, only 25% of power requirements are generated in the state; Assam has to purchase about 15% of its total power requirement from independent power producers (IPPs) at very high costs. The previous MFF concentrated mainly on transmission, although it provides some support for distribution. Therefore, proposed investments on generation are timely and help reduce the state's power deficit. Given high transmission and distribution losses, poor governance in tribal areas, and poor enabling business environment in Assam, attracting private sector investment to undertake generation and distribution businesses in Assam is difficult. Therefore, proposed investments will not negatively impact potential private investments.

5. **Demand forecast.** In 2013, a 10-year electricity demand forecast was prepared for Assam under an Asian Development Bank (ADB) technical assistance (TA) as part of a master planning exercise for the state.[1] This disaggregated forecast used a variety of techniques to estimate electricity demand for up to 2022: compound average growth rate, trend analysis, econometric analysis, and a partial end-use approach. In all cases, electricity demand is forecast to be growing at a faster rate than identified in India's official demand forecast for Assam (the electricity power survey), with expected annual growth in the range of 7%–15%. It confirmed that capacity and energy supply deficits are likely to continue for at least up to 2022 even with the addition of planned new generation from the state and central governments, and the private sector.

6. The expectation of a sustained supply deficit confirms the need for the tranche 1 investment. Moreover, because the investment will primarily replace existing capacity rather than add new capacity, there is no risk that the asset will become prematurely redundant.

[1] Technical assistance project Updating Load Forecast and Power System Master Plan for Assam as part of ADB. 2009. *Cluster Technical Assistance to India for Advanced Project Preparedness For Poverty Reduction.* Manila.

7. **Least-cost analysis.** The investment will replace the electromechanical and related equipment in an existing power station. Gas fuel supply to the site and transmission facilities for evacuation of electricity already exists and Assam Power Generation Corporation (APGC) owns the power station site. Therefore the overall capital cost of the replacement asset is expected to be significantly lower than an equivalent greenfield site. In this context, redevelopment of the existing power station is a component of Assam's least-cost generation expansion program. However, an analysis is necessary to confirm APGC's choice of reciprocating gas engines over equivalent gas turbines. The lifecycle costs of gas engines operating in open and closed cycles are compared with open-cycle gas turbines over 25 years. Maximum gas availability of 0.36 million metric standard cubic meters per day (MMSCMD) is assumed, as per current expectations for the power station site. The capacity of candidate plant was selected so that gas consumption would be the same in all cases allowing for the least-cost evaluation to be independent of the cost of gas. Plant capital costs are adjusted so that the value of additional capacity provided by gas turbines and gas engines with waste heat recovery is correctly accounted for. The analysis identifies that all three forms of generation have nearly identical combined capital and operating cost per unit of generation. Although it cannot be directly quantified, the additional operating flexibility that gas engines provide to cope with fluctuations in gas supply has value in the Assam context, and gas engines are therefore the preferred solution.

8. **Project costs.** All costs and benefits are expressed at constant second-quarter 2013 prices. The domestic price numeraire is used. Traded inputs are valued at their border price equivalent using a shadow exchange rate factor of 1.03, which was calculated using a simple trade-weighted approach. Nontraded inputs are valued at domestic prices. No significant distortions in the wage rates for skilled labor are assumed. A shadow wage rate of 0.75 is used for unskilled labor. A specific conversion factor of 0.94 is applied for project capital cost.[2] Recent changes have been made to the way gas is priced in India to better reflect international parity and to provide incentives for exploration. The price is now set for state-owned and private oil producers on the basis of long-term and spot liquid gas (LNG) import contracts as well as international trading benchmarks. For the purposes of analysis, this is adopted as proxy for a border price equivalent (adjusted for transportation to Assam). The price is adjusted over time based on an average of the World Bank's projections of crude oil, European gas, and Japanese LNG real price increases. Project operation and maintenance costs reflect India's Central Electricity Regulatory Commission's benchmarks for similar plant.

9. **Project benefits.** Because the plant will be replacing an existing operating power station and given ongoing capacity and energy deficits in Assam, most of the project's output will be nonincremental. In the without-project scenario, the existing plant will continue to operate, but increases in planned and unplanned outages will reduce the plant's availability over time. Electricity consumption within the plant itself would be expected to increase over time. In the with-project scenario, the new plant will be built and the old plant retired, and electricity will be generated with significantly reduced fuel burn (a resource cost saving) but with a slightly higher nonfuel cost of operation and maintenance. Gas savings is valued at the border price equivalent value of gas, adjusted to the domestic numeraire. Because the new plant will generate more electricity than the old plant for the same quantity of gas consumed, the investment will have some incremental benefits. However, for conservatism, only the gas saving is valued (the plant is economically viable on the basis of gas saving alone). Table 1 summarizes benefits ascribed to the investment.

[2] This is the weighted average of the conversion factors of tradables (1.03), nontradables (1), skilled labor (1), and unskilled labor (0.75) going for the capital costs.

Table 1: Economic Benefits: Quantities and Values Ascribed

Economic Benefits	Unit	2016	2017	2018	2019	2020	2021
Quantity							
Nonincremental output	GWh	347.1	339.5	332.1	324.9	317.7	310.8
Gas saving	MMSCM	112.5	112.5	112.5	112.4	112.4	112.3
Value							
Gas cost	Rs/SCM	7.45	7.33	7.24	7.13	7.04	6.95
Unit resource cost saving	Rs/kWh	2.30	2.40	2.40	2.40	2.40	2.40
Incremental nonfuel operating cost	Rs/kWh	(0.16)	(0.16)	(0.16)	(0.15)	(0.16)	(0.15)

( ) = negative value, GWh = gigawatt-hour, kWh = kilowatt-hour, MMSCM = million metric standard cubic meters, Rs = Indian rupee, SCM = metric standard cubic meters.
Source: Asian Development Bank estimates.

10. **Estimated economic internal rate of return.** The economic evaluation of the proposed investments is based on a comparison of benefits and costs between the with and without project scenario. The economic evaluation covers 20 years, including 2 years for capital investment and construction. Investment is assumed to take place during 2014–2015, and benefits are assumed to be realized from 2016. Asset residual values are ignored (their inclusion makes negligible difference to the economic internal rate of return [EIRR]). The detailed cost–benefit calculations show that the proposed tranche 1 investment is economically viable and expected to deliver significant economic benefits, even under the conservative benefit estimation approach adopted (that is, ignoring possible resource cost saving for consumers). The EIRR is estimated to be 17.3%, well above the assumed hurdle rate of 12%.

11. **Sensitivity and risk analysis.** The risk that the proposed investment does not achieve satisfactory economic returns was identified for both costs and benefits. For each of the risks identified, the sensitivity of the aggregate EIRR is tested and switching values calculated (Table 3).[3] The EIRR exceeds 12% in all cases. Based on these results, the investment appears to be economically viable.

[3] A switching value measures the percentage change in the variable required to reduce the EIRR to the assumed hurdle rate.

Table 2: Benefit and Cost Streams in the Base Case (Rs million)

Year	Benefits Nonincremental Output	Costs Capital	Costs O&M[a]	Net Economic Benefits
2014	0.0	970.2	0.0	(970.2)
2015	0.0	2,263.8	0.0	(2,263.8)
2016	776.7		57.7	718.9
2017	748.4		55.8	692.5
2018	722.7		53.9	668.7
2019	696.9		52.0	644.9
2020	673.2		50.0	623.3
2021	650.3		48.0	602.4
2022	628.4		45.9	582.5
2023	607.3		43.8	563.5
2024	587.1		41.6	545.5
2025	567.7		39.4	528.3
2026	559.9		37.1	522.7
2027	552.2		34.9	517.4
2028	544.7		32.5	512.2
2029	537.4		30.1	507.3
2030	530.3		27.7	502.6
2031	523.3		25.2	498.1
2032	516.6		22.7	493.9
2033	510.0		20.1	489.9
	Economic internal rate of return			**17.3%**

( ) = negative value, O&M = operation and maintenance, Re = Indian rupee.
[a] The O&M cost is estimated using an incremental approach considering with- and without-project scenarios. In the without-project case, O&M costs increase at a higher rate giving lower incremental O&M costs.
Source: Asian Development Bank staff estimates.

Table 3: Sensitivity Analysis

Sensitivity Parameter	**Variation** (%)	**EIRR** (%)	**Switching Value** (%)
Base case		17.30	
1. Project capital costs	+15	14.59	28.2
2. Benefits	–20	12.60	(22.4)
3. Operation and maintenance	+20	16.30	100.9
4. Commissioning delayed	1 year	14.40	
5. Combined (1+2+3+4)		12.00	

( ) = negative value, EIRR = economic internal rate of return.
Source: Asian Development Bank estimates.

12. **Distribution analysis.** The distribution of costs and benefits among stakeholders is assessed by comparing financial costs and benefits with economic costs and benefits (Table 4).[4] The economic net present value exceeds the financial net present value by Rs3,393 million for the overall investment. Electricity consumers are the greatest beneficiaries as a consequence of the gas saving pass-through, the electricity tariff, and the grant financing of 72% of the project's capital cost. The Indian economy is also a large beneficiary (approximately Rs1,365 million) due to the high value of resource savings that the investment delivers.

[4] The financial analysis is restated for the purposes of distribution analysis to consider the incremental impact of reduced fuel costs on APGC (representing a reduction in costs and a corresponding reduction in revenue, offset by the capital cost pass-through).

Table 4: Distribution of Benefits to Affected Groups (Rs million)

Item	Net Present Value at 12%			Distribution to Affected Groups	
	Economic	Financial	Difference	Government and Economy	Consumers
Benefits					
Incremental consumption	0	0	0		
Resource cost saving	3,782		3,782	3,782	
Revenue	0	(2,103)	2,103		2,103
Costs					
Investment	2,671	988	1,683	(1,683)	
O&M	267	259	8	(8)	
Corporate tax	0	(801)	801	(801)	
Net benefits	**844**	**(2,549)**	**3,393**	**1,365**	**2,103**

( ) = negative value, O&M = operation and maintenance, Re = Indian rupee.
Source: Asian Development Bank staff estimates.

13. **Sustainability.** The proposed investment is only a small part of the sector's overall investment need. However, it will make a discernable difference to the quantity and quality of electricity supply received by many consumers within the state. In the context of transparent tariff regulation that allows for APGC to recover its efficient costs, economic benefit flow is expected to be financially and institutionally sustainable. The proposed technology applied in the new power plant and growing demand for power in Assam will ensure that available gas resources are utilized in an efficient and sustainable manner to cater for power consumers' needs in the state.

B. Conclusion

14. The economic analysis confirms that the proposed tranche 1 investment is the least-cost solution and economically viable. The analysis yields an overall EIRR of 17.3%. Sensitivity and risk analysis demonstrates that the expected economic performance is robust. From an economic perspective the proposed investment should proceed.