Bangladesh

Sylhet Combined Cycle Power Plant Construction Project (I) (II)

Report Date: September 2002
Field Survey: September 2001

1. Project Profile and Japan's ODA Loan

Site Map: Sylhet District

Site Photo: No.2 Gas Turbine

1.1 Background

The installed capacity of power generation in Bangladesh was 1,437MW in 1986. More than 90% of the nation's power was generated by steam turbine, gas turbine or combined cycle power stations, which used domestically available natural gas. With energy consumption per capita of 44kWh (1984) and an electrification ratio of 4.54% (1986), the power sector in Bangladesh was less developed than in other developing countries in Asia. For instance, per capita electric energy consumption was 141kWh in Sri Lanka, 221kWh in Pakistan, 221kWh in India and 132kWh in Indonesia, in 1984. On the other hand, power demand in Bangladesh was growing rapidly, especially peak demand, which increased 13.9% yearly on average during the 2nd Five-Year Plan (1980-1985). As a result, the country suffered load shedding in 1986/87 due to the lack of sufficient power supply.

Table 1: Estimated Power Demand and Supply Balance at the Time of Project Appraisal

(Unit: MW)

Year	Installed Capacity	Firm Capacity*	Maximum Load	Demand/Supply Gap
1984	1,095	833	761	72
1985	1,115	853	887	▲34
1986	1,171	909	883	26
1987	1,587	1,131	1,160	▲29
1988	1,933	1,477	1,324	153
1989	2,293	1,777	1,551	226
1990	2,293	1,777	1,775	2
1991	2,383 (2,293)	1,867 (1,777)	2,006	▲139 (▲229)
1992	2,593 (2,503)	2,077 (1,987)	2,267	▲190 (▲280)

Source: JBIC
Note: 1) * Firm Capacity is capacity on a steady basis.
2) Figures in parentheses show levels without the project.

It was predicted that Bangladesh would suffer serious power shortage after 1991 despite efforts to expand generation capacity by installing large power plants in 1988 and 1989. In addition, as the Shahajibazar Gas Turbine Power Station (60MW) was scheduled to terminate operations in 1989, an alternative means of power generation in the Northeast region was required.

1.2 Objectives

To construct a 90MW Combined Cycle Power Plant at Fenchugani in the northeastern Sylhet District, in order to meet the growing electricity demand in Bangladesh and to secure a demand-supply balance for electric energy in Sylhet.

1.3 Project Scope

The project includes the following components:

(1) Installation of 90MW Combined Cycle Power Plant;
(2) Gas pipeline works between the North-South pipe line and the project site;
(3) Site preparation;
(4) 132kV connection between the existing transmission line and the power station;
(5) Training, and others related to the project; and
(6) Consulting services.

The Japanese ODA loan was to cover 85% of the total project cost, while the remaining 15% was to be covered by the Government of Bangladesh (GOB).

1.4 Borrower / Executing Agency

The Government of the People's Republic of Bangladesh / Bangladesh Power Development Board (BPDB)

1.5 Outline of Loan Agreement

	(I)	(II)
Loan Amount	8,170 million yen	5,943 million yen
Loan Disbursed Amount	8,063 million yen	5,917 million yen
Exchange of Notes	June 1987	September 1993
Loan Agreement	August 1987	September 1993
Terms and Conditions		
Interest Rate	1.25 % p.a.	1.0 % p.a.
Repayment Period (Grace Period)	30 years (10years)	30 years (10years)
Procurement	Partially Untied	Partially Untied
Final Disbursement Date	August 1997	August 2000

2. Results and Evaluation

2.1 Relevance

The primary objective of the project was to install a 90MW Combined Cycle Power Plant in Sylhet to meet the growing demand for electrical energy and to improve the stability and reliability of the power system in Sylhet, and in Bangladesh as a whole. In the period of the 4th Five Year Plan (1990-1995), the Government of Bangladesh was able to add 581MW of generation capacity to the nation's power sector, including the 90MW from the Sylhet Combined Cycle Power Plant. However, the net capacity increase was only 299MW due to rehabilitation required on some existing power stations. Consequently, the peak demand of 2,485MW forecast for the terminal year of the 4th Plan could not be accommodated. Peak demand served at the end of 1995 was 1,970MW. Nearly 46,962GWh of energy was generated during the period covered by the 4th Plan, 84 percent of the target of 55,735GWh. The achievement in the final year of the period was 10,806GWh, against a target of 13,577GWh. As seen in these figures, Bangladesh continues to suffer a serious power shortage.

Based on the performance of the power sector through the mid-1990s, the Government of Bangladesh set development objectives for the sector in its 5th Five Year Plan (1998-2002). The government put a priority on ensuring reliable and uninterrupted power supply through the maximum utilization of existing capacities, adding generation capacity by optimizing energy mix, and expanding the transmission and distribution network in a balanced fashion.

As the expansion and stable supply of electricity is still a priority power sector development objective, the relevance of this project is still valid.

2.2 Efficiency

2.2.1 Project Scope

The Loan Agreement concluded in August 1987 was estimated to cover almost 85% of the total project cost. As a result of the tender, however, it was found that the project could not be implemented for the originally estimated cost. The main factors causing the cost overrun were as follows: (1) It was found, as the result of tender evaluation in July 1990, that the cost for project equipment and materials increased sharply in the international market after 1987; and (2) additional civil work was required due to damage caused by flooding in 1988. In light of these external factors, which were beyond control of the Borrower, it was decided, after examining several alternatives, to provide an additional ODA loan for the project in 1992. After JBIC's second project appraisal in 1992, the construction of a cooling tower was added to the project scope. It was determined that the construction of a dam upstream in India would make it difficult to get enough water from the River Kushiyara in the dry season (from December to April). In addition, modification of the output capacity of the generator, from 90MW to 95MW, was authorized at the second appraisal based on a proposal from the contractor. There was no major modification of the project scope after 1992.

2.2.2 Implementation Schedule

The original project implementation schedule was for a total of 50 months, from April 1987 (selection of consultants) to May 1991 (commissioning), but the completion of the project was rescheduled for August 1996 (and the total duration extended to 113 months accordingly) at the time of the second appraisal in 1992. Actual project implementation lasted 82 months, from February 1989 to November 1995. The project was completed nine months ahead of schedule, having taken 31 months less than estimated in the revised implementation schedule. The commissioning dates for the turbines were as follows: August 1995 (Gas Turbine No.1), September 1995 (Gas Turbine No.2), November 1995 (Steam Turbine).

2.2.3 Project Cost

The original total project cost was 9,685 million Yen (incl. ODA loan amount: 8,170 million Yen), and the final approved project cost in 1993 was 16,603 million Yen (incl. ODA loan amount: 14,113 million yen). The actual total project cost was 14,570 million Yen (incl. disbursed amount: 13,980 million Yen). The main reasons for the increased project cost were, as explained above, (1) the unexpected equipment and material cost overrun during project implementation, and (2) the additional civil work required to repair flood damage.

2.3 Effectiveness

2.3.1 Gross Power Generation

Actual gross power generation increased after project completion in 1995, nearly reaching the expected annual target. However, after 1997, power generation output declined sharply, largely due to technical faults in operation and the breakdown of two gas turbines: No. 2 in April 1998 and No. 1 in February 1999. The damage to gas turbine No. 2 was caused by either abnormal burning, or an explosion, of fuel gas. Turbine No. 1 suffered damage to a turbine blade.

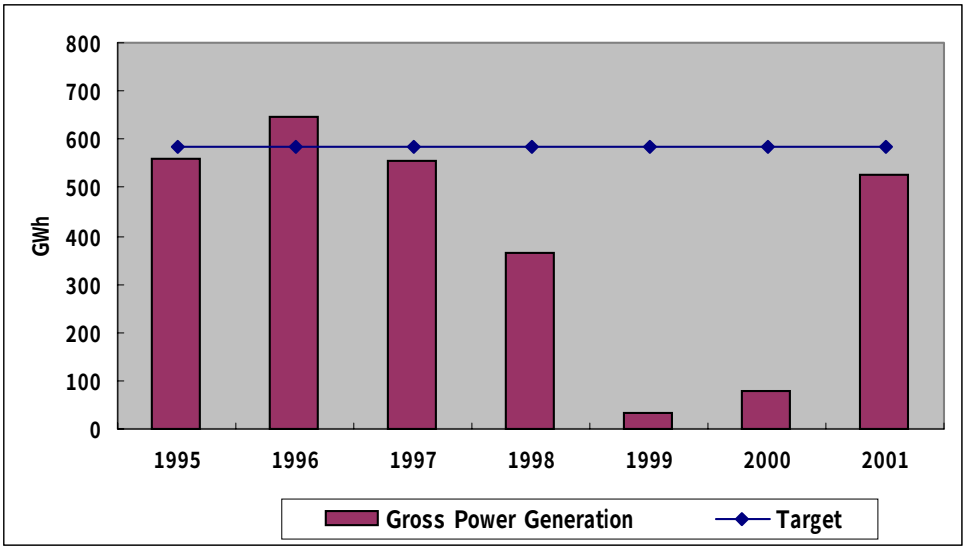
Also, the malfunction of the cooling water system for the steam turbine in the dry season compromised the performance of the gas turbine from 1995 to 2000. The steam turbine was designed to use cooling water from the Kushiyara River in the wet season (from May to November), and from well water (underground water) treated at the cooling tower in the dry season. However, after commissioning in 1995, it was found that the underground water had a high iron content, which could affect the function of the steam turbine. The treatment system in the cooling tower was unable to fully filter the iron.

Therefore, between 1995 and 2000, the steam turbine was shut down for about five months every year during the dry season due to the lack of cooling water. In addition, between February 1999 and April 2000, when neither gas turbine was operating, the operation of the steam turbine was suspended.

BPDB later completed rehabilitation work on gas turbines No. 1 and No. 2, and repair of the cooling tower was nearly complete in 2001. BPDB expects to realize the full operation of the plant shortly.

The project plant did not achieve its power generation targets in the five years after 1996, but generation levels did increase over that period, and the plant is expected to achieve its annual target shortly.

Figure 1: Gross Power Generation of the Project



Source: BPDB
Note: Target is assumed as: 95MW x 24hours x 365dasy x 0.70 (30% loss) = 582,540MWh/year

Table 2: Faults of Gas Turbine No. 1 and No. 2

	Date of Completion	Date of Fault / Breakdown occurred	Date of Re-Start of Operation	Duration of No Operation
Gas Turbine No. 1 (31 MW)	Dec. 1994	Feb. 1999	Sep. 2000	19 months
Gas Turbine No. 2 (31 MW)	Jan. 1995	Apr. 1998	Apr. 2001	36 months
Steam Turbine No. 1 (33 MW)	Jun. 1995	-	-	-

Source: BPDB

Table 3: Operation Month of the Plant

(Unit: month)

	Year of Completion (1995)	Year 2 (1996)	Year 3 (1997)	Year 4 (1998)	Year 5 (1999)	Year 6 (2000)	Year 7 (2001)
Gas Turbine No. 1 (31 MW)	11.45	11.76	10.78	11.39	1.74	3.00	11.50
Gas Turbine No. 2 (31 MW)	10.32	11.75	11.22	3.17	0	0	7.50
Steam Turbine No. 1 (33 MW)	5.14	7.93	6.47	6.40	0	3.00	11.50

Source: BPDB

2.3.2 Other Operational Indicators

Naturally, the performance in gross power generation reflected on other operational indicators, such as availability factor and utilization factor of the plant. For instance, the utilization factor of the plant peaked in 1996 (81.9%). In 1999 and 2000, utilization reached a low. Most operation was suspended (4.5% in 1999; 10.0% in 2000) due to serious damage to gas turbines No. 1 and No. 2. Utilization recovered to 66.7% in 2001.

Table 4: Operational Indicators

		Year of Completion (1995)	Year 2 (1996)	Year 3 (1997)	Year 4 (1998)	Year 5 (1999)	Year 6 (2000)	Year 7 (2001)
Peak Demand in Sylhet District (MW)	A	50	55	60	65	70	75	80
	B	45	48	55	60	65	70	74
Availability Factor * (%)	A	100	100	100	100	100	100	100
	B	92.9	86.4	78.0	57.4	4.8	n.a.	76.7
Utilization Factor ** (%)	A	100	100	100	100	100	100	100
	B	71.0	81.9	70.5	46.1	4.5	10.0	66.7

Source: BPDB

Note: 1) A=Annual Target Level (Original), B=Actual
2) Fiscal year of Bangladesh is from Jul. to June.
3) * = Operating Hour for a year / {365 (day)×24 (hr)} ×100
4) ** = Annual Generated Energy (kWh)÷{Rated Output (kW)×365 (day)×24 (hr)}×100

Recently, BPDB has developed plans to expand the generation capacity of the plant by installing gas turbines No. 4 and No. 5 by 2004. It is expected that this project will be financed by export credit.

2.3.3 Recalculation of FIRR (Financial Internal Rate of Return)

In the project appraisal, FIRR was 9.67%. FIRR was recalculated with up-dated information, resulting in a figure of 7.8%. The assumptions for the calculation of FIRR were as follows:

(Assumptions for FIRR)
Project life: 20 years after commencement of commercial operation
Benefit: Income of sale of power from the project
Cost: (i) Project cost, (ii) fuel cost, and (iii) O&M cost

2.4 Impact

2.4.1 Impact on Total Power System

As shown in Table 5, although total installed capacity, generation capacity and firm capacity increased, the

total power shortfall in the system has not improved yet. This is because, in Bangladesh generally, power demand tends to grow as supply capacity increases since the existing power supply capacity has not fulfilled the potential power demand. Looking at load shedding from 1987/88 to 2000/2001 in Table 6, it can be seen that the worst year was 1997/98, with 346 days (2,119 hours). The situation has not improved much: load shedding occurred on 283 days (1,042 hours) in 2000/01. According to BPDB's projection, generation capacity (i.e. firm capacity) is expected to accommodate increasing peak demand by 2003/2004. But it should be noted that this does not necessarily mean that the majority of the population in Bangladesh will have access to electricity, since the current electrification ratio in Bangladesh is about 18%. Further development of the power system is required.

Looking at the contribution of the project to the total power system in Bangladesh, it should be noted that Sylhet Combined Cycle Power Plant had a 3.3% share of total installed capacity in 1995/96 and 2.6% in 1999/00. With the expansion of overall generation capacity in the system, the Sylhet plant's share has declined gradually, but it is evident that the project has made a positive contribution to the total power system by providing 95MW of generation capacity. However, as discussed in the previous section, its potential contribution has not fully materialized.

Table 5: Installed Capacity, Generation Capacity, Firm Capacity, Demand Forecast, Demand Served, Load Shedding and Reserved Margin

Year	Installed Capacity (MW) *1	Generation Capability (MW) *2	Firm Capacity (MW) *3	Demand Forecast (MW) *4	Demand Served (MW) *5	Load Shedding (MW) *6	Reserve Margin (%) *7
1987/88	2,146	1,859	1,393	n.a.	1,317	200-10	41
1988/89	2,365	1,936	1,470	n.a.	1,393	170-10	39
1989/90	2,352	1,834	1,368	n.a.	1,509	180-15	22
1990/91	2,350	1,710	1,253	n.a.	1,640	340-15	5
1991/92	2,398	1,724	1,243	n.a.	1,672	550-25	3
1992/93	2,608	1,918	1,437	n.a.	1,823	480-20	5
1993/94	2,608	1,881	1,400	n.a.	1,875	540-23	0
1994/95	2,908	2,133	1,652	2,038	1,970	537-10	8
1995/96	2,908	2,105	1,624	2,220	2,087	545-10	1
1996/97	2,908	2,148	1,667	2,410	2,114	674-20	2
1997/98	3,091	2,320	1,839	2,638	2,136	711-32	9
1998/99	3,603	2,850	2,369	2,881	2,449	774-16	16
1999/2000	3,711	2,665	n.a.	3,149	2,665	536-10	0

Source: BPDB

Note: 1) Installed Capacity as of June.
2) Generation Capability is the Maximum available generation capacity after maintenance outages.
3) Firm Capacity is capacity on a steady basis.
4) Demand Forecast is the Reference Forecast of Power System Master Plan prepared in 1995.
5) The dates of maximum demand and maximum available generation capacity may not be the same.
6) Load shedding figures show the maximum and minimum in each year.
7) Reserve Margin (%) = (Generation Capability - Demand Served) ×100 / Demand Served

Table 6: Load Shedding 1987/88-2000/2001

Year	Load shedding during peak hours	
	Days	Duration (hr)
1987/88	54	74
1988/89	62	117
1989/90	29	51
1990/91	70	113
1991/92	232	660
1992/93	264	638
1993/94	210	670
1994/95	230	763
1995/96	301	1,007
1996/97	338	2,872
1997/98	346	2,119
1998/99	335	1,690
1999/2000	255	872
2000/2001	283	1,042

Source: BPDB

Table 7: Planned Load - Generation Balance (Summary)

(Unit: MW)

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Generation Capability							
Existing: Public	3,145	3,165	3,082	2,984	2,840	2,814	2,694
Existing: Private	450	450	450	450	450	450	450
Total (Existing)	3,595	3,615	3,532	3,434	3,290	3,264	3,144
New: Public	0	100	679	1,579	2,439	2,589	2,949
New: Private	235	400	1,020	1,020	1,320	1,470	1,470
Total (New)	235	500	1,699	2,599	3,759	4,059	4,419
Peak Demand [2)]	3,394	3,659	4,393	4,766	5,172	5,603	6,071
Firm Capacity [1)]	3,180	3,434	4,251	5,053	6,069	6,313	6,553
Surplus (Shortfall)	(214)	(225)	(142)	287	897	710	482
Reserve Margin (%)	13%	12%	19%	27%	36%	31%	25%

Source: BPDB
Note: 1) Firm Capacity is capacity on a steady basis.
2) Reference forecast up to 2001-02 & thereafter high forecast of Power System Master Plan prepared in 1995.

2.4.2 Impact on Utilization of Natural Gas

Based on the Government Policy promoting utilization of domestically available natural gas for power generation, BPDB has constructed power plants that use natural gas for fuel, particularly in the eastern part of Bangladesh, where natural gas production and its supply network system are established. Sylhet Combined Cycle Power Plant was one of the power plants to which natural gas was supplied. Detailed data regarding natural gas consumption at the plant were not available, but power generation overall in Bangladesh has consumed, on average, over 45% of total domestic natural gas production. The switch from imported oil to domestic natural gas has had a positive impact on foreign currency savings. Therefore, it is obvious that the project has had a positive impact on the utilization of natural gas and, moreover, on foreign currency savings, although the degree of its impact is not substantial.

Table 8: Volume of Natural Gas Production and Utilization for Power Generation

(Unit: million cubic meter)

	Year of Appraisal (1991)	Year 2 (1992)	Year 3 (1993)	Year 4 (1994)	Year 5 (1995)	Year 6 (1996)	Year 7 (1997)	Year 8 (1998)	Year 9 (1999)
Total Natural Gas Production in Bangladesh	4,650	5,060	5,512	5,964	6,621	7,161	6,923	7,512	8,244
N.G Utilization for Energy Production	2,308 (49.6%)	2,516 (49.7%)	2,647 (48.0%)	2,771 (46.5%)	3,043 (46.0%)	3,138 (43.8%)	3,137 (45.3%)	3,495 (46.5%)	3,989 (48.3%)

Source: Statistical Year Book of Bangladesh 1999, BBS.

2.4.3 Impact on Environment

The in-service assessment of the impact on environment was conducted by sending the questionnaire to BPDB. According to BPDB, there were no major negative or positive impacts on the natural environment caused by implementation of the project.

2.4.4 Impact on Local Residents

The project did not involve any relocation or resettlement of local residents.

2.5 Sustainability

2.5.1 Operation and Maintenance

Bangladesh Power Development Board (BPDB), established in 1972, is responsible for the generation, transmission, and distribution of electricity throughout the country, except for areas where the Dhaka Electricity Supply Authority (DESA) and the Rural Electrification Board (REB) oversee distribution. BPDB is under direction of the Ministry of Energy and Mineral Resources.

Actual day-to-day O&M activities are handled by Sylhet Combined Cycle Power Plant, and the BPDB head office in Dhaka provides for technical training. There are 70 O&M staff members in the plant. The general impression from the site survey is that it was well maintained.

2.5.2 Technical Capacity

Generally, local maintenance staffs at the plant perform scheduled maintenance based on the maintenance plan prescribed by the manufacturer. Major maintenance and work to repair breakdowns are generally performed in the presence of foreign experts from the manufacturer, since the local maintenance staff does not have experience in carrying out major inspection /overhauling works.

Although the number of O&M staff seems to be satisfactory, their technical skills need to be improved as: (i) BPDB did not provide technical training for the development of O&M personnel, (ii) quite a few maintenance staff members who received technical training from the manufacturer at the initial installation were transferred to other stations or sections/departments of BPDB or have already left BPDB, and (iii) technical skills have not been transferred effectively to new staff through on-the-job training (OJT).

In the project appraisal, it was noted that mechanical trouble resulted in part from the fact that BPDB ran its generators without breaks for maintenance, because of the country's chronic power shortage. In addition, the working environment is not favorable to the workers, due to the isolated environment and an irregular shift schedule. As a result, it has not been easy to maintain workers' motivation and discipline.

Through the field survey and several interviews, the consultant (i.e. evaluator) concluded that if BPDB had operated the plant using the required operational procedures and implemented scheduled and

preventive maintenance, the damage to gas generators No.1 and No.2 could have been avoided

The weakness of BPDB's O&M capacity was recognized at the time of the project appraisal, and, as a result, O&M technology transfer was added to the consulting service component at JBIC's recommendation. However, despite these efforts, BPDB's O&M capacity has not improved as much as JBIC expected. This implies that there is a limit to strengthening institutional capacity with a project-based approach and that medium- and long-term strategies for continuous technical cooperation may be important.

2.5.3 Financial Status

Comparing the financial statements made available by BPDB for 1997/98 and 1998/99, it can be seen that operating income increased about 60%, with the growth of operating revenues (12.22%) exceeding operating expenses (8.9%). However, net income has fallen, due to large foreign exchange losses. Accounts receivable increased about 27% (about 5.3 billion Taka) from 1997/98 to 1998/99.

Table 9: Comparative Income Statement

(Unit: Taka)

	Actual FY 1998-99	Actual FY 1997-98	Increase/ Decrease
Operating Revenue			
Electricity Sales	23,628,358,167	21,018,838,094	12.42%
Other Operating Income	415,753,466	406,154,999	2.36%
Total Operating Revenue	**24,044,111,633**	**21,424,993,093**	12.22%
Operating Expenses			
Fuel Cost	9,669,177,843	9,940,558,885	-2.73%
Electricity Purchase from IPP	1,216,811,509	-	100.00%
Depreciation	6,655,652,647	6,438,606,768	3.37%
Repair & Maintenance	1,571,851,586	1,035,305,457	51.82%
Personnel Expenses	1,886,458,048	1,832,089,820	2.97%
Office and Administrative Expenses	798,612,352	770,115,372	3.70%
Assets Insurance Fund	15,000,000	15,000,000	0.00%
Total Operating Expenses	**21,813,563,985**	**20,031,676,302**	8.90%
Operating Income / (Loss)	**2,230,547,648**	**1,393,316,791**	60.09%
Non-Operating Expenses			
Interest on Loans	2,554,609,968	2,583,228,343	-1.11%
Loss due to Exchange Rate Fluctuation	2,879,972,218	(1,107,429,706)	-360.06%
Net Non-Operating Expenses	5,434,582,186	1,475,798,637	268.25%
Net Income/ (Loss)	**(3,204,034,538)**	**(82,481,846)**	3784.53%

Source: BPDB

Table 10: Balance Sheet

Property & Assets (Unit: Taka)

	June 30, 1999	June 30, 1998
Fixed Assets		
Written Down Value	121,940,554,434	119,528,365,051
(Project-in-Progress)	20,065,362,595	19,983,798,461
Total Fixed Assets	142,005,917,029	139,512,163,512
Current Assets		
(Accounts Receivable-Trade)	24,933,693,608	19,592,134,456
(Accounts Receivable-Others)	2,904,685,591	2,831,987,131
(Provision for Bad & Doubtful Debts)	(527,223,891)	(464,059,767)
Total Current Assets	44,927,737,560	38,748,605,061
Total Property & Assets	**187,992,166,130**	**178,414,204,936**

Capital & Liabilities (Unit: Taka)

	June 30, 1999	June 30, 1998
Authorized Capital	100,000,000,000	100,000,000,000
Capital & Reserve	81,807,854,726	81,994,614,003
Long Term Liabilities [1]	54,551,085,717	50,924,087,690
Medium Term Liabilities [2]	1,921,193,151	1,948,363,122
Current Liabilities	45,597,729,008	39,268,952,619
Clearing Account [3]	4,114,303,528	4,278,187,502
Total Capital & Liabilities	**187,992,166,130**	**178,414,204,936**

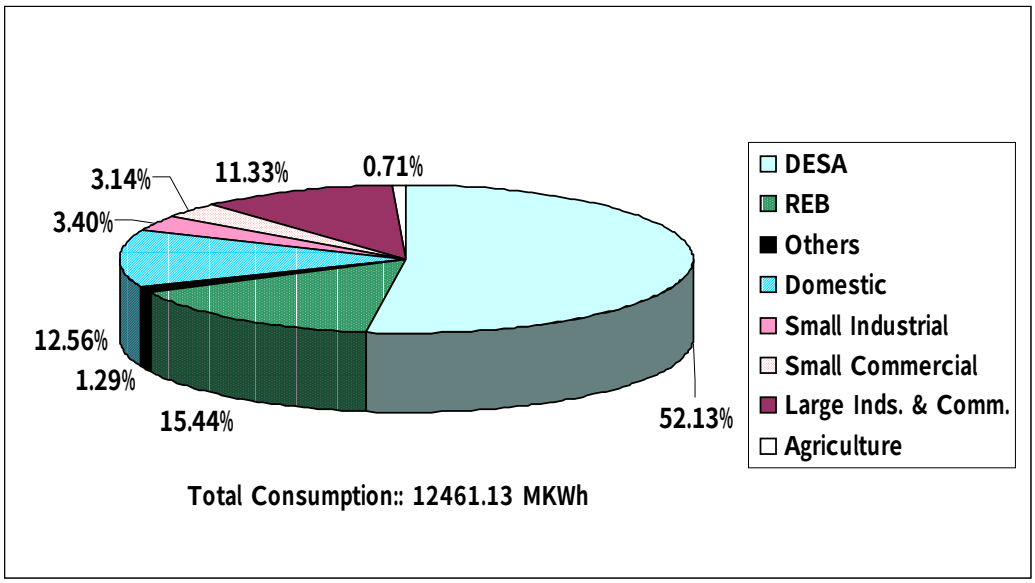
Source: BPDB

Note: Selected items shown in the table:

1) Long term liability includes government loans, foreign loans, and debenture/loans.
2) Medium tem liability includes security deposits (consumers), GPR&CPF, and pension funds.
3) The clearing account is used for inter office transactions, the transfer of funds form the head office to local offices and for fund transfer from the field to the head office.

According to the latest financial statements of BPDB, accounts receivable (principal amount) at the end of June 2001 totaled 33,995.90 million Taka, equivalent to the amount billed for 12.014 months. DESA owed 24,816.986 million Taka, so if DESA had paid in full, the amount outstanding would have equaled only 3.24 months' worth (please see breakdown by type of consumer in Figure 2). The low collection ratio is one of the major constraints affecting the financial soundness of BPDB.

Figure 2: BPDB Consumers (FY2000)



Source: BPDB

2.5.4 Power Sector Reform

The Government of Bangladesh has set development objectives for the power sector in its 5th Five Year Plan (1997-2002) as follows: (1) to ensure reliable and uninterrupted power supply and the balanced expansion of the transmission and distribution network; (2) to make utilities self-reliant through efficient management, reasonable restructuring of electricity tariffs and favorable financial arrangements; (3) to reduce system loss[1]; (4) to encourage private sector participation in the power sector; and (5) to expand power supply in rural areas.

In cooperation with the World Bank and the Asian Development Bank, GOB established (i) the Power Grid Company of Bangladesh (PGCB) to take over transmission from BPDB; and (ii) the Dhaka Electric Supply Company (DESCO) to succeed DESA. This privatization of the power sector is ongoing.

There is a series of power sector reforms on the agenda: (1) the establishment of an independent regulatory board, (2) reform of electricity tariffs, (3) division of BPDB into four regional units, and (4) the provision of necessary legal arrangements for implementation of the reforms. Nonetheless, the pace of reform remains very slow.

JBIC, in cooperation with JICA, will designate one Bangladesh power sector project as a model for improving O&M, and is making efforts to support improvements in executing agencies' performance in financial management, organization, total quality management and other key areas. It is expected that the results of these efforts will be incorporated into this project.

[1] The higher rate of system loss is one of the major constraints in the power sector of Bangladesh. Recent statistics indicate that system loss in the overall power system is 33.65%. The main reasons can be described as: (a) illegal connection to incoming lines, (b) broken consumer meters, (c) manipulation of consumer meters, (d) manipulation and/or no issuance of invoices, and (e) manually issued invoices.

Comparison of Original and Actual Scope

Item	Original*	Actual
① Project Scope		
1. Power Plant	Total: 90MW - About 30 MW Gas Turbine (Generator x 2 units) - About 30 MW Steam Turbine (Generator x 1 unit)	Total: 95MW - 31 MW Gas Turbine x 2 units - 33 MW Steam Turbine x 1 unit
2. Natural Gas Supply equipment Grid substation	- Gas metering station - Pressure regulating facilities	Same as original plan
3. Grid Substation	- Gas filtration system (132 kV Sub-station)	Same as original plan
4. Other related works	- Station auxiliaries - Control equipment - Fuel Supply equipment - Water supply equipment including water and condenser cooling water - Overhead travelling crane	Same as original plan
5. Consulting Services	Total: 125 M/M	Total: 118 M/M
② Implementation Schedule (from Selection of Consultant to Commissioning)	April 1987 – August 1996 (113 months)	February 1989 – November 1995 (82 months) (Commissioning) Gas Turbine No.1: Aug. 1995 Gas Turbine No.2: Sept. 1995 Steam Turbine: Nov. 1995
③ Project Cost		
Foreign currency	13,819 million Yen	13,670 million Yen
Local currency	2,784 million Yen (898 million Taka)	604 million Yen (242 million Taka)
Total	16,603 million Yen	14,570 million Yen
ODA Loan Portion	14,113 million Yen	13,980 million Yen
Exchange Rate	1 Taka = 3.1 Yen (as of November 1992)	1 Taka = 2.5 Yen (as of February 1996)

Independent Evaluation on Sylhet Combined Cycle Power Plant Project (I), (II)

1. Electricity is an essential input for economic growth and socio-economic development. Although the national development policies and plans have attached importance to power sector development, Bangladesh has been experiencing chronic shortage in electricity supply affecting economic activities. In order to meet the growing demand for electricity, implementation of Sylhet Combined Cycle Power Plant Project (I), (II) was completed in 1995 with financial assistance from JBIC and the project has been put into operation since then.

2. There is a strong relevance of the project in the context of socio-economic development objectives and the power sector development plans and programmes of Bangladesh. The project is also justified in view of the government's longer term policy to make electricity available to all citizens the majority of whom still do not have access to the utility. The financing of the project by JBIC is in accordance with its mandated policy to contribute to economic and social development in developing countries.

4. The project has been largely effective in achieving the desired outputs including gross power generation. Other operational indicators like availability factor, utilization factor etc. lend support to its effectiveness as well. The operation of the project suffered serious setback due to damage and malfunctioning of the systems causing drastic reduction in power generation for two years. The system, however, was restored to recover most of the lost capacity in the following year.

5. According to available data from BPDB sources, combined cycle accounted for 4.85% of the total installed capacity in 2000. The rest 95% capacity comprises steam turbine, gas turbine, hydro and diesel plants. The share of combined cycle in total installed capacity is expected to rise because of fuel and cost efficiency. Fuel cost per kilowatthour generation in 1998/99 was Tk. 0.46 for combined cycle compared to Tk.0.57 for overall thermal generation under BPDB system. The efficiency however has been constrained by inadequate operation and maintenance, lack of technical skills of the O&M staff and other external factors. As it is noted in the evaluation report the original project implementation period was extended and the original project cost was also revised upward.

6. The project makes a direct contribution to increase the country's installed capacity and satisfy the unserved power demand for expanding economic activities and population growth. The use of indigenous natural gas by the project reduces the country's dependence on imported oil and thereby contributes to foreign currency savings. Although not enumerated in the post-evaluation, the impact of the project on the local economy and poverty alleviation is considered positive. Poverty reduction and improved living standards through electrification have been evidenced in Bangladesh and elsewhere in the world.

7. As per environmental regulations, power generation project requires detailed Environmental Impact Assessment (EIA) as well as regular environmental monitoring in Bangladesh. However, since gas is a clean fuel the environmental impact of the project is considered to be within the permissible limit.

8. The sustainability of the project as it has been noted in the post-evaluation report depends on several factors. These include adequate staff strength and staff retention, improved technical skills of the O&M staff, proper motivation and discipline of the workers, technology transfer, institutional reforms, tariff rationalization and financial discipline and soundness of BPDB. In addition, efficient planning can minimize the risk of operation and reduce cost.

9. According to Fifth Five Year Plan, major impediments to BPDB's efficient operations include lack of management and commercial independence and an unclear definition of the corporate structure and responsibilities. Based on the successful experiences in other countries, various reforms measures for restructuring the energy sector have already been underway although at a slow pace. It is envisaged that BPDB can be restructured (unbundled) along functional lines into separate entities/companies – one handling generation, another operating the transmission system, and a separate company responsible for distribution. At the initial stage different units, for example, the generating stations under the generation company would be treated as separate cost/profit centres to enjoy more operating and management authority. The reforms ultimately aim at commercialization of the electricity business with greater participation of the private sector and reduced role of the government.

10. In addition to project funding, JBIC and other development partners can make significant contribution to the reform process though supporting comprehensive programme of capacity building leading to improved financial performance and total quality management of the executing agencies.