ASIAN DEVELOPMENT BANK

SAP: BAN 2003-30

SECTOR ASSISTANCE PROGRAM EVALUATION

OF ASIAN DEVELOPMENT BANK ASSISTANCE

TO BANGLADESH POWER SECTOR

December 2003

CURRENCY EQUIVALENT

Currency Unit – Taka (Tk)

At Operations Evaluation (August 2003)

Tk1.00	=	$0.01786
$1.00	=	Tk56.0000

ABBREVIATIONS

ADB	–	Asian Development Bank
AR	–	appraisal report
BPDB	–	Bangladesh Power Development Board
BTOR	–	back-to-office report
DESA	–	Dhaka Electric Supply Authority
DESCO	–	Dhaka Electric Supply Company
DfID	–	Department for International Development
ERC	–	Energy Regulatory Commission
ERP	–	Enterprise Resource Planning
GDP	–	gross domestic product
GWh	–	gigawatt-hour
IPP	–	independent power producer
JBIC	–	Japan Bank for International Cooperation
KfW	–	Kreditanstalt fur Wiederaufbau
km	–	kilometer
kV	–	kilovolt
kVA	–	kilovolt-ampere
kW	–	kilowatt
kWh	–	kilowatt-hour
LCG	–	Local Consultative Group
LRMC	–	long run marginal cost
m	–	meter
MW	–	megawatt
NGO	–	nongovernment organization
O&M	–	operation and maintenance
OEM	–	Operations Evaluation Mission
PBS	–	Pally Bidyut Samity (rural electricity cooperatives)
PCR	–	project completion report
PGCB	–	Power Grid Company of Bangladesh
PPA	–	Power Purchasing Agreements
PPAR	–	project performance audit report
REB	–	Rural Electrification Board
RPC	–	Rural Power Company
RRP	–	Report and Recommendation of the President
SAPE	–	sector assistance program evaluation
SBU	–	strategic business unit
SCADA	–	supervisory control and data acquisition
SDR	–	special drawing right
TA	–	technical assistance
TCR	–	technical assistance completion report
USAID	–	United State Agency for International Development

NOTE

(i) In this report, "$" refers to US dollars.
(ii) The fiscal year (FY) of the Government ends on 30 June.

Operations Evaluation Department, SE-1

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EXECUTIVE SUMMARY

In recognition of its unquestionable role in economic development and poverty alleviation, the provision of electricity has been one of the mainstays of the Asian Development Bank's (ADB) assistance programs, comprising about 20% of its total portfolio and averaging about $1 billion a year. For Bangladesh, since it joined ADB in 1973, the power sector has received 16 public sector loans and one private sector investment for a total of about $1.122 billion, as well as 19 technical assistance (TA) grants totaling $8.78 million.

The objective of the Sector Assistance Program Evaluation (SAPE) is multifold: (i) to provide a comprehensive and independent assessment of the impact of ADB's assistance over the past 30 years, on an aggregated basis, on the sector's development and financial performance, as well as its wider impact on economic development and poverty reduction; (ii) to identify lessons learned, and (iii) to identify critical areas where ADB operations need improvement and where ADB can have a significant impact. The scope of the evaluation encompasses all assistance to the power sector, which has been extensive, covering generation, transmission, and distribution.

Since it is not possible to evaluate the impact of ADB's assistance without examining the performance of the power sector as a whole, the evaluation adopted a systemic approach to the power sector. It is also based on a combination of desktop review of ADB project documents, interviews with key stakeholders, an inspection of key project sites and facilities, and a survey of electricity consumers. Due to limited timeframe and resources, seven projects (including 6 public sector loans and 1 private sector investment) and 5 TAs (4 advisory TAs and 1 project-preparatory TA) were chosen for in-depth evaluation.

ADB's assistance over the past three decades has aimed to help the Government in achieving its development goals by closely addressing the system needs at each stage of power sector development. Between 1973 and 1982, assistance was focused on rehabilitation and expansion of generation capacities, which were largely destroyed during the War of Liberation. Between 1983 and 1989, the sector operational strategy shifted to improving transmission and distribution. Following a brief gap in lending activities between 1989 and 1995, and from 1995 onwards, ADB became the lead development partner in the sector. Its strategy has evolved significantly from supporting expansion of capacities through public sector loans to one of continued physical investment in system rehabilitation and expansion combined with engagement of the Government through TAs, loan covenants, and extended policy dialogue on a reform agenda with an objective of sector unbundling and corporatization, and greater private sector participation.

In-depth review of available project documents, site inspections, and interviews with key stakeholders indicate that ADB has supported technically sound projects that addressed the needs at the time of the Bangladesh power sector. The projects have mostly met their physical objectives of system expansion. The power generation and transmission facilities observed are, in general, well designed and constructed though with a few exceptions. The operation and maintenance of the recently constructed generation plants is exemplary. The older generating facilities appear to be less well maintained for various reasons such as a lack of funds and reserve capacity, delayed procurement of parts, and a less dedicated management culture toward preventive maintenance. Extensive delay in implementing public sector projects, averaging 3.5 years, was the main problem experienced. This deferred project benefits and added to the continuing inadequacies in generation, transmission and distribution.

Among the five TAs evaluated in-depth, the project-preparatory TA failed to prepare a project that was suitable for ADB financing. The four advisory TAs each achieved or substantially achieved their respective objectives in the areas of sector master planning, upgrading of financial management of key sector entities, i.e., Bangladesh Power Development Board (BPDB) and Dhaka Electric Supply Authority (DESA), solicitation of private sector investment in generation, and corporatization of existing power sector units. However, sustainability of the TA on upgrading the financial management of key sector entities may be problematic due to lack of ownership and requirement for continued funding.

The impact of ADB's assistance was, at one level, reflected in sector performance. Firstly, while ADB's assistance helped to keep the overall system in approximate balance, it did not meet full capacity requirements in that demand has always run ahead of capacity. Secondly, despite progress made by BPDB and DESA in reducing system losses and improving collection of billing, the assistance fundamentally failed to improve the two traditional public utilities' operational and financial performance. Thirdly, largely owing to the persistent engagement by and assistance from ADB, the unbundling and corporatization of the power sector occurred, though in a piecemeal manner, with 4 new entities created out of the BPDB and DESA structure. The experience of the new entities shows that a more commercially oriented management culture can lead to performance improvement. In addition, ADB's assistance led to service areas near Dhaka and other places being transferred from the management of BPDB and DESA to rural electricity cooperatives (Pally Bidyut Samity [PBS]) through boundary rationalization, which quickly resulted in reductions in system losses and improvements in revenue collection. Fourthly, private investment, particularly in generation, took place in such a substantial manner that it provided most of the increased 1,000 MW installed capacity since the mid-1990s. In support of this trend, ADB provided pivotal assistance to Bangladesh in solicitation of private investment using well designed and accepted tendering procedures.

At the next level, the modest improvement in the sector's financial and operational performance was not translated, however, into greater customer satisfaction among urban residential, commercial, and industrial consumers. Interviews with selected industrial and commercial customers indicate that most users are profoundly dissatisfied with the quality of the grid supply, irrespective of particular utilities. Most industrial consumers have their own captive power generation to deal with the unreliable grid power. A World Bank survey indicates that the satisfaction level among urban households with electricity supply is generally less than 10%. It also estimated that the economic costs of unreliable power supply amounts to approximately $1 billion per annum.

The main issues facing rural customers or would-be customers are both low connection rates, which rose from 1% in the early 1970s to about 30% at the present, and poor quality of supply. The socioeconomic survey conducted as part of the evaluation indicates that the availability of electricity is positively correlated with a wide range of economic and social indicators, including higher participation rates by women in income generation, better nutrition, higher wages for the landless, and more studying and working time during evenings. However, the survey has not found statistically significant evidence that rural households with electricity have higher incomes than those without electricity, as suggested by an earlier survey. This may be caused by a series of other factors such as nongovernment organization intervention, distance to national road or urban areas, and population mobility.

The power sector is faced with multiple issues or challenges, both physical and financial. The financial challenge is critical and daunting. Many entities in the sector are financially

insolvent. BPDB owes the Government about Tk56 billion (or about $1 billion) in unpaid loans to meet capital costs and interest charges. In FY2002, the sector suffered a net operating loss of Tk7.87 billion. The sector adopts poor accounting practices, characterized by delays in finalizing accounts and completing audits, doubtful figures in the published accounts, overstating asset values (slow depreciation) and underestimating expenses, as well as inadequate provision for bad debts and personnel retirement liabilities. One of the crucial factors is the low tariffs, which are at levels that do not enable cost recovery between sector entities and are about half the long run marginal cost of power supply. Other factors include low billing collection rates and high system losses.

ADB's assistance has been relevant by addressing the changing needs of the sector over time. ADB's consistent support has been a key factor behind the sector's ongoing drive for commercialization, which helps maintain the country's macroeconomic stability. On efficacy and efficiency, most of ADB's projects have achieved their objectives of system expansion at the project level, albeit often with serious delays. Such delays diminished the projects' efficiency by delaying the benefits. This partly contributed to system supply continuously lagging behind demand. On sustainability, the technical engineering and operations of ADB projects have been generally satisfactory. The main areas where sustainability is questionable relate to the poor financial performance of the sector and its cumbersome procurement procedures. ADB assistance, particularly the more recent projects and TAs, has had significant impact on institutional structure. The power sector today is very different from that of 30 years ago. Although it is far from being commercially viable, different newly corporatized and private sector entities have demonstrated that reliable power supply at affordable and yet financially viable prices can be achieved in Bangladesh. The prices charged by the IPPs are reasonable but enable profitable operations. Some of the distribution entities such as DESCO and the larger and longer established PBSs are operating profitably or close to break-even and in accordance with good commercial principles, although they have the advantage of receiving power supplies from BPDB and DESA at subsidized prices. The continuous poor performance of BPDB and DESA are reasons for deepening reform rather than relinquishing it. This reflects continued need for further change in the structure of decision making. Overall, ADB's assistance to Bangladesh's power sector has substantially achieved its objectives at the project level but much remains to be done to achieve its sector objectives, as well as wider and more far-reaching economic and poverty-reduction impact. The priority areas for urgent improvement in sector performance include financial management, demand and load management, and system improvement and expansion.

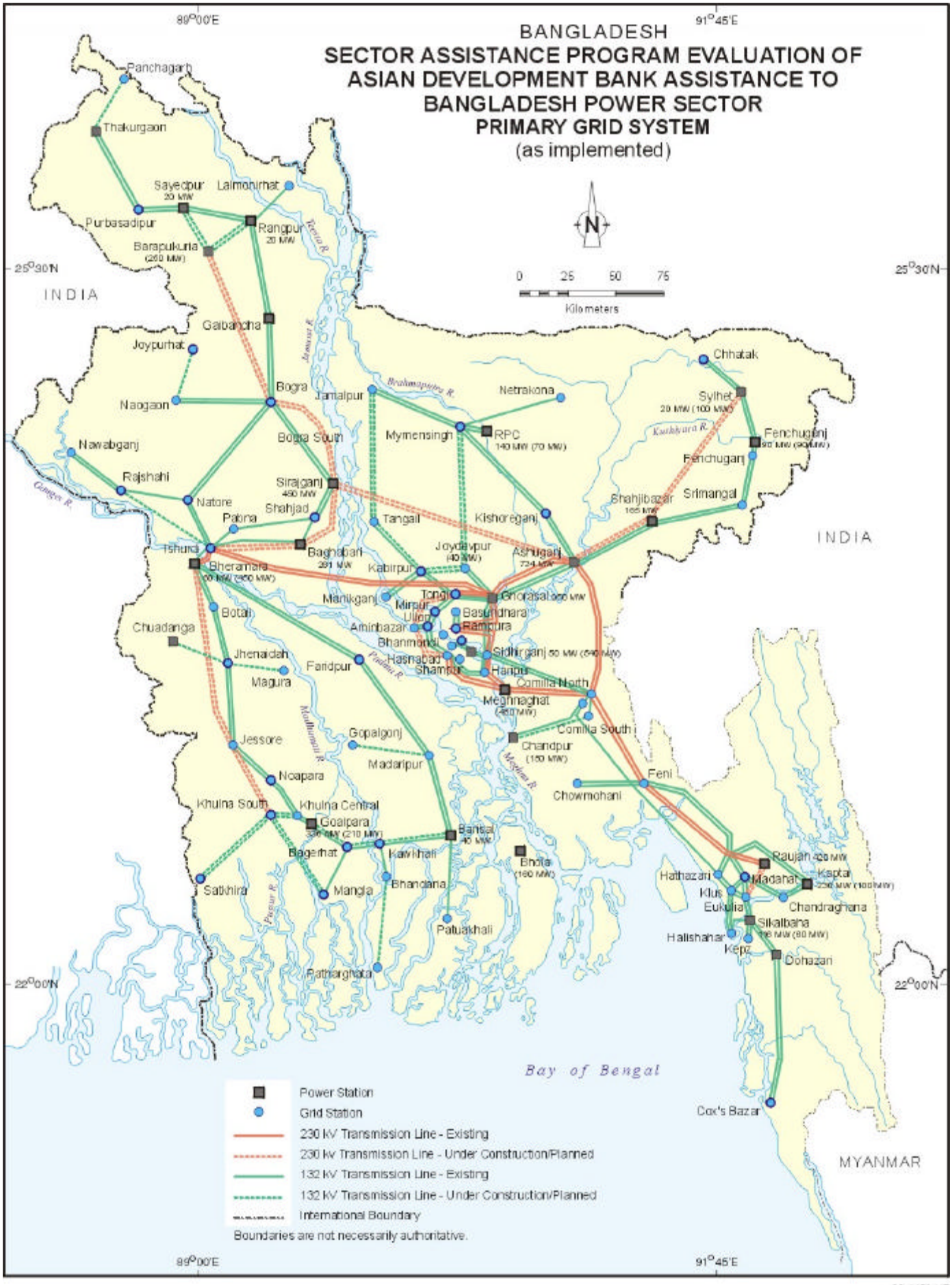
Several key lessons may be drawn from the SAPE. At the project level, these include the need to (i) minimize extensive delays with public sector project implementation, (ii) improve local capacities in project preparation, implementation, and operation and selection of appropriate technology, (iii) improve ownership of TA, (iv) improve financial management capacities, and (v) avoid use of project/phasing approach to finance a change process such as improving financial systems.

At the strategic level, first, ADB's approach to sector reform, which is based on piloting of change and learning by doing, facilitated change. By the success of the individual projects and newly created entities, the approach clearly demonstrates the direction which future reforms should take. Second, the pace of privatization in an environment such as Bangladesh, especially in transmission and distribution, will continue to be slow. Prioritization is important. Third, attaining commercial viability takes time and requires a financial and commercial overview of the sector, particularly over issues such as tariffs and debt defaults among sector entities and the Government.

With a view to the future, three possible scenarios may be assessed. The first implies a moratorium on lending pending further progress in the sector in such areas as reducing system losses, improving collections, increasing tariffs, and creating a substantive commercial operating structure. This scenario has little to recommend it, particularly in view of the progress already made in the sector and the World Bank's reconsideration of its policy with an intention to return to the sector armed with significant financial resources. The second scenario may be referred to as "business as usual". Under this scenario, ADB would continue to provide loans of US$100 to US$200 million from time to time, which would be used to tackle the worst deficiencies in the transmission and distribution network. Private finance would support generation projects, perhaps with some partial ADB or other development partner input. Reform would continue to take place slowly and there would be delays by government and the utilities in implementing agreed changes.

The third scenario is characterized by accelerated reforms and sustained investments. This scenario offers the best hope if the Government's goal that the whole country will be electrified by 2020 is to be realized. However, continuing and more rapid reforms in the following areas need to be addressed if this scenario is to materialize: creation of an independent regulator, corporatization of DESA and BPDB, mutual independence of sector entities whose transaction are governed by commercial contracts, reforms of wholesale and retail tariffs to reflect costs of supply, sector recapitalization, and a sound financial policy.

ADB should maintain its role as coordinating development partner in the sector and is in a unique position to do so. It has a wide range of experience covering all areas of activity in the power sector, an excellent sectoral overview, key skills in its resident mission, a long-term track record of working effectively with the key policy makers in the sector, and widespread support and trust in the development partner community, the Government, and sector entities.


BANGLADESH
SECTOR ASSISTANCE PROGRAM EVALUATION OF ASIAN DEVELOPMENT BANK ASSISTANCE TO BANGLADESH POWER SECTOR
PRIMARY GRID SYSTEM
(as implemented)
89°00'E
91°45'E
25°30'N
22°00'N
INDIA
MYANMAR
Bay of Bengal
Panchagarh
Thakurgaon
Sayedpur 20 MW
Lalmonirhat
Purbasadipur
Rangpur 20 MW
Barapukuria (250 MW)
Teesta R.
Gaibandha
Joypurhat
Jamuna R.
Bogra
Naogaon
Jamalpur
Brahmaputra R.
Netrakona
Chhatak
Sylhet 20 MW (100 MW)
Kushiara R.
Fenchuganj 90 MW (90 MW)
Nawabganj
Bogra South
Mymensingh
RPC 140 MW (70 MW)
Rajshahi
Ganges R.
Natore
Siraganj 450 MW
Shahjad
Patina
Tangail
Kishoreganj
Shahjibazar 165 MW
Srimangal
Ishurdi
Bheramara 60 MW (360 MW)
Baghabari 291 MW
Kabirpur
Joydevpur (40 MW)
Ashuganj 724 MW
Meghnaghat (450 MW)
Manikganj
Tongi
Mirpur
Ullon
Aminbazar
Bhanmara
Hasnabad
Shampur
Basurdhara
Rampura
Siddhirganj 50 MW (540 MW)
Haripur
Comilla North
Comilla South
Chandpur (150 MW)
Botali
Chuadanga
Jhenaidah
Faridpur
Padma R.
Magura
Madhumati R.
Jessore
Gopalganj
Madaripur
Meghna R.
Feni
Chowmohani
Noapara
Khulna South
Khulna Central
Goalpara 330 MW (210 MW)
Bagerhat
Barisal 40 MW
Kaukhali
Bhola (160 MW)
Raujan 420 MW
Hathazari
Madahat
Kaptai 230 MW (100 MW)
Khulna
Eukulia
Chandraghona
Satkhira
Pasur R.
Mongla
Bhandaria
Patuakhali
Sikalbaha 76 MW (60 MW)
Halishahar
Kepz
Dohazari
Rathnaghata
Cox's Bazar
0 25 50 75
Kilometers
Power Station
Grid Station
230 kV Transmission Line - Existing
230 kv Transmission Line - Under Construction/Planned
132 kV Transmission Line - Existing
132 kV Transmission Line - Under Construction/Planned
International Boundary
Boundaries are not necessarily authoritative.

I. INTRODUCTION

A. Background

1. Of the world's population of 6 billion, just over a billion people in the industrialized countries consume 60% of commercially supplied energy including electricity. In recognition of the unquestionable role of reliable and affordable power supply in economic development and poverty reduction, the Asian Development Bank (ADB) has consistently attached high priority to support for the energy sector but particularly the power subsector. This characteristic has been evident in Bangladesh since it joined ADB in 1973. Support for the power sector has been significant perhaps second only to that for food grain production. More recently, since 1995, ADB has been the lead development partner for the power sector, providing a third or more of the total external financing available to the sector.

2. A Sector Assistance Program Evaluation (SAPE) of ADB assistance to the power sector in Bangladesh was requested by ADB's South Asia Department's Energy Division, to review ADB's operations and their impact on the sector. ADB has 30 years of experience of assistance to this sector, covering numerous loans and technical assistance (TA) projects. During this period, the economy grew at varied but modest rate, i.e, 3-4% per annum before the mid-1990s, accelerating to 5-6% since 1996. The electricity system expanded considerably and far more people now enjoy power. Bangladesh substituted its own natural gas for imported oil as a fuel source. However, supply interruptions are still common, there are high levels of system losses, and the financial performance of the sector is unsatisfactory with a high rate of unpaid bills and financial losses by the power utilities.

B. Objectives and Scope of Evaluation

3. The objective of the SAPE is multifold: (i) to provide a comprehensive and independent assessment of the incremental impact of ADB's assistance, on an aggregated basis, on the sector's development and financial performance, as well as its wider impact on economic development and poverty reduction; (ii) to identify lessons learned; and (iii) to identify critical areas where ADB operations need improvement and where ADB can have a significant impact.

4. The scope of the evaluation covers all assistance to the power sector since Bangladesh joined ADB. ADB's support has been extensive, covering generation, transmission, and distribution, with 16 public sector loans and one private sector investment for a gross total of $1.122 billion—about 15% of ADB's portfolio in Bangladesh—as well as 19 technical assistance grants totaling $8.78 million. Out of the total $1.122 billion, $792 million, or about 70%, was used exclusively for transmission and distribution. Before 1982 advisory TA projects focused on sector planning and sector policy studies. After a 10-year gap, TA activities resumed from 1992, with a total of 11 advisory TAs valued at $5.35 million, averaging one a year. The focus of the TAs clearly shifted to improving the sector's regulatory environment, corporatization, and solicitation of private sector investment. A full list of all loans and TA projects funded by ADB over this period is in Appendix 1 (Tables A1.1 and A1.2).

5. The SAPE evaluated the aggregate development impact of all loans, investments, and TAs in Appendix 1. However, due to the scarcity of information available for some (particular for earlier projects) and the limited timeframe and resources, seven projects (including 6 public sector loans and 1 private sector investment) and five TAs (4 advisory TAs and 1 project preparatory TA) were chosen for in-depth evaluation (Tables 1 and 2). The selection criteria included (i) sector

representativeness, e.g., generation, transmission, and distribution; (ii) information availability and institutional memory; (iii) amount of the projects/TAs with preference given to larger amounts; and (iv) perceived relevance to the present country strategy and program.

Table 1: Loans and Investments Selected for In-Depth Evaluation

Project Title	Year of Approval	ADF Amount ($ million)	OCR Amount ($ million)	PS Amount ($ million)	Scope Category
Loan 0587(SF): Ashuganj Thermal Power	1982	35.00	—	—	G, T
Loan 0636(SF): Power Transmission and Distribution	1983	82.00	—	—	T, D
Loan 0683(SF): Sixth Power (Sector Loan)	1984	120.00	—	—	D
Loan 0751(SF): Seventh Power	1985	40.50	—	—	T
Loan 0963(SF): Eighth Power	1989	165.00	—	—	T, D
Loan 1356(SF): Rural Electrification	1995	50.00	—	—	R (G, D)
Inv. 7165/1793: AES Meghnaghat Power	2000	—	—	70.00	G

D=Distribution, G=Generation, T=Transmission, R=Rural.
ADF = Asian Development Fund, AES = Allegheny Energy Services, OCR = ordinary capital resources, PS =Private Sector, SF=Special Funds.
Source: Asian Development Bank.

Table 2: Technical Assistance Selected for In-Depth Evaluation

TA No./Title	Year of Approval	TA Amount ($)
TA 0714: East Zone Thermal Power	1985	1,355,000
TA 1962: Preparation of Power System Master Plan	1993	600,000
TA 2004:Financial Management Upgrade of BPDB and DESA	1993	1,000,000
TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power (Three Grants)	1995-98	598,000
TA 3343: Corporatization of Ashuganj Power Station	1999	1,000,000

BPDB = Bangladesh Power Development Board, DESA = Dhaka Electric Supply Authority, TA = technical assistance.
Source: Asian Development Bank.

C. Evaluation Methodology

6. It is conceptually not possible to evaluate the impact of ADB's assistance without examining the performance of the power sector as a whole. ADB's assistance was not undertaken in isolation but was accompanied by investments by many other development partners and by the Government. The assets purchased with ADB funding are an integral part of the power supply system and hence their performance is heavily influenced by other parts of the supply chain. TAs are designed to create long-term capacity in the electricity supply industry as well as meeting short-term requirements for particular projects. The assessment therefore adopted a systemic approach to the electricity sector, looking at overall developments over the past 30 years and in more detail for the period since 1995 when ADB became the sector's lead

development partner.[1] In addition, while the impact of individual projects is assessed based on available information and site visits, it follows a manner that forms the basis for evaluating the aggregated impact of ADB's assistance as a whole.

7. The Operation Evaluation Mission[2] (OEM) from ADB, which visited Bangladesh in July and August 2003, adopted the following approaches in information gathering:

(i) Interviews and in-depth discussions with key stakeholders in the sector, including (i) officials at the Ministry of Energy and Mineral Resources; (ii) officials of all the utilities, including Bangladesh Power Development Board (BPDB), Dhaka Electric Supply Authority (DESA), Rural Electrification Board (REB), the Power Grid Company of Bangladesh (PGCB), Dhaka Electric Supply Company (DESCO), and Rural Power Company (RPC), covering both headquarters and various operating units such as power stations, regional offices and electricity cooperatives, (iii) development partners including the World Bank, United States Agency for International Development (USAID), Japanese Bank of International Cooperation (JBIC), Kreditanstalt fur Wiederaufbau (KfW) and the United Kingdom Department for International Development (DfID), (iv) representatives of customer groups such as garment manufacturers and Chambers of Commerce as well as individual customers, (v) fuel supplier, in particular, Titas Gas Transmission and Distribution Company Limited, and (vi) union representatives.

(ii) Inspection of key assets such as power stations, substations, transmission and distribution lines, and consumer connections.

(iii) Reviews of documentation including ADB reports (i.e., Appraisal Reports (ARs)/Reports and Recommendations of the President (RRPs), Project Completion Reports (PCRs), TA Completion Reports (TCRs), Project Performance Audit Reports (PPARs), Back-to-Office Reports (BTORs), annual reports, and accounts of the utilities, consultants' reports, and reports and studies prepared by other development partners (especially the World Bank).

(iv) A survey of rural electricity consumers (a village with electricity supply) and would-be consumers (a nearby village currently without electricity supply).

8. Appendix 2 provides an "Evaluation Matrix", which forms the framework for the evaluation. In essence, the framework consists of the five building bocks of evaluation, i.e., relevance, efficacy, efficiency, sustainability, and other institutional and development impacts. For each of these criteria, a series of questions were raised, to be addressed through the evaluation. On relevance, for example, the questions included (i) Were the policy objectives outlined in the various energy policy papers appropriate in relation to the development strategies of Bangladesh in the past three decades? and (ii) Were the planned power sector interventions in ADB country strategy appropriate to reflect the policy objectives? On efficacy, efficiency, and sustainability, the questions included (i) To what extent did the power sector assistance program achieve the sector

[1] That ADB became a lead development partner by not only contributing the largest amount of financial assistance, but also by playing an instrumental role in the sector's policy and institutional reforms makes the evaluation of its incremental impact somewhat easier given its entrenched involvement in all aspects of the sector's development.

[2] The Mission comprised C.C. Yu, Evaluation Specialist (Mission Leader); David Parish, Power Sector Restructuring Specialist (International Consultant), Mike Lewis, Power Engineering and Operation Specialist (International Consultant), Kazi Zahurul Azam, Power Sector Reform Specialist (Domestic Consultant), and A. F. M. Mafizul Islam, Socioeconomic Impact Specialist (Domestic Specialist).

objectives defined in the country strategy documents? (ii) To what extent did the individual projects/TAs achieve their objectives? (iii) How do they compare to ADB power projects in other developing member countries in terms of quality of implementation taking into account project design, construction quality, delays, etc. and (iv) Are the outcomes of ADB's power sector assistance sustainable, and what are the key factors affecting sustainability or lack thereof? For each question, a list of indicators, and sources of information, and collection/analytical methods are also indicated in the matrix.

9. Impact assessment is an important objective of the SAPE, but not the only objective. The other side of the coin, or some would argue the more important objective, is, through impact assessment, to identify lessons learned from the past and improving ADB's future assistance program to the sector in order to enhance the positive impact and minimize adverse impact. This is also reflected in the matrix.

II. OVERVIEW OF THE POWER SECTOR AND ASIAN DEVELOPMENT BANK'S ASSISTANCE PROGRAM

A. Bangladesh's Power Sector: A Historical Perspective (1972–2003)

1. Trends in Generation and Supply

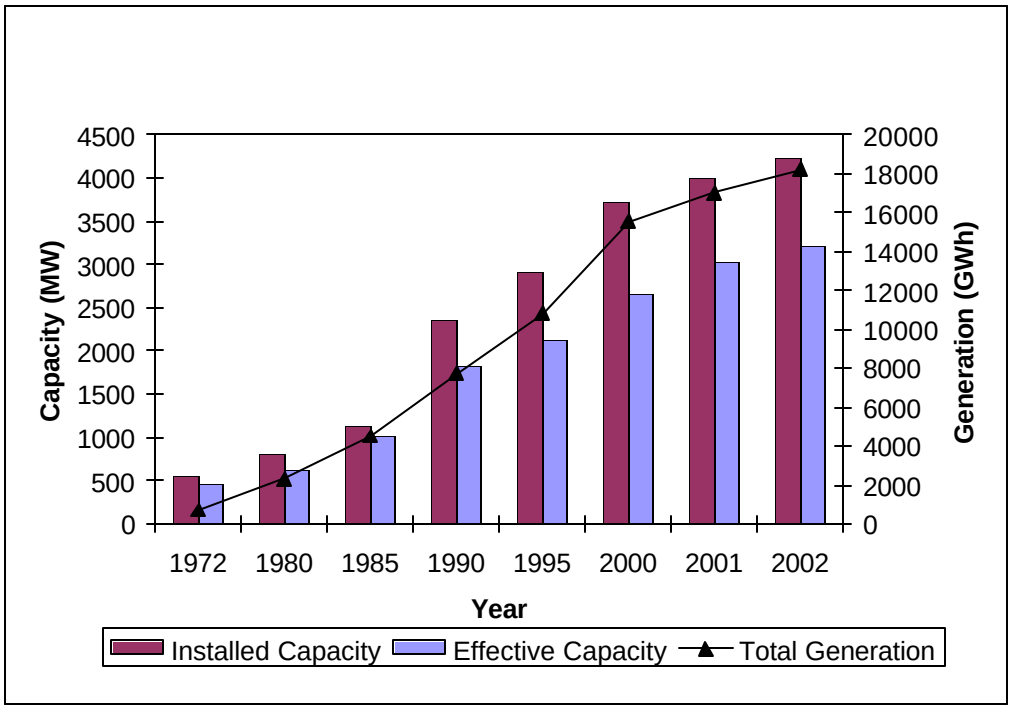
10. Bangladesh's power infrastructure was severely damaged in the War of Liberation. Supply dropped in the immediate aftermath of the war. In 1972 the capacity of the system was some 550 megawatt (MW) and the immediate priority in the post-independence period was rehabilitating existing plants. Capacity grew during the 1970s reaching a total of 822 MW by 1980, but some of these plants were old and unreliable and this is reflected in the slower growth in effective capacity.[3] Nevertheless, total generation grew far more rapidly over this period as plant was used more effectively.

11. The 1980s were a decade of significant investment and growth. Effective capacity and total generation both grew at over 10% per annum as new power plants were brought into use, often with funding from development partners such as ADB and the World Bank. This pattern changed in the early 1990s as the main development partners, led by the World Bank and ADB, withheld their lending activities for Bangladesh's power sector, due to dissatisfaction with fake reporting by key utilities of their financial results, poor commercial performance arising from excessive system losses, and failure to collect payments from customers.

12. During the early 1990s, with diminished investment funds, capacity grew slowly, with assistance from the People's Republic of China and the Russian Federation, and effective capacity grew even more slowly as plants were inadequately maintained and became older. Total generation continued to rise but this was achieved by diminishing levels of system reliability. Reserve margins effectively disappeared and BPDB and other suppliers resorted to increasing levels of load shedding. With investment levels rising again in the late 1990s, initiated by the resumption of ADB's lending activities in 1995, the system was brought back into somewhat better balance. However, supply interruptions are still common. These trends in supply are shown in Figure 1 and Table 3. Load shedding is discussed further below.

[3] Measured as the maximum available generation capacity after maintenance outage in the year.

Figure 1: Capacity and Generation Growth



Source: Bangladesh Power Development Board.

Table 3: Annualized Growth Rates of Capacity and Generation

Fiscal Year	Installed Capacity: Annualized Growth Rate (%)	Effective Capacity: Annualized Growth Rate (%)	Total Generation: Annualized Growth Rate (%)
1972–1980	5.2	3.7	16.0
1980–1985	6.8	10.2	14.0
1985–1990	15.6	12.5	11.3
1990–1995	4.3	3.1	6.9
1995–2000	5.0	4.6	7.6
2000–2001	7.9	13.8	9.4
2001–2002	5.6	6.1	7.1

Source: Bangladesh Power Development Board.

13. Trends in the development of the transmission and distribution system mirror the development of generation. The 827 kilometer (km) of 132 kilovolt (kV) transmission lines which Bangladesh had in 1972 grew to 572 km of 230 kV line and 2,634 km of 132 kV line by 2002. The distribution system expanded dramatically. In 1972 Bangladesh had only 9,010 km of distribution lines (at 33 kV and below). By 2002, the REB alone had constructed well over 100,000 km of distribution lines. Consumer numbers grew from just over 250,000 in 1972 to over 7 million today.

14. Out of the 550 MW installed capacity in 1972, about 130 MW was provided by a single hydropower station, and the remaining capacity was powered by fuel oil. However this changed

dramatically after the discovery of commercial quantities of domestic natural gas. From the 1980s onwards almost all new power plants were gas fired. Gas is now by far the dominant fuel in power supply, with only the oil-fired plants at Khulna and a small hydropower station at Karnafuli generating significant amounts of power from other sources. This transition has been hugely beneficial for Bangladesh because it no longer relies on importing oil to generate power.

15. The period since 1998 has witnessed another major change with the advent of private generating stations. These independent power producers (IPPs) are built with the benefit of Power Purchasing Agreements (PPAs) under which BPDB will purchase power from the generators. Their greater reliability is a major reason for effective capacity recently growing faster than installed generation capacity. There is now 1,290 MW of IPP plant in operation (about 30% of total installed capacity) and in FY2002 IPPs generated 3,771 gigawatt-hour (GWh) (about 21% of net generation).[4]

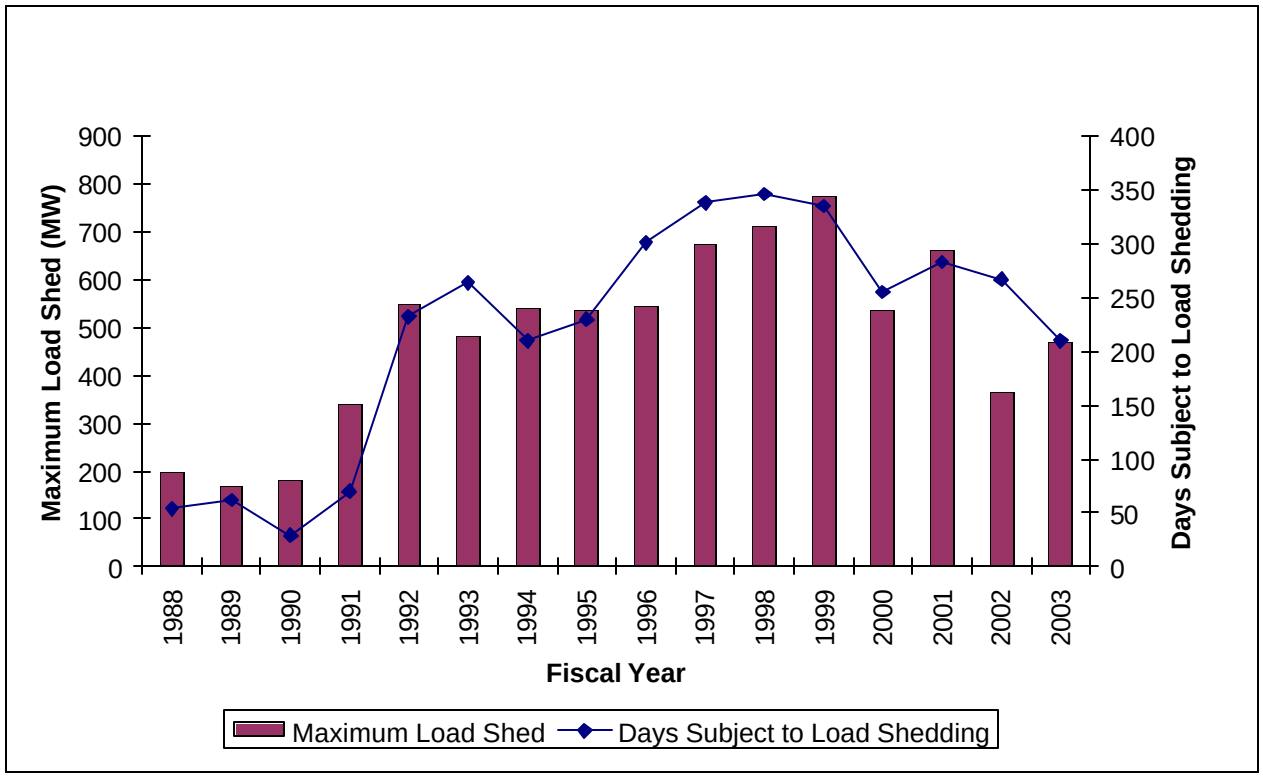
2. Trends in Demand

16. The trend in total generation is probably the best available indicator of trends in demand over the period. It is difficult to obtain fully reliable data on final consumption by consumers as the main utilities act as both retailers and wholesalers of electricity. BPDB has moved from being the sole national supplier of electricity in the early 1970s to a situation where it now supplies only about a third of retail demand. Its main customer is DESA, the main Dhaka supply utility. Both BPDB and DESA supply wholesale power to rural electricity cooperatives (Pally Bidyut Samity [PBS]) and DESA also supplies power to another Dhaka supply company, DESCO. Consequently, sales data for BPDB and DESA are a mix of wholesale and retail sales and the balance between the two changes over time. There is a danger of double or triple counting in looking at the total sales figures for each supplier.

17. In any event, sales data are poor measures of demand firstly because the full demand has not in practice been met and, secondly, because there are high levels of theft from the system that are not reflected in sales data. The unsatisfied demand on the power supply system has led to load shedding and the development of captive generation by major consumers. Load shedding grew in frequency and intensity during the early to mid 1990s. However, in the past 4 years or so there has been some improvement, as Figure 2 shows.

[4] The seemingly contradictory situation is caused by the fact that a lot of the IPPs have been running as peaking plant and as such have lower capacity utilization. The fact that much of the IPP capacities just came on line could also have contributed to the lower generation figure. For FY2003, monthly management reports from various sector entities indicate that total generation from IPPs reached 6,531 gigawatt-hour or 35% of total generation.

Figure 2: Load Shedding Between FY1988 and FY2003



MW = megawatt.
Source: Bangladesh Power Development Board.

18. Many industrial and commercial companies have decided to purchase their own captive generation plant in response to the poor reliability of supplies from the utilities. There is no information on how much capacity or generation is available in captive plants but anecdotal information suggests that it may be as much as 1,000 MW, i.e., around a quarter of the capacity of the public system.

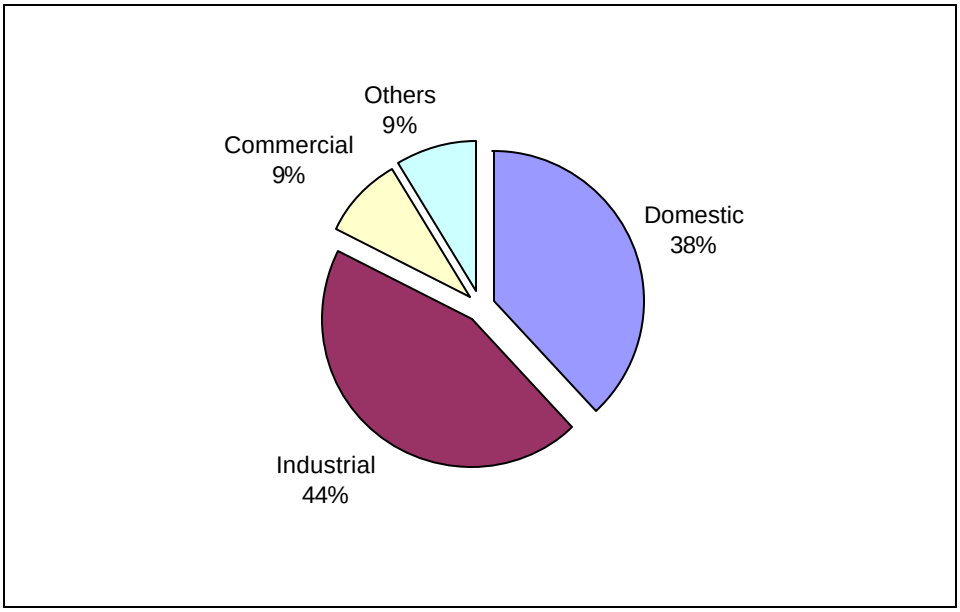
19. High levels of losses, as a result of both technical factors and the theft of power, have been a continuing issue in Bangladesh. Between 1994 and 2003 power system losses have ranged between 28.4% and 37.2%. Excessive losses appeared as a continuing theme in documents going back to the 1970s, when losses ranged between 34.6% and 42.5%. For the past 4 years, system losses have been on a downward trend and the provisional estimate of 28.4% for 2003, if confirmed, will be the lowest figure achieved since independence. Some of these losses arise from technical factors such as losses in stepping down power and in transmission and distribution.[5] However, even after allowing for these factors, the system loss of 28.4% incorporates high levels of non-technical loss, i.e., theft.

20. Despite difficulties in estimating total demand, information on actual consumption of electricity (from grid supplies exclusive of captive power) by different types of consumers is

[5] The Power System Master Plan suggested that 14% would be a reasonable level of technical losses on the Bangladesh power system. However, there are considerable technical problems with the Bangladesh transmission and distribution systems at the moment that cause it to run with excessive loads for much of the day. This tends to increase technical losses and thus the current level is probably in excess of 14%.

available. As indicated by Figure 3 below, industrial consumption accounts for 44% of the total, while commercial consumption is at a relatively low level of 9%. In comparison with other countries in Asia, Bangladesh continues to have a relatively low level of electricity consumption and availability. In 2002, consumption per head was 102 kilowatt hour (kWh), which is lower than all ADB's developing member countries except Nepal (55 kWh) and Cambodia (30 kWh). Consumption per head is far higher in India (340 kWh) and Thailand (950 kWh). Only just over 30% of the population has access to electricity, which is again higher than Nepal (18%) and Cambodia (10%) but compares unfavorably with India (82%) and Thailand (98%). The low level of consumption reflects Bangladesh's position as a predominantly agricultural country with limited industrial development. In recent years the country's industrial base has grown through the expansion of the textile sector, which is now an important exporter and employer. However, industrial development in other sectors is limited and hence electricity demand is bound to be low.

Figure 3: Consumption of Electricity by Type of Consumers for FY2000



3. Institutional and Policy Reforms

21. BPDB was created immediately after independence in 1972, through a split in the East Pakistan Water and Power Development Authority. It was created as a single utility responsible for all generation, transmission and distribution. Within 5 years, government recognized that the electrification of rural Bangladesh was a huge challenge in its own right, which required a separate institutional structure. Consequently, REB was created in 1977 to tackle this task. REB is generally regarded by development partners as one of the most successful institutions in Bangladesh.[6] Its approach to rural electrification has been studied widely to identify the potential for replication in other countries. REB operates through a structure of PBSs, or rural electricity cooperatives, established in rural areas throughout Bangladesh. There are now 67 PBSs, and they have been created in phases, beginning in 1980. REB provides TA and supervision in setting up new PBSs and also arranges finance through onlending from government and development

[6] World Bank and ADB. 2003. *Bangladesh Public Expenditure Review*. Dhaka.

partner funds. Every PBS agrees a performance target with REB each year, designed to develop their work performance and improve their financial status. The PBSs have received public subsidies in various ways and in some cases assets and customers have been passed to them from BPDB and DESA.

22. In 1991, because of BPDB's weak commercial performance and partly as a result of pressure from development partners, the Government split BPDB by creating a separate DESA to be responsible for distribution of power in Dhaka. The assets and personnel of DESA all came from BPDB and the culture and performance was essentially unchanged from that of BPDB. Consequently, the sector faced continuing commercial failure. Several key development partners withdrew from the sector. As a result, there was a mounting crisis as investment levels dropped in the face of rising demand, and power cuts became an increasingly regular occurrence.

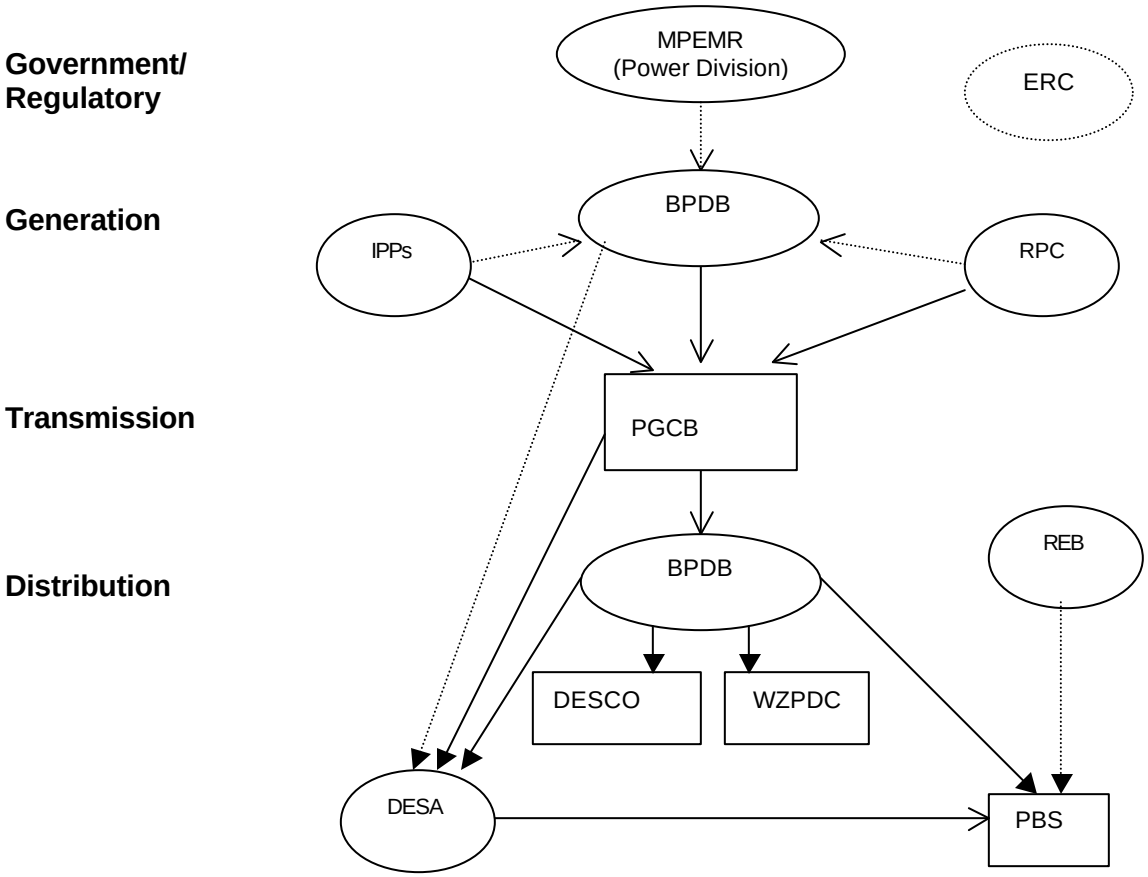
23. An Inter-Ministerial Working Group was constituted on 3 February 1993 to review the power sector. The group produced a report entitled "Power Sector Reforms in Bangladesh" which was approved in principle by the Government in September 1994. The report recommended unbundling the sector on functional lines, corporatization of sector entities, and establishing an independent Regulatory Commission. The Power Cell was created within the Ministry of Power, Energy and Mineral Resources in 1995 to drive sector reforms and promote private sector development. Energy policy has continued to develop along the lines laid down by the working group. Further new entities were created in the sector, but as companies operating under the Companies Act rather than as government bureaucracies. These included DESCO, (which has taken over retail operations from DESA in parts of Dhaka), PGCB which is now responsible for the transmission network, and RPC, a generation company part owned by REB and partly owned by several PBSs. The West Zone Power Distribution Company (WZPDC) has now been created from BPDB and is starting to operate independently and further unbundling of BPDB and DESA is planned.

24. The director of Power Cell recently made a presentation to a development partners' coordination meeting, which explained the current reform strategies as follows: (i) using natural gas as the primary fuel for electricity generation; (ii) increasing private sector participation to mobilize finance; and (iii) improving sector governance through (a) independent regulation, (b) transparent advance planning, (c) corporatization of sector entities, (d) distancing the Government's social objectives from sector's commercial transactions, and (v) promoting competition.

25. Legislation was passed on 10 March 2003 to establish an Energy Regulatory Commission (ERC), independent of Government. The intended roles of this Commission are: (i) setting electricity tariffs and determining the corresponding performance norms, (ii) collecting, verifying and disseminating sector statistics, (iii) reviewing and approving long term power planning, (iv) creating and maintaining a nondiscriminatory and commercial business environment in the sector, and (v) adjudicating disputes between sector entities. ERC has not yet been made operational but it is planned that activities should start by the end of 2003.

26. Figure 4 illustrates the present structure of Bangladesh's power sector by indicating the key sector entities and their interrelationship. ERC is included in the diagram, using a broken circle to indicate that it is not yet functional.

Figure 4: Bangladesh Power Sector



⇒	-	Flow of electricity
⇢	-	Administrative or commercial relationship
BPDB	-	Bangladesh Power Development Board
DESA	-	Dhaka Electric Supply Authority
DESCO	-	Dhaka Electric Supply Company
ERC	-	Energy Regulatory Commission
IPPs	-	Independent Power Producers
MPEMR	-	Ministry of Power, Energy, and Mineral Resources
PBS	-	Pally Bidyut Samity (Rural Electrification Cooperatives)
PGCB	-	Power Grid Company of Bangladesh
REB	-	Rural Electrification Board
RPC	-	Rural Power Company
WZPDC	-	West Zone Power Distribution Company

B. ADB's Sector Strategies and Assistance Program

27. ADB's sector strategy and assistance program may be divided into two distinctive periods, i.e., pre-1995 and post-1995.

1. Pre-1995 Period

28. Since Bangladesh joined ADB in 1973, ADB provided extensive support in power sector development, covering generation, transmission, and distribution. Between 1973 and 1982, following the War of Liberation, assistance focused on adding generation capacity. This roughly corresponded to the global energy crisis, characterized by the precipitous increases of oil prices starting in 1974 and continuing until the mid-1980s. ADB's lending policy in the energy sector was largely to follow the Governments' lead and focus on capacity expansion. ADB's first Energy Policy Paper in 1981,[7] which gave added emphasis to energy infrastructure and indigenous energy development, provided more impetus to investing in transmission and distribution as well. The 1986 operational strategy paper[8] gave the second priority to the energy sector (after food grain production). In the power sub-sector, ADB's operational strategy was to concentrate its assistance to transmission and distribution primarily in the urban areas since adequate assistance (relative to the sector's absorptive capacity) from other development partners was being directed to rural electrification. Actual lending activities fully reflected this strategy. Between 1983 and 1989, four loans were made to improve transmission and distribution, amounting to $407 million.[9]

29. However, there was a significant gap in lending activities between 1989 and 1995.[10] Policy dialogue with Government that involved ADB, the World Bank and other development partners continued during this period, which reached a broad consensus that reforms must be carried out and directed to restructuring the sector along commercial lines. The 1993 country operational strategy paper reflected this view. It states that "Despite the beneficial impact of electricity on rural incomes, it would be difficult to support a rural electrification project over the medium term. Existing institutional problems of the power entities and the likely shortages of generation capacities over the medium term would be further strained by the continuing low level of power tariffs, or by loads which aggravate peak demand."

30. During 1993, following some improvements in financial performance, the World Bank and ADB resumed lending under existing loans. During 1993 and 1994, ADB worked with the Government on formulating an investment package, which eventually became Loan 1356(SF): Rural Electrification approved in 1995. This work proceeded in parallel with sector policy reforms. The Inter Ministerial Working Group was developing its views on energy policy and, to some extent, these influenced the content of the investment package. For example, the RPC was established during 1994 to execute a component on generation, i.e., two units of 35 MW

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[7] ADB Working Paper No. 2-81: *Role of the Bank in the Energy Sector in the Region*. Manila.

[8] ADB. 1986. *Operational Strategy Paper for Bangladesh*. Manila.

[9] The 1989 country operational strategy paper, however, stressed the need to supplement ADB's conventional programs targeting urban areas with those oriented more to rural development.

[10] During 1989, BPDB received loan commitments from both the World Bank and ADB. The World Bank approved its Energy Sector Adjustment Credit ($175 million) in April, while ADB approved the Eighth Power Project ($165 million) in June. Both projects were conditional on BPDB reducing its system loss to 32% and its receivables to the equivalent of 3.5 months billings. BPDB reported that these conditions were met in early 1990, but when the accounts were published they showed far higher figures. Both ADB and the World Bank requested an explanation. The reconciliation report produced by BPDB proved unsatisfactory to both banks and they therefore suspended disbursements under their loans.

gas turbines, at Mymensingh, of Loan 1356(SF). This was a hybrid public/private generation project and the first IPP in Bangladesh. Loan 1356(SF) coincided with the issuance of ADB's second energy policy paper,[11] which placed greater emphasis on restructuring public utilities and attracting private sector investment in addition to continuing the support of energy infrastructure. The loans made after 1995 and one private sector investment reflected these priorities. The energy policy review conducted in 2000 confirmed the continuing relevance of the 1995 energy policy but provided added emphasis on poverty reduction and rural electrification.[12]

2. Post-1995 Period

31. Since 1995, ADB has been the lead funding agency in the sector, accounting for one third of all the financial assistance from development agencies in the power sector. A few other bilateral agencies, including Canadian, the People's Republic of China, Dutch, German, Japanese, Norwegian, and Russian agencies, also continued their assistance.[13] Between 1995 and 2001, ADB committed three new loans and one private sector investment. Loan 1505(SF): The Ninth Power Project was approved in 1996 and was followed in 1999 by Loans 1730(SF)/1731: The Dhaka Power Systems Upgrade Project, and in 2001 by Loans 1884(SF)/1885: The West Zone Power Development Project. Investment in private generation was through the Allegheny Energy Services (AES) Meghnaghat Power (Inv. 7165/1793). Compared to the pre-1995 period, ADB's sector strategy has evolved significantly from supporting expansion of capacities with public sector loans to a strategy of continued physical investment in system rehabilitation and expansion combined with engagement of the Government through TAs, loan covenants, and extended policy dialogue on a reform agenda, with an objective to enable sector unbundling and corporatization, greater private sector participation and reduce system losses and non-payment of bills in the key public utilities. A series of TAs were used to support privatization, corporatization, and institutional development in new power companies.

32. Aside from its own assistance program, ADB chairs the Development Partners' Coordination Group, as well as Local Consultative Group (LCG) sub-group for energy. LCG is the central mechanism for development dialogue and development partner coordination in Bangladesh, and there are 23 thematic subgroups, including energy, operating under the LCG umbrella. Development partners hold one major meeting each year to review progress and coordination in the energy sector. Quarterly meetings are also held at resident mission level.

33. Overall, several points can be made about ADB's power sector assistance program. First, ADB has been the most "consistent and reliable" development partner as expressed in interviews by many stakeholders, despite the gap in lending activities between 1989 and 1995. Second, the objectives of the assistance appeared to evolve over time, from adding generation capacity, to improving power infrastructure such as transmission and distribution, and more recently to creating an enabling environment, in terms of both physical infrastructure and policy and institutional conditions, to attract private sector investment particularly in generation. The evolution of assistance priorities has largely corresponded to ADB's policies and strategies for the energy sector at different periods, but has generally addressed the needs of the power sector development of Bangladesh. Third, as the lead and coordinating development agency, ADB may not have the "luxury" to choose and pick a particular area to which to provide assistance.[14] Rather,

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[11] ADB. 1995. *Energy Policy of the Asian Development Bank*. Manila.
[12] ADB 2000. *Energy 2000: review of Energy Policy of the Asian Development Bank*. Manila.
[13] By contrast, the World Bank preferred not to make any new loan commitment, but continued to promote policy dialogue with Government and provide some TA.
[14] For example, many bilateral partners have chosen rural electrification as their top priority of assistance. As a result, REB has received a large amount of financial assistance in the forms of grants and low-interest loans.

it increasingly finds itself in a position where it must take a systematic approach in identifying the bottlenecks and weaknesses in the overall power supply system, and providing assistance to address such bottlenecks and weaknesses. The subsequent section aims to assess the efficacy of project and TA design and implementation relative to the extent that they achieved their respective objectives.

III. PROJECT IMPLEMENTATION AND OPERATION

34. The assessment of project implementation and operation draws information from ADB documents, particularly ARs/RRPs, PCRs, and PPARs, for the projects selected for in-depth review. In addition, in order to supplement the documented information with first-hand knowledge, the OEM carried out an inspection of power stations, transmission lines, substations, and distribution systems. Due to limitations of time and resources, the visits and evaluation were on a reconnaissance basis and targeted, but not restricted to, the facilities financed under various ADB projects. Detailed findings are presented in Appendix 3, and this section summarizes the key findings and conclusions.

A. Loans and Investments

1. Generation

35. Of the 7 projects selected for in-depth review, 3 of them, either entirely or partly, provided support for expansion of generation capacities. Loan 0587(SF): Ashuganj Thermal Power, for $35 million, was approved in 1982 and completed in 1989, with a 2.5-year delay and $18.6 million cost under-run. The main objective of the project was to meet the country's demand for power beyond FY1985 and to reduce its dependence on imported crude oil by using locally available natural gas through construction of two 150 MW gas-fueled steam power-generating units and associated transmission lines. Loan 1356(SF): Rural Electrification, for $50 million, was approved in 1995 and completed in 2000, with a modest 1-year delay and $6.5 million cost underrun. The objectives of the project were to intensify rural electrification in seven PBSs and to increase the availability of power supply to five PBSs. Part of the project scope was to construct 60 MW gas-based open cycle power plant. Finally, Inv. 7165/1793: AES Meghnaghat Power consisted of an investment loan of $70 million and an additional partial risk guarantee covering a principal amount of $70 million and interest. It was approved in 2000 and completed in 2002 with no delay. The project aimed to build, own, and operate a 450 MW gas-fired combined-cycle plant.

36. All three projects were either largely implemented as envisaged or, in the case of Loan 0587(SF) and Loan 1356(SF), exceeded their original scope. Specifically, under Loan 0587(SF), the loan was to provide for the addition of two gas-fired steam turbine units of 150 MW each, but during implementation savings allowed the scope of the project to be increased to add a third 150 MW unit essentially identical to the first two units. This increased the project's contribution to base-load generation capacity from 300 MW to 450 MW. This increased capacity proved to be especially timely as the lack of generation capacity remained acute and the project had received very cost-effective proposals for the generating units. Under Loan 1356(SF), ADB was instrumental in securing the financing of the project's "Phase I", which included the first two gas turbine units each rated 35 MW for a total of 70 MW, exceeding the appraisal target of 60 MW. The added capacity was also especially timely as the need for generation to meet the increasing demand level had not abated.

37. The operation and maintenance (O&M) of the facilities varied. The three units built under Loan 0587(SF) at Ashuganj have been operating at very high availability since their commissioning in the late 1980s, reflecting well upon their design and installation. However, the units have suffered from delayed overhauls and a lack of replacement parts in the past. The reasons included a lack of funds and reserve capacity, delayed procurement of parts, and a less dedicated management culture toward preventive maintenance. The high usage also reflects the lack of reserve capacity in the system, which meant that the unit's generation could not be foregone. In comparison, the O&M of the more recently constructed Mymensingh and Meghnaghat facilities, under Loan 1356(SF) and Inv. 7165/1793, respectively, is exemplary. Both facilities employed highly motivated, well paid, and technically competent "lean and mean" work force, e.g., Meghnaghat having about 75 staff including 5 expatriate versus 70 staff including 2 expatriate at Mymensingh.

2. Transmission and Distribution

38. The remaining 4 projects evaluated in-depth and part of Loan 1356(SF) were designed to expand and rehabilitate the transmission and distribution system. Loan 0636(SF): Power Transmission and Distribution Project, for $82 million, was approved in 1983 and completed in 1992, with a 3.5-year delay and $19 million cost overrun. The main objectives of the project were to transfer more electricity from the east zone to the west zone, and to expand the distribution network in the metropolitan and coastal areas of Greater Chittagong. Loan 0683(SF): Sixth Power (Sector Loan), for $120 million, was approved in 1984 and completed in 1993, with a 4-year delay and $27 million cost overrun. Main objectives were to achieve adequate expansion of the distribution network to maintain balance among generation, transmission, and distribution facilities, and ensure better load management and effective system loss reduction. Loan 0751(SF): Seventh Power, for $40.5 million, was approved in 1985 and completed in 1994, with a 3-year delay and $9 million cost overrun. Main objectives were to enable transmission of low-cost, natural gas-based electricity generated in the east zone to consumption centers in the northern and western parts of the country, improve the reliability of the power system, and to resolve voltage problems and reduce losses in the 132 kV and 33 kV systems. Loan 0963(SF): Eighth Power Project, for $165 million, was approved in 1989 and completed in 2001, with a 7.2-year delay and $18 million cost overrun. Main objectives were to meet the electricity demand for the early 1990s in greater Dhaka, reduce system losses and improve the reliability, and provide for system control and metering facilities to help reduce non-technical system losses. Finally, as noted earlier, part of Loan 1356(SF): Rural Electrification, included components on intensification and expansion of the distribution networks of 7 PBSs, e.g., 2,900 km of 33 kV, 11 kV, and 0.4 kV distribution lines and required substation capacities.

39. Information drawn from PCR, PPAR, and the OEM's own site inspections confirmed that the projects' physical objectives were largely met and, for most of the projects, the scope was implemented as envisaged, although with serious delays. Some project components, however, failed which resulted in waste of resources. As an example, Loan 0636(SF) included the design and installation of a Supervisory Control and Data Acquisition (SCADA). At the loan appraisal and approval, the allocation was $1.45 million, at $0.95 million foreign exchange and $0.50 million equivalent local cost. The PCR indicates that $6.83 million was dispersed consisting of $6.03 million foreign exchange and $0.80 million local cost. Furthermore, despite the increased cost, the system was severely damaged by the cyclone and flooding of April 1991. It was expected to return to service by 1993 at which time it would be used to assist in ascertaining the extent of damages to the distribution facilities by the cyclone. However, the SCADA was not returned to service. While the computer components and the

telemetry equipment appear to be (possibly) in useable condition with some restoration, the OEM was informed that the remote terminal units were severely and almost universally damaged beyond repair. The costs of replacing these units were not within the financial capacity of BPDB at the time. The lack of this system has impaired the ability of the Chittagong division to manage the operation of the distribution system efficiently. In comparison, the SCADA system established in Dhaka under Loan 0963(SF) has functioned well to date, despite a 7-year delay. Daily and monthly reports of system parameters including load shedding by distribution divisions, peak loading of the distribution with time stamp, the cause of load shedding, substation and feeder loading and voltage profiles, and load profiles are generated. This information is invaluable for distribution system analysis, system operation, during system emergency conditions, and for restarts after grid failures. It can also detect overloads prior to damage to the system components.

3. Overall Assessment of Project Implementation and Operation

40. A key conclusion derived from the evaluation of project implementation and operation is that ADB has supported technically sound projects that addressed the needs at the time of the Bangladesh power sector, and they have mostly met the project objectives. The power generation and transmission facilities observed are, in general, well designed and constructed but with a few exceptions. The main problem experienced in implementation was extensive project delays, with the notable exception of Meghnaghat Power. This deferred project benefits and added to the continuing inadequacies in generation, transmission and distribution. It should be noted, however, that for all the projects, the appraisal estimates of economic internal rates of return and, for some of them, the PCR and PPAR re-estimates, were well in excess of 12%. Based on the OEM's own observation of the heavy use of the facilities built under the projects, as well as the high willingness to pay for reliable power supply as informed to the OEM by virtually all the customers interviewed, these estimates appeared to be well justified.

B. Technical Assistance

41. ADB has supported capacity building in the Bangladesh power sector through a number of TA projects. Of the 5 TAs examined in depth, the project-preparatory TA, i.e., TA 0714: East Zone Thermal Power, seemed to have failed to prepare a project that was suitable to ADB financing.[15] The implementation of the other TAs and achievement of purposes are briefly discussed below and details are presented in Appendix 3.

42. TA 1962: Preparation of Power System Master Plan was implemented in 1995. The objective was to prepare a realistic least cost development plan for the power sector for the period 1995–2010. A key component of the plan was to maximize the transfer of technology to BPDB. A Power System Master Plan unit was created within BPDB to serve as counterparts. All work was performed in Bangladesh to maximize the learning experience of the counterparts. The OEM reviewed the Master Plan and found that it was competently prepared and continues to be of significant value to the BPDB in planning system expansion and development. This was confirmed through extensive discussions with various government and BPDP officials who frequently refer to the master plan, and with the systems planning staff of BPDB, who benefited greatly from technology transfer through the TA.

43. TA 2004: Financial Management Upgrade of BPDB and DESA was designed to improve the billing and accounting systems of BPDB and DESA through computerization. It had two major components: (i) computerization of billing, and (ii) introduction of an information management

[15] None except one BPDB officials interviewed had any knowledge of the TA.

system. The first component, computerization of billing, invariably makes theft of electricity through fraud more difficult and, as such, it is often resisted by some utility employees who see it as an obstacle to their dishonest activities. Consequently, this project was always likely to make slow progress, as has proved to be the case. Neither DESA nor BPDB have fully implemented computerized billing although in both cases the system is working well in large areas of operations, and contributing to improved performance on managing system losses and collection against billing. Under the second component, the TA was also designed to introduce Oracle Financials as an Enterprise Resource Planning (ERP) system into the operations of DESA and BPDB. Some pilot projects were conducted using this new system and a number of staff members have been trained to use the Oracle system. However, detailed implementation has been deferred until the next phase of the project. At the same time, the majority of the trainees have already left BPDB and taken jobs in the private sector.

44. TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power, which included three grants, illustrated the importance of TAs in introducing new concepts and approaches to Bangladesh, e.g., through competitive bidding to solicit IPPs with PPAs. The bids for the project were evaluated on the basis of the quoted wholesale tariffs and the plant is now selling power successfully to BPDB at an internationally competitive price. Partly as a result of implementing this TA, Loan 1356: Rural Electrification under which RPC was formed as an IPP, and the Haripur project, which received similar support from the World Bank, Bangladesh now has the capacity to solicit private generation projects without further TA.

45. Work under TA 3343: Corporatization of Ashuganj Power Station to corporatize the Ashuganj power station has proceeded slowly, partly because of resistance from within the power sector to the corporatization policy and partly because of difficulties in agreeing final arrangements on a complex series of changes. The TA was originally supposed to begin in March 2000 and be completed in 12 months but it was still ongoing as of the OEM's visit in August 2003. A company has been created to be responsible for the future management of the plant and senior staff members have been put in place. However terms of the PPA and the conditions for staff to transfer to the new station are still under review. This is a test case for unbundling a station out of BPDB and setting it up as an independent company with a PPA with BPDB for sale of its output. Despite the delays, it is now reaching a conclusion and has successfully demonstrated that it is feasible to separate a power station from BPDB. This experience can be transferred to the corporatization that is planned at other BPDB stations since many issues of principle are being resolved in the course of this exercise.

46. The four advisory TAs reviewed have to a varied extent achieved their intended objectives and contributed positively to the development of the power sector over recent years. Of note is the sustainability of TA 2004, which may be problematic due to lack of ownership and continued funding required.

IV. EVALUATION OF IMPACTS

A. Impact on Sector Performance

1. Maintaining System Balance and Meeting Capacity Requirements?

47. Despite ADB-funded projects, together with those of other development partners and IPPs, having kept the overall system in approximate balance, as shown by the decline in load shedding since 1997 (Figure 2), they did not meet the full capacity requirements. Demand always

ran ahead of capacity. Delays in implementing projects, coupled with a continuing acute shortage of funds from internally generated and other external sources, strained the power system.

48. As of 2002, the annual peak demand was approximately 3,220 MW with a system annual load factor[16] of about 66% and a pronounced evening bias.[17] The system suffers from low power factor[18] during peak demand and shoulder peaks. Power factors at 0.80 on the DESA system were observed (compared to the industry standard minimum of 0.90). The OEM was informed that this is typical. The recent additions of more 230 kV circuits to the transmission grid, under Loan 0963: Eighth Power Project and other projects, have made distinct improvements in voltage profile at the 132 and 230 kV levels. But distribution voltages are very degraded during peak loading. The lack of reserve generation and "spinning reserve"[19] prevents the system from attaining a proper voltage profile (10% maximum variance) and frequency especially during peak demand. The distribution system of DESA is especially prone to load shedding and is the source of the majority of the reactive power requirements on the grid. This reflects limited expansion in the face of significant load growth, inadequate capacity, and a lack of reactive power correction. The situation was said, by some interviewed, to have been exacerbated by the lending moratorium imposed by ADB and the World Bank between 1989 and 1995, during which time much needed reinforcement and expansion of generation, transmission, and distribution capacities was foregone.

49. The BPDB distribution facilities in Chittagong, which benefited from Loan 0325(SF): Chittagong Power Distribution Project and Loan 0636(SF): Power Transmission and Distribution Project, are superior to those of DESA in the ratio of capacity to load and demonstrate a much higher level of maintenance. Records indicate that the areas of Chittagong and Mymensingh have a reasonably good voltage profile while the Bogra and Barishal areas share Dhaka's experience of severe low voltage. In rural areas, PBSs, which received considerable assistance from different bilateral and multilateral development partners including ADB's Loan 1356(SF): Rural Electrification, are well managed and their facilities well maintained. The distribution facilities are technically superior to the urban distribution in Dhaka and Chittagong. They are better suited to their intended use and maintained to a level such that they meet peak demands without exceeding their thermal or mechanical limits. The management culture of the PBSs is more oriented toward efforts to maintain a high level of service and their overall performance is superior to that of the other organizations of Bangladesh.

50. In general, however, it appears that despite significant investment in rehabilitating and expanding the power infrastructure, significant bottlenecks and weaknesses exist. These will hinder the Government's ambitious goal to make electricity available throughout Bangladesh by 2020. ADB's assistance together with that of other development partners, though highly significant

[16] Load factor is the ratio of the peak demand to average demand on an annual, monthly, or even daily basis. The peak demand is the highest one-hour consumption of the load on the system.

[17] The normal peak demand begins with a 600-700 MW increase in load at about 6 pm which extends to about 11 pm declining to minimum load of about 50% of peak by 6 am. The system annual peak is normally in mid to late summer.

[18] Power factor is the ratio between kilowatts (kW), a measure of active power, and kilovolt-amperes (kVA), a measure of reactive power. Power factor is important in that the conductors of a circuit (i.e., a transmission or distribution line) must be able to carry the kVA required by a load, not merely the kW. The increased current due to kVA, i.e., a lower power factor, results in increased losses and voltage drops in the conductors, reducing the capacity of the circuits to deliver active power. In addition, the generating sources must produce kVA if it is not provided by static sources such as capacitors in the loads.

[19] Spinning reserve can be characterized as generating units operating at rated speed and frequency but below rated load. This provides an amount of generating inertia to the system that allows the system to respond quickly to sudden changes in load or the loss of generation.

and guided by the master plan, was provided more or less in a catching-up fashion, rushing to help where crisis had already occurred. But the severe project implementation delays further diminished their effectiveness and reduced project benefits. The system requires additional generation and transmission in the near term merely to serve the existing load requirements. Expected annual load growth of about 10% or more for the foreseeable future will require that generation and transmission be provided at the same pace. Regardless of the addition of generation and transmission, DESA's distribution system requires significant capacity enhancement as well as technical modification to enable it to meet current demands. The uncorrected reactive power demands of the Dhaka area are a major factor affecting the performance of the entire grid. Without very near term corrections in the DESA distribution system, it might be prudent to attempt to suppress the demand growth in Dhaka by restrictions on the addition of new consumers until the system is of a capacity to properly supply its demand.

2. Impact on Performance of Traditional Public Utilities

51. BPDB and DESA have been the two main recipients of ADB's public sector loans (with loan covenants) and TAs in the power sector. It appears, however, that such assistance essentially failed to generate the required impetus to fundamentally improve their operational and financial performance over the years. Tables 4 and 5 provide key performance indicators for the two entities during the period between 1990 and 2001. For BPDB, system losses gradually fell from 32% in 1991 to about 14% in 2001, as bill collection rate hovered between 80 and 90%. DESA did not achieve any significant reduction in system losses during the period (excluding sales to DESCO and REB), remaining in the 30-40% range, while bill collection also stagnated in the 80-90% range. The financial ratios indicate that both BPDB and DESA have very large accounts receivable and no self-financing capacities. Therefore, they rely on Government and external financing for any system expansion and rehabilitation.

Table 4: Operational and Financial Performance of the Bangladesh Power Development Board

Item		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Economic Indicators													
Average Exchange Rate/$	Taka	34.6	36.6	39.0	39.6	40.2	40.3	41.8	43.9	46.9	49.1	52.1	55.8
Operational Indicators													
Energy Sales	GWh	4,705	4,776	6,021	6,906	7,448	8,371	8,996	9,447	10,176	11,352	12,469	14,003
Sales Growth - GWh	%		2.0	26.0	15.0	8.0	12.0	7.0	5.0	8.0	12.0	10.0	12.0
System Losses	%		32.0	28.0	21.0	19.0	18.0	17.0	16.0	17.0	17.0	15.0	14.0
Ave. Yields													
Average Selling Price	Taka/kWh	2.1	2.3	2.0	1.9	1.9	1.9	1.9	2.0	2.07	2.1	2.2	2.2
Average Selling Price 1990 Constant	Taka/kWh	2.1	2.2	1.8	1.7	1.7	1.5	1.5	1.5	1.5	1.4	1.5	1.5
Average Selling Price (cents)	cents/kWh	6.2	6.3	5.1	4.8	4.7	4.6	4.5	4.5	4.4	4.2	4.2	4.0
BDPB Collection (% of Billings)	%	—	—	85.8	90.9	84.1	89.7	91.6	86.8	82.0	69.0	82.4	86.0

Item			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Financial Performance														
Revenue	Bn.Taka		—	—	12.3	13.4	14.4	16.0	17.1	19.0	21.4	24.0	27.9	31.5
Operating Prof./(Loss)	Bn.Taka		—	—	(0.1)	0.4	0.9	0.2	0.8	0.9	1.4	2.2	2.2	0.1
Net Income	Bn.Taka		—	—	(7.5)	(3.5)	(2.8)	(4.8)	0.6	(1.3)	(0.1)	(3.2)	(3.9)	(3.7)
Financial Ratios		**Covenant**												
OR	%		—	—	101.0	97.0	94.0	99.0	95.0	95.0	93.0	91.0	92.0	100.0
RNFA	%	NA	3.9	3.9	0.0	—	—	—	—	—	—	1.9	1.7	0.1
SFR	%	>18		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DSCR	times	>1.5	0.1	0.6	0.6	0.5	0.6	0.2	0.9	1.0	1.1	0.8	0.7	0.6
AR	days	<90	—	—	164	199	249	264	277	329	373	388	388	380

— = no data available, AR = accounts receivable, BPDB = Bangladesh Power Development Board, DSCR = debt service coverage ratio, GWh = gigawatt-hour, kWh = kilowatt-hour, OR = operating ratio, RNFA = return on net fixed assets, ROR = return on rate base, SFR = self-financing ratio.
Sources: Audited Financial Statements 1991 to 2000 and BPDB Annual Report 2000.

Table 5: Operational and Financial Performance of the Dhaka Electric Supply Authority

Item		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Economic Indicators													
Average Exchange Rate/$	Taka	34.6	36.6	39.0	39.6	40.2	40.3	41.8	43.9	46.9	49.1	52.1	55.8
Operational Indicators													
Energy Sales	GWh	479	1,020	1,456	2,309	2,538	2,914	3,209	3,589	3,908	4,469	4,831	5,392
Sales Growth (%)	GWh	—	113.0	43.0	59.0	10.0	15.0	10.0	12.0	9.0	14.0	8.0	12.0
System Losses:													
Losses excluding sales to DESCO/REB	%	—	—	31.0	31.0	33.0	32.0	31.3	30.0	30.0	30.0	35.0	37.0
Average Selling Price	Taka/kWh	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.44	2.5	2.4	2.4	2.4
Average Selling Price 1990 Constant	Taka/kWh	2.5	2.3	2.2	2.2	2.0	1.9	1.7	1.9	1.8	1.6	1.6	1.6
Average Selling Price Cents	cents/kWh	7.3	6.8	6.2	6.0	5.6	5.6	5.3	5.6	5.4	4.9	4.6	4.3
Financial Performance													
Revenue (billion)	Taka	—	—	—	—	5.7	6.6	—	8.8	9.9	10.7	11.5	13.0
Operating Profit/(Loss) (billion)	Taka	—	—	—	—	(1.2)	(1.2)	—	(0.8)	(1.0)	(1.7)	(2.2)	(2.8)
Net Income (billion)	Taka	—	—	—	—	(2.0)	(1.9)	—	(1.4)	(1.5)	(1.8)	(2.3)	(3.7)
Financial Ratios													
OR	%	—	—	—	—	121.0	119.0	109.0	110.0	116.0	119.0	122.0	109.0
SFR	%	—	—	—	—	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR	days	—	—	—	—	240	251	313	351	406	425	415	313
Collection (% of Billings)	%	—	—	—	—	80.0	89.0	85.0	82.0	80.0	76.0	88.0	88.0

= no data available, AR = accounts receivable, DESA = Dhaka Electric Supply Authority, DESCO = Dhaka Electric Supply Company, GWh = gigawatt-hour, kWh = kilowatt-hour, OR = operating ratio, REB = Rural Electrification Board, SFR = self-financing ratio.
Source: Audited financial statements of DESA.

52. Over the past 8 years (since ADB's resumption of lending in 1995), continuous pressure on BPDB and DESA to improve their performance is evident. A number of initiatives contributed to this: the introduction of computerized billing under TA 2004; efforts within BPDB to make greater use of the Strategic Business Unit (SBU) concept; pressure on the Government (as one of the major defaulters) to pay its own electricity bills; TA from Japan to support reductions in system loss; and the pressure from the Government to improve results and many others. The impact is illustrated in Table 6.

Table 6: Selected Performance Measures for BPDB and DESA from 1995 to 2003

Item	1995	2000	2001	2002	2003
BPDB Zones system loss (%)	24.6	20.6	18.8	17.2	14.8
BPDB Zones system loss net of sales to REB (%)	29.4	26.7	24.9	23.2	20.7
DESA system loss (%)	30.0	25.7	25.5	25.2	20.3
DESA system loss net of sales to REB and DESCO (%)	32.0	35.0	36.6	35.6	30.9
BPDB collections as % of billings	90.2	82.3	86.0	89.2	90.2
DESA collections as % of billings	89.5	87.6	87.6	97.1	91.9

BPDB = Bangladesh Power Development Board, DESA = Dhaka Electric Supply Authority, DESCO = Dhaka Electric Supply Company, REB = rural electrification board.
Source: Asian Development Bank.

53. Of note is that both BPDB and DESA have handed parts of their distribution areas over to other suppliers, i.e., PBSs and DESCO, during the period. The gross level of losses in BPDB's and DESA's areas of operation would improve simply as a result of these transfers, as indicated by the figures which evaluate performance after netting off sales to REB and DESCO. Furthermore, system loss figures include both technical losses, through the transmission and stepping down of power before it is delivered to other retailers, and thefts. The billing figures appear to show a slight improvement for DESA and little change for BPDB over the period. However, this also needs cautious interpretation. BPDB's biggest customer by far is DESA, and DESA has defaulted on parts of its electricity bill from BPDB continuously over the past 8 years. If DESA's billing is taken out of the BPDB result, then it shows BPDB achieving collection performance of around 100% in the past 2 years. The figure for 2003 would be 98.9% if DESA is excluded. DESCO also defaulted on payments to DESA although this had only a small impact on DESA's collection performance. BPDB is, therefore, now performing at an appropriate commercial level in collecting revenue from its retail customers. DESA's performance has also improved slightly.

3. Institutional Impact: Unbundling and Corporatization

54. Largely owing to the persistent pressure and assistance from development partners particularly ADB, the unbundling and corporatization of the power sector have occurred though in a gradual manner. The general arguments in favor of unbundling and corporatization cite the greater scope for introducing competition and private sector finance.[20] Four new entities have been created out of BPDB and DESA so far, all implemented as required by ADB loan covenants. The establishment of PGCB in 1996 to run the transmission network was driven by an ADB loan condition linked to the transmission facilities for the Meghnaghat Power Station, i.e., Loan 1505(SF): The Ninth Power Project. There have been several delays in handing over

[20] There are four additional connected reasons for favoring such an approach in Bangladesh: (i) smaller entities are intrinsically more manageable, (ii) the influence of trade unions has been excessive in both BPDB and DESA (a move to decentralization has enabled changes to be introduced which would not have been possible in the previous framework; PBSs by contrast have never had union involvement), (iii) the public sector approach to work practices at BPDB and DESA was not conducive to running utilities on commercial lines and a better approach is possible as corporate entities (salaries are considerably higher in the new companies, as they are in PBSs), and (iv) the working culture in both BPDB and DESA was such that excessive levels of system loss and uncollected bills were tolerated and projects were invariably subject to considerable delays. A different institutional structure was needed to enable change.

transmission assets to PGCB but these have now been largely overcome. The corporate structure is creating a better work culture in the company and ADB is satisfied that projects are being implemented more quickly than under the BPDB framework.

55. The creation and expansion of DESCO was also driven forward by conditions imposed under Loan 1505(SF), and suffered similar delays to the creation of PGCB. DESCO was created to take over part of DESA's operations, initially in the area of Mirpur. DESCO is now taking over a further area of operations from DESA in Gulshan Circle, effective from April 2003. DESCO, which only became commercially operational in 1999, is a company and has taken a far more commercial approach to management of its supply area than DESA. Table 7 illustrates improvements in system losses and collection performance.

Table 7: Selected Performance Measures for Dhaka Electric Supply Corporation: 1999 to 2003

	Fiscal Year Ending 30 June				
Item	**1999**	**2000**	**2001**	**2002**	**2003**[a]
System loss as % of imports	40.5	32.9	29.9	26.7	21.2
Billing (Tk million)	569	1067	1297	1470	1746
Collections (Tk million)	337	836	1042	1309	1534
Collections as % of billing	59.2	78.4	80.3	89.0	87.9
Net Profit (loss) for the year (Tk million)	(133.5)	(72.6)	(79.8)	(53.7)	6.0

[a] Provisional figures.
Source: Dhaka Electric Supply Company.

56. Ashuganj Power Station Company has recently been created to run the Ashuganj power station, under TA 3343: Corporatization of Ashuganj Power Station (para. 45). The company was established in June 2000, the Board of Directors was constituted in September 2001, and management for the company has been selected, which is now running the station. Several aspects remain to be finalized including the PPA, some accounting and finance issues, and arrangements for transfer of staff. At present, the company still operates as an integral part of BPDB, and it is difficult to demonstrate achievements as a result of corporatization. To do so, it would have to demonstrate that it can match the cost and reliability records of the IPP stations.

57. The West Zone Power Distribution Company is a recent creation, under TA 3801: Corporatization of the West Zone Distribution Operations of BPDB and driven by covenants of Loans 1884(SF)/1885: West Zone Power System Development, which is taking over distribution activities in BPDB's West Zone. The management for this company has been selected but there has been only limited activity by the company as yet. The challenge will be for the company to emulate and better the achievements of DESCO.

58. Some interviews with officials suggest that ADB's piecemeal reform approach lacks an overall roadmap, and inadvertently created a sense of inequality among the sector employees as only those employed by the newly created corporate entities, through open competition, enjoy much higher salaries and benefits. However, the responsible ADB officer maintains that ADB has developed a 15-year roadmap for reforms with the Government and these "piecemeal" measures were part of this long-term plan. The OEM has not seen the plan but is of the view that these measures or projects so far are essentially pilot demonstrations that show alternative working

methods can lead to improved performance within the framework of the government's commitment to corporatization of the sector. The system wide benefits will only be obtained when these approaches are extended more widely to the existing operations of BPDB and DESA. With favorable impact achieved in the new companies, it is now more straightforward to argue the case for further and more substantive changes. The pace of change should accelerate, now that the potential impact of reform is so clear. For example, once the Ashuganj power station is operating at arms length from BPDB, it should be feasible to extend the concept to other stations within a reasonably short period. The new investment in the Siddhirganj power station in principle will be subject to corporatization. On the distribution side, the Government has committed to the corporatization of the rest of DESA (probably in two units) and of the North West zone of BPDB's distribution activities in the context of ADB's latest lending activities. Other BPDB zones should follow. Under these arrangements, most of the power sector could move into a corporate structure within a short period.

59. In addition to unbundling and corporatization, the policy reforms supported by ADB also led to areas being transferred from the management of BPDB and DESA to PBSs through boundary rationalization. These reforms quickly led to reductions in system losses and improvements in revenue collection. The best performing PBSs are the most successful electricity retailers in Bangladesh and illustrate what is achievable. For example, the Comilla PBS 1 has since 1997 consistently kept system losses in the range of 9.0% to 11.7% and achieved collections against billings in the range of 96.0% to 99.9%. The performance improvement achieved when a PBS takes over from DESA is illustrated in the table below:

Table 8: Performance Measures at Selected PBSs: 2000 to 2003

	Munshiganj PBS		Dhaka PBS 2	
Item	**2000**	**2003**	**2000**	**2003**
System loss (%)	58.0	27.0	60.9	25.3
Energy sales (GWh)	114.5	216.1	59.4	158.9
Peak demand (MW)	54.0	53.0	48.8	45.2
Billing (Tk million)	135.6	495.3	167.8	464.5
Collection to billing ratio (%)	49.1	101.9	44.4	102.5
Net deficit (Tk million)	85.9	44.0	133.9	37.3
Deficit as % of sales	63.3	8.9	79.8	8.0

GWh = gigawatt-hour, MW = megawatt, PBS = Pally Bidyut Samity (rural electricity cooperatives).
Source: Rural Electrification Board.

60. Similar results are evident in other areas where PBSs took over from DESA, although the figures appear less dramatic because the DESA areas were absorbed into an existing PBS. These figures illustrate a number of points. First, substantial performance improvements are possible with a PBS management structure. Secondly, energy sales grew substantially without impacting on peak demand, thus improving system load factor. Thirdly, both PBSs are still incurring losses and are unable to pay their energy bills for power purchased in full. System losses can be improved further. Continued improvement is shown from year to year, even though a collection of over 100% of billings cannot be sustained for as long as it would require absolute reductions in the level of customer debts. Nonetheless, if Munshiganj PBS and Dhaka PBS 2 can reduce their system losses to the PBS average (just over 17%), it would be feasible for them to achieve slightly better than breakeven results. Finally, improvements in performance at individual sector entities, i.e., BPDB, DESA, PBSs, and DESCO, have not translated into significantly improved financial performance for the sector as a whole. Tariffs have been falling

in real terms over time and many tariffs are set at levels below cost so that losses increase as the system expands.

4. Impact on Private Sector Participation

61. In recent years, most generation projects for grid supplies have been undertaken by the private sector. The RPC,[21] formed under Loan 1356: Rural Electrification (paras. 30 and 44), was quickly followed by five other IPP projects (Khulna Power Company,[22] Westmont Power, New England Power Company consortium and the two AES projects at Meghnaghat and Haripur). ADB played a catalytic role in enabling private finance for generation through its involvement in initial projects at RPC and Meghnaghat. All these projects are operating successfully in the private sector and producing power at reasonable cost to BPDB and with high levels of reliability. In addition there have been a number of IPP 11 MW plants established to serve the needs of individual PBSs and operated separately from the grid.

62. In addition to cost-effective and reliable power, these projects conferred a number of other benefits. They introduced both private capital and private sector management to the power generation sector. Private capital reduces the demand on the budgets of both government and development partners. Private sector management provides benchmarks for the efficient management of power stations in Bangladesh in terms of manning and operations and, hence, standards for which BPDB stations may aim in future. Moreover, the new investors show signs of being prepared to pursue further investments in the sector. AES, which was the leading investor in the ADB-sponsored Meghnaghat power station, is a subsidiary of the American power company Allegheny Energy Services. It subsequently invested in a further project at Haripur and the two investments are being managed in parallel by a single senior management team.[23] These developments indicate that private power generation is now widely accepted in Bangladesh, and attracts both foreign and local investors prepared to invest further in the sector. The continuity of interest is greater with local investors.

63. The overall conclusion on the institutional impact of ADB's involvement and investment in the power sector is that it led to positive developments particularly over the past 8 years since ADB became the coordinating development partner for the sector. The unbundling of the sector was partially accomplished, private generation is now an accepted feature of the power market, new institutions were set up that are achieving good results, responsibilities were transferred

[21] The RPC was originally promoted by REB and five PBSs to construct a 70MW (2 x 35 MW) gas turbine station at Mymensingh. In the second phase an additional four PBSs became involved, the percentage shareholding of REB was reduced and a further 70 MW (2 x 35 MW) of gas turbine capacity was added. There are now plans to turn the plant into a combined cycle plant through the addition of 70 MW of steam turbine capacity. This plant has an innovative management structure in that it is operated by a company part owned by an international firm and part owned by local investors. Furthermore, RPC is now developing plans for a second power station at Dhaka North. This plant will supply power direct to four PBSs in the area. It will be financed by the PBSs and managed in the same way as the Mymensingh station.

[22] The Khulna Power Company was sponsored by the Summit group, a group of private Bangladeshi companies which have investments in a number of infrastructure developments. Other investors are EL PASO international USA and Wartsila NSD Corporation Finland. The project is a 114 MW barge mounted power plant which was completed in 11 months. Summit is satisfied with its investment and has already undertaken further investments, through another subsidiary, to establish several 11 MW power stations for PBSs to increase rural power supplies. Total generation is expected to increase to 132 MW in due course. Summit will also consider further investments in larger power stations.

[23] As a result of issues in its American operations, the company wishes to pull out of a number of overseas investments, including Bangladesh. However, the two power stations, including their management team, are likely to be bought by a subsidiary of United Kingdom's Commonwealth Development Corporation which is committed to continued investment in the power sector.

from ineffective to more effective institutions, some performance improvements were achieved in the main utilities and capacity has been built within the local power sector. ADB's ability to offer loans and TAs, but subject to certain conditions, gave it powerful leverage which it generally used to good effect. Moreover, the piecemeal approach to change based on using pilot projects and building on what works, rather than working from a pre-determined blueprint for reform, has produced positive results. However, the sector continues to face many commercial shortcomings and private sector participation, though significant and successful, all concentrates in generation. Further progress in attracting private sector investment may depend on key reforms to be accomplished including an operational and independent ERC (para. 25). In this regard, legislation has already been passed with ADB assistance, i.e., TA 3129: Support for the Energy Regulatory Authority, to create an independent regulator for the energy sector and the regulator is to be appointed by the end of 2003 or early 2004.

B. Impact on Residential, Industrial and Commercial Activities in Urban Areas

64. As stated earlier (para. 1), in view of the significant expansion in power supplies since 1972, Bangladesh's modest economic growth over that period, and the dependence of modern industry and commerce on electricity, the importance of electricity for the development of many enterprises is well evident. However, the OEM was somewhat surprised by the indiscriminant nature of the criticisms laid by the representatives of industry and commerce interviewed on the performance of the power utilities. They did not differentiate between BPDB, DESA, and DESCO, or between rural and urban suppliers. Nor did they recognize any performance improvement in the past 3 years, when the level of power cuts appears to be lower. Their general view was that power supplies are highly unreliable and an impediment to economic development rather than a stimulus.[24] This is borne out by the conclusions of a recent World Bank study, which estimated that power shortages reduce the gross domestic product (GDP) by $1 billion a year and GDP growth rates by 0.5% per annum.[25]

65. The Bangladesh Garment Manufacturers & Manufacturers Association represents an industry that contributes some three quarters of Bangladesh's exports and employs about 1.8 million people (of whom about 1.5 million are women). There is significant additional employment in associated industries. The industry is profoundly dissatisfied with the quality and reliability of power supplies throughout Bangladesh. Perhaps a quarter of the Association's 3700 members have acquired standby generators so that they can continue to work during power cuts, emphasizing a willingness to pay for more reliable supplies. With the expiry in 2004 of the international Multi-Fiber Agreement, which gives textile products from Bangladesh preferential access to some international markets, there are concerns that some of the garment industry may cease operating in Bangladesh. Among others cited, poor infrastructure including quality of power supplies was ranked as one of the top reasons.

66. British Oxygen, a multinational company operating in Bangladesh and producing industrial gases, has four major plants. All of them have independent power supplies which are used for continuous operation of the plants. The nature of the industry requires that the company's plants operate continuously. Supplies from the national grid are simply not reliable enough to satisfy the company's requirements for quality or continuity. Grid supplies in this case are used as a standby and for startup operations only. These conclusions were borne out by discussions with other companies and associations. The comments received were not directed

[24] This could be in part due to the possibility that people tend to take reliable power supply for granted, such that they only notice it when there are interruptions.
[25] World Bank. 2000. *Cost of Electricity Outage in Bangladesh*. Dhaka.

solely at the power sector but rather at the whole range of government-provided infrastructure of which power is only a part.[26]

67. Attitudes at the household level are similar. A recent survey, based on the World Bank's Urban Service Delivery Scorecard[27], illustrates this, noting that electricity services are generally rated better than the police and judiciary but below health care, garbage disposal, drinking water, sanitation and education. Although questions may be raised as to the validity of the survey methodology and the practice of cross-sector comparison—and the negative perception may have also been influenced by the recent efforts by all the utilities to collect revenues more aggressively—there is little doubt that the public is profoundly dissatisfied with the power sector's performance (Table 9).

Table 9: Percentage of Households Satisfied with Electricity Services

Town	%
Dhaka	8
Chittagong	2
Khulna	12
Rajshahi	2

Source: World Bank, 2002.

C. Impact of Rural Electrification

68. Possibly the most dramatic change in the power sector over the past 30 years is the significant increase in the availability of power in rural areas, from about 1% of rural households in the early 1970s to over 30% today. Electricity offers significant benefits to rural households and improves access to production technologies, which can reduce the costs and improve the product quality of agriculture and rural industries. Commercial and industrial establishments in rural areas can improve their working environments, and their services and products. The importance of electricity as a necessary condition for development is indisputable but its contribution is intertwined with the provision of other infrastructure, both physical and social, and with a range of other factors influencing development. The impacts solely attributable to electrification are therefore difficult to quantify.

69. The OEM carried out a special socioeconomic survey to investigate such impacts, and was also able to draw on the results of a similar survey sponsored by USAID.[28] The details of the survey conducted by the OEM are presented in Appendix 4. The survey involved surveying two villages in Comilla PBS-1,[29] one with electricity, Barura (i.e., the "treatment village") and the other without electricity, Dumuria (i.e., the "control village"). The two villages have a similar social and economic environment except for the difference in electricity connection. A complete census survey has been carried out in both the villages to capture all categories of villagers and their activities.

[26] There were equally negative comments about water, roads , telecommunications, Chittagong Port, and the railways.
[27] World Bank. 2002. *Urban Service Delivery Score Card*. Dhaka.
[28] Human Development Research Center. 2002. *Economic and Social Impact Evaluation Study – Rural Electrification Program in Bangladesh*. Dhaka.
[29] One of the PBSs that benefited from Loan 1356(SF): *Rural Electrification*.

70. The benefit of electricity to rural areas may be conceptually classified as resource savings, i.e., benefits due to cheaper alternatives available because of electrification compared to existing alternatives not involving electricity, and newly generated benefits, i.e., benefits achieved only possible with the availability of electricity. For each category, these may be further divided into monetary and non-monetary benefits. A good example of resource savings from using electricity compared to alternative fuels is the difference in cost between an electric pump and an equivalent diesel pump for irrigation. A comparison was made using typical low lift pumps, shallow tube wells, and deep tube wells. The results indicate that the savings in lubricants and capital and maintenance costs give electric pumps a significant advantage both at the time of initial purchase and over the life of the pump. The total operating cost per acre of irrigated land per year is about Tk1990 for an electric pump, which is 17% less than the diesel pump.[30]

71. Perhaps the more significant type of benefits is the generated benefits, both monetary and non-monetary. At the household level, the availability of electricity is positively correlated with a wide range of economic and social indicators, including higher participation rates by women in income generation, better nutrition, higher wages for the landless, and more studying and working time during evenings. However, the survey has not found statistically significant evidence that rural households with electricity have much higher incomes (on per capita basis) than those without electricity, as suggested by the USAID study. This may be caused by a number of other factors such as nongovernment organization (NGO) intervention, distance to national road or urban areas, and population mobility. But the fact that children can study after dark, the extra economic opportunities created by electricity and the knowledge people gain from watching television are all clear areas where electricity is improving people's welfare. In addition, electricity provides a high quality of light for homes and enables the use of a wide range of electric appliances. Finally, it is more cost effective as a source of light than the main alternative of using a kerosene lamp.

72. Electricity has also had a major impact on commercial and industrial development in rural areas, with the associated employment generation. Businesses are developing in areas which have access to electricity while areas that are not connected show limited development. Electricity is clearly a necessary condition for economic growth and, where power is available, new saw mills, ice cream factories and other businesses are being established while retail outlets extend their opening hours into the evening.

73. However, it appears that the present rural electrification program has not fully addressed the poverty reduction issue, and the trickle-down impact of electrification has not reached the extreme poor in a measurable way. Inevitably, it is the better off rural households who are more willing and capable of adopting electricity first. There is a significant initial connection charge required. Survey data for households indicate that the average cost of domestic connections was Tk1,500–Tk2,000 depending on the distance to the power line. In addition, there is a payment of Tk260 to the PBS as a membership fee and guarantee deposit. It also requires around Tk1,000 for purchase of wiring materials, Tk300 for a technician to install the wiring and Tk100 for other costs. The initial capital expenditure required to get a domestic connection is therefore about Tk3,000–Tk3,500. This is about one month's income for an average family member. However, the surveys show many examples of households living at or below the poverty line which have access to electricity and are willing and able to pay for power.

[30] These are actual financial costs incurred to farmers, not economic costs. As discussed in Section V, Bangladesh's power tariffs benefit from heavily subsidized natural gas supply and are only about half the long run marginal cost of power supply.

74. The most acute problem facing electricity consumers surveyed is the irregularity of power supply and load shedding. All customers said that power supply is irregular. Ninety percent said that supply interruptions are a daily occurrence. About 50% of the consumers expressed their willingness-to-pay more for electricity provided there are no power fluctuations and round-the-clock availability of electricity is ensured. On average, customers are willing to pay around 10% more if better service quality is guaranteed. Around 85% of the non-electrified households expressed their willingness to have electricity in their households. The fact that power is now available in many villages makes it easier to extend supplies to the poorest households which are not yet connected. In this regard, the Government has an ambitious objective of extending power supplies to all villages by 2020.

V. KEY ISSUES FACING THE SECTOR

75. Despite the significant progress that the sector has made with the assistance from different development partners including ADB, much remains to be done. There are significant challenges, both in technical/engineering and commercial/financial management but particularly the latter, facing the sector. Failure to overcome any of these challenges could risk turning back the clock of reform and lead to catastrophic sector meltdown and adversely affecting the economy. This section focuses on challenges in commercial/financial management while the technical and engineering aspects, i.e., maintaining system balance and meeting capacity requirements, were described earlier (paras. 47-50) and will be addressed again in discussing future recommendations (paras. 137-140).

A. Financial Situation

76. Although reform in the Bangladesh power sector over the past 8 years has brought about numerous institutional and operational improvements, the commercial performance of the power sector is still poor and has deteriorated. BPDB and DESA have continued to make very high losses; this in turn has a damaging impact on the finances of Government. As at 30 June 2002, BPDB had arrears of interest and capital repayments to Government of Tk28.098 billion and Tk28.380 billion respectively. This is a total default of about US$1billion at the current exchange rate. There is no likelihood of these amounts being repaid; on present policies they will grow further. During FY2002, the levels of interest and repayment default rose by Tk5.621 billion and Tk1.800 billion respectively. The total amount of this default for the year, Tk7.421 billion, corresponds quite closely with the aggregate losses incurred by the electricity utilities. Losses at BPDB (Tk3.751 billion), DESA (Tk4.156 billion) and DESCO (Tk54 million) are partially offset by profits at PGCB (Tk91million), giving a net loss of Tk7.870 billion. For FY2003, unaudited information indicates that the DESCO may have been on its way to achieve breakeven, though this is unlikely to cause a significant impact on the sector's financial performance as a whole.

77. There are some positive developments at BPDB in that billings rose from Tk35.7 billion in FY2002 to Tk40.5 billion in FY2003. This reflects both higher production levels as power sold increased from 15,243 GWh to 16,332 GWh during the period and higher tariffs with effect from 1 August 2002. Moreover the source of this power has changed significantly. Generation by IPP plants increased from 3,771GWH to 6,299GWh while generation at BPDB stations fell from 13,674GWh to 12,159GWh. The cost of generation from IPP plants is lower than from BPDB plants and unit costs fall as capacity utilization increases. Hence the overall impact should be an improvement in BPDB's results. Extra payments to IPPs will be Tk2.5 billion and this should be offset partially by a small reduction in BPDB's own generation costs. Taken together with the increase in sales, the overall impact on BPDB's results should be positive and in the region of Tk2.5 billion. This positive development is enhanced by the relative stability of the Taka

exchange rate during FY2003. Exchange losses on loans accounted for some Tk2.1billion of BPDB's losses during FY2002. Overall BPDB is hoping to breakeven during FY2003.

78. Results for DESA are unlikely to improve significantly during FY2003 as DESA has defaulted further on payments to BPDB and its indebtedness to BPDB has increased by some Tk3.5 billion, a worse result than in the previous year. DESA does not benefit from generation cost reductions and when retail tariffs were increased, the tariff which DESA pays to BPDB also went up. Furthermore, DESA did not incur such significant losses on foreign loans as BPDB during FY2002. DESA's results will therefore at best only improve slightly and may deteriorate further. Moreover it will be difficult to sustain this improvement. There is scope for further reduction in system losses and for improvement in collection performance at DESA and DESCO. But these are likely to be achieved only gradually. At the same time there are shortcomings in the financial policies of the utilities, which suggest that performance is worse than the current figures imply. Furthermore, current tariff policies do not support the commercial development of the power sector and are likely to push the utilities into deeper losses over time.

B. Accounting Issues

79. Accounting standards are low in both BPDB and DESA. This is reflected in inordinate delays in finalizing accounts and completing audits as well as doubtful figures in the published accounts. BPDB's accounts for FY2002 were completed and audited on 29 April 2003. This is the most rapid completion in recent years and reflects more prompt submission of financial data using the new Integrated Management Reporting System. While this is an improvement, there is still a time lag of over 9 months from the yearend, which requires excessively slow preparation. For DESA, results are worse. According to DESA management accounts for FY2002 were passed to the auditors in April 2003. They were awaiting audit as of the OEM in August 2003.

80. Of potentially greater concern are the figures that appear in the accounts. In many cases asset values are significantly overstated and expenses are underestimated in the published financial results. In particular, (i) BPDB and DESA do not provide sufficiently for bad debts, (ii) fixed assets records are incomplete, depreciation rates are too slow and depreciation is not sufficient to cover the costs of asset replacement, (iii) stock levels and values are not properly checked, (iv) pension liabilities are not provided for, (v) balances between DESA and BPDB are not fully reconciled, and (vi) doubtful assets and liabilities are retained in the accounts even though there is no prospect of settlement.

81. BPDB provides for bad debts at the rate of 5% of receivables excluding amounts due from DESA. DESA provides 10% of all receivables. Neither utility writes off any debts, because of Government restrictions. As a result, debts dating back to the establishment of BPDB in 1972 are still maintained in the books with a 5% provision against them. As at 30 June 2002, BPDB's receivables for electricity sales were over Tk40 billion. This comprises Tk27.2 billion owed by DESA and Tk13.6 billion owed by other customers. These receivables are equivalent to over 21 months billing to DESA and over 8 months billing to other customers. The situation for DESA is similar. At 30 June 2002 DESA had receivables from consumers of just over Tk15 billion compared to sales income for the year of just over Tk14 billion. The receivables are equivalent to 13 months billing. A better policy for both utilities would be to provide for overdue final customer receivables on the basis of a fixed time period. For example, receivables overdue for 3 months would be provided at 50% of the outstanding balance, and receivables overdue for 5 months would be provided in full. This would have a once-off impact on the balance sheets of both utilities, and a continuing impact on profit and loss statements.

82. Neither BPDB nor DESA maintain fixed asset registers. As a result it is impossible to be confident about the value of the fixed assets shown in their balance sheets or the associated deprecation provisions. However it appears that the depreciation provisions are too low to provide sufficient funding for the replacement of existing fixed assets. PGCB is also likely to face significant increases in depreciation provisions. Neither BPDB nor DESA maintain and reconcile proper stock records. The financial impact of this is impossible to estimate accurately but highly unlikely to be favorable.[31] Both BPDB and DESA are failing to provide in their accounts for pension liabilities for staff, which the OEM estimated as about $200 million. The accounts of BPDB and DESA show different amounts for the balance outstanding from DESA to BPDB. According to BPDB, DESA owes Tk27.2 billion as at 30 June 2002. The corresponding figure in DESA's accounts is Tk26.4 billion.[32] This is in spite of the two sets of accounts agreeing fully on the value of energy purchases for the year. The failure to reconcile such an important balance suggests that there are likely to be other disputed balances in the accounts of DESA in particular.

83. The newly created power utilities, DESCO and PGCB are far better in preparing accounts. Both have draft accounts available quickly at the yearend. There are proper fixed asset and stock records. They apply sensible depreciation policies which better reflect likely asset lives. Full staff costs are included in the accounts. However, DESCO has adopted a very optimistic approach to bad debts. Despite having taken over one of the worst areas of DESA's operations, it is assuming that all its consumer debts since its establishment are recoverable. This is highly unlikely and not borne out by the results that DESCO has achieved to date. Collections have invariably fallen well below billings and, at the end of June 2002, amounts outstanding from customers were Tk882 million, equivalent to over 7 months energy sales. DESCO ought to adopt a proper provisioning policy immediately, as the longer this decision is deferred the more painful it will be.[33]

C. Tariffs

1. Wholesale Tariffs

84. There are two types of tariff in the electricity sector: (i) wholesale tariff charges between sector entities such as IPPs, BPDB, PGCB, DESA, DESCO and the various PBSs, and (ii) retail tariffs charged to final consumers. The various wholesale tariffs are set at the following levels:

(i) IPPs charge BPDB for power supplies in accordance with PPAs, which specify capacity and energy payments.
(ii) PGCB carries out transmission at 132 kV and delivers to DESA and BPDB's retail operations at this voltage. PGCB receives a wheeling charge of Tk0.1768 per kWh.
(iii) BPDB sells to DESA at 132 kV at Tk2.12 per kWh.

[31] There are some figures in the accounts which tend to confirm this negative view. For example in FY2002 BPDB had stock turnover of under 5% on its material and other operating supplies and under 10% on construction stores. DESA failed to reconcile its physical inventory of stock and stores with the general ledger, which is a sign of accounting problems. If proper stock recording policies were implemented then there is a strong probability of stock write offs and higher annual provisions in both utilities.

[32] DESA's accounts include an investment valued at Tk8 million in a bank which ceased operations in 1993. The amount involved is small in this case but creates questions over what other problems may be concealed in the detail of the utility's accounts.

[33] In the event that DESCO wishes to raise private finance at some point in the future, then it is inevitable that its accounts and financial policies will come under far more intense scrutiny by potential investors. An obvious failing in accounting such as this will call DESCO's entire accounts into question and will damage its ability to raise any private finance on reasonable terms.

(iv) BPDB and DESA sell to PBSs at 33 kV at rates of Tk2.05 and Tk2.12 per kWh respectively.
(v) DESA sells to DESCO at 33 kV at Tk2.17 per kWh.

85. Tariffs for the IPPs, currently averaging about Tk2 per kWh, are in accordance with PPAs, which are logical and commercial. They specify both capacity and power payments and are related to an expected plant load for each power station. These load factors range from 50% at the Khulna, Westmont and New England Power Company, to 70% for the RPC plant at Mymensingh, and 85% for the two AES plants at Megnaghat and Haripur. The PPAs for these plants have been developed following international best practice and the prices are internationally competitive. The terms of the PPAs are being honored by BPDB, so that government guarantees on these plants are not being called even though they are in place.

86. The remainder of the wholesale tariff regime is less satisfactory. It has the following defects: (i) tariffs are not structured in a way that reflects the costs of supply, (ii) tariffs are at levels that do not enable cost recovery between sector entities, and (iii) tariffs are in any event often not paid. The tariffs are invariably related solely to energy consumed. However, the cost structure of the electricity industry is also heavily influenced by the level of peak system demand and the power factor on various parts of the system. These elements are not reflected in any of the wholesale tariffs, which result in a number of perverse incentives. The power retailers have no commercial incentive to manage the system peak or to control their customers' power factor. Nor do they have any incentive to install and operate peak load meters efficiently. Partly as a result, Bangladesh suffers from both a poor system load factor and poor power factors throughout the supply system.

87. Using data from BPDB's FY2002 accounts, the cost to BPDB of generation and transmission to the 132 kV supply point is about Tk1.94 per kWh. This suggests that BPDB makes a small theoretical profit on units it sells to DESA at the current tariff of Tk2.12 per kWh, even though in practice DESA often fails to pay for the power. These calculations are based on average accounting costs to BPDB as revealed in BPDB's accounts, which understate the level of costs that BPDB is incurring. Moreover they are substantially below the level of long run marginal cost (LRMC), estimated by the OEM at $0.0724 per kWh, or Tk4.2 per kWh at the current exchange rate, assuming supplying at 132 kV. The estimation was made using up-to-date information on system expansion and based on the last comprehensive study of long run marginal costs on the Bangladesh power system carried out under TA 1962: Preparation of Power System Master Plan between 1995 and 1997, and a subsequent study by London Economics[34] based on the results of the Master Plan. The details of the estimation are given in Appendix 5. The newly estimated LRMC is about double the current accounting costs.[35]

88. Sales by BPDB to the PBSs are made at a loss even at average accounting costs. The tariff payable to BPDB by PBSs is Tk2.05 per kWh but in this case the supply is at 33 kV. There are probably further technical losses of 3% in stepping power down from 132 kV to 33 kV and

[34] London Economics. 1997. *Bangladesh Power Sector Reform, Final Report, Analysis of Long Run Marginal Costs and Tariff Recommendations*.

[35] The much higher LRMC reflects a range of factors in particular the significantly higher gas price assumed in the economic analysis of generation costs, the assumed rate of return on assets of 12% in the LRMC calculation, the under estimation of costs in BPDB's accounts and the higher cost of new equipment compared to the old equipment costs in BPDB's accounts. It would be politically and socially difficult to allow tariffs to rise to LRMC levels in the short term and in any case the argument for having a tariff for power based on LRMC is weak if gas prices are subsidized. At the very least however the calculation does show that limited tariff increases would have sound economic underpinnings.

the additional costs involved in doing this are about Tk0.38 per kWh. The estimated cost is therefore Tk2.38 per kWh. DESA buys power from BPDB at Tk2.12 per kWh. It then incurs costs to step the power down to 33 kV and technical losses as a result of this transformation. The selling price to PBSs at 33 kV is also Tk2.12 per kWh, giving DESA no compensation for these costly services. In its sales to DESCO, DESA receives compensation for technical losses as the price is set at Tk2.17 per kWh, but this does not cover the transformation costs. DESA loses about Tk0.39 per kWh.

89. By contrast, PGCB has a tariff which enables it to earn profits. It earns a wheeling charge of Tk0.1768 for every kWh of energy that moves along its high voltage transmission system (often called a "postage stamp" charge). The use of such a charge is popular in many countries and such a rate structure has advantages in that it is easily understood by the users of the grid, it is simple to meter, and the billing is simple to render and to manage. However, these apparent advantages result in indiscriminant treatment of users with different capacity demands. Transmission grids and associated facilities are designed and constructed with the capacity to transmit the peak system demand. Therefore, it is the amount of coincident monthly peak demands placed on the grid that largely determines the cost of the grid, both for initial construction and future enhancement. A tariff structure for the use of the grid, i.e., wheeling, should be structured as a charge per kilovolt-amperes (kVA), not kW, of coincident demand during the peak 30 minute monthly demand on the system. There should be an additional, but lower unit charge for the non-coincident peak demand if such is of a higher level than the coincident peak. An additional charge should also be included per kWh of monthly energy transmitted. PGCB would receive bonuses and suffer penalties depending on whether it managed transmission so as to do better or worse than agreed levels of loss in the transmission system. This structure would compensate PGCB for the capacity provided and encourage the users to maintain a high system power factor and to try to direct their peak usage toward off-system peak times, thereby enhancing the system load factor. It would also create an incentive for generators to provide additional reactive compensation to the grid thus improving power factors. Implementing this form of tariff would entail the use of time-of-day metering and accurate determination of the peak loading on the grid. The advent of the proposed National Load Dispatching Center will provide for the accurate determination of the various users coincident and monthly total usage as such a facility requires accurate determination of delivery in real time. The other main problem with the current transmission tariff is that it is almost wholly borne by BPDB as the power purchaser and generator. The tariff is being restructured and increased so that the electricity distributors pay it. This makes commercial sense as power wheeling is a service provided to the distributors and hence it is logical for them to pay.

90. These tariffs, irrespective of their validity, are in reality often not paid. DESA has not paid in full for energy purchased from BPDB for many years. According to BPDB accounts, in FY2002, DESA paid Tk9.8 billion from a billed amount of Tk15.4 billion. The figures in DESA's accounts differ and state that DESA paid Tk12.2 billion out of a billed amount of Tk15.3 billion. DESCO is also defaulting on payments to DESA. Both BPDB and DESA have at times fallen into arrears on payments to PGCB, although these payments are currently up to date. Some of the PBSs which have taken over supply areas from BPDB and DESA have also fallen into arrears on payments to their supplier, because of time lags in reducing levels of system losses and payment defaults from their previous high levels.

91. In general, the wholesale tariff arrangements are weighted in favor of PGCB, DESCO and PBSs, to the detriment of DESA. BPDB is in an intermediate position. While BPDB and DESA have many commercial shortcomings, it is important to bear these tariff factors in mind in evaluating their overall performance.

2. Retail Tariffs

92. The structure of retail tariffs is somewhat more rational, but still has numerous anomalies and shortcomings. There are separate tariffs for residential consumers, irrigation, small industrial, nonresidential, commercial, medium voltage (11 kV), high voltage (33 kV), high voltage (132 kV), and street lighting. The retail tariffs of BPDB, DESA, and DESCO are identical and tariff revisions require government approval for BPDB and DESA. DESCO has the right to set its own tariffs but has not exercised this right. Current tariff levels together with details of the increase in tariffs since1997 are shown in Table 10.

Table 10: Bangladesh Power Development Board and Dhaka Electric Supply Authority Tariffs Since 1997

		Tariff (Tk per kWh)		
Consumer Category		**1 Jan 97**	**1 Jan 03**	**% Increase**
A	Residential 0 – 100 units	1.80	2.26	26
	Residential 101 – 300	1.80	2.42	34
	Residential 301 – 500	2.95	3.62	23
	Residential 501 – 700	4.00	4.73	18
	Residential over 701	5.20	5.99	15
B	Agriculture pumping	1.75	1.84	5
C	Small industrial flat rate	3.15	3.83	22
	Small industrial off peak rate	2.40	3.05	27
	Small industrial peak rate	4.60	5.36	17
D	Nonresidential light and power	2.55	3.20	25
E	Commercial flat rate	4.30	5.04	17
	Commercial off peak rate	2.95	3.62	23
	Commercial peak rate	6.95	7.20	04
F	General purpose 11 kV flat rate	2.95	3.62	23
	General purpose 11 kV off peak rate	2.35	2.99	27
	General purpose 11 kV peak rate	5.60	6.41	14
G	General purpose 132 kV – time 23.00 – 06.00	0.85	1.42	67
	General purpose 132 kV – time 06.00 – 13.00	1.75	2.36	35
	General purpose 132 kV – time 13.00 – 17.00	1.00	1.58	58
	General purpose 132 kV – time 17.00 – 23.00	4.50	5.25	17
	General purpose 132 kV – flat rate	2.05	2.68	31

Consumer Category		Tariff (Tk per kWh) 1 Jan 97	1 Jan 03	% Increase
H	General purpose 33 kV flat rate	2.75	3.41	24
	General purpose 33 kV off peak rate	2.25	2.89	28
	General purpose 33 kV peak rate	5.35	6.14	15
J	Street lights and water pumps	3.00	3.60	20

kV – kilovolt, kWh = kilowatt-hour.
Source: Bangladesh Power Development Board and Dhaka Electric Supply Authority.

93. The PBS retail tariffs are structured in a similar way but are slightly higher than BPDB tariffs to reflect higher distribution costs. For example the lifeline tariff for the first 100 units of consumption per month range from Tk2.53 to 2.90 per kWh compared to Tk2.26 per kWh charged by BPDB. Commercial tariffs are from Tk5.11 to 5.15 per kWh compared to the BPDB rate of Tk5.04 per kWh. The PBSs do not have time-of-day related tariffs.

94. There are a number of features of the existing tariff system that merit review. In particular, (i) tariffs are not being increased in line with inflation and this is damaging the viability of the power sector, (ii) the structure of tariffs do not reflect costs, (iii) certain tariff categories are heavily subsidized, by both Government and other tariff classes, and (iv) many tariffs are in practice not paid. On the first point, Table 10 shows tariff increases since 1997. During this period, the overall inflation rate has been about 28.6%. Power tariffs are therefore generally rising more slowly than inflation. This also reflects that the cost of generation may have decreased due to more IPP capacities coming on line.

95. Power tariffs are increased in accordance with a formula agreed between the Government and development partners in 1996. Tariffs are supposed to be increased every 6 months to reflect changes in fuel costs and exchange rate movements, but in practice these were not strictly implemented. For example, there were no increases in FY2001, only one increase in FY1998, and it has been over a year since the last increase. As a result of tariff increases below the inflation rate, the improvements in BPDB's and DESA's system losses and debt collection have not translated into overall improvements in financial performance. Unless retail tariffs increase, the power system will incur increasing losses as it expands.

96. Similar to wholesale tariffs, the structure of retail tariffs is not designed to reflect the cost structure. Few consumers are subject to maximum demand tariffs. Time-of-day tariffs are only applied to a limited number of consumers and even here there are often problems with metering. Large users,[36] industrial and commercial, are required to take actions to maintain their power factor above a certain minimum. If these consumers fail to do so, they can be assessed a penalty. However, most of such users do not comply, many of the low power factor loads are unknown to DESA and BPDB, and the penalties are not uniformly assessed. These are major concerns because the power factor of the Bangladesh system, especially in Dhaka, is very poor with consequent damage to the distribution network and other problems. The tariff for large users should be modified so that the correct economic signals are provided. The tariff for large users should be based upon a two-part structure. A capacity demand charge and an energy charge should be incorporated into this tariff with the demand based upon kVA rather than kW. Depending upon the justification, the demand can be either the peak 30 minute integrated

[36] The "large" can be set by either capacity demand or monthly energy use.

demand in kVA or the coincident demand with the distribution system peak. The second part of the rate should be for kWh use. This tariff structure encourages users with low power factor and/or high monthly or coincident demand to correct their power factor and shift their demand timing if it is economical for them to do so. Alternatively, if the users decide that it is more economical to do nothing and pay for their usage patterns, then the distribution utility will receive compensating revenue to cover its increased cost of power factor correction and demand. This restructuring parallels the proposals for revised PGCB tariffs set out above.

97. Small-scale retail consumers, irrigation customers and street lighting and pumping customers are paying tariffs that are clearly below cost. They are the major beneficiaries of subsidies which are received both through the overall losses of the power sector and from certain other tariff classes, i.e., cross-subsidization from high usage domestic, commercial, and medium and high voltage consumers who pay far higher rates. The other major beneficiaries of subsidies are the many customers who are not paying electricity bills. The utilities have been taking a far more commercial approach in the past few years and collections are running at close to 100% of retail billings in parts of the system. However, there are still some customers who systematically fail to pay their power bills, in particular in the public sector.[37] Unless this situation is rectified, improvement in the tariff structure could only achieve very moderate success.[38]

VI. CONCLUSIONS, LESSONS, AND FUTURE RECOMMENDATIONS

A. Overall Assessment

1. Relevance

98. Reliable and affordable power is vital to economic development and poverty alleviation. The socioeconomic survey conducted during this evaluation revealed a clear association between availability of electricity to households and more economic and human development opportunities and a series of socioeconomic indicators. The fifth national plan concludes: “it is essential that the minimum electricity growth rate is maintained at a factor of 1.5 of GDP growth, and adequate and reliable supply of electricity is a pre-requisite to attain this goal.” The plan recognizes the importance of electricity for the alleviation of poverty, socio-economic and human development and the expansion of industry.

99. Over the past 30 years, ADB’s consistent and comprehensive support for Bangladesh’s power sector has set it apart from other development partners. The priorities of ADB’s assistance evolved over time, appropriately, in response to changing needs of the Government in achieving economic development and ADB’s policy changes. Before 1982, assistance focused on rehabilitation and expansion of generation capacity. The 1983 country operational strategy paper for Bangladesh gave the second priority to the energy sector (after food grain production). ADB’s operational strategy in power shifted from generation to transmission and distribution primarily in the urban areas since adequate assistance from other development partners was being directed to rural electrification. ADB’s actual lending activities closely reflected this shift of sector strategies and objectives. There was a gap in lending between 1989 and 1995, although policy dialogue continued. Since 1995 ADB’s sector strategy has evolved significantly from supporting expansion

[37] It should be borne in mind that BPDB defaults to Government greatly exceed public sector defaults to the utilities.

[38] In a recently completed OED Special Evaluation Study of Cost Recovery in the Power Sector, it was found that, among the 14 developing member countries included in the study, Bangladesh was among the worst performing group of countries, together with India, Kyrgyz Republic, Pakistan, and Tajikistan, using a predetermined set of criteria related to achieving full cost recovery of power sector projects. One of the main causes for the poor performance is low tariffs and collection rate.

of capacities with public sector loans, as was typically the case for the pre-1995 period, to a strategy of continued physical investment in system rehabilitation and expansion combined with engaging the Government on a reform agenda through TAs, loan covenants, and extended policy dialogue, aimed at enabling sector unbundling and corporatization, greater private sector participation and reducing system losses and non-payment of bills in the key public utilities. Overall, the sector assistance program has been relevant.

2. Efficacy and Efficiency

100. ADB has applied most of its assistance modalities at its disposal to Bangladesh's power sector over the last 30 years, and the results indicate that these modalities are generally effective for achieving different objectives:

(i) ADB's public sector lending with loan covenants has mostly achieved their objectives at the project level, albeit with extensive delays in implementation, and has been crucial in resolving system bottlenecks and weaknesses in generation and particularly transmission and distribution, and in maintaining an approximate system balance;
(ii) ADB's private sector lending and credit guarantee played a catalytic role in leveraging private financing into generation. The IPPs have provided significant new capacity and generated electricity at internationally competitive prices; and
(iii) ADB's TAs, particularly recent ones, have targeted key areas of capacity building and policy reform such as sector planning, financial management, sector unbundling and corporatization. These provide necessary foundations for further sector reform including privatization.

101. Most of the projects reviewed in depth by OEM were technically sound and implemented with satisfactory to good quality. They generally met the physical objectives identified at the time of appraisal and were procured broadly in line with budget. The appraisal estimates and, for some of them, subsequent PCR and PPAR re-estimates of the economic internal rates of returns were generally well in excess of 12%, which appeared to be justified based on the OEM's own observation of the heavy use of the facilities. However, delays in public sector project implementation were extensive, ranging from 1 to 7 years with an average of 3.5 years.[39] These delays diminished the projects' efficiency by delaying benefits. This was particularly detrimental as many of these projects were already lagging behind requirements at the conception and appraisal stage. As a result, ADB's assistance always appeared to be catching up, and supply continuously lagged behind demand. Because generation capacity was insufficient and transmission and distribution systems were overloaded, sound projects did not translate into a sound supply system. Poor management of system losses and unsatisfactory maintenance exacerbated these problems. Hence power supplies to consumers were generally unsatisfactory and the reputation of the system is poor.

102. There has been significant progress on some institutional and financial issues, particularly in sector unbundling, corporatization and private sector participation in generation. But some institutional and financial aspects of the sector remain unsatisfactory. TAs on upgrading financial management including implementing computer billing and on corporatization of a power plant out of BPDP's existing structure achieved limited or slow progress. As a result,

[39] Many ADB projects experience delays but it is difficult to derive a benchmark for comparative purposes because of different circumstances across different countries and sectors. However, some countries, most notably the People's Republic of China, are known to complete projects within schedule.

both BPDP and DESA still use manual billing for some operational areas which are inefficient and susceptible to theft. Where loan conditions required institutional reforms, they were implemented, but often with delays. Moreover, the sector continues to make significant losses. The realized financial rate of return on investments in the sector is negative. The main area where results have not been achieved is in reducing sector subsidies.

103. In general, at the sector level, ADB's changing objectives, i.e., from expansion of generation capacities in the 1970s to early 1980s, to improvement of transmission and distribution system from the mid-1980s to the mid-1990s, and to a strategy of continued physical investment in system rehabilitation and expansion combined with engaging the Government on a reform agenda to enable sector unbundling and corporatization and greater private sector participation, have been partly met. However, the degree of the achievement of the objectives at the sector level appears to be less satisfactory than that at the project level, and indicates that much more intense efforts by all parties involved are needed to achieve greater progress in sector performance. The trends are encouraging in that indicators such as system losses and debt collection performance are improving year on year and future plans are sound, but much remains to be done.

3. Sustainability

104. The technical engineering and operations of ADB projects have been generally satisfactory. This is well illustrated by the Ashuganj Power Station. The units procured under Loan 587 were commissioned during 1986 to 1988 and achieve very high availability, e.g., 87.2% for Unit 3. The power utilities in Bangladesh generally have the necessary engineering and operational human resources to sustain the investments financed by ADB. The OEM noted, however, that the newly created or better managed sector entities including RPC, DESCO, various IPPs, and to a lesser degree, REB and PBSs, tend to attract more motivated and competent engineering/operation personnel with better corporate culture and compensation packages. Moreover, the successes at the level of individual projects stand alongside serious failings at system level because the supply system is inadequate to meet demand.

105. The main area where sustainability is questionable is finance. This is reflected in several aspects. Power tariffs are not high enough to enable the utilities to self-finance replacement investments and the sector makes significant losses that have to be covered by government subsidy. The sector lacks sufficient qualified financial specialists and poor accounting damages both day-to-day operations and management decisions and long-term strategic investment programs. BPDB and DESA function like government agencies when procuring spare parts and maintenance work. Even for relatively low cost parts, procurement procedures can take months even years. This hampers the operation and sustainability of the projects.

4. Institutional, Socioeconomic and Other Impact

106. ADB influences institutional and policy reforms through its TA programs, policy dialogue, and loan covenants. The impact is highly evident. Various new and more commercially oriented sector entities have been created in generation, transmission, and distribution, including RPC, DESCO, and various IPPs. The impact of these entities goes beyond the institutions themselves. They have demonstrated that commercial operations can achieve better results by improving both quality of services and financial performance of the sector. Various TA projects funded by ADB have also helped build the sector's capacity to solicit bids from the private sector for IPPs and carry out power system investment planning. The continuous poor performance of BPDB and DESA are reasons for deepening reform rather than relinquishing it.

107. Power sector investments have had significant socio-economic impact in rural areas. Only about 1% of rural Bangladesh had access to electricity 30 years ago but today the level is over 30%.[40] Various studies including a recently completed survey funded by USAID and a survey conducted as part of this evaluation indicate that availability of electricity in a rural household is positively correlated with a wide range of other economic and social indicators. Both studies show that rural households with electricity have more income-generating and commercial activities, greater use of family planning, higher participation rates by women in income generation, better nutrition, and better life quality in general. While in most of these cases, correlation rather than causality was observed, the impact of electricity on income generation (particularly for the landless) and improvement of welfare is unquestionable. However, electricity is a necessary, but not sufficient, condition for economic development. Other factors, such as distance to urban areas and main roads and NGO interventions, also play a critical role. The present rural electrification program has not fully addressed the poverty reduction issue, and the trickle-down impact of electrification has not reached the extreme poor in a measurable way.

108. In the urban sector, the impact of electricity on economic development and life quality is less centered on its availability (most urban households and businesses are connected), but more related to the quality of supply. Most business representatives interviewed expressed profound dissatisfaction with the quality of power supply in Greater Dhaka irrespective of the different suppliers. Other available information also suggests that urban households are generally dissatisfied with the service. It was estimated by the World Bank that the unreliable power supply costs the economy about $1 billion per annum.

109. Power sector operations have environmental implications through, for example, increased or reduced air emissions. In Bangladesh, the exploitation of natural gas had significant environmental benefits. ADB-financed generation projects including earlier ones generally involved replacing imported crude oil with locally produced cleaner natural gas. ADB-financed transmission and distribution projects are environmentally neutral or even beneficial by reducing the need to have many smaller and relatively inefficient power plants.

5. Overall Assessment

110. Overall, ADB's assistance to Bangladesh's power sector has substantially achieved its objectives at the project level but much remains to be done to achieve its sector objectives, and wider and more far-reaching economic and poverty-reduction impact. The priority areas for urgent improvement include financial management, demand and load management, and system improvement and expansion.

B. Lessons Learned

111. The evaluation of ADB's 30-year assistance program in Bangladesh's power sector has generated lessons both at the project and strategic levels.

[40] The average 1% per annum is by no means a fast growth rate for rural electrification in view of the fact that the first 30% is relatively easy to achieve due to the geographical proximity of the connected areas to urban centers. It will get increasingly difficult and costly to connect more remote rural areas as the percentage reaches a certain level.

1. Project-Level Lessons

a. Minimizing Implementation Delays in Public Sector Projects

112. Delays in public sector project implementation have become more a norm than exception, which ranged from 1 year to 7.2 years, averaging 3.5 years. The reasons behind the delays were complex, including ambitious scheduling, poor front-end project preparation by executing agencies, and delays caused by right-of-way issues and procurement procedures, etc. In addition, ADB's insistence on compliance with loan covenants related to sector unbundling and corporatization was critical for some projects. The extensive delays experienced by public sector projects form a contrast to the case of the ADB-facilitated private sector investment project, i.e., Inv. 7165/1793: AES Meghnaghat Power, which was completed within schedule. While project delays are fairly common for most ADB projects across developing member countries, the magnitude of the delays in Bangladesh is more severe and systemic, and tend to have more adverse impact on the power infrastructure as these projects were long overdue even in the planning and appraisal stage. Future public sector power projects should learn from private sector experience in project implementation. In particular, the Government and the public sector entities must recognize that time is literarily money in project implementation, in terms of both interest paid during construction and foregone project benefits when projects are not completed on time. ADB should also assist the Government and executing agencies in devising realistic project scheduling and not pressurize the Government into a position of signing the loan agreement and paying the commitment fees when it recognizes that the necessary conditions for starting a project are not in place.

b. Improving Local Capacities in Project Preparation, Implementation, and Operation and Selection of Appropriate Technology

113. The OEM was impressed with the range of engineering talent that the sector entities possess. BPDP, with ADB assistance, has also gained valuable experience in sector planning. However, most ADB financed projects rely heavily on foreign consultants and expertise in project design, supervision, and operation. This not only added to the financial costs of the projects, but also was not conducive for the sustainability of the projects. As a long-term goal, the Government, sector entities and ADB should attach greater priority to building domestic capacities in these areas and providing a better incentive structure to retain such talent. Several officials interviewed expressed concern that while the practice of adopting state-of-the-art technology in power generation and other areas with foreign design, supply, and even operation helps achieve high efficiency, it is not helpful for employment generation, which is particularly crucial for a country like Bangladesh to attain wider developmental impact. Therefore, it may be argued that greater consideration should be given to the selection of "appropriate" technology, in terms of costs (including costs of spare parts and maintenance), technological levels, and requirements for local operational expertise, rather than the best available technologies.

c. Improving Ownership of TA

114. In discussions with BPDB and DESA, it is clear that their ownership of TA 2004 is low, it often being viewed as an ADB project. Hence, when ADB funding is not available, progress ceases. While the benefits of, for example, having a computerized billing system in Chittagong are appreciated, this does not create sufficient impetus for change so that the development of financial systems proceeds even when external assistance is not available. However, ownership

of loan and investment projects, as well as other TAs such as TA 1962 (master plan), appears to be much stronger.

d. Improving Financial Management Capacities

115. While BPDB and DESA generally lack the human resources to execute power projects in an efficient manner, such deficiency is particularly noticeable in financial and accounting areas. It is difficult to recruit and retain qualified accountants on public sector pay scales. But even at lower levels, it is not possible to recruit good data entry personnel because of recruitment restrictions and the poor quality of in-house personnel. As a result, large areas of accounting are managed by temporary staff who are paid on a daily basis. The data in the financial systems are in many cases of poor quality and the absence of proper stock and fixed assets records makes the transition to a modern system complex. Despite the fact that both BPDB and DESA face continuing financial crises, they should be prepared to devote resources to improving financial systems, since such investments generally repay themselves very quickly.

e. Avoiding Use of a Project/Phasing Approach to Finance a Change Process

116. Due to the severe lack of self-financing capabilities and, thus, growing dependency on external (mostly concessional) financing, and cumbersome procurement procedures, most of routine system maintenance and upgrade is turned into projects and phased financing. An example is funding for the implementation of a new information management system, which is essentially the development of a process rather than a single project. In a modern utility, systems are developed and improved all the time and this requires a range of piecemeal improvements to hardware and software on a day-to-day basis. The implementation of a system such as Oracle Financials is bound to incur significant initial expenses, for example in buying licenses for software and new servers, computers and printers. But it is not realistic to produce in advance a detailed schedule of every expenditure item and adhere to it throughout the implementation process. Equipment changes all the time, companies such as Oracle regularly produce new versions of their software. An important lesson here for ADB is to be extra careful and selective in financing such systems when sustainability is known to be problematic and its usefulness is questionable, and focus on those areas with a greater benefit-cost ratio, e.g., computer billing.

2. Strategic Level Lessons

a. An approach to sector reform based on piloting change and learning by doing can work more effectively than one based on a detailed plan.

117. ADB's operational strategy and sector objective to promote reforms over the past 8 years entailed initiating a number of piecemeal changes that act as pilot or demonstration projects to illustrate reform's potential. These changes were mainly institutional, designed to show that alternative structures could achieve better results than the existing power utilities. For example, ADB helped to create RPC and to solicit bids for the Meghnaghat private power project. These projects demonstrated institutional alternatives to BPDB in promoting and running power stations. Similarly, ADB's lending conditions required the separation of DESCO from DESA and of PGCB from BPDB. These corporate structures provided a better basis for running distribution in Dhaka and transmission than DESA or BPDB. The transfer of areas of

distribution from DESA and BPDB to PBSs showed that cooperatives can perform distribution more successfully than these utilities.

118. These changes have been based on agreed principles such as increasing private sector participation to mobilize finance and improving sector governance through measures such as independent regulation, corporatization of sector entities and promoting competition. However, the changes have not been accompanied by any detailed longer-term plan or statement on planned reforms by ADB or Government. Nor has ADB sought longer commitments to reform beyond the specific short-term steps agreed as conditions in loan covenants. The conditions have also avoided the issue of tariffs. Inevitably this has permitted some ambiguity over next steps. By providing limited funding linked to these piecemeal reforms, ADB has differentiated itself from the World Bank which has sought a more thorough commitment to a reform plan and not offered any loan funding since 1989. In practice this piecemeal approach has facilitated change. By the success of the individual projects and newly created entities, the approach clearly demonstrates the direction which future reforms should take. It has a number of advantages. It minimized staff discontent. It avoided confronting the Government with major decisions during the early stages of the reform process. It enabled reforms to be tested and, if proved successful, extrapolated.

b. The pace of privatization in an environment such as Bangladesh, especially in transmission and distribution, will continue to be slow and it is important to prioritize.

119. Privatization offers benefits. First it accesses private capital. Second it introduces private sector management skills, which are generally superior for managing commercial entities. Bangladesh has had considerable success in introducing private finance and management to generation. The IPPs are producing power at reasonable prices and high levels of reliability compared to experience elsewhere in Asia. Management practices in the private power stations are following international industry standards and best practices. Both local and foreign capital came into the sector through these stations, enabling government and development partners to allocate resources to other parts of the supply chain. Local investors are willing to invest further in the sector. The projects have required government guarantees to get off the ground but these guarantees have not been called as BPDP, the power purchaser, has honored the agreements.

120. There is as yet no private finance in transmission and distribution and little prospect of introducing it in the short term. None of the entities in the sector will be able to borrow from the private sector without government guarantees until there is a legal and commercial framework in place. Selling equity in any of the companies at realistic prices will be an even greater challenge. This situation reflects experience in many developing countries; it is easier to introduce private finance to generation than to transmission and distribution. However, private sector management skills are probably needed more urgently in distribution than in any other part of the power supply chain. The transfer of some operations from BPDB and DESA to PBSs illustrates the scope for improvement. Furthermore, DESCO is making use of private contractors to carry out meter reading and some other aspects of billing. This may well be one of the biggest areas of benefit from introducing private sector management. Further extension of the DESCO or PBS models is likely to produce greater short-term benefits than aiming for full privatization and the introduction of private finance.

c. Attaining commercial viability takes time and requires a financial and commercial overview of the sector.

121. Despite the positive developments in recent years, the Bangladesh power sector remains far from commercial viability. There has been little recent improvement in this area. Improvements in system losses and bill collection have been offset by tariffs increasing more slowly than inflation, and system expansion has made overall losses higher. As a result there are debt defaults of over $1 billion from the power sector to the Government. Moreover the structure and levels of wholesale and retail tariffs and the commercial relationships between the entities in the power sector do not yet provide a structure for sector viability. This area needs to be the urgent focus of government activity and ADB lending conditions. It will require more financial input from ADB and probable further TA support. While it was acceptable to leave this area on one side in the mid-1990s, during the early stages of the reform dialogue, the level of debt default and its implications for public expenditure management suggest that attention has been delayed too long.

C. Future Recommendations

122. In designing recommendations for the future of ADB's assistance program to the Bangladesh power sector, it is helpful to assess the following three possible scenarios.

1. Scenario No. 1: Lending Moratorium Pending Further Reforms

123. Under this scenario, a moratorium on lending will be imposed pending further progress in the sector on such areas as reducing system losses, improving collections, increasing tariffs, and creating a commercial operating structure. This scenario has little to recommend it. Since the cabinet approved power sector reforms in September 1994 and ADB resumed lending in 1995 there has seen steady if limited progress in sector reform. Private generation projects are running successfully and at reasonable cost, system losses have improved, collections have increased and new entities such as DESCO and PGCB have been created. DESCO and the PBSs have both improved substantially on the loss and collection performance of their predecessors in areas they took over. Overall financial performance is still poor and the reform process has been very time consuming. But, with further commitments for change already in place and many favorable indicators, this would be a most inopportune moment to cease lending activities. The World Bank has come to recognize the detrimental nature of a lending moratorium[41] and is planning to resume lending to the sector after a 14-year absence.

2. Scenario No. 2: Business as Usual

124. The second scenario is a continuation of the present situation. ADB would continue to provide sector loans of $100 to $200 million from time to time, which would be used to tackle the worst deficiencies in transmission and distribution. Time overruns on loan funded projects would continue. Private finance would support generation projects. The conditions on loans would be partially met. DESCO and PGCB would continue to operate reasonably commercially and the Ashuganj Power Station Company and West Zone Power Distribution Company would slowly become established as separate entities. Other development partners might support projects, especially in rural electrification, but there would be limited funding for DESA or BPDB. The World Bank would largely stay on the sidelines. The sector would continue to make losses and

[41] It was suggested by some that the investment gap between 1989 and 1995 left by ADB and the World Bank's lending moratorium caused further rehabilitation and maintenance delays on the system and exacerbated an already grave situation.

there would be continued default by DESA to BPDB, and BPDB to Government, thus imposing a continuing burden on public finances. Customers, particularly urban industrial, commercial, and residential customers, would remain dissatisfied with the power supply and some would develop captive generation. Rural connections would grow faster than the rest of the sector due to the heavy presence of development partners in rural electrification.

125. This scenario is as much as Bangladesh can expect if it continues with slow progress in sector reform. It is unlikely under this scenario that Bangladesh could even come close to the objective of extending power throughout rural areas by 2020. Power cuts would continue to be a feature of daily life and limit economic growth. The power sector would continue to receive indiscriminate subsidies and be a burden on public finances. In practice gradual change may be difficult to sustain. Change over the past 8 years has been gradual for demonstration purposes and minimizing discontent. However, some of the changes now being implemented cannot be gradual, for example passing responsibility for tariff and commercial issues to an energy regulator, and there is a strong case for accelerating the pace.

3. Scenario No. 3: Accelerated Sector Reforms and Sustained Investments

126. The third scenario envisages a substantially increased flow of funds to the power sector, accompanied by more rapid reform that creates a commercial power sector within 2 to 3 years. There are signs that commitment to reform is growing and as such the third scenario is a realistic one. It is also consistent with ADB's strategy for the sector, which envisages acceleration in reforms. This scenario is in many ways the most rewarding but also the most challenging and it will require greater commitment from Government. It offers the possibility of significantly more reliable power supplies for Bangladeshi consumers, faster economic growth, and more rapid progress with rural electrification.

127. The third scenario is characterized by accelerated reforms and sustained investments. It offers the best hope if the Government's goal that the whole country will be electrified by 2020 were to be achieved. To achieve this goal, the Government estimated that approximately Tk750 billion (about $14 billion at the current exchange rate) will be needed in the next 16 years, or $875 million per year. Through the REB and PBS structure, Bangladesh has created a widely admired and supported framework for rural electrification, which is capable of implementing further extensions to rural power supplies. Provided that sector reforms are maintained and extended, development partners are keen to extend further funding to REB and the PBSs. However, it is unrealistic to expect development partners to meet the full cost of extending rural electrification to the whole country. It is also unrealistic to expect the Government to bear ever-increasing subsidies to BPDB in order to compensate for increasing levels of debt default. Further self-financing will be required from the power sector, necessitating both greater efficiency and higher tariffs.

128. The use of the Government's 2020 electrification goal as a benchmark does not necessarily mean that the OEM concurs with the Government on the realistic nature of the timeframe. In practice it will be difficult to achieve, because of financial and human resource constraints. However, even if the completion date needs to be pushed back to 2030 or later, the objective is a sound one. Rather than focusing undue attention on an end date that can only be speculative at this stage, it would be more productive to assess the requirements to sustain a growth rate in rural electrification levels of around 10% per annum over the next 5 years. The financial and operational requirements will quickly demonstrate the importance of moving away from the current regime of indiscriminate subsidy and towards a structure that views internally

generated funds as a key contribution to the achievement of rural electrification investment goals.

111. The following areas of reform need to be addressed to increase investment. These reforms are pre-conditions for bringing private finance into transmission and distribution. Under present arrangements private bond finance will only be feasible with government guarantees or from government controlled banks. Private equity finance will only be available on highly disadvantageous terms, if at all.

a. The Energy Regulator

129. Important progress has been made toward an operational and independent ERC (paras. 25 and 63). However, many in Bangladesh doubt whether regulation will be effective. Experience with the telecommunications regulator has been unsatisfactory. There are more safeguards in the legislation establishing the energy regulator, but only through experience will people come to respect and trust the independence and effectiveness of the energy regulator. This concern is reinforced by international experience. A recent World Bank report on private sector participation in the power sector[42] drew attention to "many instances of ineffective regulators due to poor legislation, lack of autonomy, weak technical skills, and politicization of decisions."

b. Corporatization

130. Commitments have been given to development partners about corporatization of DESA; some zones of BPDB are in process of corporatization. The experience with the creation of DESCO should enable more rapid transition elsewhere in Bangladesh. Corporatization also needs to encompass more power stations. BPDB has a conflict of interest as both the single buyer of power and the main generator. This arrangement is workable while Bangladesh faces major supply shortages but may act as a disincentive to new IPPs if suppliers fear that BPDB will favor its stations over purchases from IPPs. Corporatization will also give station managers incentives to manage plants efficiently. Haripur power station was turned into a SBU but the experience was not fully satisfactory as financial arrangements for rewarding staff were established and then rescinded. SBU status can be a useful first step to corporatization but it is not an alternative.

c. Commercial Contracts

131. The present structure of the power sector relies on the utilities cooperating rather than behaving commercially. BPDB maintains power supplies to DESA even though DESA does not pay its bill, and DESA does not cut off DESCO even though it loses money on every unit it sells. In future, relationships between separate sector entities will need to be covered by contracts, specifying not just price but also all aspects of terms and conditions. The recently completed grid code and the PPAs under which IPPs supply power to the grid are examples of this type of contractual arrangement. Many similar structures between generators, wholesalers and retailers will be needed to make the power system fully commercial. This is a priority area for the regulator.

[42] World Bank. 2003. *Private Sector Development in the Electric Power Sector, A Joint OED/OEG/OEU Review of the World Bank Group's Assistance in the 1990s*. Washington.

d. Wholesale Electricity Tariffs

132. Present wholesale electricity tariffs merely reallocate revenues within the power sector. They have little economic rationale and do not encourage efficient management of the system. These tariffs need to be reformed so that they are cost based. This should lead to the creation of maximum demand and energy tariffs by BPDB for power retailers and the use of kVA rather than kW as the basis for demand metering and pricing so as to encourage management of the power factor. It should also mean that PGCB will be rewarded or penalized for management of losses in the transmission system, by metering of power supplies both in and out of the grid, and PGCB's revenue depending partially on its effectiveness at managing losses. Wholesale tariffs raise significant social issues as the current tariff structure is designed to subsidize power supplies to PBSs. This is discussed further below.

e. Retail Electricity Tariffs

133. Retail tariffs will also have to be reformed. The Government has recently accepted the principle of cost-based tariffs. In due course, individual power retailers will set their own levels and structures, subject to the constraints imposed by the regulator. With wholesale tariffs that reflect costs, retailers will also be under pressure to adopt a cost-based structure. Tariffs will inevitably rise in order to make the system profitable. Some categories of consumer are highly subsidized at present, in particular small-scale domestic consumers and irrigation. Government will have to decide a policy on these consumer categories.

f. Sector Recapitalization

134. Most of the electricity sector is insolvent and requires recapitalization. BPDB was overdue on some Tk56 billion of payments to the Government at 30 June 2002. A voucher scheme could recapitalize the sector, based on this overdue debt, and solve several other problems at the same time. The Government can create securities called BPDB debt default vouchers and distribute them to public sector entities that have overdue electricity bills. They can pass these vouchers to their retail supplier, such as DESCO or DESA. The retailer can then pass the security on to its supplier until all the vouchers are passed to BPDB, which can then reduce its indebtedness to Government. No cash needs to change hands.[43] This process will not resolve all sector indebtedness and there will have to be equity injections into BPDB, DESA and DESCO. The recapitalization should take place when tariffs are at commercial levels and companies have commercial freedom to disconnect or install pre-payment meters for all defaulting consumers.

D. Risks and Challenges Ahead

1. Managing the Risks

135. Each of the three scenarios outlined earlier has associated risks. The risks associated with a lending moratorium (inaction) or maintaining *status quo* are deemed unacceptable by most stakeholders in the sector. The third scenario, accelerated reforms and sustained investments, entails more complex risks that need to be properly managed.

[43] It would be dangerous to use cash to conduct this sort of transaction because of the risk of leakage. There are already examples of public sector entities receiving cash allocations from Government to pay power bills but using them for other purposes. There are a number of disputes between retailers and customers and between sector entities over amounts due and these should be resolved as a condition for completion of the capital restructuring.

a. Foreign Exchange Commitments

136. A recent World Bank review[44] concluded that Bangladesh would find it increasingly difficult to meet its financial obligations from PPAs with IPPs, or production-sharing contracts with international gas companies, unless new sources of foreign exchange are tapped. This is a serious risk and has proved an obstacle to rapid expansion of IPPs elsewhere in Asia. Government is in the best position to manage the foreign exchange risk, and should adopt policies to promote more exports of competitive products including textiles and natural gas. Development partners also have a responsibility in not pushing Bangladesh into further indebtedness by improving loan quality and providing balance-of-payment support if necessary.

b. Maintaining Balanced Investment

137. Bangladesh has considerable experience of implementing IPPs and further investments are under active preparation. Transmission and distribution systems must expand in parallel with this investment. Otherwise, there is a risk of having unused IPP projects subject to take-or-pay contracts at the same time as substantial power outages, as experienced in several Asian countries. The OEM identified several significant "bottlenecks" that, if corrected, would result in significant improvements in system performance.

138. The most significant problem with the existing transmission is that several lines are consistently overloaded. These include Ashuganj-Ghorashal 230 kV, Ghorashal-Tongi 230 kV, Meghnaghat-Hasnbad 230 kV, the two 132 kV circuits at Ishurdi substation, and Haripur-Ullon 132 kV. This condition results in severe reactive power losses, which aggravates the low voltage profile across the system, but especially in the Dhaka area. Future planned line construction and additional generation will alleviate this problem, but the problem with low voltage is becoming acute and cannot wait on a future transmission project. The problem can be alleviated by the immediate addition of power factor corrective capacitor banks installed on the 11 kV DESA and DESCO systems. As ADB has a pending loan, which will include capacitor banks, this procurement and installation should be expedited.

139. The completion of the 230 kV ring from Comilla North-Meghnaghat-Kallyanpur-Tongi will alleviate the current low voltage conditions on the east of Dhaka. At present, the generation from Meghnaghat and Haripur is restricted to the east and west due to a lack of transmission. The western areas of Bangladesh require completion of the Western "Backbone" transmission to reduce dependence on the East-West Interconnection and to provide for the planned generation additions. This line is planned to be a double circuit 230 kV connecting Sayedpur generating to Barapukuria generating to Bogra to Baghabari to Ishurdi to Bheramara to Jessore to Goalpara. The completion of this line will not only reduce the dependence upon the East-West Interconnection, but will effectively increase the generation in the east. An 80 MW generating facility is planned at Tongi on the northwest edge of the Dhaka area. With its completion, the 132 kV Joydevpur-Kabirpur line is required to alleviate the overloading of the Ghorashal-Tongi 230 kV line.

140. These appear to be the pressing needs to reduce the current overloading of transmission and to provide for improved load flow in the 4-6 year timeframe. However, generation additions will continue to be necessary. A lack of generating capacity is the biggest restriction to the government's electrification goal. While there are numerous additional generating facilities under planning, many will be of gas turbine designs which are better suited to peaking operations than

[44] World Bank. 1999. *Foreign Direct investments in Bangladesh: Issues of Long-run Sustainability*.

for base load generation. Recent advances in combined cycle gas-fired plant design have resulted in proven designs for such plants in the range of 600 MW at efficiencies exceeding 50 %. ADB had previously considered a plant of this capacity at the Meghnaghat site. The advent of the 450 MW IPP generating plant, AES Meghnaghat, was referred to as a "Phase I" of that concept. ADB should revisit that concept with an aim to provide the necessary inducements for the construction of a 600 MW combined cycle generating plant sited near Tongi on the Northwest of Dhaka. This plant would have ready access to the 230 kV transmission ring around Dhaka and to the East-West Interface line. The plant would offer very efficient base-load generation resulting in reduced gas use and permit the proposed single-cycle gas turbines to assume more of the peak system load. The minimum system load is now far in excess of 600 MW. A 600 MW base-load plant would be able to operate at a very high load factor and its efficiency would place it first on the merit dispatching system.

c. Regulation

141. Effective regulation of the power sector is challenging and requires extensive, high quality commercial and financial skills. Bangladesh is fortunate in being able to draw on the experience of other countries in this area. However, this experience is at best mixed and many regulators have failed to live up to expectations. A rapidly changing institutional environment will make regulation even more difficult. The Government can help to ensure the effectiveness of the regulatory commission by minimizing interference and appointing an experienced and qualified chairman. Development partners including ADB can play a crucial role in providing assistance in capacity building and training, introducing experience from other countries, and helping identify problems as they emerge.

d. Implementation and Operation Capacity

142. Bangladesh's record in utilizing ADB assistance shows lengthy delays in implementation. Despite recent examples where implementation has proceeded more rapidly, such as PGCB's investment in the transmission network, the overall record suggests that the country will struggle to cope with a significantly greater investment program with its limited absorptive capacity. The sector entities, Government, and development partners need to work jointly to improve such capacity through training and learning by doing. Compared to the many competent engineers in Bangladesh's power sector, accounting and financial expertise is severely lacking. As the sector takes on further responsibility for managing resources, it will require more of these skills.

2. Meeting the Challenges

143. Managing these risks creates challenges for development partners, the Government and sector entities, and they need to work in concert to meet these challenges.

a. Challenge for ADB and Other Development Partners

144. Compared to most other developing member countries, the role of development partners in Bangladesh may be particularly important due to the country's low self-financing and other capacities. The first key challenge for ADB reflects the power sector's heavy demand for capital resources. Bangladesh potentially needs up to $1 billion per annum for several years and still may not meet power demand in full. ADB has to decide on the mix of lending instruments to use. It is also likely to need to fund (or find other development partners to fund) extensive TAs. The establishment and development of the new Energy Regulatory Commission and the full corporatization and commercialization of DESA and BPDB will inevitably be complex and

demanding projects which could create demand for TA far in excess of the costs ADB has incurred in the recent past.

145. There are signs that other development partners, particularly the World Bank, are poised to come back to the sector in a substantive manner. ADB should undoubtedly welcome this new development. However, caution should be made against going to the other extreme, namely, to inundate the sector with "easy" money at a time when sector reform has reached a critical juncture and consistent "pressure" for deepening reform is essential. There are also issues of absorptive or implementation capacities, governance, corruption, and overall system planning. So far, development partners particularly bilateral ones, tend to focus on rural electrification or areas of their particular interests.[45]

146. As the interest of development partners in the sector increases, coordination becomes more important. Despite the imminent return of the World Bank with its significant financial resources, ADB is uniquely well placed to maintain its role as coordinating development partner in the sector. It has a wide range of sector experience, an excellent sector overview, relevant skills in its resident mission, a long-term track record of working effectively with key policy makers in the sector, and widespread support and trust in the development partner community, the Government and sector entities. However, it will have to cope with greater complexity as more partners become increasingly involved. As coordinator, ADB will have to ensure that investment in rural distribution is balanced by extra transmission and generation. It will also have to devote much of its own investment to the less attractive areas in order to keep the power system in overall balance and ensure that the reform process continues. At present, ADB chairs the LCG's energy sub-group. The papers for the latest sub-group meeting focus almost exclusively on ADB's dialogue with Government. Important developments such as commitments given to the World Bank on electricity tariffs are mentioned only in passing and without reference to, for example, proposed increases in tariffs by the end of 2003. An expanded program of investment in the sector will necessitate an enhanced role for other development partners and better information flows. The recently created website for the LCG may have a role to play in improving information flows.

147. Another increasing challenge faced by development partners is monitoring sector performance. In recent years, monitoring has mostly focused on simple performance indicators, especially levels of system losses and revenue collection as a percentage of billing, with little focus on profitability and issues of loan defaults. This needs to change. Development partners will also need to monitor far more institutions than in the past. ADB must enhance the financial scrutiny of the energy sector both through its missions and in day-to-day monitoring.

148. Finally, development partners should take a more sectoral approach rather than deal with individual entities. At present many of the conditions on ADB loans are focused on the management and financing of entities that ADB has helped to create. For example, ADB is pressing for a tariff increase for PGCB, the only entity in the power sector that is already

[45] The World Bank has proposed a $200 million loan for rural electrification and may assist the Energy Regulatory Commission. USAID is actively supporting the Regulatory Commission and has long-term funding available to sustain this suport. JBIC, USAID and KfW are willing to continue funding the power sector and may make extra commitments if investments are successful. DfID may commit new resources, following a period of absence because of unsatisfactory results in supporting DESA. Other development partners are seeking opportunities to assist REB in rural electrification. Bilateral partners who have formerly provided funds include the United States, Kuwait, Japan, Finland, Canada, Switzerland, France, Norway, Saudi Arabia, and the Netherlands. The attraction to development partners of supporting successful organizations such as REB and the PBSs is enhanced by the link between rural electrification and alleviating poverty.

profitable. This approach is understandable in the initial stages of reform when new entities require detailed support, but the focus needs to change in future as the rest of the power sector moves into commercial structures. With the establishment of the regulator, ADB should shift away from the approach of using loan conditions to favor one entity over another. However, ADB does need to press for the rapid establishment of commercial relationships between the various companies in the new Bangladesh power sector.

b. Challenge for Government

149. The Government should be more proactive in selling reform programs, both within the sector and to the general public. Power sector reform has many positive attributes. It should improve the availability and reliability of power supplies, create more rewarding careers for people working in the industry, reduce theft, improve government finances and free additional resources for investment in rural electrification and other social programs. However, the public focus is often on negative aspects such as increased power tariffs and unemployment.

150. The Government should accelerate its own decision-making and bow out of decisions in some areas. One of the reasons for performance problems in the power sector is the delay in receiving approvals for decisions from Government. A major advantage of the corporate structure is that it eliminates the need for government approval on decisions such as procurement of replacement parts. Many of the reform steps taken over the past 8 years have been delayed awaiting government approval, for example, on asset transfers. If the Government can move more promptly then the whole reform program can accelerate.

151. The Government can make the regulator operational, independent and effective quickly. The senior staff of the regulatory body need first class commercial and financial skills in order to function effectively and should be appointed soon. Senior positions will be difficult to fill. Bureaucrats lack the necessary skills and it would be preferable to recruit most senior staff from outside the power industry. However, they will need to acquire detailed sector knowledge quickly.

152. The Government can continue to have policy goals for the power sector, but will need to find new ways to meet those goals. At present Government subsidizes the power sector in three ways. First, there are cross-subsidies in the tariff structure which favor small domestic consumers, irrigation customers and the PBSs at the expense of other power users and in particular commercial and industrial users. Second, there are explicit subsidies to PBSs. Loans and grants from development partners are passed on to REB at a 2% interest rate and are on-lent by REB to PBSs at 3%. Government also accepts the foreign exchange risks on such loans and bears the losses of newly established PBSs while they are attaining viability. Third, there are de facto subsides to BPDB through loan defaults. In a commercial framework for the industry the third type of subsidy through payment defaults would be unacceptable. Moreover, the first type of cross-subsidy would need to be made explicit in some way through instructions to the regulator and the industry in license conditions. In the absence of such explicit arrangements, retailers would put tariffs to currently subsidized consumers up to a cost recovery level.

c. Challenge for Sector Entities

153. The main challenges facing the sector entities include (i) full sector-wide corporatization, (ii) improving project implementation capacities and reducing project delays, (iii) improving financial management and accounting practices, (iv) improving O&M of existing facilities, (v) tariff adjustments to achieve cost recovery and reasonable profits, and (vi) labor rationalization and provision for pensioners, and (vii) human resources development and capacity building, particularly in operation and financial management.

ASIAN DEVELOPMENT BANK LOANS AND TECHNICAL ASSISTANCE IN THE POWER SECTOR, BANGLADESH

Table A1.1: Loans

Project Title	Year of Approval	ADF Amount ($ million)	OCR Amount ($ million)	PS Amount ($ million)	Scope Category
Loans 0141(SF)/0142: Bangladesh West Zone Power	1973	9.25	1.20	—	G
Loan 0212(SF): Bangladesh West Zone Power (Supplementary)	1974	4.55	—	—	G
Loan 0325(SF): Chittagong Power Distribution	1977	27.75	—	—	D
Loan 0523(SF): Power System Rehabilitation and Expansion	1981	26.50	—	—	G, T
Loan 0587(SF): Ashuganj Thermal Power	1982	35.00	—	—	G, T
Loan 0636(SF): Power Transmission and Distribution	1983	82.00	—	—	T, D
Loan 0683(SF): Sixth Power (Sector Loan)	1984	120.00	—	—	D
Loan 0751(SF): Seventh Power	1985	40.50	—	—	T
Loan 0963(SF): Eighth Power	1989	165.00	—	—	T, D
Loan 1356(SF): Rural Electrification	1995	50.00	—	—	R (G, D)
Loan 1505(SF): Ninth Power	1996	134.40	—	—	T
Loans 1730(SF)/1731: Dhaka Power Systems Upgrade	1999	75.00	82.00	—	T, D
Loans 1884(SF)/1885: West Zone Power System Development	2001	60.20	138.70	—	T, D
Inv. 7165/1793: AES Meghnaghat Power	2000	—	—	70.00	G
Total		**830.15**	**221.90**	**70.00**	**1,122.05**

D=Distribution, G=Generation, T=Transmission, R=Rural, ADF=Asian Development Fund, OCR=Ordinary Capital Resources, PS=Private Sector, SF=Special Funds.

Table A1.2: Technical Assistance

TA No./Title	Year of Approval	TA Amount
A. Advisory		
TA 0095: Bangladesh West Zone Power	1973	250,000
TA 0111: Bangladesh Energy Policy Study	1974	50,000
TA 0130: Bangladesh Energy Study	1974	1,250,000
TA 0487: Power System Master Plan Study	1982	250,000
TA 1743: Review of Electricity Legislation and Regulations	1992	90,000
TA 1962: Preparation of Power System Master Plan	1993	600,000
TA 2004: Financial Management Upgrade of BPDB and DESA	1993	1,000,000
TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power	1995	211,000
TA 2715: Valuation of Assets of Dhaka Electric Supply Company	1996	175,000
TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power (Sup)	1997	222,000
TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power (Sup)	1998	165,000
TA 3129: Support for the Energy Regulatory Authority	1998	900,000
TA 3244: Capacity Building of Dhaka Electric Supply Co. Ltd.	1999	90,000
TA 3343: Corporatization of Ashuganj Power Station	1999	1,000,000
TA 3801: Corporatization of the West Zone Distribution Operations of BPDB	2001	900,000
Subtotal		**7,153,000**
B. Project-Preparatory		
TA 0218: Power Systems Rehabilitations	1977	150,000
TA 0460: Power Transmission and Distribution	1982	50,000
TA 0672: Seventh Power	1985	75,000
TA 0714: East Zone Thermal Power	1985	1,355,000
Subtotal		**1,630,000**
Grand Total		**8,783,000**

TA=Technical Assistance, BPDB=Bangladesh Power Development Board, DESA=Dhaka Electric Supply Authority.

EVALUATION MATRIX

Issues	Questions	Indicators and Information Required	Source of Information	Data Collection/ Analysis
A. Relevance of ADB assistance to the power sector development in Bangladesh and development goals of the country	Were the policy objectives outlined in the various energy policy papers appropriate in relation to the development strategies of Bangladesh in the past three decades? Were the planned power sector interventions in ADB country strategy appropriate to reflect the policy objectives? Were the ADB tools and instruments adequate to achieve the policy and project objectives? Were there significant shifts in the types of power sector projects in the context of policy changes both at ADB and the country? Were such shifts appropriate in terms of addressing system needs and long-term developmental impact taking into account the power system being interconnected?	Information on evolution of ADB's energy policies overtime Information on ADB's country operational strategy Indicators for measuring the historical performance of the power sector in relation to overall economic growth, e.g., per capita electricity consumption, % of overall and rural population with access to electricity. Information on key bottlenecks of the system.	ADB documents (RRPs, TA papers, BTORs, PCRs, and PPARs.) Country operational strategy and assistance plan documents ADB energy policy papers Published studies on the power sector in Bangladesh Government statistical yearbooks	Desk review of ADB's policy papers, operational strategies, and other related publications. Preliminary evaluation of the relevance of individual projects and TAs based on PCRs and PPARs. Interviews with the Government and EAs to get their perspective on how well ADB's assistance has addressed their needs.
B. Efficacy, efficiency, and Sustainability	To what extent did the power sector assistance program achieve the sector objectives defined in the country operational strategy documents? To what extent did the individual projects/TAs achieve their objectives? How do they compare to ADB power projects in other countries in terms of quality of implementation taking into account project design, construction quality, delays, etc. Are the outcomes of ADB's power sector assistance sustainable? What are the key factors affecting sustainability or lack thereof? Given the poor financial performance of the power sector, how has ADB assistance affected the performance, and how can ADB help improve the sector's financial health and project sustainability more effectively?	Indicators for measuring progress in achieving sector development objectives, e.g., length of distribution and transmission network, added generation capacities, % of system losses and changes overtime, load shedding, collection-to-generation and collection-to-import ratios, estimated % contributed by ADB projects. Economic internal rates of returns of ADB projects. Financial performance indicators such as net income or loss for major utilities, operating ratios, debt service coverage ratio, return on net fixed assets, etc.	ADB documents (RRPs, TA papers, BTORs, PCRs, PPARs) Country operational strategy and assistance plan documents Published studies on the power sector in Bangladesh Annual reports or other publications of the key utilities including BPDB, DESA, REB, etc.	Field inspection to assess the quality of implementation, operation and maintenance, and long-term sustainability of ADB's power sector projects in Bangladesh. Interviews with the Government and EA officials on issues related to implementation, operation and maintenance, and long-term sustainability. Depending on the needs and information availability, the economic internal rates of return of some projects selected for in-depth evaluation may be reassessed. Analysis of the financial performance for the EAs and ADB project's impacts on the financial performance.

Issues	Questions	Indicators and Information Required	Source of Information	Data Collection/ Analysis
C. Development and institutional impacts of ADB assistance to the power sector	Have ADB power projects/TAs contributed significantly to improving the country's macroeconomic environment and facilitated economic growth? How did improvement in power supply affect economic activities (e.g., development of SMEs, agriculture, export sectors)? How does improvement in power supply affect quality of life for the poor particularly women and children? Has ADB made a difference in lifting the capacities of the country's key utilities including BPDB, DESA, REB, etc? How are such efforts compared to similar efforts made by ADB in other countries in terms of effectiveness and why?	Socioeconomic indicators for the project areas vis-a-vis unconnected or recently connected areas, including income, literacy rate, average number of TVs/radios per household, number of working hours per day, schooling ratio, number of SMEs, and productivity improvement in the agriculture and export sectors. Information related to the staffing, reorganization, compliance with ADB loan covenants related to restructuring by BPDB, DESA, REB, etc.	Main beneficiaries of the ADB power projects including residential, commercial and industrial customers, as well as unconnected households. Main utilities including BPDB, DESA, REB, etc.	Review existing information on the socioeconomic impact of electricity supply. A socioeconomic survey of approximately 150 residential, commercial and industrial customers and would-be customers on impact of power supply on their economic activities and well-being. Interviews with EAs on the impact of ADB assistance particularly TAs on capacity building and sector restructuring.
D. Lessons for future ADB assistance to the power sector in Bangladesh	What lessons can be learned from the 30-year experience in terms of selecting relevant projects, design and implementation, and maximizing impacts? Given the performance of the sector, does ADB need to do more of the same to achieve greater impact or does it need to drastically improve the design and implementation of the projects/TAs? Over the long run, should ADB select a few priority areas to provide more in-depth assistance (larger amounts) or cover all key areas as in the past? What actions, if any, can be taken immediately to improve ADB's portfolio performance?	Government strategies and priorities in the power sector development, e.g., the Government's policy paper "Power Sector Reforms in Bangladesh" (PSRB) and its more recent updates. ADB's operational strategy for future Bangladesh power sector Experience, policies, and best practices of other development agencies	Policy dialogue with the Government during the Country Programming Mission Other development partners	Extensive consultations with other development partners active in the power sector in Bangladesh including the World Bank, JBIC, DFID, etc. on division of subsectors for financing by different agencies, different approaches and operational strategies. Holding a dissemination workshop to be participated by key government departments, EAs, and key development partners to discuss future assistance strategies and aid coordination.

ADB = Asian Development Bank, BPDB = Bangladesh Power Development Board, BTOR = back-to-office report, DESA = Dhaka Electric Supply Authority, DFID = Department for International Development, EA = executing agency, JBIC = Japan Bank for International Cooperation, PCR = project completion report, PPAR = project performance audit report, PSRB = Power Sector Reforms in Bangladesh, REB = Rural Electrification Board, RRP = Report and Recommendation of the President, SME = small and medium enterprise, TA = technical assistance.

PROJECT IMPLEMENTATION AND OPERATION

1. This appendix draws information from Asian Development Bank (ADB) documents, particularly appraisal reports/reports and recommendations of the President, project completion reports (PCRs), and project performance audit reports (PPARs), for the projects selected for in-depth review. In addition, in order to supplement the documented information with first-hand knowledge, the Operations Evaluation Mission (OEM) carried out an inspection of power stations, transmission lines, substations, and distribution systems. Due to limitations of time and resources, the visits and evaluation were on a reconnaissance basis and targeted, but not restricted to, facilities financed under various ADB projects.

A. Loans and Investments

1. Loan 0587(SF): Ashuganj Thermal Power

2. The $35-million loan was approved in 1982 and completed in 1989, with a 2.5-year delay and $18.6 million cost under-run. The main objective of the project was to meet the country's demand for power beyond FY1985 and to reduce its dependence on imported crude oil by using locally available natural gas as the main fuel for power generation. The scope of the project included (i) construction of two 150 megawatt (MW) gas-fueled steam power generating units and associated transmission lines and switchyard expansion works; (ii) institutional improvements of the Bangladesh Power Development Board (BPDB), i.e., accounting improvement and training on management.

3. At appraisal, the loan was to provide for the addition of two gas-fired steam turbine units (units 3 and 4) of 150 MW each. In addition, the loan would provide for a 48-kilometer (km) double-circuit 230 kilovolt (kV) transmission line to connect Ashuganj to the Ghorasal substation near Dhaka and the construction of a training simulator for the operators. This loan was especially well suited to the needs of the sector. It would add 300 MW of base-load generation capacity to BPDB as well as the necessary transmission capacity to transmit the resulting generation to the Dhaka distribution area. In the mid-1980s, BPDB urgently needed additional generation capacity. The total installed capacity of generation at appraisal in 1982 was about 837 MW but this was projected to increase to 1000 MW by 1990. The loan was accompanied by a TA for the preparation of the first Master Plan for the expansion of the electrical sector (TA 0487: Power System Master Plan Study, Appendix 1, Table 1.2).

4. During implementation, savings allowed an increase in project scope to add a third 150 MW unit essentially identical to the first two units. This increased the project's contribution to base-load generation capacity from 300 MW to 450 MW. This increased capacity proved to be especially timely as the lack of generation capacity remained acute and the project had received very cost-effective proposals for the generating units. It is important to note that the design of the facility was adequate to support the additional unit without undue effects upon the supporting and common features or additional construction. The lower-than-expected costs of the units therefore conferred a significant benefit.

5. The generating units have suffered from delayed overhauls and a lack of replacement parts in the past. The units procured under the project were commissioned in late 1986 (Unit 3) and May 1987 (Unit 4). The added third unit was commissioned in March 1988. Unit 3 is undergoing rehabilitation after 127,886 hours of operation. This represents an availability of about 87.2% since commissioning. This is very high for a steam turbine unit operating for some 16 years without rehabilitation and indicates that the design and installation were very well done. It also

indicates that normal overhauls and preventive maintenance and inspections were foregone. This reflects the lack of reserve capacity in the system, which meant that the unit's generation could not be foregone. Units 4 and 5 are now over 15 years old but have not been rehabilitated to date. Unit 4 has had an availability of about 91.3% and Unit 5 of about 90.4%. As with Unit 3, these are very high and reflect well upon their design and installation.

6. The project, which provided for the construction of the three steam turbines, has achieved fully the main objective and already proven to be sustainable as the units have been in operation for about 15-17 years. The ongoing change to a corporate form of ownership and operation (under various ADB TAs), if successfully implemented, can reinforce the sustainability of the project outputs by increasing the quality of operation and maintenance (O&M). The project was effective as it provided 450 MW of needed generation of high availability to the power sector of Bangladesh.

2. Loan 0636(SF): Power Transmission and Distribution Project

7. The $82 million loan was approved in 1983 and completed in 1992, with a 3.5-year delay and $19 million cost overrun. The main objectives of the project were (i) to transfer more electricity from the east zone to the west zone, and (ii) expand the distribution network in the metropolitan and coastal areas of Greater Chittagong to meet the load forecast through 1990. The scope included transmission and distribution facilities: 132 kV transmission lines, both new and the installation of a 2nd circuit; 33 kV subtransmission lines; 132 kV-33 kV substations; 33-11 kV substations; 11 kV switching stations; distribution transformers, and 11 kV and 400 V distribution lines. Additional features of the project included the design and installation of a Supervisory Control and Data Acquisition (SCADA) system and associated control center, a concrete pole factory, and communication equipment.[1]

8. Both phases of the project (under earlier Loan 0325[SF] and Loan 0636[SF]) were well designed as the distribution system in and around Chittagong was insufficient to serve the projected demand increase. The peak demand in Chittagong was 104 MW in 1982, increasing to 159 MW by 1984. The demand was projected to increase to 338 MW by 1990. That would entail an annual average load growth of about 16%. The coastal area demand was about 15 MW and projected to increase at an annual rate of 18.7% to 50 MW in 1990. The very rapid increases in demand required an extensive upgrading of the existing distribution system including the 132–33 kV substations.[2] The effect of Loan 0636(SF) was somewhat dampened by the delay of some 4 years in implementation. However, savings from the project were utilized, with ADB's concurrence, to effect repairs to the system caused by an unusually severe flooding combined with high tides in 1988.

9. One of the components included in Loan 0636(SF) was the establishment of a pre-stressed concrete pole manufacturing plant. This was included to provide a source of concrete poles for the distribution expansion. The plant was completed in 1987 and established under BPDB. It produces pre-stressed concrete poles of high quality. The plant produces 4 models of poles in sizes (lengths) of 9 meters (m), 12 m, and two versions of 15 m. The poles are suitable for all 33 kV, 11 kV, and 400-V distribution line construction. Production capacity is such that 70 each of the 4 pole models can be produced daily. The original intent was to provide for the 28,000 poles that were needed for the project. After project completion, the plant has provided poles for the needs of BPDB, Dhaka Electric Supply Authority (DESA), and recently for some of

[1] The project was estimated to have resulted in the addition of about 46,000 consumers.
[2] The present demand is now at about 430 MW.

the needs of the Pally Bidyut Samity (or rural electricity cooperatives [PBSs]) who had previously used wood poles exclusively. The plant has been successful in competitive tendering in recent times.

10. Loan 0636(SF) also included provision for the construction of a system control center, also referred to as a distribution SCADA system. At the loan appraisal and approval, the allocation was $1.45 million, comprising $0.95 million foreign exchange and $0.50 million equivalent local cost. The PCR indicates that $6.83 million[3] was dispersed under the corresponding line item consisting of $6.03 million foreign exchange and $0.80 million local cost. Furthermore, despite the increased cost, the system was severely damaged by cyclone and flooding in April 1991. It was expected to return to service by 1993 at which time it would be used to assist in ascertaining the extent of damages to the distribution facilities by the cyclone. The OEM visited the center. Observation of the installed components and the mimic board and conversations with the BPDB personnel at the center indicate that the SCADA was not returned to service following the damage of the 1991 cyclone. While the computer components and the telemetry equipment appear to be (possibly) in useable condition with some restoration, the OEM was informed that the remote terminal units[4] were severely and almost universally damaged beyond repair. The costs of replacing these units were not within the financial capacity of BPDB at the time. The lack of this system has impaired the ability of the Chittagong division to manage the operation of the distribution system efficiently.

11. Overall, with the exception of the dysfunctional SCADA, the project has achieved its main objectives albeit with delays. Chittagong distribution appears to be well managed despite somewhat high system losses.[5] The reported system losses in Chittagong were 24% in FY2000, declining to 18% in FY2003. Management is of the opinion that these consist of about 8% technical losses and 10% non-technical. However, the system does not have the means, (i.e., distribution analysis software) to determine the theoretical technical loss. This should be rectified in the very near future. The lack of such software is not only preventing the distribution engineers from performing loss evaluations but also prevents proper planning of system improvements, reactive correction placement and sizing, and proper system protection design. The management is taking actions to lower the system losses. It is vigorously pursing illegal users and disconnecting them.[6]

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[3] The PCR lists a contract award to GEC Measurements for the construction of the System Control Center in an amount that appears to be 3,500,420.00 Pounds Sterling and a subsequent award to GEC Power Instrumentation for 224,758.00 Pounds Sterling. At the exchange rate of British Pounds to the US dollar circa 1988 and the stated Taka exchange rate, these would correspond to the listed amount of $6.03 million.

[4] The data collection and control devices located at substations and other remote locations that communicate with the Center by radio transmission.

[5] A computerized billing system (provided under ADB TA 2004) has been installed together with a system of customers paying their bills at various banks within the service area. The computerized billing is functioning well but is now in need of a larger and faster server.

[6] In FY2002, 7,148 consumers were disconnected with 683 cases filed in the courts. In other actions, a survey of consumer meters has been instituted. In FY2002, 25,186 defective meters were located with replacement of 7,072. In a similar effort, 3-element meters have been installed at the connections of large users. In the first 9 months of FY2003, 81 of these meters have been installed. The average metered consumption of energy at these locations compared to the originally installed meters has increased by 17%. This is a very promising result and full implementation could result in a significant reduction in losses. However, the slow procurement of the 3-element meters and the available manpower tends to delay this effort. Another effort to reduce losses has involved the installation of meter grounding on the single-phase meters. During the last 3 years and the first 9 months of FY2003, about 142,998 meter-grounding connections have been installed. This represents about 10% of the single-phase customers. Comparing average consumption before and after installation shows an increase of 3% to 10%.

3. Loan 0683(SF): Sixth Power (Sector Loan)

12. The $120 million sector loan was approved in 1984 and completed in 1993, with a 4-year delay and $27 million cost overrun. The objectives of the project were to (i) achieve adequate expansion of the distribution network to maintain balance among generation, transmission, and distribution facilities, (ii) ensure better load management and effective system loss reduction, and (iii) improve operation and maintenance of generating stations. The scope of the project included (i) distribution expansion in Dhaka's electric supply; (ii) distribution expansion in 18 towns; (iii) augmentation of substations capacities in 17 132/33 kV grid substations; (iv) installation of meters and improvement of relay and protection arrangements; (v) spare parts, equipment required for the rehabilitation of 10 power stations; (vi) hardware and software for the computerization of BPDB's operations; and (vii) extension of BPDB's training arrangement with utilities of Thailand and other countries.

13. The diverse nature, both in terms of geographical coverage and technical scope of the sector loan rendered that the OEM could not conduct specific project-facility inspection. According to PCR, the project components were implemented largely as envisaged but with increased quantities of the equipment procured by taking the advantage of the appreciation of Special Drawing Right (SDR) against the dollar. The OEM viewed the increased procurement as appropriate in view of the much-needed augmentation of the capacities for the Dhaka distribution network and the 18 towns distribution networks targeted for expansion and rehabilitation. The project delay of 4 years was caused by a combination of factors including increased project scope, late appoint of consultants, and prolonged procurement and construction periods. Component (vi), computerization, was implemented but with delay. This component has formed the basis for furthering the computerization of BPDB's operation as assisted by subsequent TA 2004 (paras. 36–37). Component (vii), training with other utilities in region, was not pursued due to disagreement between ADB and BPDB in selection of participants and countries. On the whole, the PCR noted that 95% of the originally expected disbursements was completed at original loan closing date and have had a positive economic and social impact. It considered the project generally successful.

4. Loan 0751(SF): Seventh Power

14. The $40.5 million loan was approved in 1985 and completed in 1994, with a 3-year delay and $9 million cost overrun. The objectives of the project were to (i) enable transmission of low-cost, natural gas-based electricity generated in the east zone to consumption centers in the northern and western parts of the country, (ii) to improve the reliability of the power system, (iii) to resolve voltage problems and reduce losses in the 132 kV and 33 kV systems; and (iv) to utilize more efficiently the output of existing and planned power stations. The scope of the project included (i) construction of 326-km 132 kV transmission lines, and 8-km of 230 kV lines; (ii) six new 132/33kV substations; and (iii) extension of six existing 132/33 kV substations.

15. In addition to PCR, a PPAR was completed in 1998. The two documents jointly provide valuable information on the project's implementation, operation, and impact. The PCR indicates that the project scope was increased to include construction of additional 132 lines, upgrading of an existing 132 kV line to 230 kV level, extension of an existing 132/33 kV substation and construction of an additional 132/33 kV substation. This was made possible by the appreciation of SDR against the US dollar. 15 months additional time was required to accommodate the increased scope. The PPAR provides additional

operational indicators, which indicate that, despite the fact that actual load demand was less than 70% of the appraisal estimate, the project objectives were substantially achieved with better load capacity and transformer capacity, improved system voltage across 33 kV, and reduced system losses across 33 kV. Both PCR and PPAR rated the project generally successful.

5. Loan 0963(SF): Eighth Power Project

16. The $165 million loan was approved in 1989 and completed in 2001, with a 7.2-year delay and $18 million cost overrun. The objectives of the project were to (i) meet the electricity demand that was forecast for the early 1990s in greater Dhaka, (ii) reduce system losses, (iii) eliminate suppressed demand caused by inadequacies in transmission and distribution, (iv) improve the reliability of power supply in greater Dhaka, (v) provide system control facilities to enable continuous monitoring of power flows in the distribution system to achieve greater operational efficiency and reliability, and (vi) provide metering facilities to help reduce nontechnical system losses. The scope of the project included expansion of facilities for electrical power transmission and distribution in greater Dhaka through (i) adding 110 km 230 kV lines and two new 2303 V/132 kV substations; (ii) adding eight new, and extending five existing, 132 kV/33 kV substations and 220 km 132 kV lines; (iii) adding nine new, and extending 22 existing, 33 kV/11 kV substations and associated 33 kV distribution facilities; (iv) extending 11 kV/0.4 kV substation facilities; (v) upgrading system control facilities through a SCADA system; (vi) providing consumer service facilities and metering; and (vii) providing ancillary equipment (vehicles and boats) and computer facilities for the planning of power distribution. In addition, the loan savings due to the SDR appreciation were used to finance rehabilitation of Khulna thermal power station, procurement of additional distribution line materials, and computer and office equipment, etc.

17. The PCR noted that the original project components were implemented as envisaged and additional components were implemented using loan savings due to SDR appreciation. However, the project experienced severe delays, caused by slow start, delays and bottlenecks in implementing many components, and disagreement between consultants and DESA over bid specifications for SCADA. An important feature of the project's implementation was the non-compliance by both BPDB and DESA with the project's financial covenants, which eventually led to the decision by both ADB and the World Bank to cease any new loan commitment pending improvement of the financial performance of the two utilities. Despite the delays and the non-compliance of the covenants, the PCR rated the project successful based on a review of relevance, efficacy, efficiency, sustainability, and impact on institutional development.

18. The OEM visited the SCADA system established under the project. The system came into commercial operation in late 1998 after a 7-year delay. The SCADA system[7] replaced the previous monitoring and control practice.[8] Unlike the BPDB Chittagong system, the DESA SCADA has functioned well to date. Daily and monthly reports of system parameters including load shedding by distribution divisions, peak loading of the distribution with time stamp, the cause of load shedding, substation and feeder loading and voltage profiles, and load profiles are generated. This information is invaluable for distribution system analysis, system operation, during

[7] The system design included a dual main computer, 3 work stations, a system mimic board with 720 led indicators, a training simulator, a planning and analysis personal computer station, and one work station located at Siddhirganj Load dispatch Center. Telemetry requirements are provided by a radio system of point-to-point design to interconnect the substations which are included in the system.

[8] It was a system of 78 telephone connections manned by DESA personnel relying on their memory of the distribution system configuration to respond to problems and outages reported in the system.

system emergency conditions, and for restarts after grid failures. It can also detect overloads prior to damage to the system components.

19. The vendor's warranty period has expired and there is a growing shortage of spare parts. The SCADA system controls and displays have not been updated to include the recent additional substations and circuits. Training is now being performed in-house without the benefit of the vendor's support and there is a possibility of the loss of trained operators due to transfers and attrition. The provision of a training program, spare parts and updated mimic and monitor displays is a growing need that should be satisfied in the next distribution rehabilitation and enhancement program in DESA. Otherwise, the vitally necessary planning and analysis of the distribution system will be undertaken without a significant tool.

6. Loan 1356(SF): Rural Electrification

20. The $50 million loan was approved in 1995 and completed in 2000, with a modest 1-year delay and $6.5 million cost underrun. The objectives of the project were to (i) intensify rural electrification in seven PBSs; (ii) increase the availability of power supply to five PBSs, and (iii) introduce the basic elements of corporatization, commercialization, and private sector participation in the power sector. The project scope included (i) construction of 60 MW gas-based open cycle power plant; (ii) intensification and expansion of the distribution networks of 7 RECs by a total of 2,900 km of 33 kV, 11 kV and 0.4 kV distribution lines and required substation capacities; (iii) computerization of the accounting and commercial operations of the 7 RECs. The PCR indicates that the project was successfully implemented as conceived and expanded subsequently, and met the intended objectives. The project implementation, financing arrangements, and coordination among all parties were considered as a role model. Overall, the project was rated highly successful.

21. The OEM visited the Mymensingh Power Station, owned and operated by the Rural Power Company (RPC) Limited, which received assistance from the project, i.e., component (i). The station was one of the first IPPs in Bangladesh and operates under dispatch by the Power Grid Company of Bangladesh (PGCB) with payments according to a PPA. The station has an installed capacity of 140 MW, obtained from four gas turbine units each rated 35 MW. ADB was significantly involved in several aspects of this station. Under Loan 1356(SF), ADB was instrumental in securing the financing of the project's "Phase I", which included the first two gas turbine units, the switchyard, and the 3 km of connecting transmission line to the nearby grid substation. As with previous loans for generation, this was especially timely as the need for generation to meet the increasing demand level had not abated.

22. The station commenced commercial operation in November 1999 after suffering construction delays.[9] Phase II, which was the installation of additional two gas turbines of the same rating as the Phase I units, commenced commercial operation in December 2000. Phase II was financed entirely by the PBSs and commercial banks.[10] Thus ADB's assistance established a commercially viable private sector enterprise. The plant's performance since commercial operation began has exceeded the requirements of the PPA and has bettered the guaranteed

[9] The major delay was an unexpected lack of draft in the adjacent river. Much of the major equipment was assembled off-site in the form of a barge. The plan entailed the delivery to the site by barge, after which the equipment was set on the permanent foundations. The lack of sufficient draft in the navigation channel delayed the delivery.

[10] The OEM's visit coincided with a group from an international bank, which was to finance Phase III of the plant's expansion.

values of output and heat rate.[11] Observation of the operation of the plant indicates that the plant is operated and maintained to standards that are of the highest order[12] and this is accomplished with minimal staffing, with a total staff of approximately 70 persons. The Mymensingh Power Station is an excellent example of disciplined operating standards providing dependable and efficient generation in the Bangladesh power sector. It provides a successful example of the IPP concept in operation. The Project is technically effective and sustainable for the expected 25-30 year life of the phase I generating units. This sustainability is predicated on the design quality of the generating units, and the commitment to sound O&M practices by the operators.

23. Loan 1356(SF) also provided for the upgrade of the distribution and substations of 7 PBSs, i.e., component (ii). The OEM visited one of the 7 PBSs, Comilla PBS-1, to observe the impact of ADB's activities[13] as well as to assess the operation of these organizations.

24. The PBS served 150,713 connected consumers in 2002 with a total of 196,082,088 kilowatt-hour (kWh). Purchased energy was 221,887,147 kWh with estimated system losses of 9%, reflecting a steady improvement from 25% in its fifth year operation 17 years ago. This loss figure is close to the expected level of technical losses for a system of this configuration, indicating that losses from other causes such as thefts are very low. Comilla reports that their percentage of bills collected is 99.9% for the most recent year. This level of system losses and collection efficiency is outstanding. While a large portion of this improvement is attributable to the increasing number of consumers, much is due to the observed dedication of the staff to improve their performance and that of the system. In comparison to the much larger percentage system loss of DESA and the various units of the BPDB distribution,[14] it is clear that the culture and systems design of the PBS is superior to that of the urban distribution companies.[15]

25. Under the project, the PBS has also successfully implemented a computerized billing system with the aid of local consultants. The data entry personnel were trained in-house and are predominately female. Observations of their activities indicate that they have obtained a high level of expertise in billing data entry and have a good knowledge of the software functions. This activity also indicates that the management culture of the PBS[16] is effective in running a distribution utility.

26. ADB's provision of distribution upgrades was effective in that it enabled the 7 PBSs involved to expand and improve their distribution facilities, which contributed toward a significant increase in the area of the country with access to electricity. The financial performance of the PBSs and the high standard of O&M confirm the sustainability of the Project. Discussion with the

[11] For the Phase I equipment, for FY2002, the availability was reported to be 98%. The load factor was 36%, and the applicable heat rate (expressed in per unit fuel consumption) was 0.40 per standard cubic meter.

[12] The plant design includes multiple layers of back up control levels to ensure high availability. Plant control is state of the art with computerized generation control and a complete monitoring system of all significant data. All major equipment instruction and maintenance manuals are on hand. A complete set of spares, including spare turbine blades are maintained and properly stored.

[13] The socioeconomic impact study as part of the evaluation was conducted in and around this area (Appendix 4).

[14] The reported losses of these distribution entities are generally two to three times the losses of Comilla PBS-1.

[15] The quality standard of the distribution facilities and substations are high with lines that are well constructed and maintained. The PBS maintains its own transformer repair facility in order to ensure a supply of transformers and to control the quality. The rewinding was observed to be well done and the personnel well trained in the tasks. The PBS has acquired a state of the art optical meter calibration unit and performs revenue meter calibrations and replacement on a scheduled basis. These activities demonstrate a professional and service oriented culture in the PBS management and personnel.

[16] The OEM recognizes that the observed PBS is considered to be one of the two or three top performing PBSs. However, its obvious success on multiple levels indicates that there is a management culture within Bangladesh that can provide for efficient utility operation.

distribution engineer at Comilla confirms that the distribution facilities are installed with sufficient capability to serve the expected load growth for a minimum of 10 years.[17]

7. Inv. 7165/1793: AES Meghnaghat Power

27. The investment loan of $70 million, together with an additional partial risk guarantee covering a principal amount of $70 million and interest, was approved in 2000 and completed in 2002 with no delay. The project aimed to build, own and operate a 450 MW gas-fired combined-cycle plant consisting of two natural gas-fired turbine generators, two heat recovery steam generators, and one steam turbine generator and its related facilities.

28. The OEM visited the project site of Meghnaghat Power Station. It was established as an independent power producer (IPP), constructed and initially operated by AES, a USA-based firm which owned and operated several independent power producers (IPPs) in numerous countries. The plant design included by-pass stacks to enable the MPS to operate in either single or combined cycle modes. The steam turbines were to be capable of operation at base load or in two shifting load operations. The construction took 22 months and it was completed with no delay.[18] It began commercial operation in November 2002 as AES Meghnaghat Power Plant. The plant has been referred to as "the least cost IPP in Asia",[19] and has achieved an availability of 90% to date. While the PPA for the plant allows for a 38-day annual outage for major inspections and O&M, no outages are allowed during March-May. The management is comfortable with such restrictions and does not expect to have any problems meeting them. The confirmed heat rate established at commissioning is 7,067–7,070 kilojoule (kJ)/kWh, which exceeds the rate assumed at appraisal by ADB. The plant has demonstrated a gross generation of 463 MW with 450 MW net output. Availability for FY2003 was reported at 94.2%.

29. There have been problems with some of the auxiliary equipment. One example is the gas compressors where one unit has failed. However, these are provided with an installed spare so it has not affected the operation. Control of the plant is provided through a very modern software control package and computerized control. All control functions that affect the availability of the generating units are duplicated and are available at several control levels to ensure adequate back up of all control functions. All significant operating parameters of the generating units are monitored including vibration and various temperatures. Contrary to what was described in ADB's loan appraisal documents, the plant was not equipped with by-pass stacks and as a result can only operate in single cycle mode for a limited time, approximately one hour according to the management. This should have resulted in a significant reduction in the construction cost of the station but does limit the available operational options.

30. The plant staffing is similar to that of the Mymensingh station with about 75 staff (para. 22). However, where Mymensingh has 2 expatriate staff, Meghnaghat has 5. The management informed the OEM that this would probably be decreased after the initial year of operation; their responsibilities also extend to AES's other plant at Haripur. Observation of the units and the general areas indicated that the standards of maintenance and housekeeping of the station

[17] Even when the lines require re-conducting, the initially installed conductor can be relocated thus extending its service life. The substations were observed to be well constructed and maintained. The transformers provided under the Project are well maintained and monitored and should provide normal service life in their application.

[18] It was the only project among those which received in-depth evaluation that did not experience delays. This compares favorably with the public sector loans being evaluated for which the average delay was 3.5 years.

[19] The OEM was not able to confirm the accuracy of this.

approaches that of Mymensingh, keeping in mind the additional complexity and size of the combined cycle Meghnaghat Power Station as compared to the Mymensingh plant.

31. ADB's involvement in the initial engineering design, solicitation of private sector investment, through TA 2338 (para. 38), and the partial risk provision were essential parts of the basis for the project which otherwise may not have materialized. The plant management informed the OEM that the TA was not only instrumental in the successful implementation of this project, it has also helped improve Bangladesh's capacity in procuring similar IPP projects in the future. The plant became available at a time of considerable generation shortfall during most contingency situations. Its availability avoided significantly larger amounts of load shedding in the DESA and other distribution service areas. In addition, the location of the plant has greatly improved the voltage profile of distribution in the Dhaka area during peak loading periods. In general, the project is effective, as it has provided an efficient source of 450 MW of much needed generation to the power sector at reasonable cost. The project is likely to be sustainable through its expected 25-30 year operational life given the current operator's culture of dedicated O&M and the design of the generating units and auxiliaries.

8. Overall Assessment of Project Implementation and Operation

32. A key conclusion derived from the evaluation of project implementation and operation is that ADB supported technically sound projects that addressed the needs at the time of the Bangladesh power sector. They have mostly met project objectives. The power generation and transmission facilities observed are, in general, well designed and constructed but with a few exceptions. The O&M of the recently constructed generation plants, i.e., Mymensingh and Meghnaghat facilities, is exemplary. The older generating plants, e.g., Ashuganj Power Station, appear to have been less well maintained for various reasons such as a lack of funds and reserve capacity, delayed procurement of parts, and a less dedicated management culture toward preventive maintenance. The upcoming or ongoing corporatization of these plants should improve significantly their future operation. The main problem experienced in implementation was extensive project delays, with the notable exception of Meghnaghat Power. Delays deferred project benefits and added to the continuing inadequacies in generation, transmission and distribution. It should be noted, however, that for all the projects, the appraisal estimates of economic internal rates of return and, for some of them, the PCR and PPAR re-estimates, were well in excess of 12%. Based on the OEM's own observation of the heavy use of the facilities built under the projects and the high willingness to pay for reliable power supply as informed to the OEM by virtually all the customers interviewed, these estimates appeared to be well justified.

B. Technical Assistance

33. ADB has supported capacity building in the Bangladesh power sector through a number of TA projects. Of the 5 TAs examined in depth, with the exception of TA 0714: East Zone Thermal Power,[20] all the other TAs to a varied extent achieved their intended objectives and contributed positively to the development of the power sector over recent years.

1. TA 1962: Preparation of Power System Master Plan

34. TA 1962 was implemented in 1995. The objective was to prepare a realistic least cost development plan for the power sector for the period 1995–2010. The master plan updated

[20] The PPTA seemed to have failed to prepare a project that was suitable to ADB financing. None except one BPDB official interviewed had any knowledge of the TA.

previous master plans, prioritized the projects, and addressed the physical and financial resources required to implement the projects. A key component of the plan was to maximize the transfer of technology to BPDB. A Power System Master Plan unit was created within BPDB to serve as counterparts. All work was performed in Bangladesh to maximize the learning experience of the counterparts.[21]

35. The OEM reviewed the Master Plan in the context of current conditions. The plan was competently prepared and structured and continues to be of significant value to the BPDB in planning system expansion and development. This was confirmed through extensive discussions with various government and BPDP officials who frequently refer to the master plan, and with the systems planning staff of BPDB, who benefited from technology transfer through the TA. These staff are capable of planning extensions of the generation and transmission facilities, and updating the master plan. In addition, analytical load flow studies of the installed and planned transmission system are prepared with computer software furnished by supplier The planning and analysis studies reviewed are insightful and prepared in a competent manner. The need for studies is primarily driven by questions from various managers in BPDB, and the staff can produce a complete analysis of the current and planned system.[22]

2. TA 2004: Financial Management Upgrade of BPDB and DESA

36. TA 2004 was designed to improve the billing and accounting systems of BPDB and DESA through computerization. It builds on two previous ADB investments in the areas of accounting and finance through Loan 0581(SF): Ashuganj Thermal Power and Loan 0683(SF): Sixth Power, both of which had components for the improvement of accounting and computerization. Computerization of billing invariably makes theft of electricity through fraud more difficult and, as such, it is often resisted by some utility employees who see it as an obstacle to their dishonest activities. Consequently, this project was always likely to make slow progress, as has proved to be the case. Neither DESA nor BPDB have fully implemented computerized billing although in both cases the system is working well in large areas of operations, and contributing to improved performance on managing system losses and collection against billing. In some areas, computerized billing is now regarded positively. Chittagong is an example where the management now wants to obtain further IT equipment to make greater use of computerized billing. Furthermore, BPDB has implemented an integrated management reporting system, which is now enabling financial data to be reported more quickly from zones and regional accounting offices to head office. The TA was also designed to introduce Oracle Financials as an Enterprise Resource Planning (ERP) system into the operations of DESA and BPDB. Under the TA, some pilot projects were conducted using this new system and a number of staff have been trained to use the Oracle system. However,

[21] The TCR concluded that the TA had been generally successful with all objectives successfully realized. The BPDB personnel could now be expected to update the plan on a regular basis as all software and other tools had been transferred to the BPDB unit.

[22] BPDB needs to keep computer hardware and software and the skills of its staff up-to-date in order to continue to make best use of the investment in preparing the Master Plan. This may in turn require further support through TA from time to time, but the amounts involved are unlikely to be large. Any further assistance will help to reinforce the results of a very successful TA.

detailed implementation has been deferred until the next phase of the project. At the same time, the majority of the trainees have already left BPDB and taken jobs in the private sector. [23]

37. There are several ways of looking at progress on TA 2004. As an immediate impact, the TA has achieved results in that large areas of billing at DESA and BPDB are now computerized. However the overall picture is that both DESA and BPDB have fallen progressively further behind good commercial practice in accounting and billing over the past 10 years. It is very rare to find a modern utility which has any areas of its billing undertaken manually and which does not produce monthly profit and loss accounts as part of its management accounts. However neither DESA nor BPDB is fully computerized and both lack a fully functioning integrated accounting system. From this perspective, capacity building in the utilities has clearly been insufficient and the project has not met its objectives. Moreover, experience with newer entities such as DESCO and smaller entities such as some of the PBSs shows that these problems can and have been overcome in Bangladesh. DESCO is already able to produce full monthly management accounts. PBSs such as Comilla have managed to implement computerized billing with more limited external support and against a shorter time scale, and are now themselves proceeding to fuller computerization of their accounting.

3. TA 2338: Solicitation for Private Sector Implementation of the Meghnaghat Power

38. TA 2338, which included three grants, illustrated the importance of TAs in introducing new concepts and approaches to Bangladesh, e.g., through competitive bidding to solicit IPPs with power purchasing agreements (PPAs). The bids for the project were evaluated on the basis of the quoted wholesale tariffs and the plant is now selling power successfully to BPDB at an internationally competitive price. Partly as a result of implementing this TA, Loan 1356(SF): Rural Electrification under which RPC was formed as an IPP, and the Westmont project, which received similar support from the World Bank, Bangladesh now has the capacity to solicit private generation projects without further TA.

4. TA 3343: Corporatization of Ashuganj Power Station

39. Work under TA 3343 to corporatize the Ashuganj power station has proceeded slowly, partly because of resistance from within the power sector to the corporatization policy and partly because of difficulties in agreeing final arrangements on a complex series of changes. The TA was originally supposed to begin in March 2000 and be completed in 12 months but it was still ongoing as of the OEM's visit in August 2003. A company has been created to be responsible for the future management of the plant and senior staff members have been put in place. However terms of the PPA and the conditions for staff to transfer to the new station are still under review. This is a test case for unbundling a station out of BPDB and setting it up as an independent company with a PPA with BPDB for sale of its output. Despite the delays, it is now reaching a conclusion and has successfully demonstrated that it is feasible to separate a power

[23] In view of the likely changes in the long-term structure of the power industry, it is doubtful whether it is worth supporting the further implementation of Oracle Financials at this stage. The costs are high, the future benefits are doubtful, since smaller distribution companies and individual power stations are unlikely to want to use ERP software such as Oracle Financials, and the risks of failure are high. It may be more useful to focus resources for on further extension of computerized billing, which has demonstrable benefits in the short term and will be useful in any new industry structure. New entities such as the West Zone Power Distribution Company can then make their own decisions about the accounting software they wish to use to produce financial management information, in the same way as DESCO.

station from BPDB. This experience can be transferred to the corporatization planned at other BPDB stations since many issues of principle are being resolved in the course of this exercise.

5. Overall Assessment of TAs

40. The four advisory TAs reviewed have, to a varied extent, achieved their intended objectives. TA 1962 (master plan) and TA 2338 (Meghnaghat Power) have fully achieved their objectives and their impact appears to be far reaching and long-lasting. The impact of TA 2004 (financial management) appears to be less so and TA 3343 (corporatization) is still ongoing, although progress has been made in both financial management and corporatization. In particular, sustainability of the TA 2004 may be problematic due to lack of ownership and continued funding required.

SOCIOECONOMIC AND POVERTY REDUCTION IMPACT ASSESSMENT

A. Introduction

1. Background

1. This appendix assesses the socioeconomic and poverty reduction impact of rural electrification. Electricity offers significant benefits to rural households and improves access to production technologies, which can reduce costs and improve the product quality of agriculture and rural industries. Commercial and industrial establishments can improve their working environments, and their services and products. The importance of electricity as a necessary condition for development is indisputable but its contribution is intertwined with the provision of other infrastructure, both physical and social, and with a range of other factors influencing development. The impacts solely attributable to electrification are therefore difficult to quantify.

2. The first part estimates the reductions in costs associated with electrification in a range of applications, e.g., electric lighting versus kerosene lamps; diesel pumps versus electric pumps for irrigation; and diesel engines versus electric motors in industrial applications. These cost savings are however only part of the wider economic impact. The other economic impacts are harder to measure though perhaps more important. The social and economic benefits and poverty reduction impact provided by electrification to individual sectors have been addressed here in relative and qualitative terms since quantitative data is hard to obtain.

2. The Survey Design

3. The survey was conducted in the area covered by Comilla PBS-1,[1] which is based in Chandina, Comilla district, about 75 km from Dhaka. It is the second oldest PBS under REB and has shown tremendous growth in electricity connections over the last two decades. The number of consumers grew from only 5,474 in FY1982 to 150,713 in FY2003, an increase of 27.5 times over 22 years (Table A4.1). At present, households are the largest consumer of electricity (43.44%), followed by industries (41.30%), irrigation (9.20%) and commerce (6.06%) (Table A4.2).

Table A4.1: Growth of Electricity Consumers, Comilla PBS-1

Fiscal Year	Number of Consumers	Annual Growth Rate (%)
1982	5,474	—
1986	17,672	44.56
1992	41,004	18.86
1996	64,833	11.62
2003	150,713	16.56

[1] One of the PBS'es that benefited from Loan 1356(SF): *Rural Electrification*.

Table A4.2: Consumer-Wise Distribution of Electricity Consumption in PBS-1 for FY2003

Consumer Category	Total Consumption (kWh)	% of Total Consumption	Average Consumption per Consumer per Year
Domestic	68,071,298	43.44	621
Industries	64,709,080	41.30	35,506
Irrigation	14,408,599	9.20	7,860
Commerce	9,501,618	6.06	838
Total	**156,690,595**	**100.00**	**—**

4. Two representative villages within the Comilla PBS-1 area were chosen for the survey—one with electricity, Barura (i.e., the "treatment village") and the other without electricity, Dumuria (i.e., the "control village"). The two villages have a similar social and economic environment except for the difference in electrification. A complete census survey has been carried out in both villages to capture all categories of villagers and their activities. There are four types of electricity consumers in the Comilla area: households, agriculture, industry, and commerce. Accordingly, the survey is divided into four parts:

(i) Household survey: a structured questionnaire survey of all the households in the treatment and control villages.

(ii) Irrigation survey: a survey of electric pump users in the treatment village and diesel pump users in the control village. This also follows a structured questionnaire survey.

(iii) Commerce and industrial surveys: the diverse nature of industrial and commercial consumers precluded the use of a standard questionnaire. Instead, managers of several different types of industrial and commercial business were interviewed informally, supported by some checklists.

(iv) Focus group discussions: the survey conducted focus group meetings with different social groups—farmers including pump users, village elites, commercial shop owners, industrialists, workers and NGOs.

5. For agricultural, industrial and commercial consumption, some additional samples were taken beyond the treatment and control villages.

3. Characteristics of Study Villages

6. Barura, the treatment village, is 7 km, and, Dumuria, the control village, is 3 km from Comilla PBS-1 headquarters. In the treatment village, about 20.4% of the households have not yet been connected with electricity (Table A4.3). The two villages have many similar characteristics. The same road connects the villages. The total number of households is almost

the same (206 in the treatment village and 203 in the control village). The population in the treatment village (1,211) is 5% higher than in the control village (1,156), and as a result the average family size is slightly higher (5.8 in the treatment village and 5.7 in the control village). Both villages are dominated by agricultural production. The total cultivable land area is 110.21 acres in the treatment village and 129.24 acres in the control village and pattern of land distribution among households is also similar (e.g., the landless household ratio is 28.5% for the treatment village compared to 29% for the control village). Cropping intensity is the same in both villages. In the treatment village 48% of land is irrigated compared to 51.6% in the control village. Both have primary schools, but the treatment village has a high school for secondary education. The control village has no high school but its secondary school students attend a high school at nearby Chandina. However, the treatment village has a growth center market with a much higher number of commercial establishments (45) than the small market in the control village (7). The treatment village also has far more industrial establishments (10) compared to the control village (2). The inhabitants of the control village use the nearby Chandina market, which is similar in nature to the treatment village growth center market. The control village has some advantages. It is closer to PBS-1 and Upazila headquarters as well as the national highway. Even though the village is not connected to electricity, it enjoys more nongovernmental organization (NGO) interventions and has other physical and social infrastructure.

Table A4.3: Distribution of Households by Family Size in the Treatment and the Control Village and Electricity Connection

	Treatment Village (%)		Control Village (%)
Family Size	**Households With Electricity**	**Households Without Electricity**	**Households Without Electricity**
Up to 3	31 (77.5)	9 (22.5)	40 (100.0)
4–6	63 (81.8)	14 (18.2)	84 (100.0)
7–9	46 (70.7)	19 (29.3)	57 (100.0)
10 and above	24 (100.0)	0 (0.0)	22 (100.0)
Total Households	**164 (79.6)**	**42 (20.4)**	**203 (100.0)**

B. Theoretical Framework

1. Household Consumption

7. The use of electricity for lighting homes has significant monetary and non-monetary benefits compared to traditional fuel such as kerosene. Being connected to electricity also enables households to use electric fans, refrigerators, irons, radios, televisions, and cookers. These appliances have major implications for the quality of life. Electric lighting helps children spend longer hours studying, women spend longer hours undertaking household work, and the poor find employment in activities that can contribute to their welfare.

8. The impact of electricity consumption on households has been determined by comparing treatment and control villages in terms of (i) cost savings (comparative costs of electricity and kerosene lamps), (ii) duration of household lighting (electricity and kerosene lamp use), (iii)

duration of children studying at night, (iv) duration of women's household work at night, and (v) poor people's gainful employment activities at night. To gain further insight into the impact of electricity, households in the treatment village using electric fans, refrigerators, irons, radios, televisions, and cookers have been analyzed in terms of the percentages of households using these electrical assets, and their values per household. The qualitative impact is determined by assessing the impression and preferences expressed by consumers on standard of living, comfort, price, and safety in electricity consumption.

2. Agricultural Consumption

9. Power use in agriculture can contribute directly to agricultural development in three ways. First, it may reduce the cost of irrigation by making available cheaper, more efficient, and convenient pumps. Second, it may augment farm income through an increase in the gross cropped area either through an increase in cropping intensity or area under cultivation. Third, farm employment may increase as the gross cropped area rises. Thus, the landed poor and the landless benefit as employment opportunities increase. The growth of agro-based industries in rural areas may also create employment opportunities.

10. The impact of electricity use in agriculture is determined by estimating (i) cost savings from electric pumps compared to diesel pumps; (ii) gross cropped area and cropping intensity in treatment and control villages; (iii) increases in income arising from increased crops and declines in energy costs, (iv) employment benefits to the poor by using employment norms for the principal crops and the increase in gross cropped area. These might be valued at the wage rate of the treatment village for agricultural labor.

3. Commercial and Industrial Consumption

11. Providing electricity in an electricity-deficient area can promote commercial and industrial growth by encouraging new commercial and industrial establishments and enhancing capacity utilization in existing establishments. This leads to the creation of employment opportunities in the area and sets off multiplier effects on output and employment throughout the economy. The impact of electricity consumption on commerce and industry is estimated by comparing (i) opening hours, (ii) total turnover, and (iii) investment in the treatment and control villages. Commercial and industrial growth affects poverty reduction by creating employment opportunities and through the trickle-down effect of economic growth. Employment benefits are estimated by comparing the employment level in commercial and industrial establishments in these two villages. The share of unskilled labor in the employment generated reflects the benefits to the poor.

4. Review of Earlier Studies on Rural Electrification

12. A recent USAID funded study[2] in Bangladesh covered 1380 households with electricity in electrified villages, 421 households without electricity in electrified villages and 690 households without electricity in non-electrified villages. It considered a number of socioeconomic variables to assess their interrelation with rural electrification. Key findings are summarized below in Tables A4.4 through A4.6.

[2] Human Development Research Center, Dhaka, Bangladesh, October 2002. *Economic and Social Impact Evaluation Study – Rural Electrification Program in Bangladesh*.

Table A4.4: Impact of Electricity on Rural Households

Socioeconomic Indicators	Households With Electricity	Households Without Electricity in Electrified Villages	Households Without Electricity in Non-Electrified Villages
Dependency ratio	0.64	0.73	0.68
Literacy rate (%)	70.8	54.3	56.4
Average no. of persons per HH involved in IGAs	1.8	1.7	1.9
Average no. of IGAs (primary and secondary) per HH involved in IGAs	2.2	2.1	2.4
Average annual income per household (Tk)	92,963	41,110	56,523
Average per person daily food intake (K. Calories)	2,372	2,208	2,312
Gini coefficient	0.61	0.68	0.67
Infant mortality rate (infant deaths/1,000 life births)	42.7	53.8	57.8

IGA = income generating activities, HH = household.
Source: USAID, 2002.

Table A4.5: Impact of Electricity on Agriculture (Yield in Maund per Acre)

Season	With Electric Pump	With Diesel Pump
Aus HT	40	36
Aman HT	50	29
Boro HT	54	52

Source: USAID, 2002.

Table A4.6: Impact of Electricity on Industry

Indicator	Electrified Industries	Non-Electrified Industries
Cost-output ratio	0.65	0.85
5-Year turnover growth (%)	78.0	8.0
5-year employment growth (%)	40.7	4.4

Source: USAID, 2002.

13. The USAID study generally takes the difference in the value of a variable between electrified and non-electrified household as the impact of electrification. This is not a sound methodology since it is confusing causation with correlation. In rural Bangladesh, villages with a good general standard of infrastructure such as roads and markets tend also to be the villages

which are connected to the electricity network. The study makes no attempt to assess the impact of electricity separately from other infrastructure factors.

C. Socioeconomic Impact of Electrification

1. Resource Savings

14. The average monthly expenditure on electric lighting reported by the electrified households in the treatment village was Tk290. The expenditure on lighting for the households using kerosene in the treatment village was Tk148. Thus, there is no cost saving to the electrified households in terms of lighting. Electrified households also keep a kerosene lamp as a standby as there are frequent power failures and load shedding. However, spending on kerosene was lower in the treatment village than the control village households, i.e., Tk27 per month for electrified households versus Tk148 in the non-electrified households in the control village. Electrification reduces use of kerosene for lighting and thus saves foreign exchange.[3]

15. The difference in cost between an electric pump and an equivalent diesel pump is used to compute the benefits of rural electrification for irrigation. A comparison was made using typical low lift pumps (LLP), shallow tube wells (STW), and deep tube wells (DTW). The results indicate that the savings in lubricants and capital and maintenance costs give electric pumps a significant advantage both at the time of initial purchase and over the life of the pump. The total operating cost per acre of irrigated land per year is about Tk1990 for an electric pump, which is 17% less than the diesel pump.

16. There is a clear preference for the use of electric motors over diesel engines in rural industries and commerce where electricity is available. The basis for this preference is primarily the lower financial cost.[4] The average cost per operating hour is Tk77 for an electric engine, 9% less than for a diesel engine. An electric engine is cheaper for two major reasons, the lower cost of energy and lower maintenance cost.

17. The survey identified some mill owners and agricultural users with an interest in converting back from electricity to diesel to overcome problems of unreliable energy supply and, in the case of irrigation, to take advantage of the mobility of diesel pumps, which are portable. In Bangladesh, the introduction of the motorized 'shallow boat' for use during the rainy season has created an additional demand for motive power. The diesel engine used on the pump is also suitable for powering a boat, This engine also has potential for powering rice mills, providing on-farm transportation, plowing fields, etc. Several of these uses are important in rural areas.[5] The potential for increasing the use of the diesel engine on a pump, which would otherwise lie idle for 8 months in the year, was referred to in our field surveys. However, the impact is likely to be limited since, for many applications, it is financially advantageous to use electricity for irrigation and to purchase a diesel motor for other uses.

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[3] The USAID study indicated financial implications on the imports of Bangladesh. Currently, all rural households in Bangladesh annually consume 775.53 million liters of kerosene as fuel for domestic use. If 100% of rural households were connected to electricity, the annual volume of consumption would drop to 366.58 million liters, that is, projected annual savings of about 410 million liters, which costs Tk7361.1 million. Thus ensuring 100% electrification of rural households would have a major impact not only in reducing the dependency on kerosene, which is purchased using scarce foreign currency, but also on the overall economy and macroeconomic stability. This method, however, overlooks the foreign exchange cost of the power stations required to generate the increased power demands arising from full rural electrification.

[4] In order to understand the magnitude of this difference, a comparison was made between a 25 HP diesel engine and a 25 HP electric motor. These sizes are commonly found in rural industries.

[5] Even locally fabricated half-ton farm trucks are powered by these engines.

2. Generated Benefit on Households

18. Average household incomes are marginally higher (1.6%) in the treatment village (Tk44,150) than the control village (Tk43,470) (Table A4.7). However, taking household size into consideration with the average household size in the treatment village slightly larger (5.8) than that of the control village (5.7), the per capita incomes of the two villages are statistically identical, i.e., Tk7,613 for the treatment village and Tk7,626 for the control village.[6] The average annual expenditure of households in the treatment village is Tk42,825 compared to Tk41,731 in the control village. The survey also showed a positive correlation between size of household, income and electricity consumption. The electricity bill as a percentage of total household expenditure increased with income but was less than 2% for most households. As expected, the ownership of electrical appliances increased with average monthly income. Despite the lack of electricity, 25% of respondents in the control village reported owning radios and cassette players, which are run by batteries, indicating a strong demand for electricity connection. In the treatment village, all electrified households reported that they run their radios, cassette players and TV by electricity.

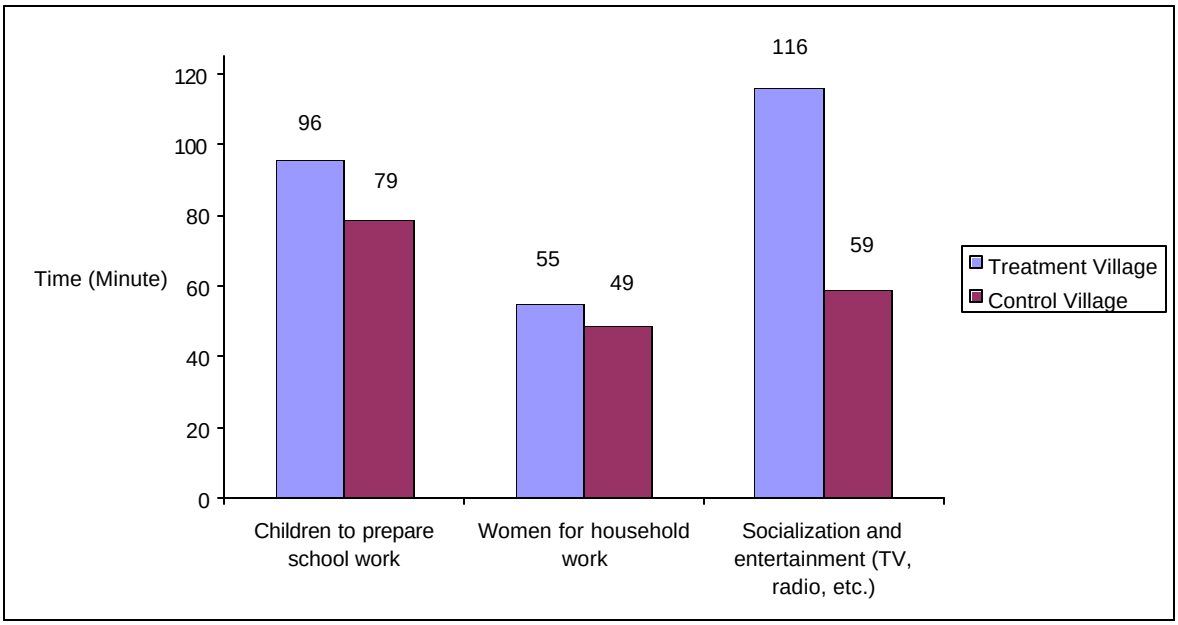
Table A4.7: Distribution of income and households in the Treatment and Control Village

Income Range (Annual) (Tk)	Households in Treatment Village (%)	Households in Control Village (%)
<15,000	8.2	7.9
15,001 – 24,000	13.1	13.8
24,001 – 35,000	17.3	17.4
35,001 – 45,000	20.9	14.8
45001 – 55,000	10.6	20.3
55,001 – 65,000	6.2	3.1
65,001 – 75,000	8.2	9.9
> 75,000	15.5	12.8
Average income (Tk)	44,150	43,470

19. Availability of electricity increases the options available to families. Households in the treatment village use electricity for entertainment, socialization, information and communication (TV and radio), children's education, and economic gains (household work, home business, sewing, embroidery, etc). In the treatment village children's homework time is 22% higher, women's household work time is 12% higher, and people's socialization including information and communication (TV and radio) time is 96% higher than the same activities in the control village (Figure A4).

[6] This result contrasts with the USAID survey (Table A4.4), which shows significantly higher household income for electrified households than non-electrified ones. There could be several possible reasons. First, the USAID survey had a much larger sample size while the current survey included only two villages. Second, the control village has the advantage of being closer to national highway and urban areas, as well as more NGO interventions. Third, the mobility of population implies that poor population tends to flow to where economic opportunities lie (i.e., the treatment village), which may bring down average per capita income.

Figure A4: Comparison of Time Spent Per Day on Household Activities



20. Electrification appears to have little impact on health, hygiene and sanitation. The survey examined awareness of 20 public health issues. On average, the respondents in the treatment village reported awareness of 10.4 issues compared to 11.5 issues in the control village. Similarly, 74% of the electrified households reported use of hygienic latrines (sanitary, sealed closed) compared to 83% in the control village. These results may reflect more extensive NGO interventions in the control village, which is closer to Upazila headquarters and national highway.[7] However, some public health indicators are more positive in the treatment village. The infant mortality rate in the electrified households in the treatment village is 64.5 per thousand live births, compared to 79.2 in the control village. Rural electrification was also positively correlated with the regular use of contraceptives, which were used in 33% of electrified treatment village households compared to 30% of treatment village non-electrified households and 23% of households in the control village.

21. The higher standard of living and better quality of life of inhabitants of the treatment village compared to the control village is evident from higher annual per capita expenditure on all items of expenditure. The annual per capita expenditure on food in the treatment village (Tk4,523) was 4% higher than for the households in the control village. No significant difference was observed in household expenditure on education between the treatment village and the control village.

22. Household heads in the electrified households in the treatment village on average spent 51.2 minutes after sunset on income generating activities, compared to 49.6 minutes for the non-electrified households in the treatment village, and 39.1 minutes for households in the control village. Irrespective of availability of electricity in the household, 85% of respondents said that electricity created significant employment opportunities. The most widely identified were the possibility of working at night, expansion of local trade and business activities, generation of employment opportunities for unemployed youth, broadening of employment

[7] NGOs are often criticized for being location biased. They prefer places with easy and quick communications.

opportunities in crop culture, establishment of small and cottage industries, and increased opportunities for poultry raising.

3. Generated Benefit on Agriculture

23. The two villages make similar use of irrigation. There are no significant differences in the hours of use of pumps (1,000 hours STW and LLP and 2,000 hours DTW in a year), area irrigated (48% of land in treatment village and 51% of land in control village) or the pattern of ownership. The principal factor affecting both the decision to purchase a pump and the choice between a diesel and an electric pump appears to be financial cost.

24. The yield rates (output per unit of land) were estimated for alternative crop varieties and compared between treatment and control villages. Modern varieties produce more output per unit of land than the traditional varieties in all three seasons: about one and a half times higher during the Aus season, three-fourths higher during the Boro season, and one-half higher during the Aman season. On average, the yield of the modern varieties is about 100–125% greater than the yield of the traditional ones. The yields are similar in the treatment and control villages. Nonetheless, labor demand in agriculture is higher in the treatment village. In the peak season, the daily wage in the control village is around Tk120 whereas in the treatment village it is as high as Tk130 to 150. In the land preparation, and transplanting and weeding stages, labor demand per acre of cropland is almost the same in both villages. But in the harvesting and threshing stage, labor demand is 20% higher in the treatment village than the control village. This may be due to farmers extending working hours for threshing under electric lighting. The higher wages in the treatment village has a more favorable impact on the landless.

4. Generated Benefit on Rural Industries and Commerce

25. 78 rural industries and commercial firms were surveyed in the treatment and control villages, of which 40% were mills for rice, pulses or other agricultural products, saw mills, and ice-cream factories, etc. The remainder are almost all commercial shops. Of the total, 80% reported having one or more electrical motors and 11% reported having installed capacity in excess of 30 horsepower. By contrast only 8 reported having diesel engines. Only 18% of the electrified industries reported consumption in excess of 1 megawatt-hour per month and 30% reported a consumption of less than 0.4 megawatt-hour per month.[8]

26. Before electricity became available, only 10 to 12 commercial establishments were located in the survey area. In the control village there was one handsaw mill with only half a dozen commercial shops in the market. This sawmill has already moved to a location where electricity is available. There has been no growth of industrial or commercial enterprises in the control village for the last 10 years. In the treatment village and in semi-urban areas, there has been rapid growth of rural industries and commercial firms. It was reported by industrialists that, during the last 10 years, the volume of output has doubled and the value has tripled in electrified industries. Moreover, shops have longer hours of operation (until 11 pm) in the treatment village. There is also a spillover effect of rural electrification on employment in various support services.[9]

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[8] More intensive use of appliances and higher consumption of electricity were observed in the sample industries and commercial firms located near the semi-urban center, around and within the Upazila Sador market area.

[9] The USAID study estimated that 63,220 industries using rural electricity employ 983,829 persons; and electrified industries, on average, generate 11 times more employment than non-electrified industries. Rural and wholesale shops using rural electricity employ 848,630 persons.

27. The pattern of investment in the treatment village and the control village shows that average investment per household was almost same (Table A4.8). Total expenditure including investments was significantly higher in the treatment village. There were significant differences in patterns of investment between the villages. Directly productive investments account for 11.7% of total expenditure in the control village, but only 7.3% in the treatment village. Households in the treatment village also spent proportionately more on construction of housing and acquisition of livestock. But the rate of investment in agricultural equipment and tools, cottage industry, and business was significantly higher in the control village. The reason may be that the control village is closer to urbanized areas. The villagers can benefit from the advice of the Upazila Agriculture Officer more easily and, thus, procure more high yield variety seeds, fertilizer, and pesticide from the Upazila bazaar. Although the control village does not have any industry, many of the villagers have investment in Chandina bazar (Upazila Bazar). This could also be due to the fact that availability of electricity allows households to spend more on improving their housing and sanitary conditions, and on consumer electronic goods.

Table A4.8: Pattern of investment in treatment village and the control village

Type of investment	Amount per Household (Tk)		As a Share of Total Expenditure (%)	
	Treatment	Control	Treatment	Control
Directly productive investment			7.3	11.7
Agriculture	1,762	2,078	3.9	5.6
land development	270	212	0.6	0.6
agricultural l tools and equipment	150	816	0.3	2.2
draft animals and livestock	1,290	988	2.9	2.6
other agriculture	52	62	0.1	0.2
Non-Agriculture	1,538	2,264	3.4	6.1
industry	58	450	0.1	1.2
business	1,422	1,748	3.1	4.7
transport	58	66	0.1	0.2
Other investment and spending	2,954	1,972	6.5	5.3
housing	2,372	1,454	5.3	3.9
sanitation	58	54	0.1	0.1
consumer durables	524	464	1.2	1.3

5. Generated Benefit in Poverty Reduction

28. An assessment of the impact of rural electrification on poverty reduction is difficult. While causal links between rural electrification and poverty reduction are difficult to establish, there are a number of positive linkages. It appears that rural electrification in the treatment village has improved poor people's welfare in per capita calorie intake. In the treatment village 45% of primary target group households live below the poverty line, consuming less than 2,000 calories per capita per day, compared to 56% in the control village. These figures may be compared to a national average of 44.3% of calorie poor households.

29. There is no statistically discernible difference of per capita income between the two villages for possible reasons explained earlier (para. 18 and footnote 6). Income distribution is also similar in the treatment and control villages. The income share of the top 10% of the household is 20.5% in the treatment village, compared with 21.2% in the control village. The

income share of the bottom 40% of households is 22.7% in the treatment village and 22.9% in the control village. Electrification seems to have no impact on the distribution of income as measured in terms of Gini ratio.[10] The concentration ratio is 0.66 in treatment village, compared with 0.67 in the control village.

30. Rural electrification may be affecting labor use and wages in agriculture. In paddy cultivation in the treatment village, labor costs are about 30% higher, and in harvesting and threshing labor use is 7% higher compared to the control village. At the threshing stage, most employees are women.

31. Electrification attracted more private investment to the treatment village. In the Barura market, one saw mill, one rice mill, an ice-cream factory and several commercial shops were established, thus generating long-term employment opportunities. The owners are from outside the treatment village. This leads to a reduction in the use of family farm labor and an increase of wage labor in agriculture, providing employment for those with marginal or no land, who are usually the poor.

32. Rural electrification provided benefits to destitute women, too. Though the treatment and control villages have similar yield rates, women's work opportunities for post-harvest processing increased in the treatment village. The development of rural electrification increases women's labor force participation in poor households; for the landless, participation of women in economic activities increases from 10% to 20%.

6. Willingness to Pay

33. Willingness to pay refers to the amount that customers are potentially prepared to pay for electricity. It does not suggest that tariffs should be set as high as this willingness to pay. Rather, willingness to pay is a useful guide to the maximum levels which could be set. There are three different components of willingness to pay for domestic consumers. The first is the willingness to convert assets from savings to household connections. The initial cost for connection includes the cost of house wiring and light fixtures, the security deposit and a cost for connecting to the existing distribution lines if these are located more than 30 meters from the household. The second component is the willingness to purchase appliances which use electricity. Because of the price of these appliances relative to rural incomes, such purchases are generally made through an exchange of assets. The third component is the willingness-to-pay for monthly consumption of energy. This expense is generally paid out of current income. The available data is limited and it is only possible to examine some aspects of willingness to pay by the rural households.

34. Survey data for households indicate that the average cost of domestic connections was Tk1,500–Tk2,000 depending on the distance to the power line. In addition, there is a payment of Tk260 to the PBS as a membership fee and guarantee deposit. In addition, it requires around Tk1,000 for purchase of wiring materials, Tk300 for a technician to install the wiring and Tk100

[10] It is an indicator of income inequality reflecting the distribution of income throughout the population. It is measured with the help of Lorenz curve and the line of equality. If income is distributed equally across the population, the coefficient is equal to 0, that is, every one has the same income. Any deviation from equality means the ratio moves towards 1. If coefficient is closer to 1 means a few individuals predominantly hold the income. Gini coefficient 1 means perfectly unequal distribution, that is, one person has all income, and every one else earns nothing.

for other costs. The initial capital expenditure required to get a domestic connection is therefore about Tk3,000–Tk3,500. This is about one month's income for an average family member.

35. The most acute problem facing electricity consumers is the irregularity of power supply and load shedding. All customers said that power supply is irregular. Ninety percent said that supply interruptions are a daily occurrence. About 50% of the consumers expressed their willingness to pay more for electricity provided there are no power fluctuations and round-the-clock availability of electricity is ensured. On average, customers are willing to pay around 10% more if better service quality is guaranteed. Around 85% of the non-electrified households expressed their willingness to have electricity in their households.

36. The respondents who used electricity in the treatment village and potential consumers in the control village were asked about the reasons for their preference for electric lighting over kerosene lighting. The choices offered were quality, comfort, price and safety in order of preference. The first preferences were quality 65%, comfort 16%, price 5% and safety 12% in the treatment village. The corresponding figures in the control village were quality 74%, comfort 15%, price 3% and safety 8%. In both cases, price is the least significant factor. This strongly suggests a high willingness to pay for electric lighting since the overall benefits of electric lighting significantly exceed the actual electricity prices, which is only one of a number of factors influencing consumer choices.

D. Conclusions

37. Electrification contributes to economic and social development, particularly in rural areas, in several ways, including cost-saving, increasing productivity, expanding commercial and industrial activities, and creating employment opportunities and longer hours of work. Spill-over effect of electrification and its trickle-down benefit reduces poverty in the rural areas. But poverty issue is not fully addressed in the rural electrification program. Poor households still could not enjoy the benefit of domestic electricity consumption. Many of them are not aware of the benefit. More targeted policies and strategies should be designed and implemented to accelerate the process of poor people's access to electricity.

38. Many NGOs provide house-building financing loan for the poor. These NGOs can be encouraged similarly for initial electricity connection for the poorer.

39. As technology advances with the electricity, the Government and NGOs can provide need-based skill training to the rural youths for self-employment generation.

40. The local markets can be electrified with top priority and these markets should be made the center of all economic activities by providing incentives for establishing small and cottage industries and others to generate more income and employment, and thereby facilitate the process of minimizing forced rural-to-urban migration.

41. Rural electrification program should be given top priority among all types of infrastructure development, with poverty reduction as the centerpiece of such a program.

ESTIMATION OF THE LONG RUN MARGINAL COSTS OF ELECTRICITY GENERATION AND DISTRIBUTION

A. Methodology and Past Estimates

1. Long run marginal costs (LRMCs) of electricity generation and distribution were calculated in 1996 by a London Economics study. The results are set out in a report dated April 1997 and are heavily based on the Power Sector Master Plan, prepared in 1995, under TA 1962: Preparation of Power System Master Plan. The methodology used involves taking the base case system Master Plan and, using the same analytic model, evaluating the impact of a 5% increase in demand for each year of the projection period. This covers both the impact of increased demand on capital costs for new investment and the impact of those investments on operating costs. Based on this analysis, the extra costs associated with an extra kWh of demand are calculated. The calculations were undertaken at economic prices rather than financial prices. They were prepared in the United States (US) currency rather than local currency as the vast majority of plant and equipment for power generation has to be imported and international fuel prices are also set in US currency. The calculations are complex and time consuming to undertake, requiring detailed access to computer models and system plans. This appendix updates the calculations based on movements in the prices of key inputs in the period since 1995.

2. This approach is valid so long as the generation investment program recommended in the Master Plan remains broadly unchanged. The recommended program is for a mix of single cycle gas turbine investments for meeting peak demands and combined cycle plant for base load demand. Such a program continues to be likely to be the preferred approach to meeting Bangladesh's electricity needs so long as sufficient gas supplies are available. Moreover, the type of plant incorporated in the Master Plan does not change over time, which ensures that the LRMC will stay reasonably stable. The LRMC calculated by London Economics is presented in Table A5.1 below.

Table A5.1: Average Long Run Marginal Cost for Bangladesh Power Development Board and Dhaka Electric Supply Authority in US cents per kWh in 1996 Prices at 12% Discount Rate

Item	Generation	132 kV	33 kV	11 kV	440 V	Total
Generation	5.54					5.54
132 kV	5.71	0.50				6.21
33 kV	5.89	0.52	0.63			7.03
11 kV	6.07	0.53	0.65	1.06		8.30
440 V	6.36	0.56	0.68	1.11	0.91	9.61
Total	**6.36**	**0.56**	**0.68**	**1.11**	**0.91**	**9.61**

kV = kilovolt, kWH = kilowatt-hour, V = volt.
Source: London School of Economics, 1996.

3. These calculations were converted to local currency at the ruling exchange rate of US$1=Tk40 and used, along with other information, to devise tariff recommendations. The LRMCs rise at progressively lower voltage levels for two reasons. First, there are technical losses at each stage in the transmission and distribution processes, which means that, for example, more power has to be generated to supply a consumer at 440 V than at 33 kV. This is

reflected in the figures in each column. Second, consumers at lower voltage levels impose costs through the increased costs of providing the extra parts of the distribution system. This is reflected in the figures in each row. Generation costs are always the most important component of total cost and account for over two thirds of total cost at even the lowest voltage level.

4. Marginal costs are further analyzed between peak and off-peak cost levels. The peak period is between 5:00 PM and 11:00 PM in the evening. The results are as follows:

Table A5.2: Peak and Off-Peak Long Run Marginal Costs for Bangladesh Power Development Board and Dhaka Electric Supply Authority in US cents per kWh in 1996 prices at 12% discount rate

Item	Peak	Off-Peak	Average
		400 V Level	
Generation	9.73	5.88	6.36
Transmission	1.29	0.21	0.56
Distribution	6.22	1.00	2.69
		11 kV level	
	Peak	Off-peak	Average
Generation	9.12	5.65	6.07
Transmission	1.23	0.20	0.53
Distribution	3.94	0.63	1.71
		33 kV level	
	Peak	Off-peak	Average
Generation	8.76	5.50	5.89
Transmission	1.19	0.19	0.52
Distribution	1.45	0.23	0.63

kV = kilovolt, V = volt.
Source: London School of Economics, 1996

5. The peak and off-peak marginal cost figures for generation appear high compared with the average figures. This may be because they are calculated from the performance characteristics of individual plant rather than overall system performance.

6. The generation costs of US cents 5.54 per kWh are further broken down in the report between capacity and fixed operations and maintenance costs of US cents 2.75 per kWh, and fuel and variable operations and maintenance costs of US cents 2.79 per kWh. These components can in turn be compared with peak and off-peak figures as follows:

Table A5.3: Long Run Marginal Costs of Generation in US cents per kWh in 1996 Prices at 12% Discount Rate

	Peak	Off-Peak	Average
Capacity and fixed O&M	4.41	2.37	2.75
Fuel and Variable O&M	3.74	2.82	2.79
Total	**8.15**	**5.19**	**5.54**

O&M = operation and maintenance.
Source: London School of Economics, 1996.

B. Factors Affecting LRMC and Revised Estimates Using Updated Information

7. There are a number of factors that could significantly affect these marginal cost estimates. The most important factor would be any change which invalidated the system Master Plan. In practice, the Master Plan is still broadly valid and gas turbine and combined cycle plant are likely to dominate the investment in generation provided that gas supplies are available. Other factors which may have an influence are considered below together with an evaluation of their impact on marginal costs.

1. Demand forecasts

8. The Master Plan took FY1994 as its base year and projected growth in demand of 10% per annum for the period to 2000, falling to 8.9%, 8.1% and 7.9% in subsequent five year periods. Over the period FY1994 to FY2002, retail sales by the distribution companies (i.e., excluding sales to other distributors) rose by over 12% per annum and there is little sign of this growth slowing in the short term. Continuing supply interruptions show that demand is not being fully satisfied at present and many industrial consumers use captive power plants rather than relying on the utilities for supplies. The growth of demand from rural consumers is particularly rapid with the creation of new electricity supply cooperatives and the expansion of existing entities. Rural demand growth over the period FY1994 to FY2002 has been at a rate of over 22% per annum. In a system such as Bangladesh, the faster-than-expected growth in demand is likely to reduce marginal costs but very slightly as it means that new plant is fully utilized more quickly and larger plant, which is generally cheaper per unit of output, can be introduced in the system more rapidly.

2. System load factor

9. The system load factor assumed in the report was 60%. The latest system load factor is slightly over 60% but this reflects peak period load shedding and may therefore be expected to reduce in the future as system reliability improves. With the very rapid growth in domestic load associated with the rural electrification program, it may well reduce below 60%. But any decision by users of captive power plant to go over to supplies from the national grid would probably work in the opposite direction as industrial power demand usually has good load characteristics. The impact of any reduction below 60% would be to increase marginal costs at the system peak. However, given the way in which marginal costs at peak and off-peak are calculated for generation, the impact is likely to be very small at the generation level. There is also a potential small impact on peak transmission and distribution costs. But there is too little evidence to justify any change in the assumption of a 60% load factor.

3. The price of generation plant

10. The additional plant in the revised Master Plan based on the 5% increment to the demand forecast is exclusively 100 MW single cycle turbines and 300 MW combined cycle plants. These were priced in 1995 at $576 per KW for 100 MW gas turbines and US$844 per KW for 300 MW combined cycle plant. The present day price for such plant is about US$570 per kW for 100 MW gas turbines and US$860 per KW for 300 MW combined cycle plant. These prices have barely changed, reflecting the competitive international market for generation plant.

4. Fuel costs

11. Most of Bangladesh's electricity is generated from gas, both at present and in the planning period. This gas has been valued in both the Master Plan and the London Economics tariff study at a price of $2.28/Gigajour. The base crude oil price forecast in the Master Plan was

$17 per barrel for Brent crude. Since 1995, crude oil prices have fluctuated but they are currently approaching $30 per barrel. This is well above the $17 level assumed in the Master Plan and there is little likelihood of prices falling back to these levels. A planning assumption of $25.50 per barrel would be realistic in the current environment and this suggests a 50% increase in the energy price assumptions used in the LRMC calculation. An increase of 50% in economic fuel prices will lead to an increase of just under 50% in marginal fuel and variable operations and maintenance costs. This is a very significant increase.

5. Generation plant efficiency

12. Increases in generating plant efficiency impact on gas costs. New plant is likely to be 6-8% more energy efficient than equivalent plant in 1995. This leads to a reduction of 6-8% in unit fuel costs.

6. Technical losses

13. Technical losses from generation to low voltage distribution were assumed to be about 14% in the LRMC calculation. This figure was taken from the Master Plan and was based on data from the Republic of Korea. It is still a reasonable estimate for the Bangladesh system in the long term although short-term technical losses are clearly higher than this because of deficiencies in the distribution and transmission.

7. Non-technical losses

14. Non-technical losses are not allowed for in the long run marginal cost calculations. Hence the cost figures do not include any allowances for theft of power or non-payment of bills. This continues to be an appropriate approach.

8. Transmission and distribution equipment costs

15. The Master Plan estimated the costs of transmission at $170,000 per km for 132 kV single strand line, $230,000 per km for 230 kV single strand line, and $290,000 per km for 230 kV double strand line. Corresponding current cost figures are about $185,000 for 132 kV single strand, $245,000 for 230 kV single strand, and $300,000 for 230 kV double strand. All the figures show small increases, averaging about a 5% increase.

9. Exchange rates

16. The exchange rate between the US$ and the taka has moved from $1=Tk40 in the Master Plan and costing study to about $1=Tk58 today. This is a significant devaluation and more than offsets differences in inflation rates between Bangladesh and the US since 1996. Over the past seven years, inflation in Bangladesh has been over 30% and in the US about 20%. This in turn implies that the real exchange of the taka has been devalued over the period. This difference is likely to lead to a small reduction in the long run marginal cost when measured in US currency since the price of local inputs should have risen by less than the price of imported inputs. However, as generation equipment is largely imported and fuel is valued in the US currency, the impact will be quite limited. Moreover, certain inputs that were local inputs were shadow priced in the Master Plan study to allow for a foreign exchange premium and this premium will be reduced if the exchange rate is now closer to a market level.

17. The overall impact is, therefore, in approximate terms, an increase of 35% in fuel and variable operating and maintenance costs and of 5% in transmission and distribution costs. Reworking the figures in Tables A5.1, A5.2, and A5.3 with these revisions gives the following:

Table A5.4: Average Long Run Marginal Costs for Bangladesh Power Development Board and Dhaka Electric Supply Authority in US cents per kWh in 2003 prices at 12% Discount Rate

	Generation	132kV	33kV	11kV	440V	Total
Generation	6.52					6.52
132kV	6.72	0.53				7.24
33kV	6.93	0.55	0.66			8.14
11kV	7.14	0.56	0.68	1.11		9.49
440V	7.48	0.59	0.71	1.17	0.96	10.90
Total	**7.48**	**0.59**	**0.71**	**1.17**	**0.96**	**10.90**

kV = kilovolt, V = volt.
Source: Operations Evaluation Mission.

Table A5.5: Peak and Off-Peak Long Run Marginal Costs for Bangladesh Power Development Board and Dhaka Electric Supply Authority in US cents per kWh in 2003 prices at 12% Discount Rate

	400V level		
	Peak	**Off-Peak**	**Average**
Generation	11.29	7.00	7.48
Transmission	1.35	0.22	0.59
Distribution	6.53	1.05	2.82
	11 kV level		
	Peak	Off-peak	Average
Generation	10.58	6.72	7.14
Transmission	1.29	0.21	0.56
Distribution	4.14	0.66	1.80
	33 kV level		
	Peak	Off-peak	Average
Generation	10.17	6.55	6.93
Transmission	1.25	0.20	0.55
Distribution	1.52	0.24	0.66

kV = kilovolt, V = volt.
Source: Operations Evaluation Mission.

Table A5.6: Long Run Marginal Costs of Generation in US cents per kWh in 2003 Prices at 12% Discount Rate

Item	Peak	Off-Peak	Average
Capacity and fixed O&M	4.41	2.37	2.75
Fuel and Variable O&M	5.05	3.81	3.77
Total	**9.46**	**6.18**	**6.52**

O&M = operation and maintenance.
Source: Operations Evaluation Mission.

18. These figures are very high compared to the current levels of costs and tariffs in the Bangladesh power system. This reflects the high gas cost established by valuing gas at an oil price equivalent. In practice, the gas price is far lower. These costs could not be used as a basis for formulating tariffs on the Bangladesh system in the immediate future for two reasons. First, the tariff increases would be very large and hence there would be serious political and social obstacles to implementation. Second, it is far from certain that a long run marginal cost approach to electricity pricing could be justified while gas continues to be heavily subsidized. However, the figures do show that long run marginal cost considerations are clearly not an argument for putting off tariff increases.