PART V ENERGY COST AND TARIFF BALANCE

Chapter 19 Financial Performance of the Power Sector

19.1 Overview of the Electricity Tariff System in Bangladesh

The Electricity Act of Bangladesh was established in 1910, during the period when Bangladesh was under the British rule. In 1937, the Electricity Rules were established as a more detailed regulation. The Electricity Act was amended afterwards to reflect the changes of governing structure, first when Bangladesh gained independence as East Pakistan and second as it gained independence as Bangladesh, it has also been amended several times afterwards.
In 2003, the Bangladesh Energy Regulatory Act was established to take over a number of provisions from the Electricity Act, including tariff setting as well as license to power generators, transmitters and distributors (public & private).
In the next year 2004, in accordance with the stipulation of the Bangladesh Energy Regulatory Act, BERC (Bangladesh Energy Regulatory Commission) was founded as the organization responsible for Bangladesh's electricity and other energy tariff policies. Major electricity tariff policies published by BERC include "the Power Pricing Framework (2004)," "the Vision 2020 - Tariff guidance," and "the BERC Electricity Tariff Regulations (including bulk supply tariff, wheeling charge and retail tariff)."

Table 19-1 Major Tariff Policies

■ Power Pricing Framework (2004)
■ Vision 2020 - Tariff guidance
■ BERC Electricity Tariff Regulations:
Generation : BST - Bulk Supply Tariff
Transmission : Wheeling Charge
Distribution : Retail Distribution Tariff

Source: South Asia Regional Initiative for Energy Integration (SARI/EI)

Principles and methodologies for tariff fixation are set in BERC's Tariff Regulations. Principles are fixed, but may be adjusted if necessary to a certain extent. In case of dispute, the Bangladesh Energy Regulatory Commission will come up with a resolution.
BERC's interaction with the government is defined in Article 22(i) of BERC Act as its ability to extend co-operation and advice to the Government, if necessary, regarding electricity generation, transmission, marketing, supply distribution and storage of energy.
Some highlights of the "Power Pricing Framework (2004)" and "the Vision 2020" are as follows. According to the Power Pricing Framework, while the average end-user electricity tariff for each customer class is set to fully cover reasonable costs of supplying electricity, subsidy from the Government is also defined. It further defines that rates are established each for cases of peak and off-peak, fixed cost (capacity cost) and variable cost.
The Vision 2020 emphasizes the necessity of electricity tariff that reflects the cost of electricity supply, the importance of efficiency, economical use of resources, good performance and optimum investment and the need to safeguard the interests of the consumers. The Vision also states that generation, transmission, distribution and supply are conducted on commercial principles. Differential tariff will be set related to time of the day to facilitate efficient demand side management.

Table 19-2 Tariff Policies

Act/ Policy	Highlights
Power Pricing Framework, 2004	・ The electricity tariff to cover costs of supplying electricity. ・ Government subsidy ・ Differentiated rates for certain cases : Peak and off-peak Fixed cost (capacity cost) and variable cost
Vision 2020	・ Electrcity tariff that reflects the cost of supply ・ Efficiency, economical use of the resources, good performance and optimum investment are important ・ Interests of the consumers ・ Generation, transmission, distribution and supply on commercial principles ・ Time-related tariff to facilitate efficient demand side management

Source: South Asia Regional Initiative for Energy Integration (SARI/EI)

Current electricity tariff table, which was set by BERC in 2015, is as follows. Different tariff rates are set for each type of customers.

Table 19-3 Electricity Retail Tariff Structures in Bangladesh (as of 2015)

	Consumer Category	Energy Charge (BDT/kWh)	Service Charge (BDT/month)	Demand Charge (BDT/kW/month)
1	**Category A: Residential**		1-Phase: 10.00 3-Phase: 30.00	15
	Life Line: 1-50 Units	3.33		
	a First Step: From 00 to 75 units	3.80		
	b Second Step: From 76 to 200 units	5.14		
	c Third Step: From 201 to 300 units	5.36		
	d Fourth Step: From 301 to 400 units	5.63		
	e Fifth Step: From 401 to 600 units	8.70		
	f Sixth Step: From 601 to above	9.98		
2	**Category B: Agricultural pumping**	3.82	30	40 (Applicable for approved demand more than 30 kWh)
3	**Category C: Small Industries**		70	40 (Applicable for approved demand more than 30 kWh)
	a Flat Rate	7.66		
	b Off-Peak Time	6.90		
	c Peak Time	9.24		
4	**Category D: Non-Residential (Light & Power)**	5.22	1-Phase: 10.00 3-Phase: 30.00	20
5	**Category E: Commercial & Office**		1-Phase: 10.00 3-Phase: 30.00	25
	a Flat Rate	9.80		
	b Off-Peak Time	8.45		
	c Peak Time	11.98		
6	**Category F: Medium Voltage, General Purpose (11 KV)**		400	45 (For Maximum Demand)
	a Flat Rate	7.57		
	b Off-Peak Time	6.88		
	c Peak Time	9.57		
7	**Category G-2: Extra High Voltage, General Purpose (132 KV)**		500	40 (For Maximum Demand)
	a Flat Rate	7.35		
	b Off-Peak Time	6.74		
	c Peak Time	9.47		
8	**Category H: High Voltage, General Purpose (33 KV)**		450	40 (For Maximum Demand)
	a Flat Rate	7.49		
	b Off-Peak Time	6.82		
	c Peak Time	9.52		
9	**Category J: Street Light and Water Pumps**	7.17	1-Phase: 10.00 3-Phase: 30.00	20

Source: Bangladesh Energy Regulatory Commission (BERC)

Note: "Non-residential category" includes public services such as street lighting and non-residential use such as water pumps.

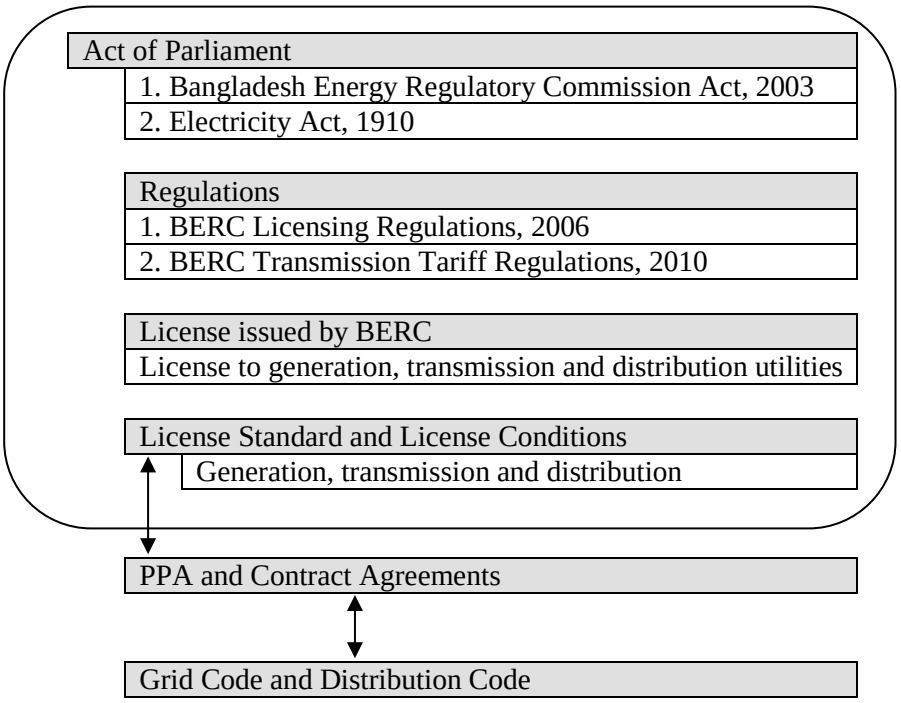
In addition, the BERC Act 2003 determines the electricity tariff issues, dispute resolutions and relationship with the government as follows:

Table 19-4 Tariff Policies

Act/ Policy	Highlights
BERC Act 2003 Tariff Issues	Article 22 : (b) to ensure efficient use, quality services, determine tariff and safety enhancement of electricity generation and transmission, marketing, supply, storage and distribution of energy; BERC Electricity Tariff Regulations
BERC Act 2003 Dispute Resolutions	Article 22 : (j) to resolve disputes between the licensees, and between licensees and consumers, and refer those to arbitration if considered necessary *licensees are utilities that have acquired their licenses. (k) to ensure appropriate remedy for consumer disputes, dishonest business practices or monopoly
BERC Act 2003 Relationship with Government	Article 34 : BERC determines tariff in accordance with government Policies. BERC consults with Government in preparing the Tariff methodologies only.

Source: South Asia Regional Initiative for Energy Integration (SARI/EI)

According to the Electricity Act and BERC Act, the upper level regulations, BERC publishes regulations including the BERC Licensing Regulations (2006) and the BERC Transmission Tariff Regulations (2010).



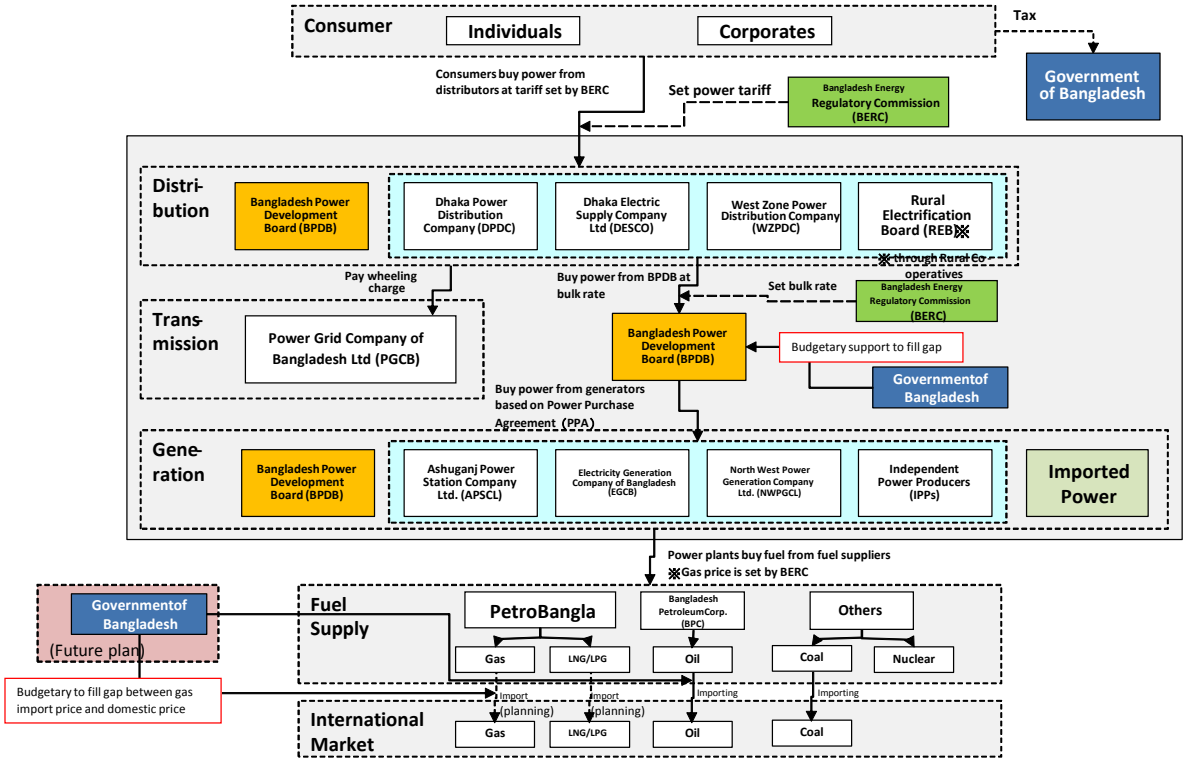
Source: South Asia Regional Initiative for Energy Integration (SARI/EI)

Figure 19-1 Hierarchy of Governance for Transmission

19.2 Overview of Funding Related to the Power Sector

Main relevant institutions of the power sector are identified and their cash flows among these institutions are investigated. In this section, the operation phase and the capital investment phase are investigated separately (see Figure 19-2 and Figure 19-3).

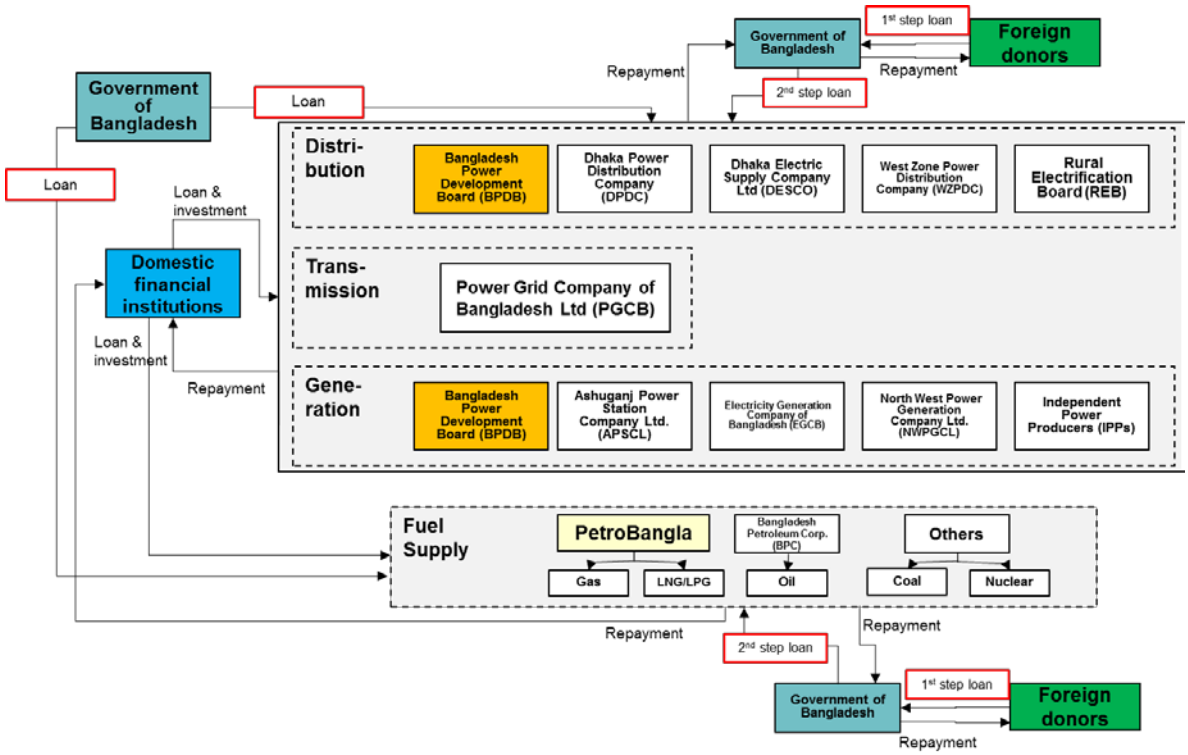
In the operation phase, the cash inflow from consumers, i.e. both individuals and corporates, to distributing entities (BPDB, DPDC, DESCO, WZPDC and REB) based on the power tariff set by BERC. These distributing entities buy power from BPDB at bulk rate which is also determined by BERC. The distribution entities pay wheeling charge to PGCB, the only entity responsible for power transmission in Bangladesh. In addition to transmission charge, BPDB as the single power buyer also purchases power from generation entities based on individual Power Purchase Agreement (PPA) between BPDB and each power generating entity. These generation entities purchase fuel (gas, oil, coal, etc.), which are required for power generation, from primary energy suppliers. In cases where the fuel needs to be procured from abroad, these primary energy suppliers purchase fuel from oversea markets.



Source: JICA Survey Team

Figure 19-2 Cash Flow of Bangladesh Power Sector for Operation Phase

In the capital investment phase, businesses in the power sector (including power generation, transmission and distribution) borrow from the government of Bangladesh (GOB) as well as financial institutions (including international donors, i.e. World Bank, Asia Development Bank, JICA, and local commercial banks). In case of international donors, loan is injected into projects in a 2-step manner. At step 1, the GOB signs a loan agreement and borrows from international donors using concessional loan from these donors. In step 2, the GOB provides loans in BDT to businesses with their own conditions. Details of these loan conditions are given in the following section.



Source: JICA Survey Team

Figure 19-3 Cash Flow of Bangladesh Power Sector for Capital Investment

19.2.1 Donors' assistance programs for the Bangladeshi power sector

Business entities in the power sector raise funds for capital investments from various sources of finance, notably the government of Bangladesh and commercial banks, as well as international donors such as World Bank (WB), Asia Development Bank (ADB), JICA, etc., also considering their financial situation. Loan condition of those sources is summarized below based on interviews and review of public documents.

(1) Overview

International development aid agencies that are main partners in the energy sector in Bangladesh are Asian Development Bank (ADB), Islamic Development Bank, and World Bank. There are also major bilateral aid partners including Japan, Germany, Kuwait, Norway, etc. The areas of support include power generation, transmission and distribution upgrading, energy sector reforms, assistance to the regulatory commission, rural electrification, power plant upgrading and capacity addition, capacity building, and planning.
Major financing projects by development partners are listed in the table below.

Table 19-5 Recent Major Financing Projects by Development Partners in the Bangladeshi Power Sector

Development Partners	Project Name	Duration	Amount (million BDT)
Abudabi, Kuwait Fund, OPEC, Saudi Arabia,	Construction of Shikalbaha 225 MW Duel-Fuel Combined Cycle Power Plant	2012-2016	13,754
ADB	Installation of a 5 MW Solar Photo Voltaic Grid Connected Power Plant in Kaptai	2012-2016	1,573
ADB	Installation of an Off Grid Wind Solar Hybrid System with HFO/Diesel Based Engine Steven Generator in Hatia Island	2012-2014	947
ADB	Upgradation of Khulna 150 MW Peaking Power Plant to 225 MW Combined Cycle Power Plant	2012-2016	7,866
ADB	132 KV Grid Network Development Project in Eastern Region	2013-2016	6,932
ADB	Solar Street Lighting Program in City Corporation	2012-2015	2,366
ADB	Construction & Expansion of Distribution network of North & South Zone under DPDC	2013-2016	3,431
ADB	Running Project: Construction of 132/33/11KV Grid S/S in DESCO Area	2013-2017	5,435
ADB	Augmentation & Rehabilitation of Distribution System in DESCO Area	2013-2017	11,064
ADB, IDB	Construction of Ashuganj 450 MW Combined Cycle Power Plant (North)	2011-2015	299,960
ADB, IDB	400/230/132 KV Grid Network Development	2014-2017	23,382
ADB, KfW,	Development of New 132/33 KV and 33/11 KV Sub-Station under DESA Project	2006-2015	3,710
AFD, ADB	Construction of new 132/33 KV & 33/11 KV S/S under DPDC	2013-2017	12,937
EA	Chapainawabganj 100MW HFO Based Power Plant	2013-2015	8,924
ECA	Shahjibazar 330MW Combined Cycle Power Plant	2013-2015	19,458
ECA	Construction of Bibiyana-3, 400MW CC Power plant	2013-2016	23,614
ECA	Extension of Barapukuria Coal Fire Thermal Power Station by 275MW (3rd Unit)	2013-2017	18,356
ECA	Construction of Ghorasal 365MW CC Power Plant	2013-2017	16,532
ECA	New Project: Ghorasal-3 Repairing Project	2015-2017	19,869
EIB	Conversion of Shahjibazar 2*35 MW Power Plant to 105 MW Combined Cycle Power Plant	2013-2016	3,071
EIB	Conversion of Baghabari 100 MW to 150 MW Combined Cycle Power Plant	2013-2015	4,342
IDA	Construction of Siddhirganj 335 MW Peaking Combined Cycle Power Plant	2009-2015	18,223
IDA	Upgradation of Rural Electricity Distribution System (Dhaka, Chittagong & Syslet Division)	2014-2018	37,050

Development Partners	Project Name	Duration	Amount (million BDT)
IDB	Bhola 225 MW Duel Fuel Combined Cycle Power Plant	2011-2015	14,058
IDB	Conversion of 150 MW Sylhet Gas Turbine Power Plant to 225 MW Combined Cycle Power Plant	2014-2017	6,570
IDB	Rural Electrification Expansion Barisal Division Programme-1	2010-2016	1,560
JICA	Bheramara Combined Cycle Plant Development (360 MW)	2010-2017	32,211
JICA	National Power Transmission Network Development Project	2013-2017	17,675
JICA	Bangladesh Central Zone Power Distribution Project	2009-2015	10,083
JICA	Rural Electrification Upgradation Project (Rajshahi, Rangpur, Khulna and Barisal Divisions)	2013-2016	10,543
JICA	Running Project: Matarbari 2*600MW Ultra Super Critical Coal Fired Power Project	2014-2023	289,390
KfW	Pre-Payment Metering for Distribution Comilla & Mymensingh	2013-2015	10,083
KfW	Pre-payment Metering Project for Six NOCS Division under DPDC	2013-2015	910
Kuwait Fund,	Greater Chittagong Power Distribution Project, Scada Rehabilitation	2009-2015	859
NDF, ADB, NORDIC,	Development of 10 Town Power Distribution	2003-2015	2,690
UDCF	Bibiyana-Kaliakoir 400 KV & Fenchuganj-Bibiyana 230KV Transmission Line	2010-2017	7,400
WB	Enhancement of Capacity of grid Substation & Transmission Line for Rural Electrification	2014-2017	9,123

ADB = Asian Development Bank, ECA= export credit agency , EDCF = Economic Development Cooperation Fund, EIB= European Investment Bank, IDA =International Development Association, IDB=Inter-American Development Bank, KfW = Kreditanstalt fur Wiederaufbau, JBIC = Japan Bank of International Cooperation, JICA = Japan International Cooperation Agency, NDF = Nordic Development Fund, NORAD = Norwegian Agency for Development Cooperation

Source: Planning Commission "ANNUAL DEVELOPMENT PROGRAMME FOR 2013-2014", "2014-2015", "2015-2016")

The World Bank has been involved in the development of the power sector in Bangladesh for a long time. Since 1989, the World Bank has provided about 1.1 billion USD to support project costs and totaling 4.4 billion USD for power sector development ("Project Performance Assessment Report", World Bank 2014). In particular, approximately 50 million USD of loan was provided from FY2000 to FY2013 to the power sectorprojects.

ADB, during 1993-2015, provided loan, grant, and technical support for 99 projects of total 4,170 million USD to enegy sector. This accounts for 22.9% of total provided loan, grant, and technical support from ADB to Bangladesh ("Asian Development Ban Member Fact Sheet (Data are as of 31 December 2015)", ADB 2016)

(2) Loan conditions

Notable donors which participate in the power sector of Bangladesh are WB, ADB and JICA. They provide businesses in the country's power sector loans with very different conditions as shown in Table 19-6.

Regarding JICA loan, as Bangladesh has become a lower-middle income category country, JICA can provide ODA loan to Bangladesh (inter-governmental loan) at annual interest rate and interest rate

during construction of 1.4%, repayment period of 30 years and grace period of 10 years.
Regarding WB loan, although the loan condition varies from project to project, it is assumed in this estimation that interest rate is 5% p.a., repayment period is 15-year with a 5-year grace period.
As for ADB loan, the project owner can borrow 100% of the project cost under a 2% p.a. interest rate, 25-year repayment period with a 5-year grace period.

Table 19-6 Loan Conditions of WB, ADB and JICA Loans

Loan condition	WB*)	ADB**)	JICA
Annual interest rate	0.75%	2%	0.7%
Interest rate during construction	0.75%	2%	0.7%
Repayment period	38 yrs	25 years	30 years
Grace period	6 yrs	5 years	10 years

*) Loan condition in the case of International Development Association
**) Loan condition in the case of Asian Development Fund

Source: Interviews and public documents ("Terms and Conditions of Japanese ODA Loans (Effective from October 1, 2014)" for JICA loan, " Asian Development Fund: FAQs (http://www.adb.org/site/adf/faqs)" for ADB loan and "IDA Terms (Effective as of July 27, 2016)" for WB loan)

Regarding the funding scheme, it should be noted that funding international donors are injected to project owners in a 2-step manner. As a results, there exists 2 levels of principal and interest payment, which is principal and interest payment by the government of Bangladesh to donors (step 1), and that of project owners to GOB.
The annual interest rates of loan provided by multi-lateral and bi-lateral financial entities at step 2 during the construction and the operation are assumed to be the same with that of GOB loan.

19.2.2 Financial support from the government of Bangladesh

The government of Bangladesh provides loan to support the capital expenditure of state-owned enterprises and according to "Lending and relending terms of local/Foreign currency loans" published by the Ministry of Finance, loan conditions are stipulated to each enterprise.
In the case of BPDB, BPDB is mandated to maintain its capital structure at "debt 40%: equity 60%". In the actual application, its mandate is modified to "debt 60%: equity 40%", considering the recent trend of BPDB's balance sheet (see Figure 19-14), in which government's financial support (subsidies) is injected to BPDB every year so that the ratio of the sum of capital reserve and government subsidies to the total asset is maintained around 40%.
Annual interest rate for the government loan to BPDB is basically 3%, but if financing from international donor agencies to principal capital exists, it could be 3-5% depending on a ratio of the financing. The loan currency is Bangladeshi Taka. Pay-back grace period is 5 years. A pay-back period is 15 years after the pay-back grace period. It is necessary to pay interests during the pay-back grace period.

Table 19-7 Loan Conditions of Government of Bangladesh (Case of loan to BPDB)

Debt : equity ratio	40%:60% *
Annual interest rate	3%
Interest rate during construction	3%
Repayment period	20 years
Grace period	5 years

Source: Ministry of Finance "Lending and relending terms of local/Foreign currency loans", Interviews with BPDB.

Note: in actual application, government subsidies are provided to BPDB so that its capital structure maintains "debt 60%: equity 40%" ratio.

19.2.3 Loan conditions of commercial banks to the power sector

Loan conditions of commercial banks to the power sector are as follows. Annual interest rate and interest rate during construction are both 13%. Repayment period is 15 years without grace period.

Table 19-8 Loan Conditions of Commercial Banks

Annual interest rate	13%
Interest rate during construction	13%
Repayment period	15 years

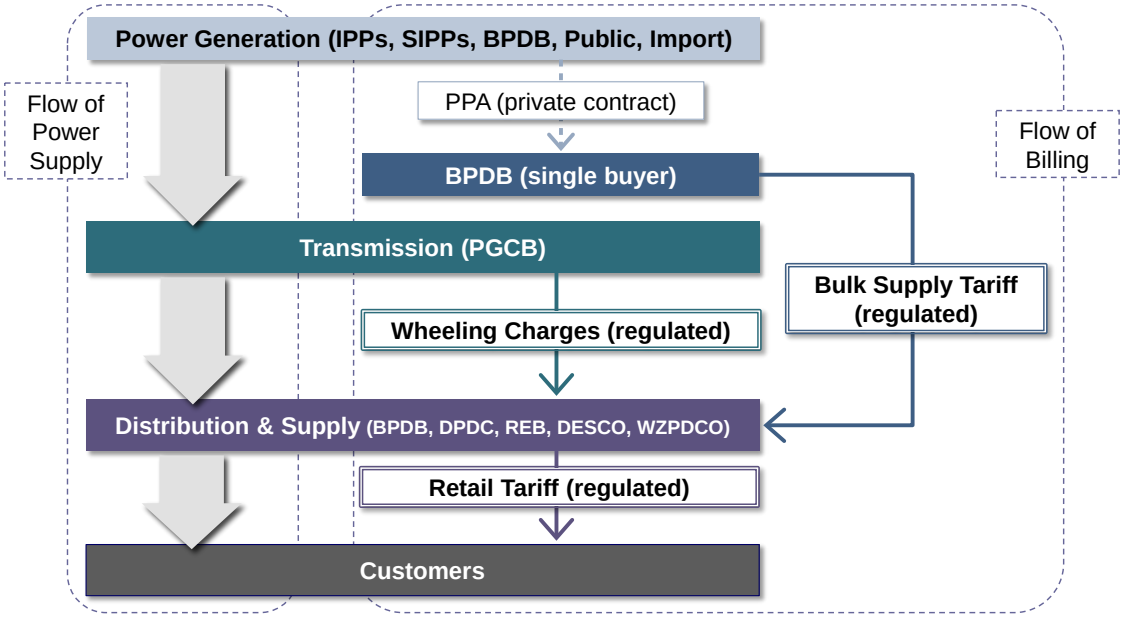
Source: Interviews with BPDB

19.3 Financial Performance of Main Players in the Power Sector

Different business entities exist in power generation, transmission, and distribution sectors in Bangladesh power sector; there is an interaction of electricity and billing between each sector. In order to grasp the overview as to what extent the current retail electricity tariff posed on end consumers can cover for the necessary cost for the operation of the power sector, the overall balances of the power sector and the financial situation of the each utility was analyzed.

19.3.1 Financial performance of the overall power sector

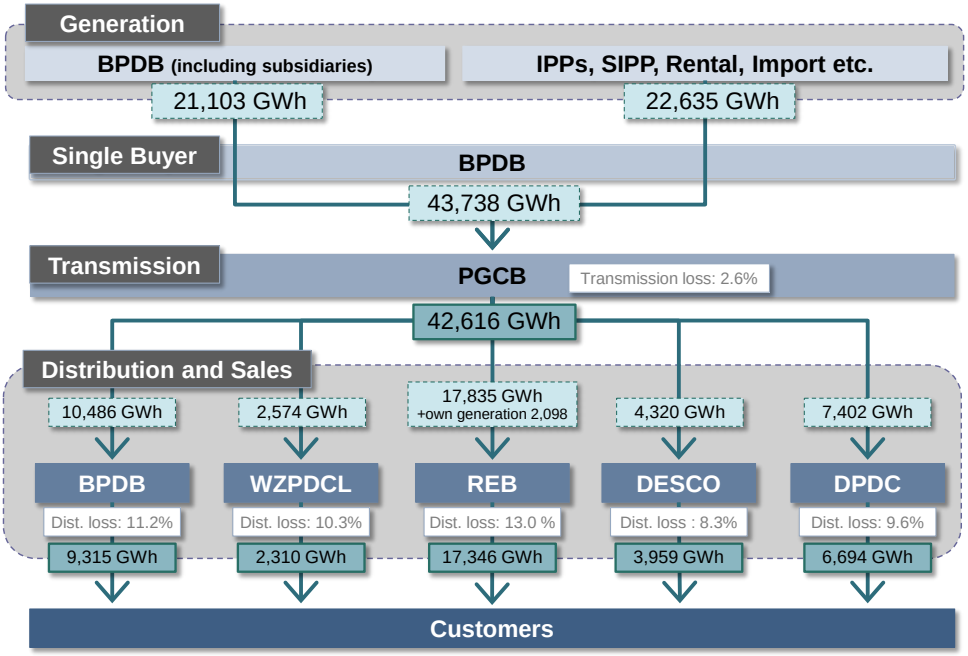
The flow of power supply and flow of billing in Bangladesh power sector are illustrated in Figure 19-4. The flow of power supply starts from each generation utility, which is then transmitted using the transmission grid of the transmission operator (PGCB) and the distribution grid of the distribution operator, finally reaching the customers.
On the other hand, the flow of billing is slightly different. Power generated in IPPs, SIPPs, BPDB plants, public plants, and imported power are all bought by BPDB, the single buyer in Bangladesh power sector, based on the PPA (power purchase agreement) with each generation entity and BPDB. The purchased power, which is purchased by distribution entities at the regulated bulk supply tariff, is transmitted by PGCB to the distribution entities. The distribution entities pay PGCB the wheeling charge for power transmission. Finally, power is supplied to the customers by distribution entities at a regulated retail tariff.



Source: JICA Survey Team

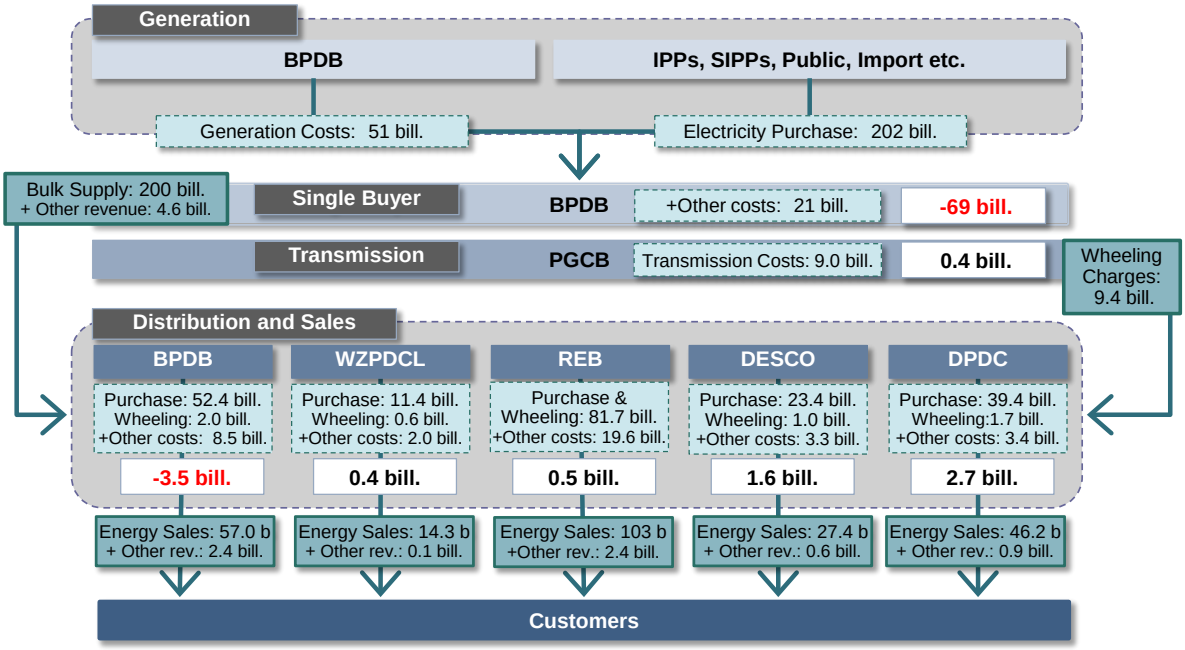
Figure 19-4 Flow of Power Supply and Flow of Billing

Figure 19-5 and Figure 19-6 describe the flow of power supply and billing between the main stakeholders of the Bangladesh power sector in 2015.



Source: JICA Survey Team

Figure 19-5 Overview of Power Supply Flow (2015 Snapshot)



Source: JICA Survey Team

Figure 19-6 Overview of Financial Situation (2015 Snapshot)

As stated above, there are various generation entities other than BPDB, including IPP, SIPP, and public plants. All of the generated electricity is purchased by the generation division of BPDB as the single buyer. The power is then wholesaled to distribution utilities such as WZPDCL, REB, DESCO and DPDC, as well as to its own distribution division.

In FY2014-2015, BPDB purchased total electricity worth 202 billion BDT from IPP, SIPP, public plants, rental plants, and India (power import); other than this electricity purchase cost, 51 billion BDT was incurred for generation at BPDB's own plants, and 21 billion BDT was incurred for other expenses including general administration cost. On the other hand, BPDB sells the purchased and generated electricity to the distribution entities for 200 billion BDT. Its revenue is far below its generation cost, resulting in a loss of approximately 70 billion BDT.

The transmission operator, PGCB, covers its transmission cost by collecting wheeling charges from the distribution entities. It had a slightly positive margin in FY2015, but its profitability is low.

Each distribution entity supplies electricity to the customers. In FY2014-2015, distribution entities sold approximately 248 billion BDT worth of electricity to the customers. Taking a look at the balance of the distribution sector after offsetting its payment of wholesale electricity and wheeling charges and its own cost of distribution, while all distribution entities but BPDB have a positive margin in FY2014-2015, BPDB's distribution division records a negative margin of approximately 3.5 billion BDT. In other words, both the generation and the distribution divisions of BPDB are in a financial deficit, resulting in a total of 72.8 billion BDT as entire BPDB.

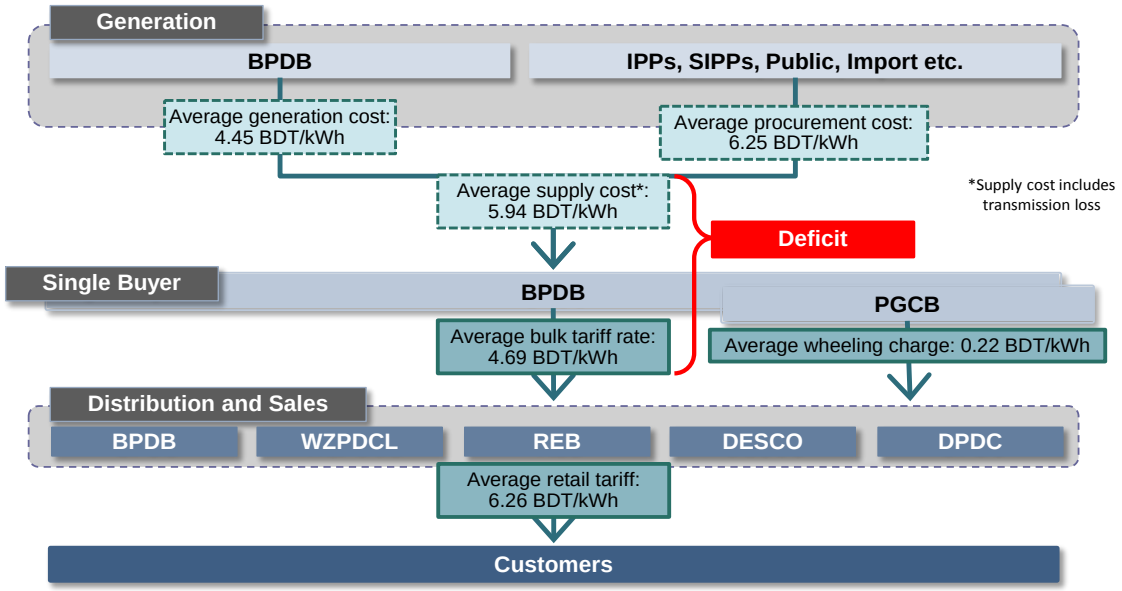
From the aforementioned analysis, it can be concluded that the financial deficit in the power sector can be accredited to the differences in cost of electricity procurement paid by BPDB to the generation entities and bulk supply tariff. Table 19-9 and Figure 19-7 compare the electricity purchase cost per electricity supply and wholesale electricity cost per electricity supply. In FY2014-2015, BPDB procures electricity from the generation entities and its own generation plants at an average price of 5.94 BDT/kWh (after applying general administration cost) and sells to the distribution entities at an average bulk supply tariff of 4.69 BDT/kWh.

Distribution entities sold electricity to the customers at an average of 6.26 BDT/kWh in FY2014-2015. Although there is no deficit between the retail electricity tariff and the bulk supply tariff, the final balance of distribution entities are either a small positive margin or a negative margin.

Table 19-9 Generation Cost, Supply Cost, and Bulk Supply Tariff

Particulars	Unit	FY2013-14	FY2014-15
a) Procurement cost (without general administration cost)	BDT/kWh	5.81	5.78
b) Procurement cost (including general administration cost)	BDT/kWh	5.96	5.94
c) Bulk supply tariff	BDT/kWh	4.71	4.69
c)-b) Difference between bulk supply tariff and procurement cost	BDT/kWh	-1.25	-1.25

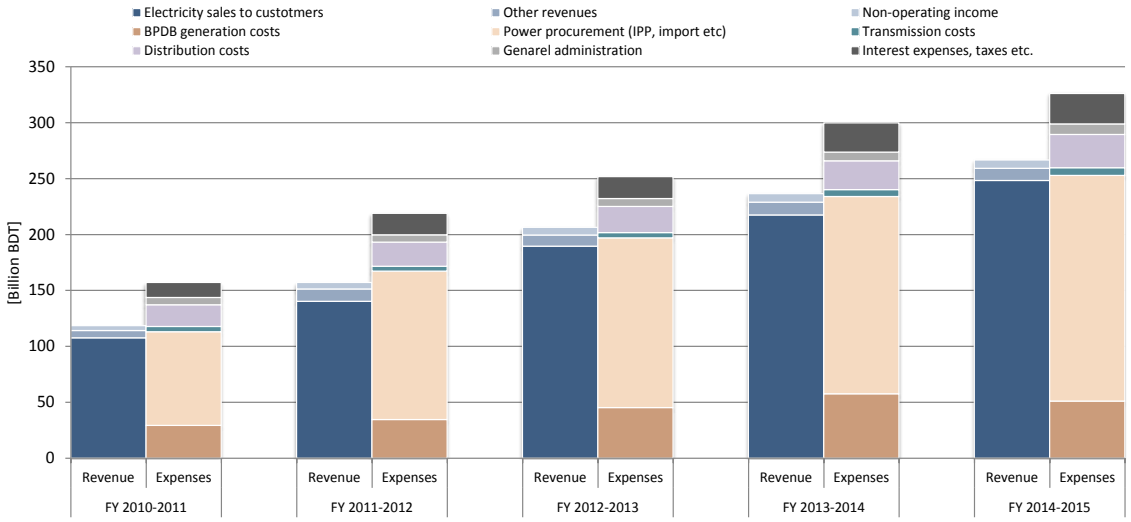
Source: BPDB, PGCB, WZPDCL, DESCO, and DPDC Annual Reports



Source: JICA Survey Team

Figure 19-7 Supply Cost, Bulk Supply Tariff, and Retail Tariff of Electricity (FY2014-2015)

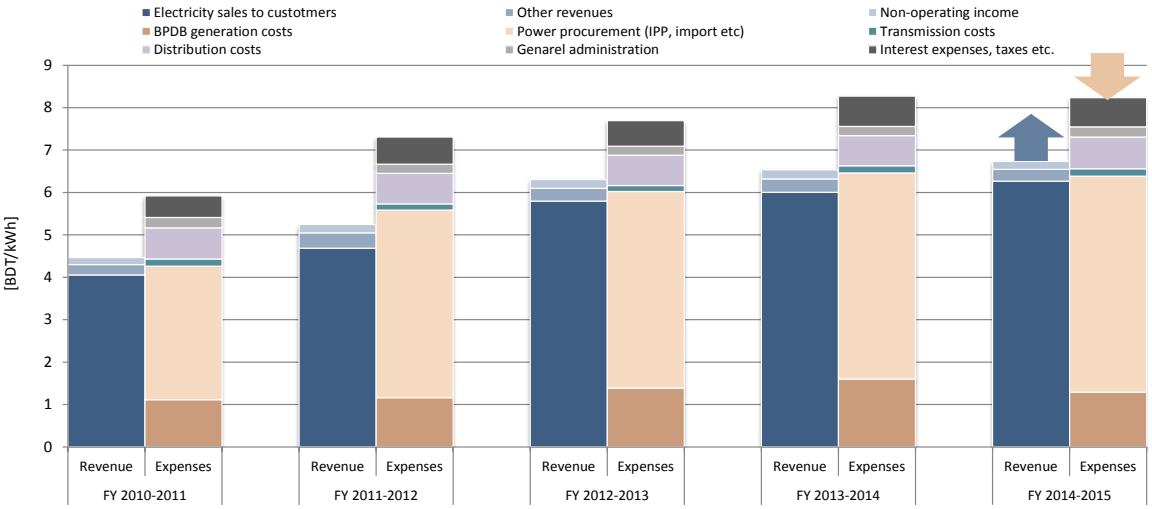
In order to determine to what extent the retail electricity tariff is able to cover for the electricity supply cost of the whole power sector, this study analyzed the financial situation of the virtual "vertically integrated utility," which is the consolidated balance of the BPDB, PGCB and distribution entities. In other words, the analysis of the "vertically integrated utility" integrates the P/L statement of these utilities, by offsetting the revenue and expenses incurred from transaction between each utility. The estimated result of the consolidated balances is summarized in Figure 19-8. The left bar of each year shows the revenue (mainly consisting of electricity retail revenue) and the right bar shows the expenses. The figure shows that the revenue of retail electricity from the customers does not cover the costs of generation (sum of costs from BPDB's own generation plants and electricity purchase cost).



Source: BPDB, PGCB, and distribution utilities annual report

Figure 19-8 Consolidated Balances of the Bangladesh Power Sector (billion BDT)

Figure 19-9 shows the consolidated revenue and expenses of each utility of the power sector per electricity sales to customers (BDT/kWh). While electricity tariff revenue rate has increased annually, cost per kWh has increased as well; therefore, the revenue has not been able to cover the costs. However, cost per kWh slightly decreased between FY2013-2014 and FY2014-2015 while the revenue per unit increased; hence there was a little improvement during the period though the balance is still a huge negative.



Source: BPDB, PGCB, and distribution utilities annual report

Figure 19-9 Consolidated Balances of the Bangladesh Power Sector per Electricity Sales (BDT/kWh)

As stated above, in order to maintain the financial soundness of the power sector, appropriate measures need to be taken, including the raise of electricity tariff and reduction of the supply cost, especially the cost of electricity purchase which accounts for more than half of the total supply cost. Such analysis on the supply cost is conducted in the next chapter.
In this chapter, the financial situation of each power utility is analyzed more in details.

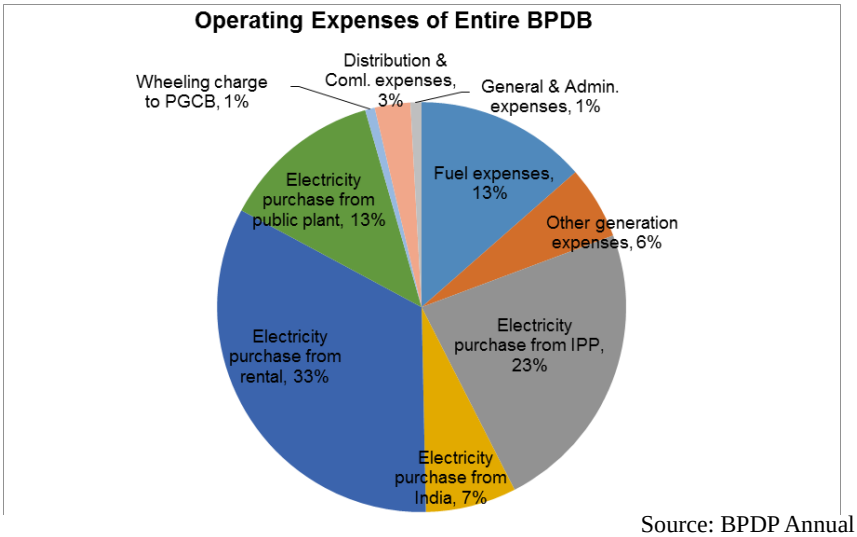
19.3.2 Financial performance of BPDB

Table 19-10 and Figure 19-10 show the entire balances of BPDB, including its generation division and distribution division. As already stated, both BPDB's generation and distribution divisions are in a financial deficit, especially in generation division which includes the cost of electricity purchase. Of the operating expenses incurred in FY2014-2015, electricity purchase accounts for approximately 75%; payment to rental plants, particularly holds approximately one third of the total electricity purchase cost.

Table 19-10 Balances of the Entire BPDB (million BDT)

Head of accounts	FY2013-14	FY2014-15
1. Operating Revenue	**194,288**	**211,876**
Energy Sales (Bulk)	186,371	204,921
Other operating income	7,917	6,955
2. Operating Expenses	**244,789**	**264,624**
Fuel expenses	41,927	35,869
Other generation expenses	15,824	15,248
Electricity purchase from IPP	44,634	61,313
Electricity purchase from India	11,457	19,003
Electricity purchase from rental	97,503	87,748
Electricity purchase from public plant	22,724	33,656
Wheeling charge to PGCB	1,849	2,018
Distribution & Coml. Expenses	6,970	7,451
General & Admin. Expenses	1,901	2,318
3. Operating profit/loss	**-50,501**	**-52,748**
4. Other expenses (including exchange fluctuations)	17,591	20,082
5. Net income/loss for the year	**-68,092**	**-72,830**

Source: BPDB Annual Report 2014-2015



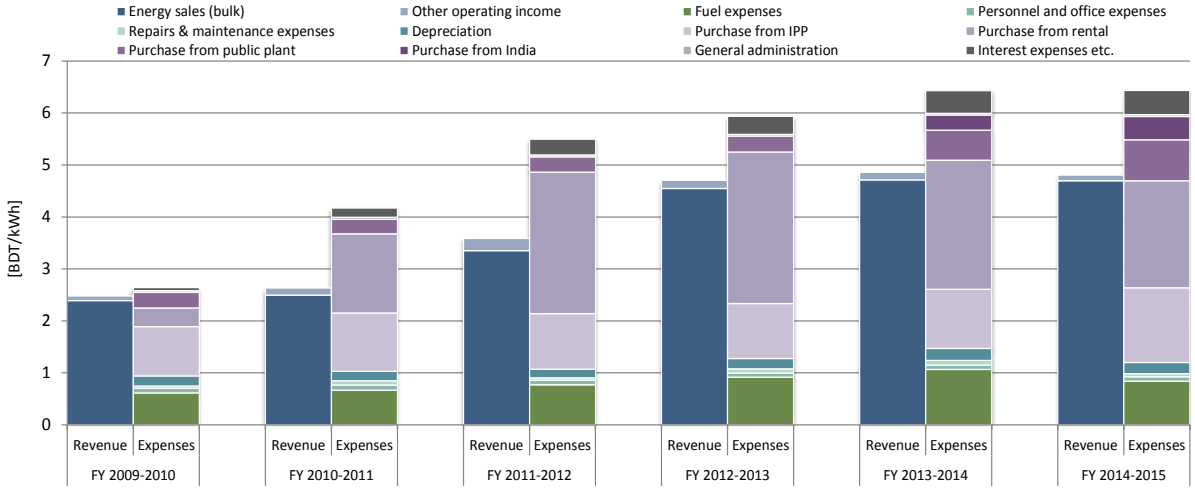
Source: BPDP Annual Report 2014-2015

Figure 19-10 Operating Expenses of the Entire BPDB

The financial performance of BPDB's generation division and distribution division are each investigated below.

(1) Balances of the Generation Division

Figure 9-11 illustrates the revenue and expenses of BPDB generation division per electricity supply. Balances of BPDB's generation division greatly worsened in FY2010-2011, and thereafter its revenue from bulk supply has been far less than its cost. When analyzing by each item, it can be seen that increase in its electricity purchase cost is far larger than the increase in its own generation cost. In other words, BPDB has expanded its portion of electricity purchase, instead of increasing its own generation plant, to meet the increased electricity demand. However, such measures have increased the overall cost of the generation division, leading to the enlarged gap between the bulk supply tariff revenue and its costs.



Source: JICA Survey Team

Figure 19-11 Revenues and Expenses of BPDB Generation Division per Electricity Sales (BDT/kWh)

(2) Power Distribution Division

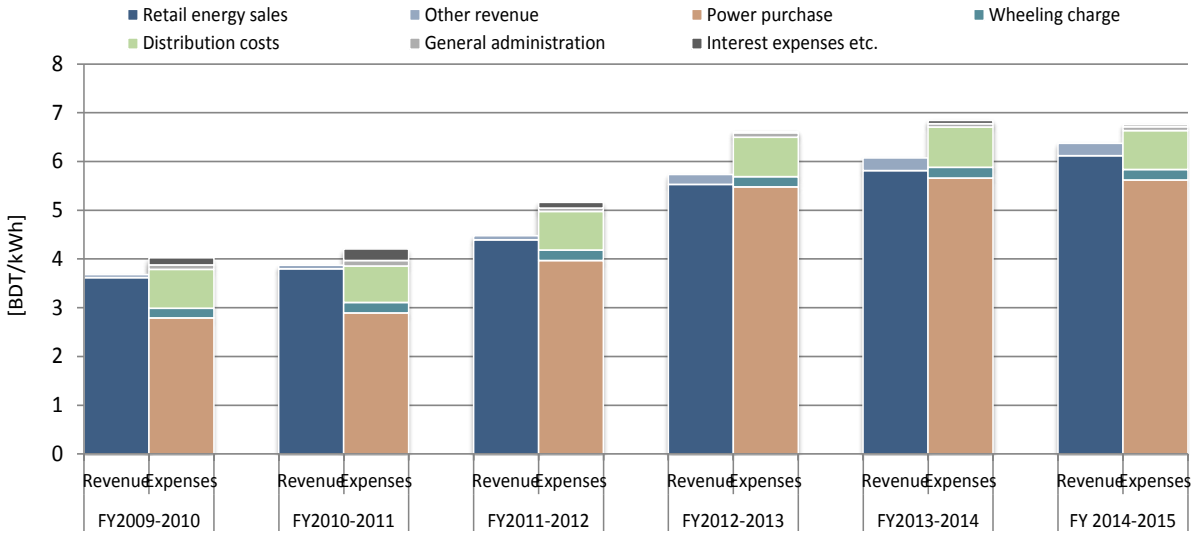
Figure 19-12 illustrates the revenue and expenses of BPDB's distribution division. As stated above, revenue from electricity retail sales is not sufficient to cover the full costs of supply, including its own distribution expenses and wheeling charge; therefore, as with the case of the generation division, BPDB's distribution division has continuously been in a financial deficit.

Considering that other distribution entities, which are analyzed later in the section, have mostly been balancing their revenue and expenses (although their balances do not have much leeway), and that bulk supply tariff is set differently among the distribution entities, BPDB could be setting a higher level of bulk supply tariff for itself (the distribution division) to mitigate the financial deficit of the generation division. The average power procurement cost, bulk supply tariff, and the average retail tariff of BPDB's distribution division are described in Table 19-11.

Table 19-11 Overall Balances of BPDB (Distribution)

Particulars	Unit	FY2012-13	FY2013-14	FY2014-15
Wholesale electricity purchase cost	mil. BDT	42,161	47,896	52,365
Wholesale electricity purchase (before distribution loss)	GWh	8,737	9,597	10,486
Average bulk supply tariff	BDT/kWh	4.83	4.99	4.99
Retail electricity sales	mil. BDT	42,562	49,163	57,024
Retail electricity	GWh	7693	8456	9315
Average retail tariff	BDT/kWh	5.53	5.81	6.12

Source: BPDB Annual Report



Source: BPDB Annual Report

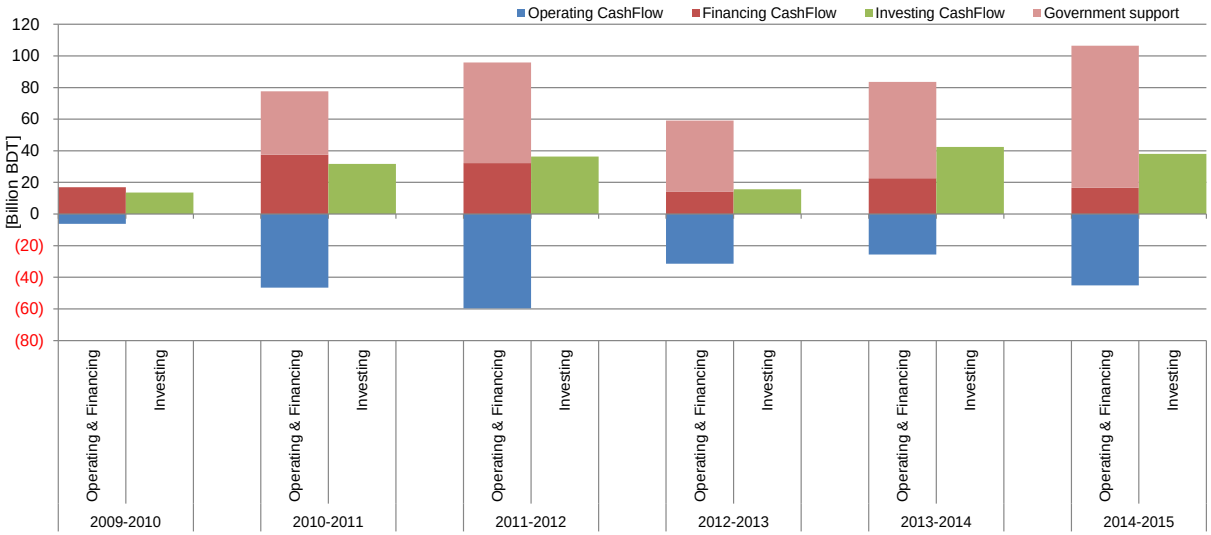
Figure 19-12 Revenue and Expenses of BPDB Power Distribution Division per Energy Sales (BDT/kWh)

(3) Cash Flow and Balance Sheet (Subsidization Issues)

Figure 19-13 shows the annual cash flow of the entire BPDB. The right bar (green) of each year shows the investing cash flow, or the amount of capital investment. The blue part of the left bar of each year shows the operating cash flow, and the dark red part of the left bar shows the financial cash flow. In other words, the figure describes how BPDB procures capital investment funding, from its own sources and external sources. Budgetary support from the government, or subsidy, was recorded separately from the financial cash flow in BPDB's cash flow sheet; therefore the amount is shown in light red.

In general, power utilities tend to show a positive operating cash flow. This is because the operating cash flow includes the profit after tax and other non-cash expenses such as depreciation, which often is a large positive in infrastructure businesses. Therefore, when conducting a cash flow analysis, it is usually the case to compare between the operating cash flow (depreciation, which is return from the past capital investment) and investing cash flow (future capital investment); if large amount of funding is necessary for capital renewal and extension, the shortfall is procured from external sources (positive financial cash flow), while if there is not a large amount of capital renewal and extension needed, necessary funding for reinvestment decreases, and funding from external sources is returned (negative financial cash flow).

However, special attention needs to be paid to the fact that operating cash flow has always been negative in BPDB's cash balance, especially since FY2010-2011. This is due to the fact that generation division of BPDB has recorded a large amount of financial deficit, therefore offsetting the positive operating cash flow from depreciation to a negative operating cash flow as a whole. This situation can be noted as very strange and unsound, considering the nature of power utilities' business model.



Source: BPDB Annual Report

Figure 19-13 Cash Flow of the Entire BPDB

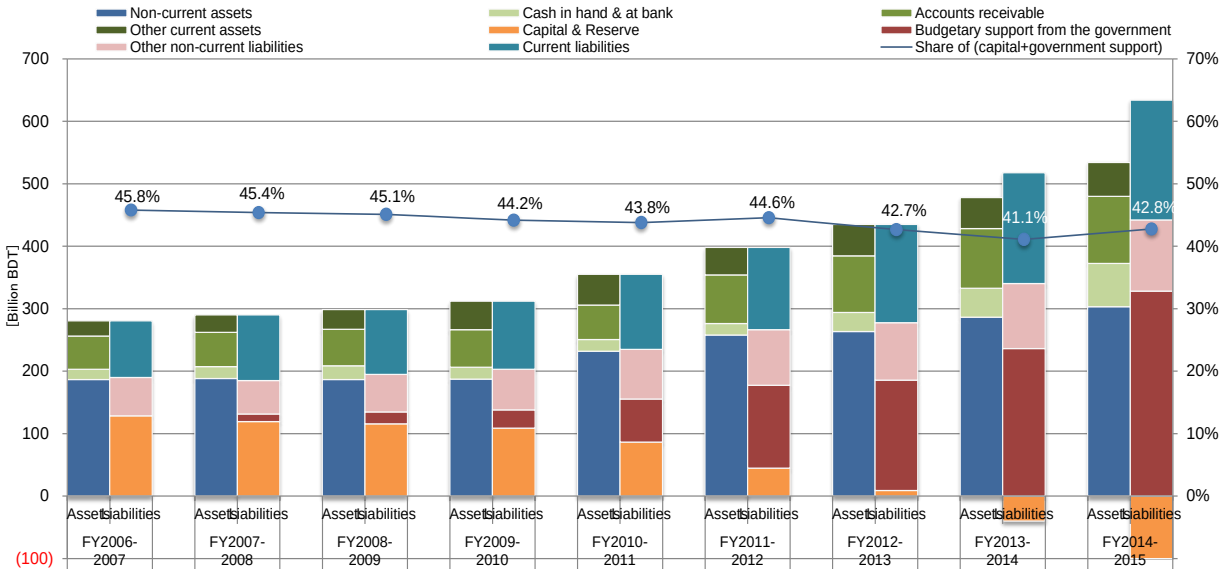
In addition to the cash outflow from the capital investment, operating cash flow, which is supposed to be positive, is recording a net outflow. Since the regular operations cannot maintain the funding of BPDB, the Government of Bangladesh has been providing "budgetary support from the government," which is provided separately from the normal loans. As there is a net increase of budgetary support each year, the accumulated balance of this budgetary support has been growing for the past three years, as shown in Table 19-12.

Table 19-12 Budgetary Support from the Government to BPDB (billion BDT)

Item	FY2010-2011	FY2011-2012	FY2012-2013	FY2013-2014	FY2014-15
Balance of budgetary support	69.005	132.572	176.634	236.363	328.215
Net increase of budgetary support	40.000	63.567	44.062	59.729	91.852

Source: BPDB Annual Report

Figure 19-14 illustrates the annual balance sheet of the entire BPDB. The left side of the bar graph shows the asset, while the right side of the bar shows the liabilities and capital reserve. Due to accumulated deficit, the capital reserve (shown in orange in the graph) has decreased each year, which as a result turned BPDB's capital reserve into capital deficit from FY2013-2014. Budgetary support from the government (shown in dark red in the graph) to BPDB has been increasing rapidly to make up for depleting capital reserve. The line graph shows the percentage of capital reserve and balance of subsidies to the whole asset; the percentage has maintained to be in 40's, which implies that while the subsidy is provided as a liability, its actual role is similar to equity injection. As discussed in 19.2.2 , BPDB is mandated by the government to maintain its capital structure to be "debt 40%: equity 60%" as the loan condition, but currently the government appears to provide subsidies to BPDB so that the share of capital reserve (including subsidies) constantly accounts for more than 40%, though not 60%.



Source: BPDB Annual Report

Figure 19-14 Balance Sheet of the Entire BPDB

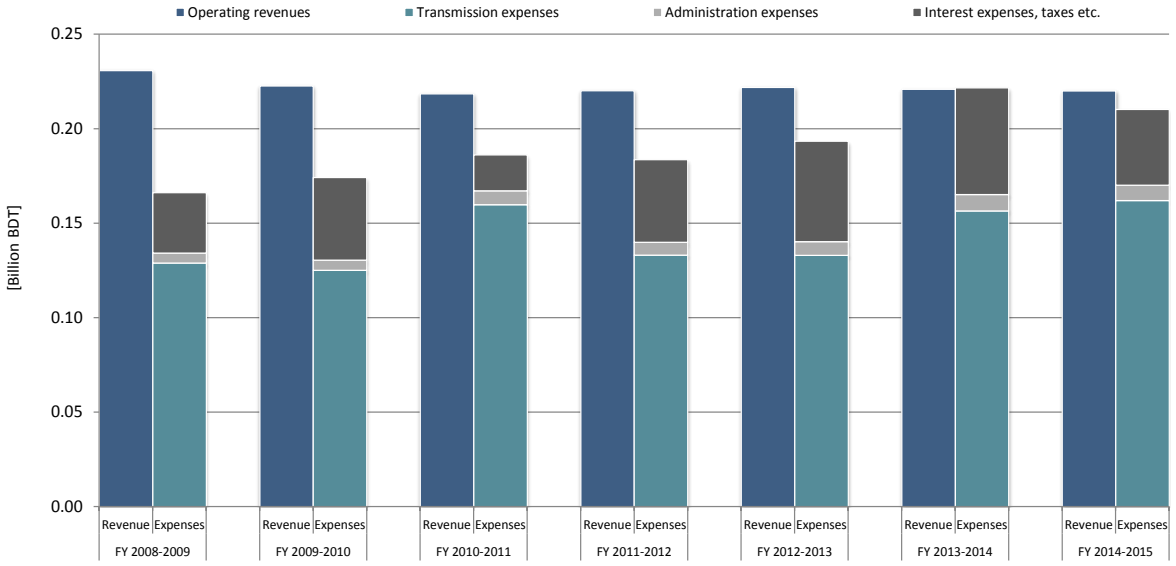
In fact, such issues are already recognized among the government of Bangladesh. According to the article of Financial Express on 29th Aug, 2015, a government official commented that the government is considering converting BPDB's large debt into equity. Requisite debt-equity ratio that is mandated by the government is 40:60; they must improve their debt-equity ratio promptly. If loan of "Budgetary Support from Government against Subsidy (Difference of Buying & Selling Rate)" is converted into equity, capital and reserve of BPDB as of FY2014-2015 increases to 228.4 billion BDT, and the ratio of capital reserve against total asset improves to around 40%.
However, while this measure may tentatively contribute to improving the financial situation, unless BPDB's situation of back spread is resolved, it is clear that the financial situation would worsen again. In order to resolve the situation, raising the bulk supply tariff and retail tariff would be necessary; such measures will be further considered in the following chapters.

19.3.3 Financial performance of PGCB and distribution entities

The study also analyzed the financial situation of power utilities other than BPDB, including PGCB and each distribution entity.

(1) Financial Performance of PGCB

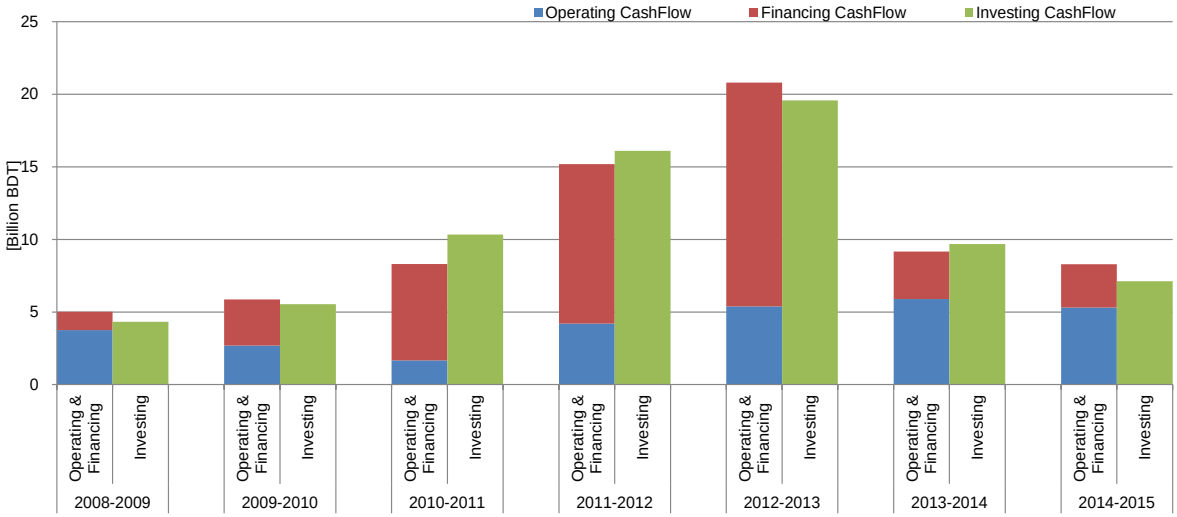
PGCB is the only system operator which possesses all transmission facilities/equipment and the license to conduct power transmission operations in Bangladesh. Each distribution entity pays wheeling charge at a rate approved by BERC.
The historical trend of PGCB's revenue and cost balances per electricity supply, based on its financial statement data, is shown in Figure 19-15. The wheeling charge rate has continued to be set at a fixed rate for a long period (0.2291 BDT/kWh), thus its revenue per kWh has been almost constant. On the other hand, cost per kWh has gradually increased, which is reducing the profit margin of PGCB. If its financial balances continue to worsen, it could have negative impacts on PGCB's transmission investment plan.



Source: PGCB Annual Reports

Figure 19-15 PGCB's Revenue and Cost Balances per Energy Supply (BDT/kWh)

PGCB's cash flow is shown in Figure 19-16. Its operating cash flow has been positive, which is a sound situation for a power utility company (compared to BPDB). Investing cash flow of PGCB was constantly increasing from FY2008-2009 to FY2012-2013, implying that there was a large need for capital investment for new construction and/or renewal. Because the capital investment far exceeded the operating cash flow, PGCB's debt financing greatly increased each year during that period. After 2013, the fund needs for capital investment became moderate and the additional loan decreased.



Source: JICA Survey Team

Figure 19-16 PGCB Cash Flow

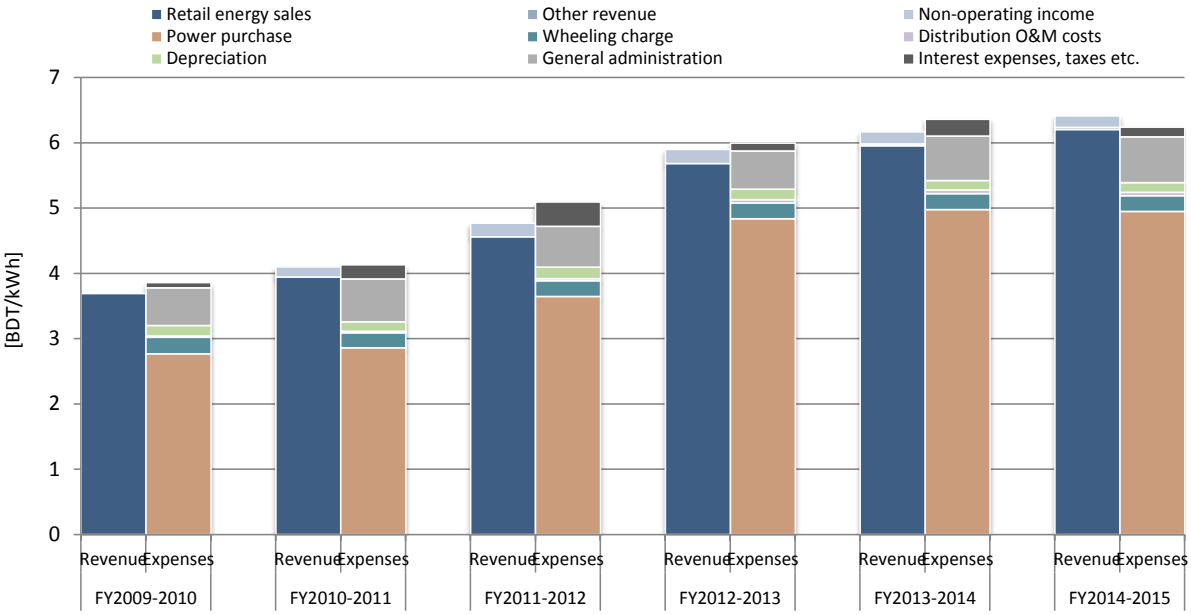
(2) Financial Performance of WZPDCL

WZPCL's revenue and expenses, and its balances per electricity sales are illustrated in Table 19-13 and Figure 19-17. WZPDCL had been in a slight deficit in the past several years, as its revenue was slightly smaller than its expenses. However, in FY2014-2015, it had a slight profit margin.

Table 19-13 Overview: Balances of WZPDCL

Particulars	Unit	FY2012-13	FY2013-14	FY2014-15
Wholesale electricity purchase cost	mil. BDT	9,379	10,606	13,430
Wholesale electricity purchased (before distribution loss)	GWh	2,187	2,394	2,574
Average bulk supply tariff	BDT/kWh	4.29	4.43	5.22
Retail electricity sales	mil. BDT	11,019	12,693	14,402
Retail electricity	GWh	1,939	2,132	2,310
Average revenue per unit	BDT/kWh	5.68	5.95	6.23

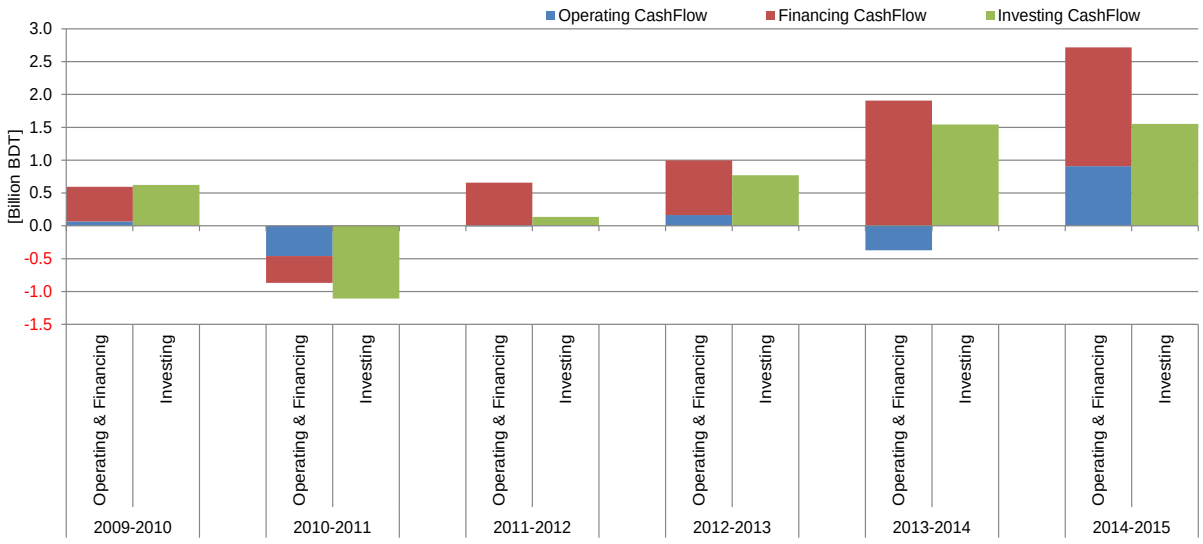
Source: WZPDCL Annual Report



*per kWh of retail sales
Source: WZPDCL Annual Reports

Figure 19-17 WZPDCL Balances per Energy Sales

The cash flow of WZPDCL is shown below in Figure 19-18. WZPDCL's operating cash flow was negative from FY2009-2010 to FY2011-2012, like the case of BPDB, though the amount is much smaller. It was positive in FY2012-2013, then turned negative in FY2013-2014, and became positive again in FY2014-2015. Investing cash flow of WZPDCL has been increasing since FY2011-2012, which drives WZPDCL to rely more on debt financing.



Source: WZPDCL Annual Report

Figure 19-18 WZPDCL Cash Flow

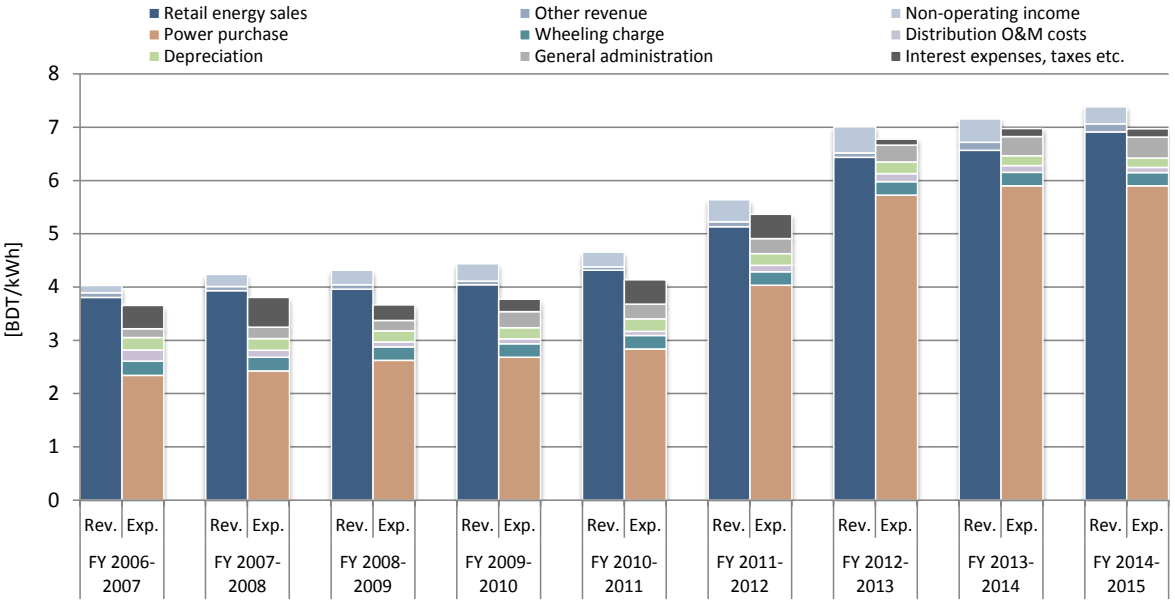
(3) Financial Performance of DESCO

DESCO has maintained a positive final margin, but since FY2012-2013, the margin has been small, after including the contribution from non-operating revenues (i.e. revenues other than electricity sales); that is, it has not been able to cover its expenses with its revenue from electricity sales. Table 19-14 and Figure 19-19 illustrate such situation.

Table 19-14 Overview: Balances of DESCO

Particulars	Unit	FY2012-13	FY2013-14	FY2014-15
Wholesale electricity purchase cost	**mil. BDT**	**20,393**	**22,898**	**24,344**
Wholesale electricity purchased (without distribution loss)	GWh	3,726	4,067	4,320
Average bulk supply tariff	BDT/kWh	5.47	5.63	4.58
Retail electricity sales	mil. BDT	21,951	24,431	27,358
Retail electricity	GWh	3,412	3,722	3,959
Average revenue per unit	BDT/kWh	6.43	6.56	6.91

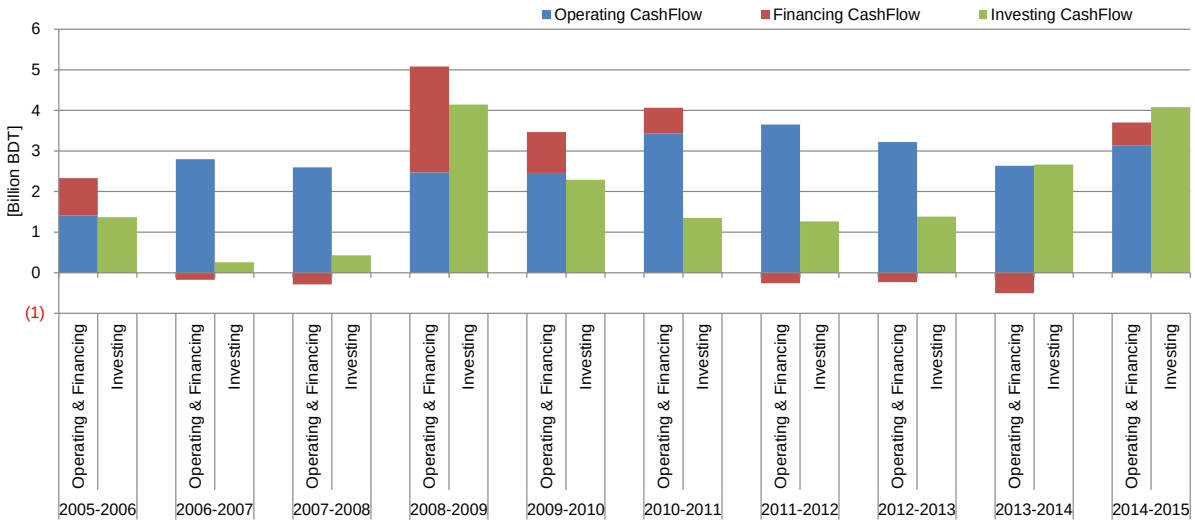
Source: DESCO Annual Report



*per kWh of retail sales
Source: DESCO Annual Reports

Figure 19-19 DESCO Balances per Energy Sales (BDT/kWh)

DESCO's cash flow situation, illustrated in Figure 19-20, is far better than that of BPDB and WZPDCL. Its operating cash flow is mostly covering its investing cash flow. In other words, it implies that the return from past capital investment is large enough for funding the reinvestment, and there is little reliance on additional debt financing to make up for this. However, capital investment has been increasing in the past few years; if such trend continues, it may press DESCO to rely more on debt financing in the future.



Source: JICA Survey Team

Figure 19-20 DESCO Cash Flow

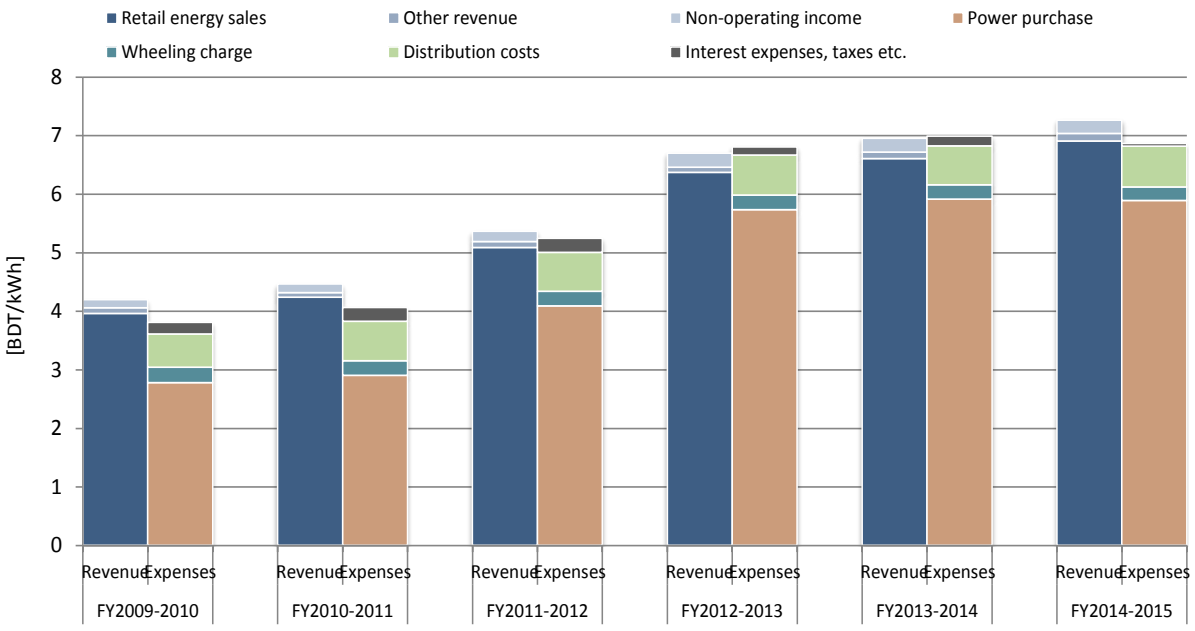
(4) Financial Performance of DPDC

Up until FY2011-2012, DPDC had a positive margin, but as increase in retail electricity tariff could not catch up with the increase in bulk supply tariff, it turned into financial deficit for FY2012-2013. Table 19-15 and Figure 19-21 illustrate such situation.

Table 19-15 Overview: Balances of DPDC

Particulars	Unit	FY2012-13	FY2013-14	FY2014-15
Wholesale electricity purchase cost	mil. BDT	34,076	37,498	39,424
Wholesale electricity purchased (without distribution loss)	GWh	6,593	7,038	7,402
Average bulk supply tariff	BDT/kWh	5.17	5.33	5.33
Retail electricity sales	mil. BDT	37,851	41,882	46,218
Retail electricity	GWh	5,943	6,341	6,694
Average revenue per unit	BDT/kWh	6.37	6.60	6.90

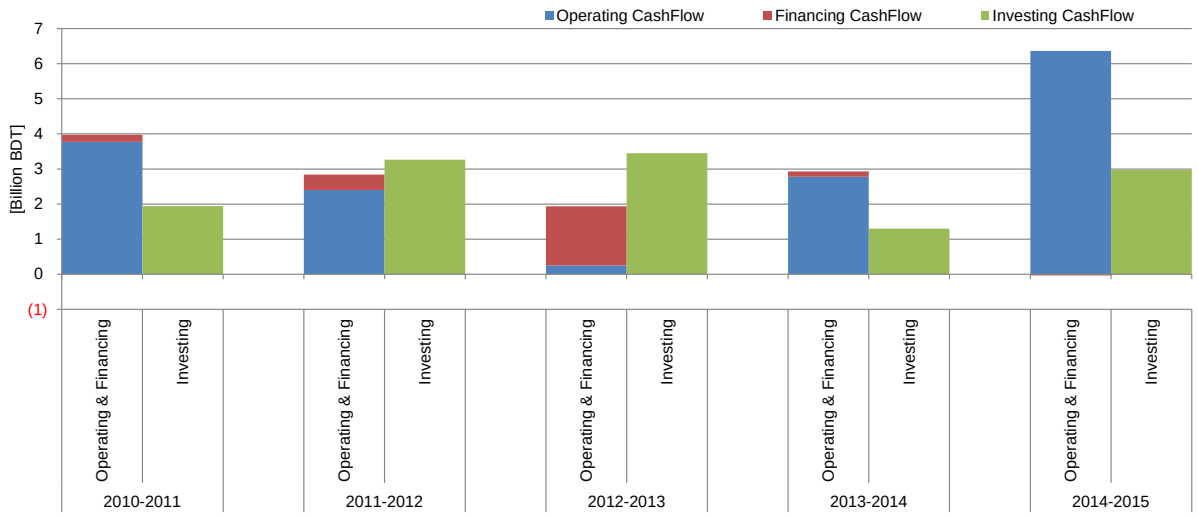
Source: DPDC Annual Report



*per kWh of retail sales
Source: DPDC Annual Reports

Figure 19-21 Balances of DPDC per Energy Sales (BDT/kWh)

Annual changes in DPDC's cash balance are shown in Figure 19-22. As with the case of DESCO, its operating cash flow mostly covers its capital investment and its reliance on additional debt financing is small; it has maintained a relatively sound financial situation.



Source: JICA Survey Team

Figure 19-22 DPDC Cash Flow

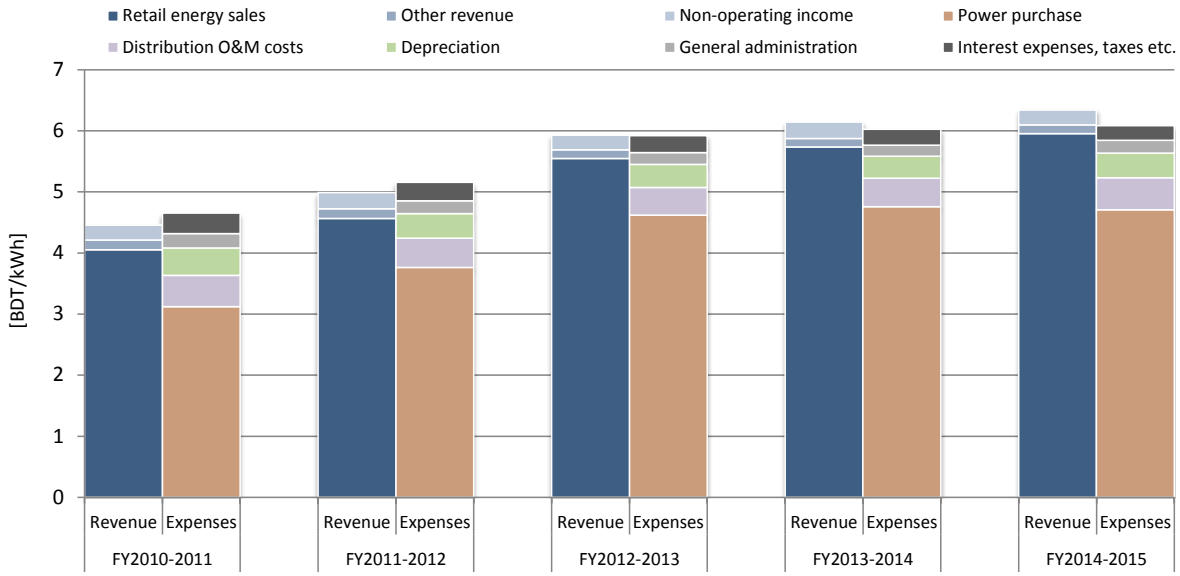
(5) Financial Performance of REB

REB, unlike the other distribution entities, does not publish its financial statements on its website; therefore, its financial data was acquired directly from REB in this survey. Since the format of the financial data was different from a standard P/L statement, the survey reorganized the items so that the data would be comparable with the other entities; however, it needs to be noted that even after reorganizing, the data format may not be exactly the same for comparison.
REB's margins turned from negative to positive after FY2012-2013, and its operating margins have been gradually improving. Its average bulk supply tariff from BPDB has not increased as much compared with the other distribution utilities. This may be due to the fact that BPDB's bulk supply tariff to REB is set at a lower level than the other distribution entities, one type of internal subsidization. Such situation is shown in Table 19-16 and Figure 19-23.

Table 19-16 Overview: Balances of REB

Particulars	Unit	FY2012-13	FY2013-14	FY2014-15
Wholesale electricity purchase cost	mil. BDT	63,580	74,180	81,712
Wholesale electricity purchased (without distribution loss)	GWh	14,222	16,161	17,835
Average bulk supply tariff	BDT/kWh	4.47	4.59	4.58
Retail electricity sales	mil. BDT	76,316	89,362	103,309
Retail electricity	GWh	13,754	15,582	17,346
Average revenue per unit	BDT/kWh	5.55	5.73	5.96

Source: Documents provided by REB



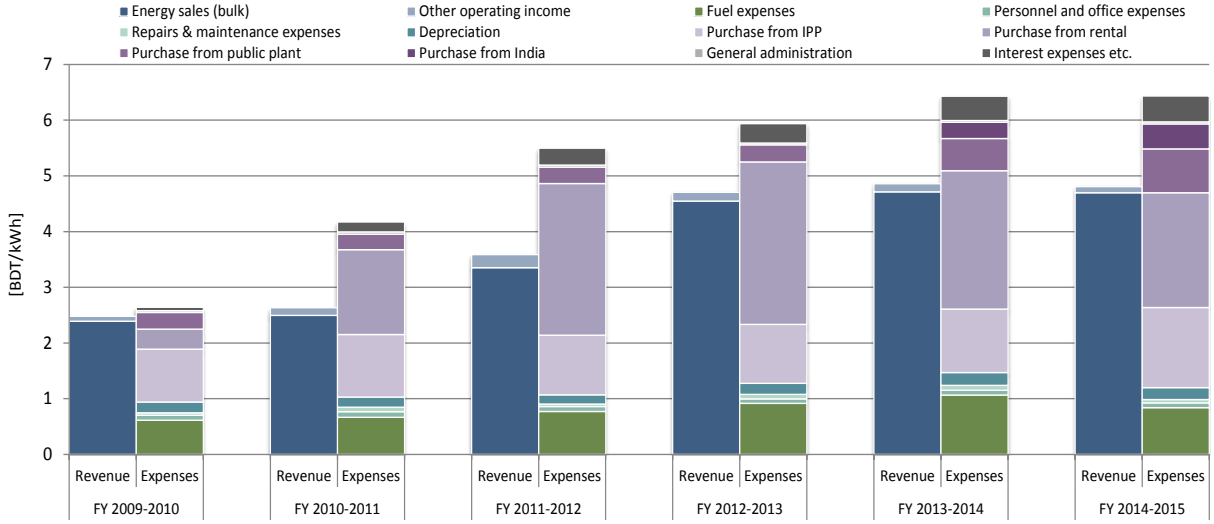
*per kWh of retail sales
Source: Documents provided by REB

Figure 19-23 Balances of REB per Energy Sales (BDT/kWh)

19.3.4 Cost structure of power generation

(1) Historical Trend of Generation Cost (Electricity Procurement Cost) of Bangladesh

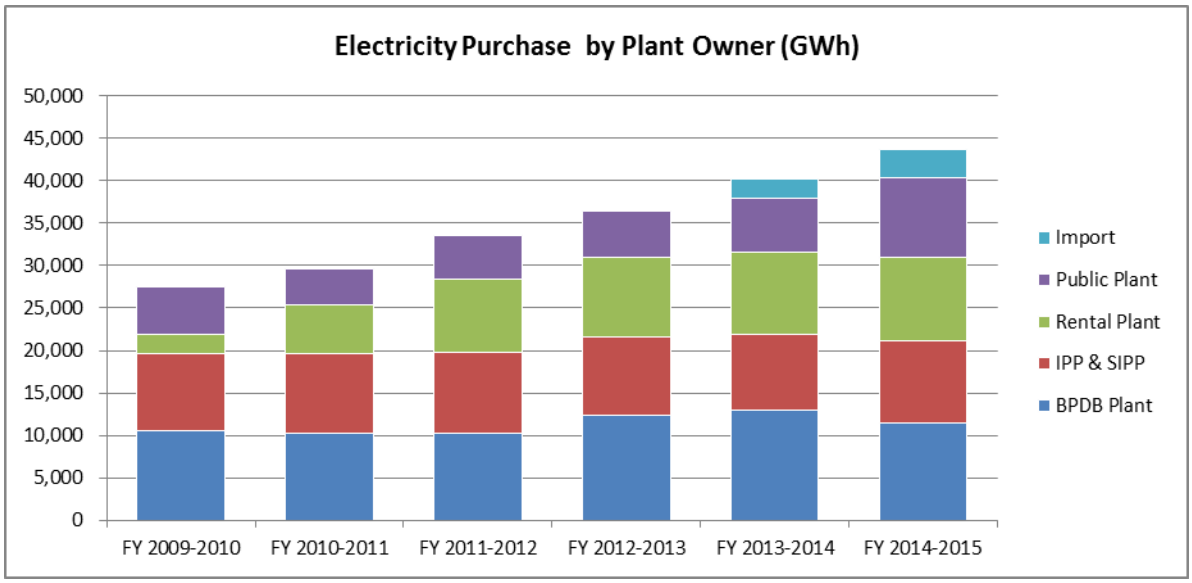
As already stated in the previous sections, the current electricity tariff rates are not sufficient to cover its actual cost of electricity supply. As shown in Figure 19-24, the cost of BPDB generation division, especially its electricity procurement cost, has been increasing rapidly recently, and the raise in electricity tariff has not been able to catch up with such increase.



Source: BPDB Annual Reports

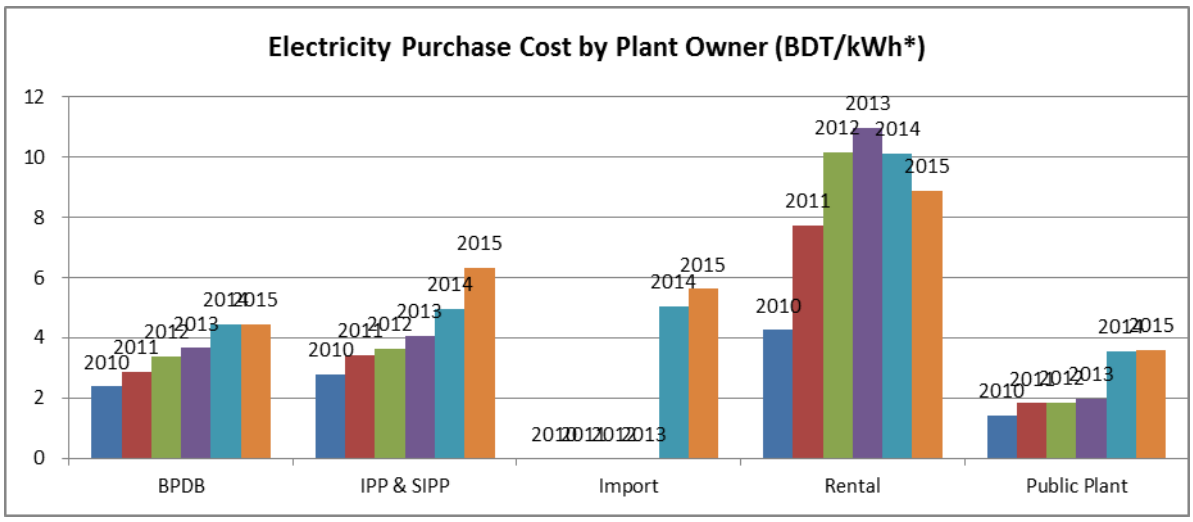
Figure 19-24 Balances of BPDB (Generation Division) per Electricity Sales (BDT/kWh)

Electricity procurement of BPDB by supplier is shown in Figure 19-25. The figure shows that its electricity purchase, especially from rental plants, has been increasing along with recent increase in electricity demand. Although the average electricity purchase cost of rental plants, as shown in Figure 19-26, has been in a decreasing trend since FY2013-2014, it is still very expensive compared with other suppliers. The average electricity purchase cost from rental plants was 8.90 BDT/kWh in FY2014-2015, whereas the average for IPP/SIPP and public plants in the same year was 6.33 BDT/kWh and 3.61 BDT/kWh, respectively. Thus, one of the main reasons of increasing electricity cost can be largely due to the increase in electricity purchase from rental plants that are much more costly than other plants.



Source: BPDB Annual Reports

Figure 19-25 BPDB Electricity Procurement (Breakdown by Plant Owner)

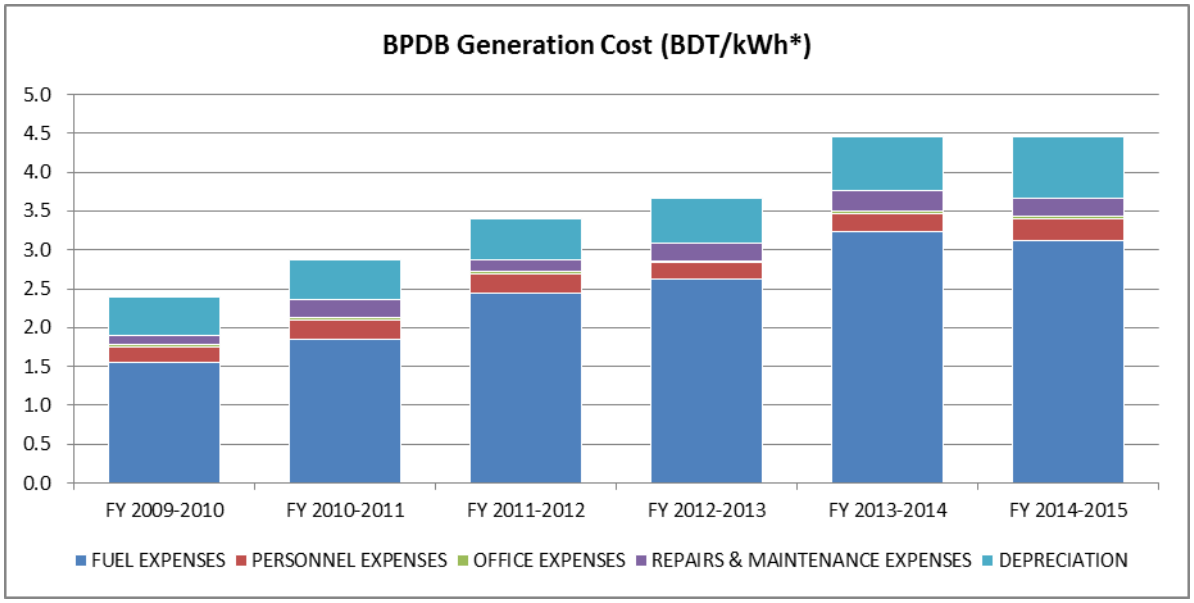


*per kWh of electricity purchase (net generation for BPDB)
Source: BPDB Annual Reports

Figure 19-26 BPDB Electricity Purchase Cost (by Plant Owner)

(2) Generation Cost of BPDB

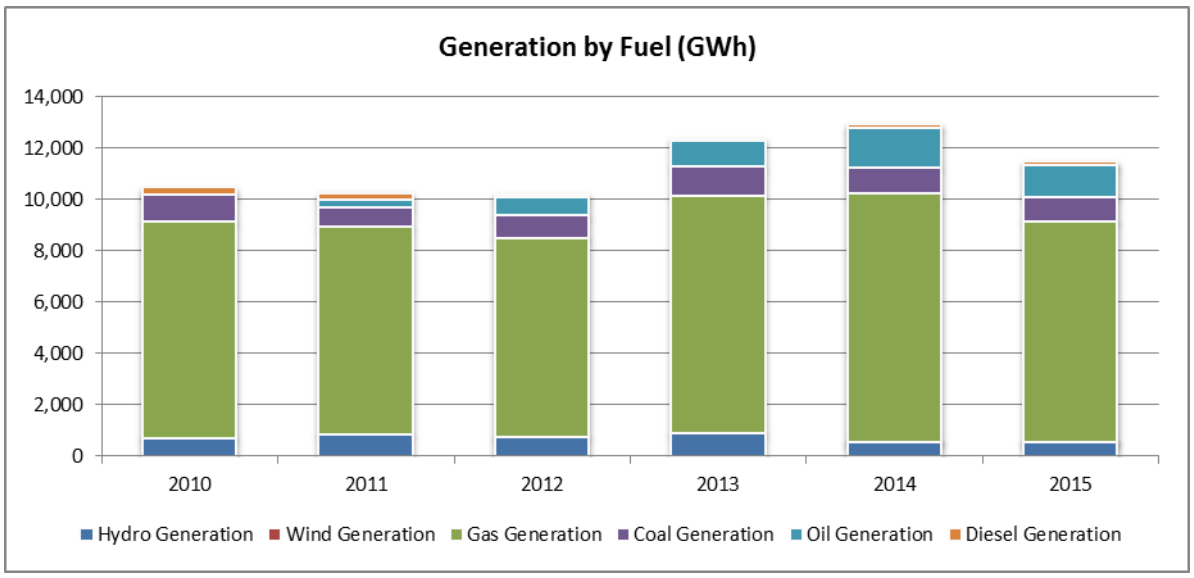
As it can be seen from the figures above, there has been an increase in not only the electricity purchase cost from external generation entities, but also the generation costs of BPDB's own plants as well, mainly due to the increase in fuel cost, as shown in Figure 19-27.



*per kWh of net generation
Source: BPDB Annual Reports

Figure 19-27 Generation Cost of BPDB's Own Plants

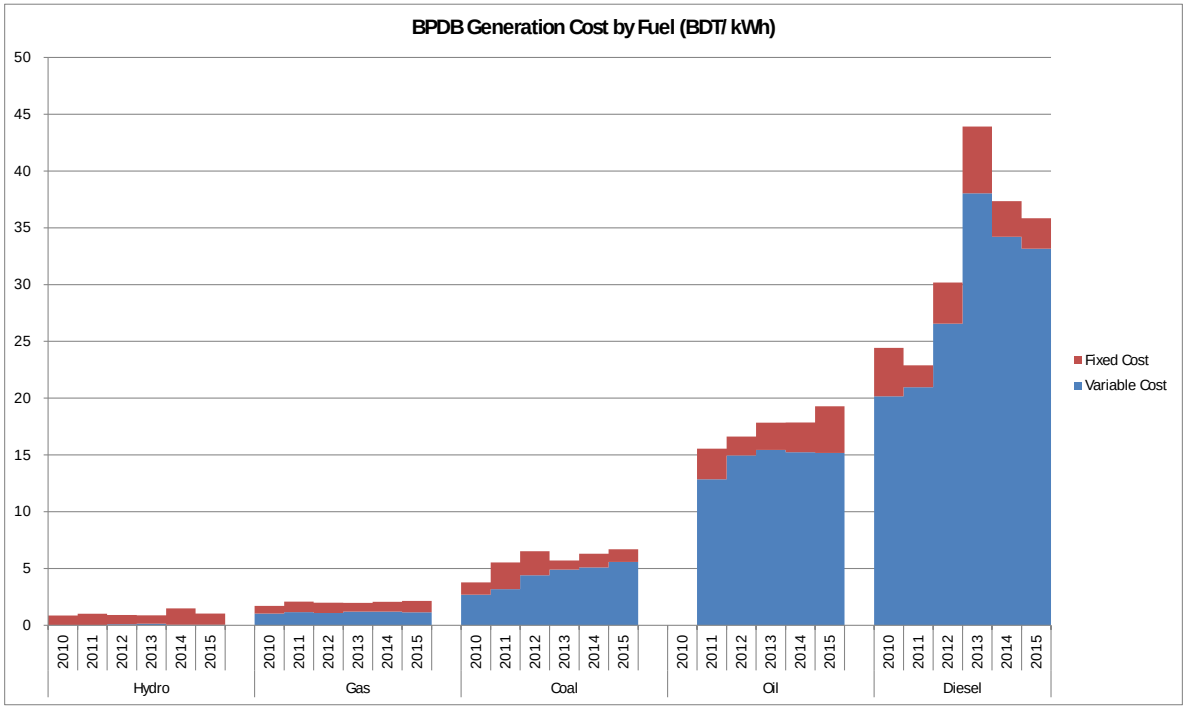
Figure 19-28 illustrates the breakdown of generated electricity in BPDB plants by fuel type. Gas fuel holds a major share of the total generated electricity; however, the increasing portion of oil fuel, which is more costly than gas, can be considered as one of the factors for the increased cost.



Source: BPDB Annual Reports

Figure 19-28 Breakdown of Electricity Generation by Fuel in BPDB Owned Plants

Generation cost by fuel in BPDB owned plants is shown in Figure 19-29. In BPDB owned plants, generation cost of oil and diesel are significantly higher than other sources.
It may seem strange that the generation cost of coal plants is higher than gas plants, which is different from the general trend. This is because while the fuel supply of gas for electricity has relied on domestic procurement and a low fuel price has been maintained compared to the international prices, the fuel price for coal plants does not differ significantly from the international prices, even if the fuel is domestically procured. Therefore, if the supply cost of gas is raised to the international level in the future, it will have a significant effect on the overall generation cost. In order to mitigate such predicted rise in fuel prices, achieving higher thermal efficiency in power plants (current average of 33.29% in the public sector, according to 2015 BPDB AR) will be required promptly.



*per kWh of net generation
Source: BPDB Annual Reports

Figure 19-29 Generation Cost of BPDB's Own Plants (by Fuel)

Regarding the subsidy for electricity tariff in Bangladesh, in addition to the budgetary support from the government to BPDB for its financial deficit as already explained in the previous chapter, the current situation of gas fuel price for electricity being kept lower than the international level can be considered as a kind of subsidy for fuel cost. While the former type of subsidy for electricity is clearly stated on the financial statement as an item "subsidy from the government," the latter type can be considered to be a "hidden subsidy" as it is not clearly seen on financial statements.

19.3.5 Summary of the financial performance of the power sector and implications for the way forward

(1) Financial Performance of the Power Sector in Bangladesh

Analyzing the balances of the each power utility (BPDB, PGCB, WZPDCL, DESCO, DPDC and REB), while both the generation and distribution division of BPDB were in a financial deficit, the transmission operator PGCB and other distribution entities have maintained a small amount of profit margin or sometimes a slight financial deficit. However, by analyzing the power sector as a vertically integrated utility (the consolidated P/L statement of the six utilities), it can be seen that the power sector of Bangladesh as a whole has continuously been in a financial deficit.

A large part of the deficit in the power sector comes from the deficit incurred in BPDB, especially its power generation division. In other words, one can perceive such situation as follows: although the retail electricity tariff has gradually been raised, it is still set at a low level, and as a result, in order to maintain the business of distribution entities, the standard of bulk supply tariff is much lower than the actual the costs of generation and procurement.
As a result, BPDB has had a large amount of financial deficit each year, and its operating cash flow, which is generally positive for a power utility, has been negative in the past few years. In order to avoid its own capital reserves from depleting and becoming short of operation funding, BPDB has been maintaining its operation by acquiring budgetary support from the government, of which accumulated balance has been rapidly increasing in the past years.
PGCB, the sole operator of power transmission system, has maintained to perform relatively well and maintained a certain margin of profit. However, while the wheeling charge rate has been fixed for a long period of time, its cost has been gradually increasing; therefore, but its profitability has been worsening in recent years.
As for the distribution utilities, the situation in most entities is better than BPDB's distribution division, and some of them have maintained a margin of profit. However, their profitability does not appear to be high enough to maintain financial soundness. It also needs to be noted that, because the cost of power purchase from BPDB accounts for a large share in the costs of supply of distribution utilities, if bulk supply tariff is raised for improving the financial conditions of BPDB, it is essential to raise the retail electricity tariff at the same time.

(2) Implications for the Way Forward

In order to turn the power sector's financial performance ino sound conditions, it is strongly recommended that achieving the revenue-cost balance so that the power sector does not need to rely on government subsidies. In order to do that, not only tariff increase to meet the costs of supply but also cost reduction, especially reduction of power procurement cost, needs to be taken.

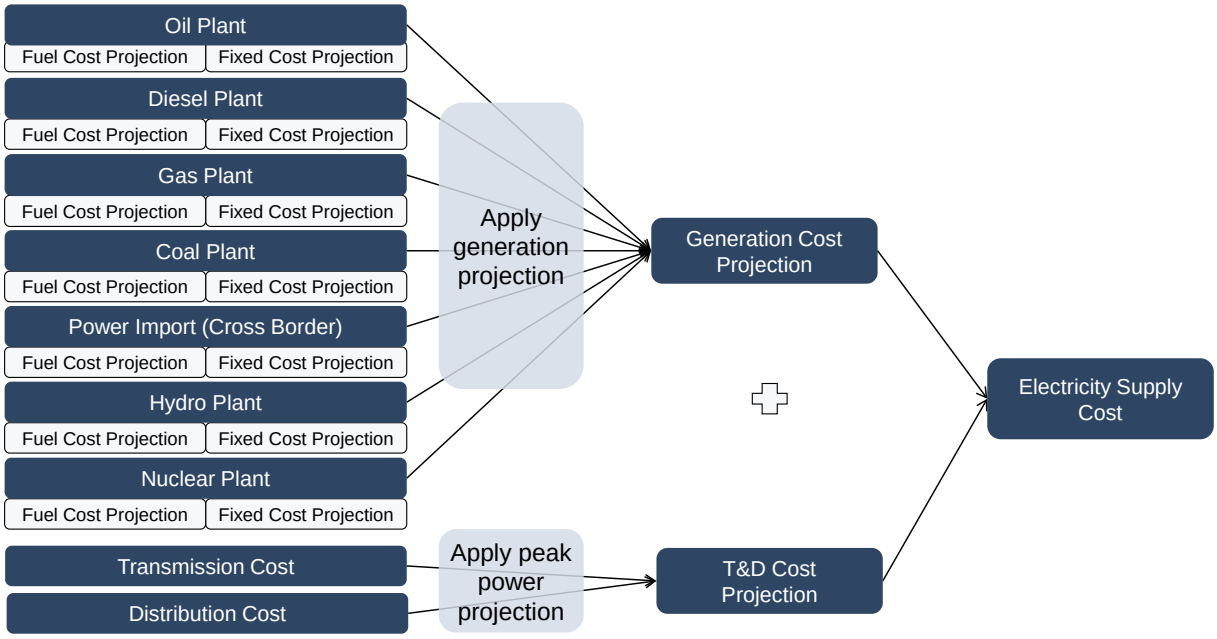
Tariff Increase
Considering that BPDB's financial condition is in a critically serious situation and the financial support from the government has been increasing, raising bulk supply tariff for BPDB to cover the costs of power generation is indispensable. This will also lead to the increase of retail tariff, otherwise the distribution companies will also be faced with financial difficulties.

Cost Reduction
In the meantime, reducing the costs of power supply, especially power procurement, should also be addressed for mitigating the negative effect of tariff increase on households and national economy. Above all, power procurement from small rental power plants, which is much more costly than other types of power generation and recently has been increasing both in volume and price, needs to be dealt with. Because the efficiency of these small power generators is not higher than large-scale power plants, they should be driven away gradually. In order to so that, developing large-scale power plants in a timely manner to meet the increasing power demand is important.

Necessity of Roadmap and Action Plan
However, both of the aforementioned can be made only gradually, because the former needs to conside the negative effect of drastic tariff increase and the latter cannot evade from the obligation of power purchase agreement (PPA). Hence it is supposed to take certain time to achieve the revenue-cost balance and totally remove the deficit. If government support still needs to be employed for some period, the government should provide a mid- and long-term roadmap as well as a short-term action plan to show how and when the dependence on subsidies will be removed.

19.4 Estimation of the Future Costs of Electricity Supply

To serve for the analysis on the effect of raising electricity tariff on Bangladesh national economy (to be discussed in Chapter 21), future projection of electricity supply cost was estimated. In this estimation, the cost of electricity supply was segregated into power generation cost and transmission & distribution costs, and then the power generation cost was estimated for each of gas-fired, oil-fired, coal-fired, diesel, hydro, and nuclear plants, as well as power import, segregated into fuel cost (variable cost) and other costs (fixed cost). As for the future projection of energy mix as the condition of power generation cost, Scenario 3 of the Power Development Plan as discussed in Chapter 11 was referred to.



Source: JICA Survey Team

Figure 19-30 Projection Method of Electricity Supply

The projection methods of fuel cost and other costs are described hereafter.

19.4.1 Projection of generation cost

The projection of the variable cost (US cent/kWh) in generation cost referred to the parameters of Scenario 3 of the Power Development Plan in Chapter 11, where the total fuel cost (million USD) for each plant type (i.e. oil, diesel, gas, coal, power import, hydro and nuclear) was estimated based on the fuel price projection of IEA's "World Energy Outlook".
In the same manner, the projection of the fixed cost (US cent/kWh) in generation referred to the parameters of Scenario 3 of the Power Development Plan, where the total fixed cost (million USD) for each plant type (i.e. oil, diesel, gas, coal, power import, hydro and nuclear) was estimated considering the inflation rate in the future.

19.4.2 Projection of transission and distribution costs

For the projection of transmission and distribution costs, a simplified methodology was employed based on the assumption that these costs, mostly fixed cost, increase in accordance with the peak generation demand (MW). Referring to the data provided in the financial statements of PGCB and distribution entities, the unit costs per peak generation demand for the past years was calculated, and then the unit costs in the future were estimated taking into consideration these historical data and the inflation rate. The result was multiplied by the peak power projection provided by the Power Development Plan, to derive the projection of transmission and distribution costs.

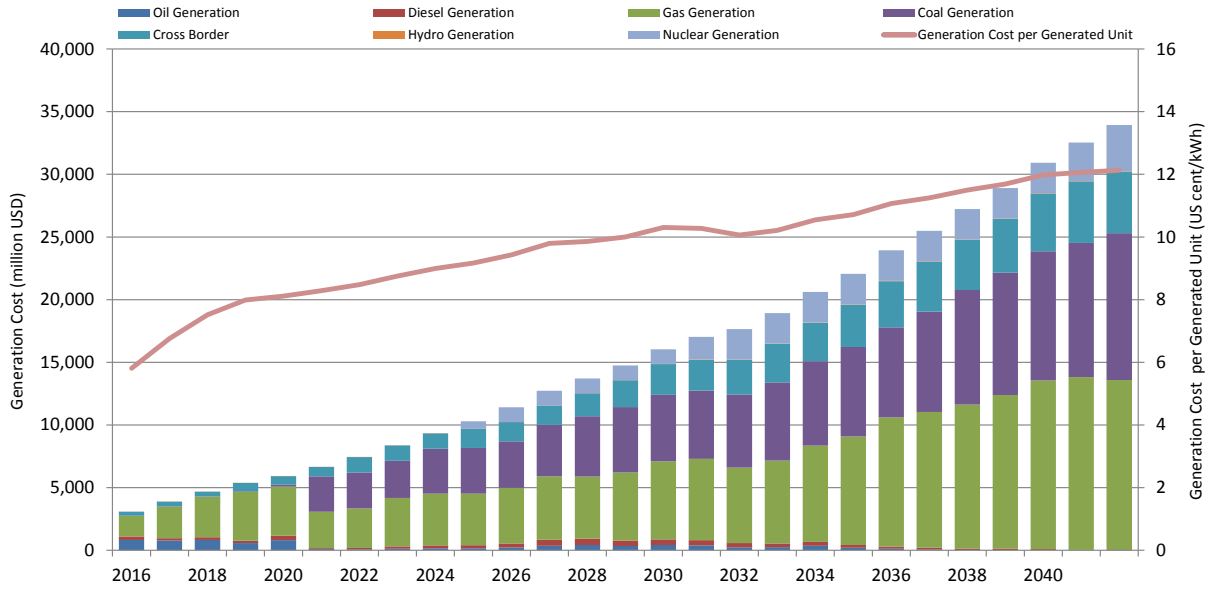
19.4.3 Results of the cost estimation

Figure 19-31 and Figure 19-32 are the projection of generation cost in USD and in BDT respectively. The bar chart in these figures is the total generation cost broken down by the plant type (gas, coal, oi, hydro, nuclear etc.), whereas the line chart in these figures is the average cost of generation per generated unit (in US cent/kWh and BDT/kWh).

The total generation cost increases from approximately 3.9 billion USD in 2016 to 33.9 billion USD in 2041, which is about 9.1% increase per annum. In terms of BDT, the total electricity supply cost increases from 0.31 trillon BDT in 2016 to 3.40 trillion BDT, which is about 10.1% increase per annum. In this study, the exchange rate of BDT against USD is expected to depreciate (from 79 BDT/USD in 2016 to 100 BDT/USD in 2041) because of the higher inflation rate in Bangladesh than that of international price, hence the growth rate of nominal prices in BDT becomes higher than that in nominal USD.

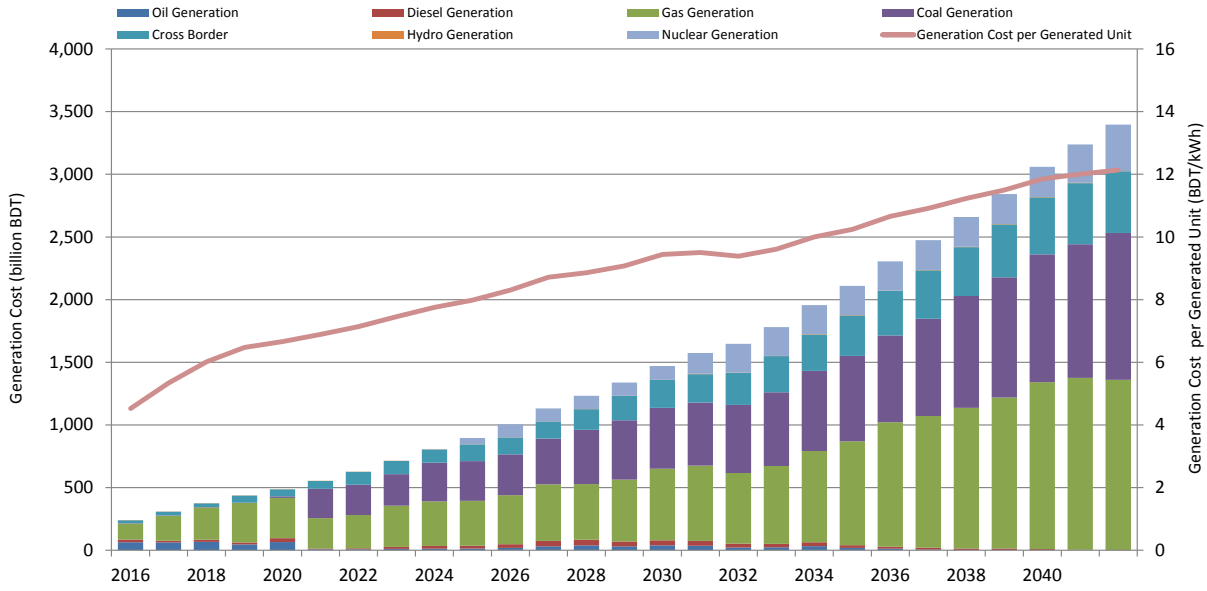
The average cost of generation per generated unit in US cent/kWh nearly doubles from 6.76 US cent/kWh in 2016 to 12.13 US cent/kWh in 2041, which is about 2.4% growth per annum. In terms of BDT/kWh, it increases from 5.34 BDT/kWh to 12.14 BDT/kWh in 2041, about 3.3% growth per annum. It can be observed from these figures that the increase of average generation cost becomes dull in a year when the share of gas-fired power generation becomes low. Because this cost projection uses international fuel prices, not the current domestic prices in Bangladesh, the generation cost of gas-fired power plant becomes higher than that of coal-fired, hydo, and nuclear power plants, though it’s still lower than that of oil-fired and diesel power plants.

The increased share of coal-fired and nuclear power plants, as well as that of power import that is mainly hydro, contributes to mitigating the overall increase in the generation cost. Generation of oil plants, whose fuel cost is extremely expensive, is nearly driven away by 2041.



Source: JICA Survey Team

Figure 19-31 Projection of Generation Cost by Fuel (USD)



Source: JICA Survey Team

Figure 19-32 Projection of Generation Cost by Fuel (BDT)

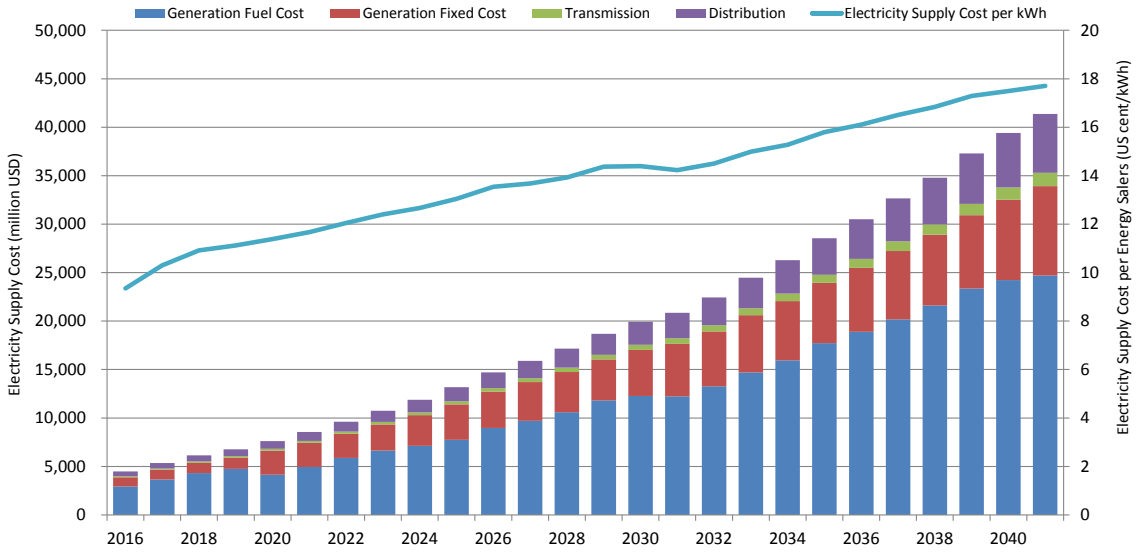
The projected cost of electricity supply, which includes not only generation cost but alos transmission and distribution costs, are shown in Figure 19-33 (in USD) and Figure 19-34 (in BDT). In the same manner, the bar chart in these figures is the total cost of supply consisting of generation fuel cost, generation fixed cost, transmission cost, and distribution cost, whereas the line chart is the average cost of supply per energy sales (in US cent/kWh and BDT/cent). It needs to be noted that Figure 19-31 and Figure 19-32 used "kWh of power generation" while Figure 19-33 and Figure 19-34 used "kWh of energy sales to end-consumers" after transmission and distribution losses, thus the denominator to calculate the unit cost is different.

The total electricity supply cost increases to approximately 4.5 billion USD (0.35 trillion BDT) to 41.4 billion USD (4.14 trillion BDT) in 2041, which is 9.3% (10.3%) increase per annum.

The average cost of electricity supply per kWh of energy sales is expected to increase from 9.34 US cent/kWh (7.38 BDT/kWh) in 2016 to 17.70 US cent/kWh (17.72 BDT/kWh) in 2041. During this period, the average cost of supply increases by 2.6% per annum (3.6% per annum in BDT). This growth rate is expressed in nominal prices. In terms of real price that excludes the effect of inflation, the cost of electricity supply is expected to increase by about 1.1% per annum.

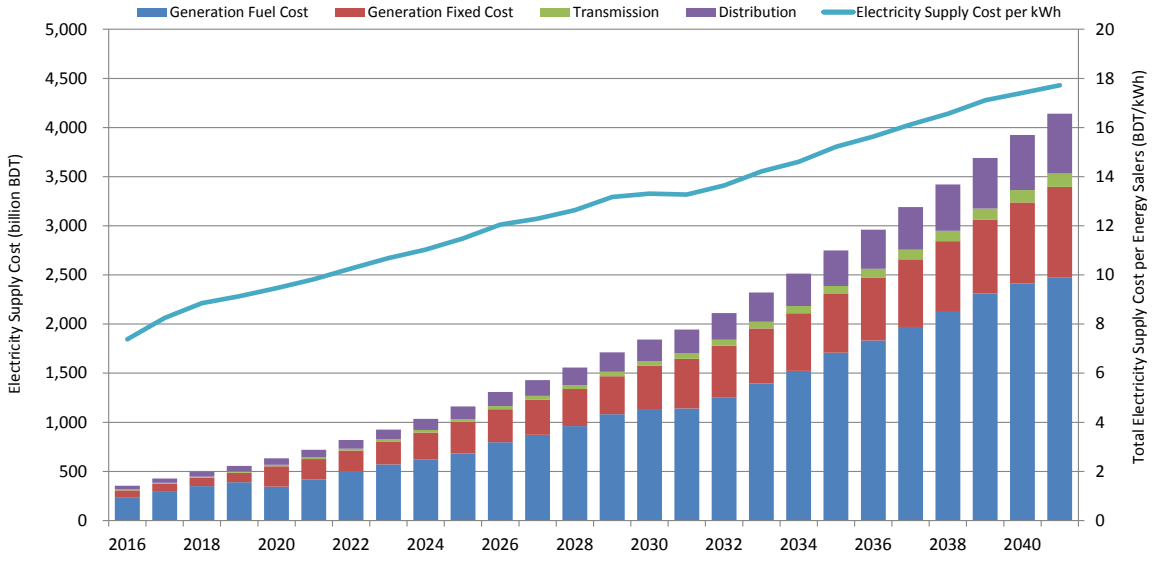
In the anaylysis of overall electricity supply cost of a virtual "vertically integrated utility" in Section 19.3.1 , the average costs of power supply for FY2014-2015 were approximately 8.23 BDT/kWh. The gap between this and the estimated electricity supply cost for 2016 (7.38 BDT/kWh) can be accredited not only to the recent declining trend of international prices of oil and gas but also to the difference of methodology in calculating the generation costs; while the cost analysis of the virtual "vertically integrated utility" is based on the actual accounitng data, projection up to 2041 is the simulation using the international fuel prices outlook as provided by IEA and the fixed cost of a model power plant.

Therefore, though this cost projection may not be perfectly consistent with the historical trend in the past, its result is sufficient to obtain an implication that the cost of electricity supply (real price) in Bangladesh is expected to increase by around 1%-1.5% per annum as a long-term prospect.



Source: JICA Survey Team

Figure 19-33 Projection of Electricity Supply Cost (USD)



Source: JICA Survey Team

Figure 19-34 Projection of Electricity Supply Cost (BDT)

Chapter 20 Financial Performance of the Gas and Oil Sector

20.1 Natural Gas Tariff

20.1.1 Overview of natural gas tariff in Bangladesh

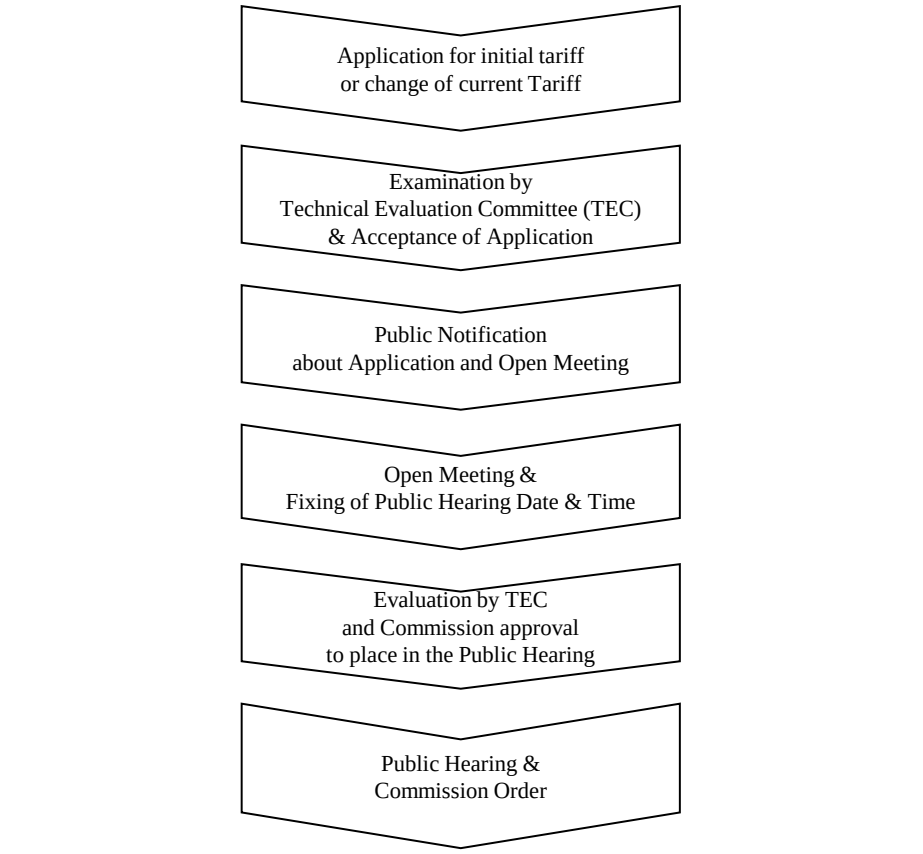
Like the case of electricity tariff, BERC (Bangladesh Energy Regulatory Commission Act) is authorized to regulate the tatiff of natural gas and petroleum products.

Table 20-1 BERC's Missions

· Enforcement of fiscal discipline of the energy sector
· Introduction of performance targets and incentive-based regulation
· Introduction of uniform operational standards and quality of supply
· Transparency in tariff determination and economic efficiency
· Increased opportunities for development of competitive markets
· Increased opportunities for efficiency and economic growth
· Public involvement into the energy sector

Source: BERC website

BERC has prepared two regulations regarding the gas sector, i.e. Gas Transmission Tariff Regulation (2010) and Gas Distribution Tariff Regulation (2010). These regulations are formulated in consideration for the new entrant of private entities and stipulate the procedures to approve the tariff of gas transmission and distribution, such as the procedure of submitting the application for gas tariff by a licensee, BERC's procedure of reviewing the application for gas tariff, and the procedure of issuing the approval for applied gas tariff.
Both regulations specify in detail the standard methodology to calcurate the costs of supply as the basis of tariff calculations. Figure 20-1 shows the outline of the process to determine natural gas tariff.



Source: "Data Collection Survey on Bangladesh Natural Gas Sector - Final report" (JICA, 2012)

Figure 20-1 Process of Determining Natural Gas Tariff in Bangladesh

Natural gas tariff is classified by the following customer categories. For commercial customers the tariff rate is set in proportion to the mcf (1000 cubic feet) of metered gas consumption, whereas for residential customers two types of tariff rates are provided, i.e. rate per metered consumption and monthly fixed rate in accordance with the appliances in use. Table 20-2 shows the historical trend of natural gas tariff rates.

- Power generation
- Fertilizer raw material
- Industrial
- Commercial
- Tea estate
- Captive power generation
- CNG station
- Seasonal industry (brick field etc.)
- Domestic (metered)
- Domestic (monthly fixed rate in accordance with the appliances in use)

Table 20-2 Natural Gas Tariff Rates Since1969

(Unit: BDT/mcf)

Effective from	Power	Fertilizer	Industry	Commercial	Tea estate	Captive Power	CNG Statioon	Brick field (seasonal)	Domestic		
									Metered	Single Burner	Double burner
28.06.1969	1.60	1.60	2.92	6.40	-	-	-	-	6.40	6.30	10.50
19.06.1974	3.72	3.72	7.20	12.00	-	-	-	-	12.00	15.00	28.00
01.12.1977	5.00	5.00	9.00	13.00	-	-	-	-	13.00	16.00	30.00
02.06.1979	6.25	6.25	16.00	17.00	-	-	-	-	16.00	20.00	36.00
07.06.1980	7.75	7.75	18.00	19.00	-	-	-	-	18.00	22.00	40.00
07.06.1981	9.30	9.30	27.75	28.00	-	-	-	-	20.00	25.00	45.00
01.07.1982	10.50	10.50	31.00	31.00	-	-	-	-	27.00	35.00	65.00
30.06.1983	11.50	11.50	36.00	36.00	-	-	-	-	34.00	45.00	80.00
27.06.1984	13.05	13.05	36.00	45.20	-	-	-	51.00	34.00	45.00	80.00
30.06.1985	15.66	15.66	43.20	54.24	-	-	-	61.20	40.80	60.00	100.00
28.06.1986	19.09	19.09	52.14	65.39	-	-	-	78.30	44.88	66.00	110.00
18.06.1987	24.82	24.82	52.14	85.00	72.30	-	-	78.30	56.10	80.00	130.00
01.07.1988	28.54	28.54	59.96	97.75	83.15	-	-	90.05	56.10	92.00	150.00
01.07.1989	33.00	28.54	70.00	110.00	83.15	-	-	-	65.00	100.00	170.00
01.07.1990	37.95	32.82	80.42	126.50	95.62	-	-	-	74.75	115.00	195.00
01.07.1991	39.08	33.98	85.23	134.22	100.62	-	-	106.19	74.75	115.00	195.00
01.05.1992	43.05	37.39	93.74	134.22	110.16	-	43.05	116.67	82.12	126.00	215.00
01.03.1994	47.57	41.34	103.07	147.53	113.26	-	-	128.28	82.12	160.00	250.00
01.12.1998	54.65	47.57	118.93	169.90	130.26	86.37	-	147.25	94.86	185.00	290.00
01.09.2000	62.86	54.65	136.77	195.39	149.80	99.11	-	169.33	109.02	210.00	330.00
01.01.2002	65.98	57.48	143.57	205.30	157.16	104.21	-	177.83	114.40	275.00	350.00
01.09.2002	70.00	60.00	140.00	220.00	140.00	100.00	-	220.00	120.00	325.00	375.00
15.02.2003	-	-	-	-	-	-	70.00	-	-	-	-
01.07.2004	72.45	62.15	145.20	228.50	145.20	-	-	228.50	126.10	340.00	390.00
01.09.2004	-	-	-	-	-	103.50	-	-	-	-	-
01.01.2005	73.91	63.41	148.13	233.12	148.13	105.59	-	233.00	130.00	350.00	400.00
25.04.2008							282.30	-	-	-	-
01.08.2009	79.82	72.92	165.91	268.09	165.91	118.26	-	-	146.25	400.00	450.00
12.05.2009							509.70		-	-	-
19.09.2011							651.29		-	-	-
01.09.2015			190.86	321.68	182.64	236.73	764.55		198.22	600.00	650.00

Source: PetroBangla Annual Report 2014, No. BERC/Tariff/Gas-12/Transmission & Distribution/3056

According to the gas sales regulations, gas retail tariff can be revised once a year. However, despite such stipulation, there have been cases where the regulations are revised irregulary on short notice due to the strong requests from the government.

The latest revision of natural gas tariff became effective since 1st September, 2015. BERC declared the price hike in a press briefing at BERC office on 27th August, 2015. According to No. BERC/Tariff/Gas-12/Transmission & Distribution/3056, the revised tariff rate was 600 BDT/month and 650 BDT/month for single and double burners respectively, that were up from 400 BDT/month and 450 BDT/month.

20.1.2 Comparison of natural gas tariff in Bangladesh with other countries

Table 20-3 compares the natural gas retail tariff in Bangladesh as of 2011 with other countries in Asia. The table illustrates that Bangladesh's retail gas tariff rates are significantly lower than other countries For example, gas tariff for power generation in Bangladesh is about two fifths of that in Pakistan and less than 10% of that in Singapore. In comparison with Pakistan where the economic conditions are relatively similar, tariff rates for CNG stand and residenrial costomers are slightly higher in Bangladesh, but in comparison with India, tariff rate for CNG stand is about half and the residential tariff is about one sixth in Bangladesh .

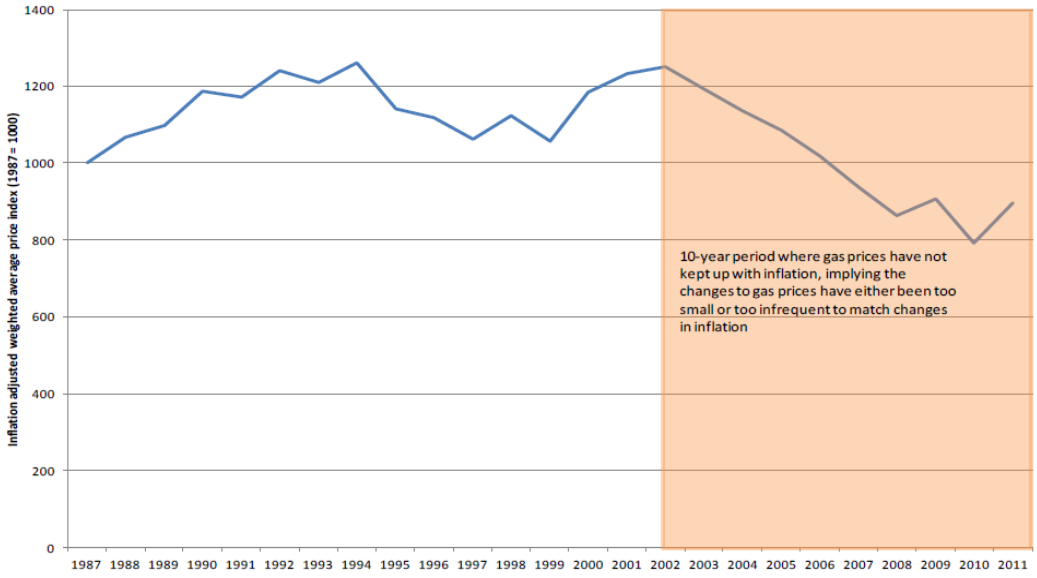
Table 20-3 Comparison of Gas Tariff Rates in Bangladesh with other Asian countries

(Unit: USD/mcf)

Country / *Effective Date of Tariff*	*Bangladesh* *19/09/2011*	*Pakistan* *7/08/2011*	*India* *1/12/2011*	*Malaysia* *1/06/2011*	*Thailand* *1/06/2011*	*Indonesia* *1/06/2011*	*Singapore* *1/06/2011*
Consumer Category							
Power	1.05	5.14	5.06	4.36	5.81	6.7	13.79
IPP	1.05	4.34					
Fertilizer							
Feed Stock	0.96	1.17	5.06				
Power	1.56	4.99					
Industry	2.19	4.99	18.19	5.12	6.2	5.97	35.21
Cement		7					
Ice Factory		6.05					
Captive Power	1.56	4.99					
CNG	8.6	6.57	16.17				
Large Commercial	3.54	6.05	18.19	5.12			
Small Commercial	3.54	6.05	23.51	5.12			
Domestic	1.93	1.24	12.27				
Tea Estate	2.19						

Source: ADB "Bangladesh: Tariff Reform and Inter-sectoral Allocation of Natural Gas" (2013)

Figure 20-2 shows the historical trend of average natural gas price in Bangladsh since 1997 indexized on real-price basis and with 1997 price as base year. If this curve is on a upward trend, the natural gas price increased higher than the general price level and if this curve is on a downward trend, the increase of natural gas price was lower than that of general price level. As this figure shows since 2002 the gas price increase has not come up with the inflation, i.e. gas price on real-price basis has been declining.



Source: "Bangladesh: Tariff Reform and Inter-sectoral Allocation of Natural Gas" (ADB, 2013)

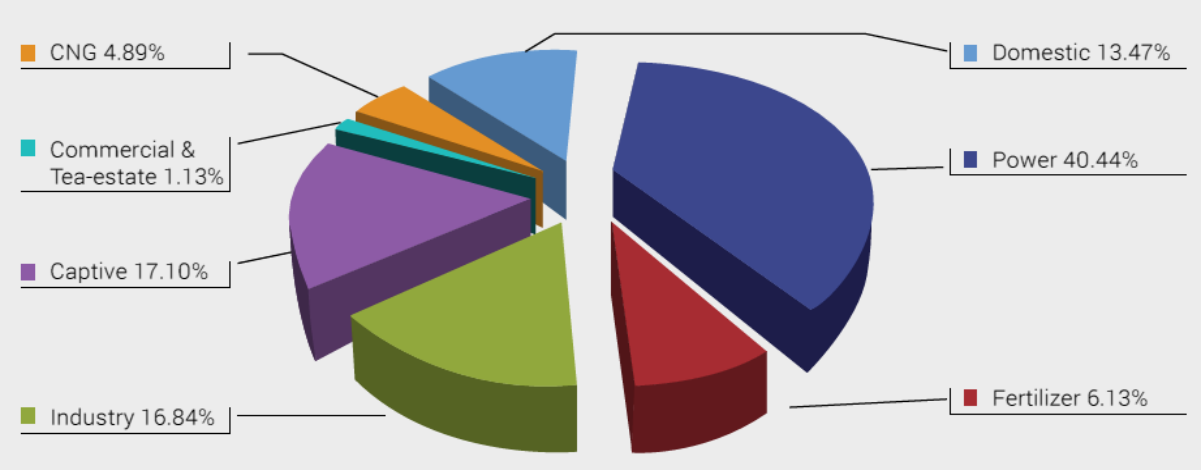
Figure 20-2 Trend of Average Gas Price Indexized with 1997 Price Level

20.2 Financial Performance of Petrobangla and BPC

In Bangladesh, natural gas supply is exclusively operated by the state-owned Bangladesh Oil, Gas & Mineral Corporation (Petrobangla). Petrobangla also has a subsidiarie companiess in coal suppylOi supply is handled by another state-owned company, Bangladesh Petroleum Corporation (BPC).

20.2.1 Petrobangla

Petrobangla is a state-owned company in charge of exploring fossil fuel resources natural gas business in Bangladesh. Petrobangla, along with its subsidiary companies, explores and develops natural gas, as well as operating the production, transmission, distribution, and retail of natural gas., It also conducts gas exploration with international oil companies (IOCs) under production sharing agreements (PSAs). Total natural gas sales as of FY2014-2015 were 877.3 billion cubic feet (BCF), and the power sector consumed about 40% of total gas sales (see Figure 20-3).



Source: Petrobangla's annual report 2013

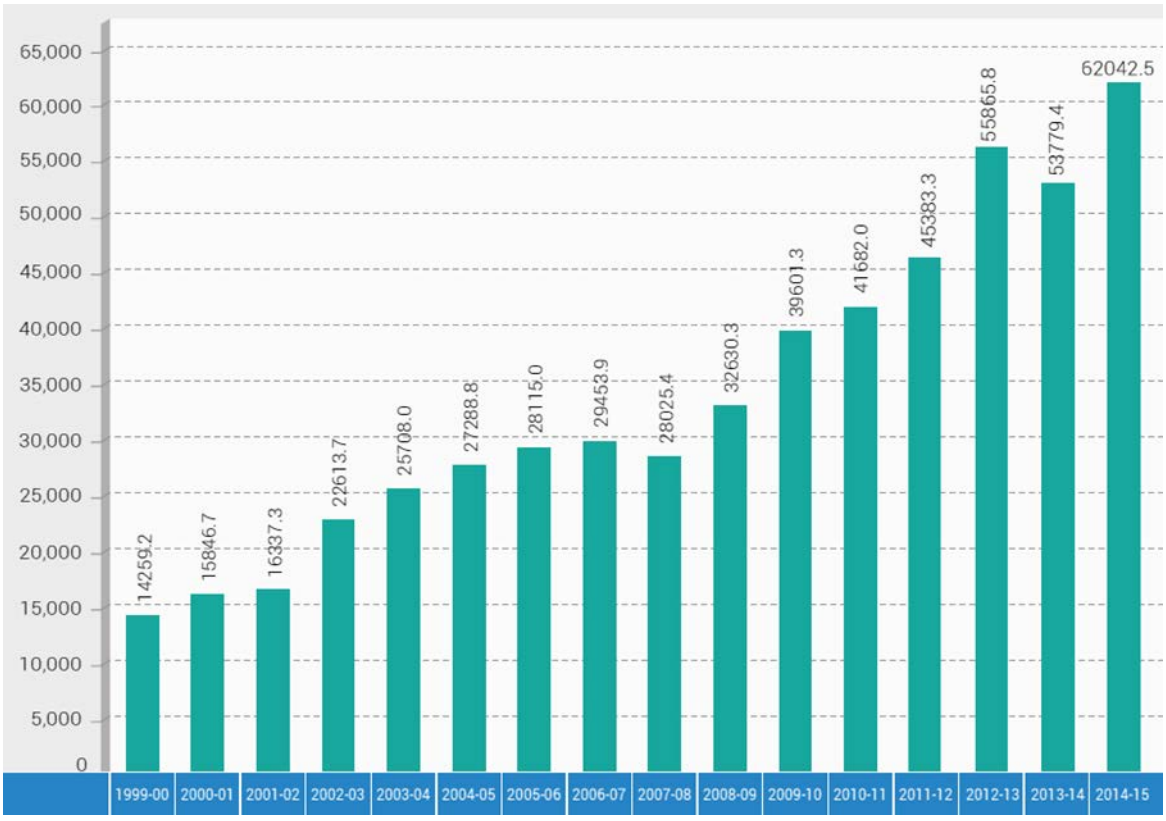
Figure 20-3 Sectorial Breakdown of Natural Gas Consumption in FY2014-2015

Gas tariff rates are determined upon the approvl of BERC. As shown in Table 20-2, gas prices for power generation and fertilizer raw material are set lower while gas prices for industrial and commercial sectors are set relatively higher.

According to Petrobangla's annual report of 2015, the consolidated revenue of Petrobangla group was 280,759 millionBDT, while the total expnses including the consts of sales, interest SD (supplementary duty), VAT (value-added tax), etc. reached 246,966 million BDT. The net profit after deducting income tax, dividend paid to the government etc. was 431,825 million BDT.

That is, Petrobangla has been making profit on its income statement andpaying taxes and duties to the government. The taxes and duties paid by Petrobangla to the government consist of various items such as SD (supplementary duty), VAT (value-added tax), DSL (debt-service liability) and CD (custom duty) and the total amount paid to the national budget in FY2014-2015 was 62,043 million BDT.

The profitability of Petrobangla, despite the very low tariff rates of natural gas compared to other countries, is due to the low costs of domestic gas production and the revenues from PSC (production sharing contract) that Petrobangla concluded with exploration companies such as IOCs. However, as the domestic gas production is supposed to decline and the country's dependence on imported LNG that is much costly increases, Petrobangla will be faced with difficualty in making profit under the current natural gas tariff rates. In other words, unless the natural gas prices are raised to match the international price level, Petrobangla's contribution to natural budget will deceline and in the future Petrobangla's financial conditions may become unsustainable without subsidies, as BPDB has already been in the situation.



Source: Petrobangla's annual report 2015

Figure 20-4 Taxes and Suties Paid by Petrobangla to the Government of Bangladesh

Table 20-4 Breakdown of Taxes and Duties Paid by Petrobangla to the Government of Bangladesh

Year	SD+VAT	DSL	Income Tax	Dividend	CD/VAT	Royalty	Total
1997-98	8431.1	2745.7	862.8	1000.1	404.1	-	13443.8
1998-99	9116.9	2984.9	1030.6	1500.0	168.0	-	14800.4
1999-00	8618.9	3253.3	1105.1	1150.0	131.9	-	14259.2
2000-01	11049.2	2503.8	1142.1	1058.6	93.0	-	15846.7
2001-02	10541.3	3327.3	917.2	1428.9	122.6	-	16337.3
2002-03	15576.4	3395.9	1456.8	1499.8	684.7	-	22613.7
2003-04	18235.2	3708.9	1620.4	1750.0	393.5	-	25708.0
2004-05	18481.0	3681.1	2530.6	2000.0	596.2	-	27288.8
2005-06	18526.7	3440.0	3597.8	2154.8	383.2	12.5	28115.0
2006-07	18801.5	4145.5	3665.1	2500.0	329.2	12.6	29453.9
2007-08	17900.6	3223.4	6490.5	-	350.1	60.9	28025.4
2008-09	19313.5	3533.0	7507.6	1715.3	554.7	6.3	32630.3
2009-10	20064.7	3331.2	10057.5	3281.6	2211.1	655.3	39601.3
2010-11	21625.5	3209.0	11050.9	4198.4	884.2	714.0	41682.0
2011-12	26668.1	2989.3	9378.9	3875.8	1470.6	1000.6	45383.3
2012-13	23861.6	3350.1	14257.2	8395.8	4596.4	1404.7	55865.8
2013-14	31616.0	2856.3	11854.2	4460.8	1443.0	1549.1	53779.4
2014-15	37498.6	2392.3	9471.7	11009.0	1425.4	245.5	62042.5

Source: Petrobangla's annual report 2015

20.2.2 Bangladesh Petroleum Corporation (BPC)

Bangladesh Petroleum Corporation (BPC), through its subsidiary companies as follows, conducts the import, refinery, storage and sale of crude oil and petroleum products.

- Refinery: ERL
- Lubricant blending: ELBL and SAOCL
- LPG bottling: LPGL
- Sales of petroleum products: POCL, MPL and JOCL.

The domestic prices of petroleum products are basically set to follow the international price level, because, unlike the natural gas that is produced domestically, oil is mostly imported. However due to the government control on prices, oil prices in domestic market are much less volatile than international prices. Therefore, when the rising trend of international oil prices continues, a negative gap between high import cost and low sales price can affect the financia conditions of BPC. Like the case of BPDB, government loan to suppot the finances of BPC when its financial conditions becomes seriously worse.

A study report published by IISD (International Institute for Sustainable Development) "Energy Subsidies in Bangladesh: A profile of groups vulnerable to reform" (August 2013) estimates the government subsidies to petroleum product in Bangladesh by calculating the difference between the price of imported petroleum products and the domestic price regulated by the government. According to this analysis (see Table 20-5) subsidies to diesel oil increased significantly from 1.22 BDT/litre in FY2009-2010 to 16.43 BDT/litre in FY2011-2012. Though the domestic price was raised from 44

BDT/litre to 61 BDT/litre during the same time, the rapider increase of import cost widened the negative gap.

Table 20-5 Subsidies for Imported Diesel Oil and Furnace Oil

	Sales (million litres)	Per-unit supply cost (BDT/litre)	Selling price (BDT/liter)	Per-unit subsidy (BDT/litre)	Total subsidies (million BDT)
2009-2010					
Diesel	3045.894688	45.22	44	1.22	3715.992
Furnace oil	210.08653	38.00	30	8.002583	1681.235
2010-2011					
Diesel	3841.784894	62	46	16	61468.56
Furnace oil	589.275594	58.33	42	16.33	9622.87
2011-2012					
Diesel	3843.053914	77.45	61	16.45	63218.24
Furnace oil	956.20127	65.13	55	10.13	9686.319

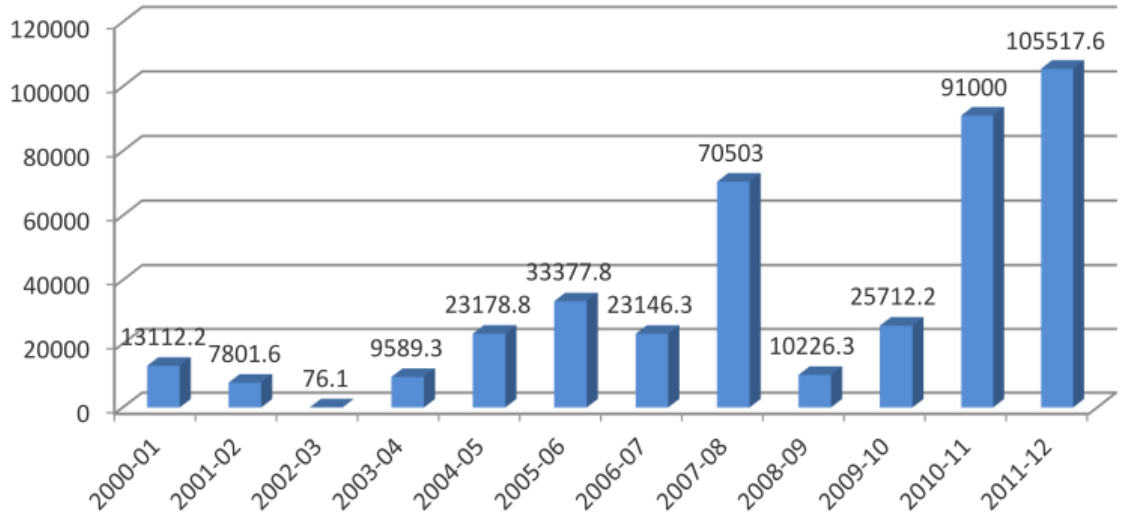
Source: IISD "Energy Subsidies in Bangladesh: A profile of groups vulnerable to reform" (2013)

Because BPC has not disclosed its financial statements since FY2010-2011, details of its current financial situation are not clear, but as of FY2010-2011 the costs of sales were 312,347 million BDT, which far exceeded the annual sales 230,086 million BDT. The gross loss was 82,261 million BDT and after deducting interest payment and so on, the final net loss was 97,900 million BDT. In the previous year FY2009-2010, the costs of sales were 193,466 million BDT whereas the sales were 173,497 million BDT, the gross loss was 19,972 million BDT and the final net loss was 25,712 million BDT. The financial balance was worsened significantly in a year because of the price spike of crude oil at that time.

According to the aforementioned IISD report, BPC had been in net loss for more than 10 years and the situation especially got worse since late-2000s (see Figure 20-5).

BPC's balance sheet as of FY2010-2011 tells that the company's cumulative loss far exceeded its share capital and reserves and that the company is in a capital deficit of -320,280 million BDT. Even in the previous year it had a capital deficit of -222,281 million BDT but the situation was further worsened.

The recent trend of lowered crude oil prices is expected to mitigate the worsened trend of BPC's financial conditions, and it is recommended that appropriate price policies are implemented for diminishing BPC's cumulative loss taking advantage of this situation, and that, as the next step to follow, price policies are reviewed so that the price control are gradually removed and the domestic prices are more linked to international prices (market prices).



Source: IISD "Energy Subsidies in Bangladesh: A profile of groups vulnerable to reform" (2013)

Figure 20-5 Historical Trend of BPC's Annual Loss (Unit: million BDT)

Chapter 21 Tariff Policy

21.1 Methodologies of the Analysis

In order to analyze the impacts on macro economy caused by increase of electricity tariff and natural gas price, this study utilized a macroeconomic analysis model called GTAP (Global Trade Analysis Project).
The GTAP model is a computable general equilibrium model (CGE model) developed based on the general equilibrium theory of microeconomics. This model, which was developed by Professor Hertel at Purdue University in 1992, aimed at making an impact analysis on tariff reduction or elimination, and this model covers the whole world.
The data set concerning the GTAP model is updated every few years. The latest version at present is the GTAP DATA BASE 8 on the basis of the global economic data in 2007, which categorizes the whole world into 134 regions and 57 industries. This version which was released in 2012 contains detailed categories of Asian and African countries, and data contained in the database is indicated in American dollars.
Since the GTAP model has spread internationally and is considered reliable, it is being used by international organizations such as the World Bank and OECD and research institutes of many countries.
By using the GTAP model, future forecasts become possible based on exogenous conditions. The primary exogenous variables of the GTAP are population (total population/labor population), tax ratio (such as a ratio of tariff), productivity, capital, and so on. Endogenous variables include various items such as GDP, the amount of trade (by industries/countries), output (by industries), private consumption (by products), and so on. Therefore, it is possible to forecast economies by selecting population (total population/labor population) and productivity as well as GDP of countries and regions other than the Indian Ocean Rim Association (such as Japan, China, America, and the EU) as exogenous conditions. Besides, it is also possible to forecast multiple scenarios by changing exogenous conditions.

In this study, the following parameters were used for the GTAP analysis.

- Category of area: Bangladesh, Asian countries, other countries in the other region;
- Category of sectors: Agriculture, coal*, oil*, gas*, electricity, industry, service;

Note) Items with asterisk (*) are used only for analysis of gas price increase

21.2 Analysis on Electricity Tariff

21.2.1 Single-year analysis

(1) Scenario setting

As the first step to analyze the economic impacts of electricity tariff increase on the national economy of Bangladesh, impact of the price increase on the economy was analyzed by using the parameters as of 2014, which is the latest available data for GTAP. In this study, this is called “single-year analysis”

The following three scenarios were envisaged as for the increase of electricity tariff.

- Scenario (a): average electricity tariff (consumer price) increase by 10%
- Scenario (b): average electricity tariff (consumer price) increase by 20%
- Scenario (c): average electricity tariff (consumer price) increase by 30%

Aforementioned increase rates are indicated in real price in USD. Considering the inflation rate in Bangladesh and depreciation of BDT against USD, the rate of tariff increase in nominal BDT becomes 19% in scenario (a), 29% in scenario (b), and 40% in scenario (c).

In Bangladesh, electricity tariff for final consumers is different depending on customer categories. However, due to the methodological limitation of the GTAP analysis, a single price increase ratio was applied to each scenario in the analysis (for example, one “average” 10% electricity tariff increase was used uniformly for scenario (a) regardless of different customer categories.

(2) Result of analysis: Impact on Bangladesh economy

The results of the GTAP analysis on electricity tariff increase are summarized in Table 21-1. 10% increase of electricity tariff, which is the scenario (a) in the table, pushes real GDP downward by 0.72% (USD 810.7 million). Similarly, 20% increase, which is the scenario (b), results in the downturn of real GDP by 1.45% and in the case of 30% increase, which is the scenario (c), real GDP is declined by 2.17%. The results show that the impact on nation economy is considerably huge especially in the scenario (c). Compared to the impact on national economy as a whole (GDP), the impact on real export and real import seem to be relatively small.
The results of sectoral analysis are shown in Table 21-2 and Table 21-3. If the electricity tariff is increased by 10% it will lead to the decrease of products in all sectors by between 0.2% and 0.4%. Electricity tariff increase by 10% also results in the decline in consumption in all sectors by between 0.6% and 1%.
In Table 21-3, which shows the effect on import and export, the impact on electricity sector is significantly high. However, the international trade of electricity itself is still trivial in Bangladesh, and the impact of tariff increase on the import and export of industrial products is relatively limited.

Table 21-1 Impacts of Electricity Tariff Increase on Bangladesh National Economy (single year analysis)

	(a) 10% Increase		(b) 20% Increase		(c) 30% Increase	
	Change ratio (%) in real USD	Monetary value (million USD)	Change ratio (%) in real USD	Monetary value (million USD)	Change ratio (%) in real USD	Monetary value (million USD)
Impact on real GDP	-0.72	-810.7	-1.45	-1618.6	-2.17	-2424.0
Impact on real export	-0.28	-79.3	-0.56	-157.7	-0.83	-235.1
Impact on real import	-0.27	-94.7	-0.55	-189.5	-0.82	-284.2

Source: JICA Survey Team

Table 21-2 Impacts of Electricity Tariff Increase on Each Sector (single-year analysis): production and consumption

	Production			Private sector's consumption		
	(a) 10% Increase	(b) 20% Increase	(c) 30% Increase	(a) 10% Increase	(b) 20% Increase	(c) 30% Increase
Agricultural sector	-0.21	-0.43	-0.65	-0.59	-1.18	-1.76
Electricity sector	-0.42	-0.77	-1.08	-2.56	-4.92	-7.1
Industrial sector	-0.27	-0.54	-0.81	-0.69	-1.37	-2.05
Service sector	-0.36	-0.72	-1.07	-0.98	-1.95	-2.91

Source: JICA Survey Team

Table 21-3 Impacts of Electricity Tariff Increase on Each Sector (single-year analysis): export and import

	Real export			Real import		
	(a) 10% Increase	(b) 20% Increase	(c) 30% Increase	(a) 10% Increase	(b) 20% Increase	(c) 30% Increase
Agricultural sector	2.51	5.08	7.71	-1.67	-3.31	-4.93
Electricity sector	-41.33	-63.78	-76.71	33.21	73.37	121.24
Industrial sector	-0.5	-1.00	-1.5	-0.05	-0.10	-0.16
Service sector	1.41	2.85	4.32	-1.3	-2.59	-3.87

Source: JICA Survey Team

21.2.2 Time-line analysis

(1) Scenario setting

As the next step to follow the aforementioned single-year analysis, a time-line analysis was conducted to analyze the impact of electricity tariff increase on the national economy in a future timeline from 2014 to 2041. The Case 1 assumes that the cost of electricity supply increases by 1.5% in real price per annum, such as increase from usin imported LNG etc., which refers to the analysis result in Chapter 19, and several scenarios were envisaged, as shown in Table 21-4, for analyzing the impact on macro economy of Bangladesh. The increased electricity tariff will come up with the cost of electricity supply by 2021 in Scenario 1, by 2031 in Scenario 2, and by 2041 in Scenario 3.

For simplicity, the Case 2, i.e. scenario analysis without assuming the increase of supply cost was also conducted as shown in Table 21-5.

Table 21-4 Scenarios of Electricity Tariff Increase: Case 1 (cost increase)

Scenario	Annual Increase in real USD
Increase of supply cost	1.5%/year in real price (9.5%/year in nominal BDT)
Base scenario	1.5%/year in real price (9.5%/year in nominal BDT)
Scenario 1	4.2%/year in real price (12.4%/year in nominal BDT) until 2021 1.5%/year in real price (9.5%/year in nominal BDT) from 2022
Scenario 2	2.6%/year in real price (10.7% in nominal BDT) until 2031 1.5%/year in real price (9.5%/year in nominal BDT) from 2032
Scenario 3	2.2%/year in real price (10.3%/year in nominal BDT) until 2041

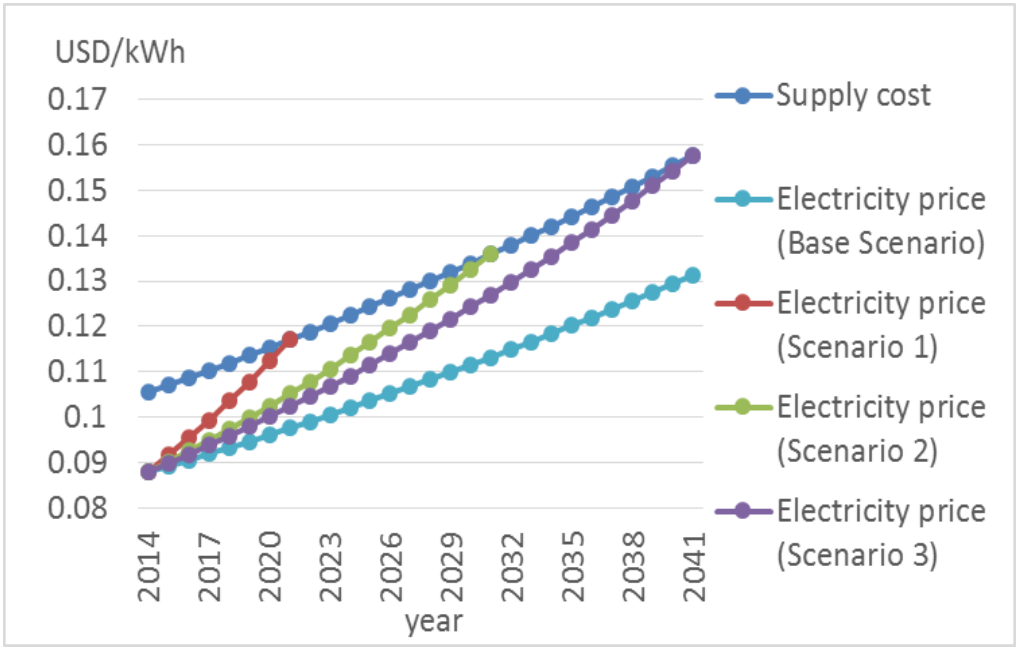
Source: JICA Survey Team

Table 21-5 Scenarios of Electricity Tariff Increase: Case 2 (no cost increase)

Scenario	Annual Increase in real USD
Increase of supply cost	0%/year
Base scenario	0%/year
Scenario 1	2.6%/year in real price (10.7%/year in nominal BDT) until 2021 0%/year from 2022
Scenario 2	1.1%/year in real price (9.1%/year in nominal BDT) until 2031 0%/year from 2032
Scenario 3	0.7%/year in real price (8.7%/year in nominal BDT) until 2041

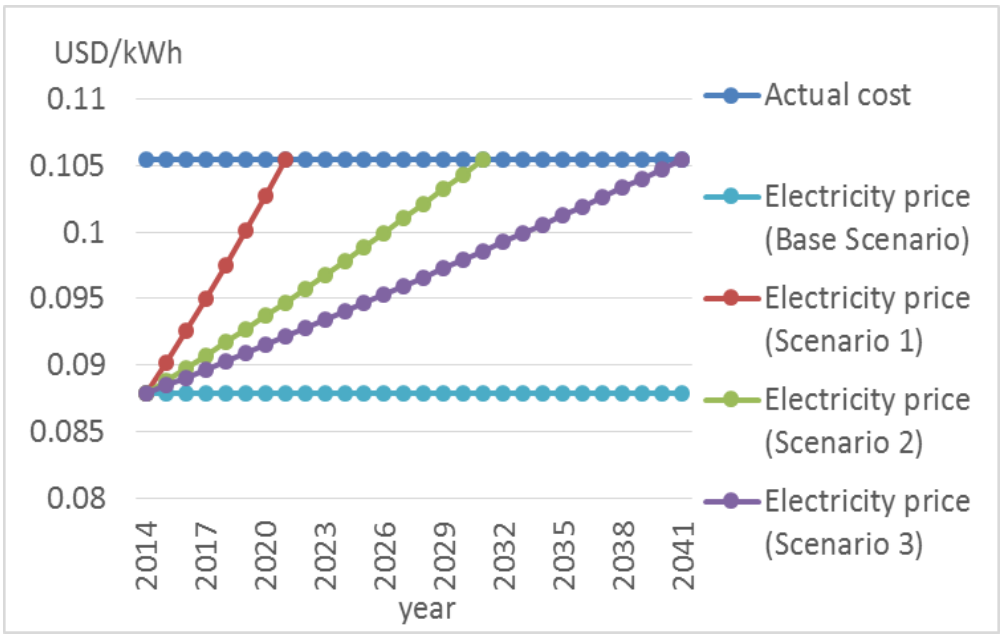
Source: JICA Survey Team

Figure 21-1 and Figure 21-2 summarize these scenarios of tariff increase.



Source: JICA Survey Team

Figure 21-1 Scenario of Increase of Electricity Tariff (Case 1)



Source: JICA Survey Team

Figure 21-2 Scenario of Increase of Electricity Tariff (Case 2)

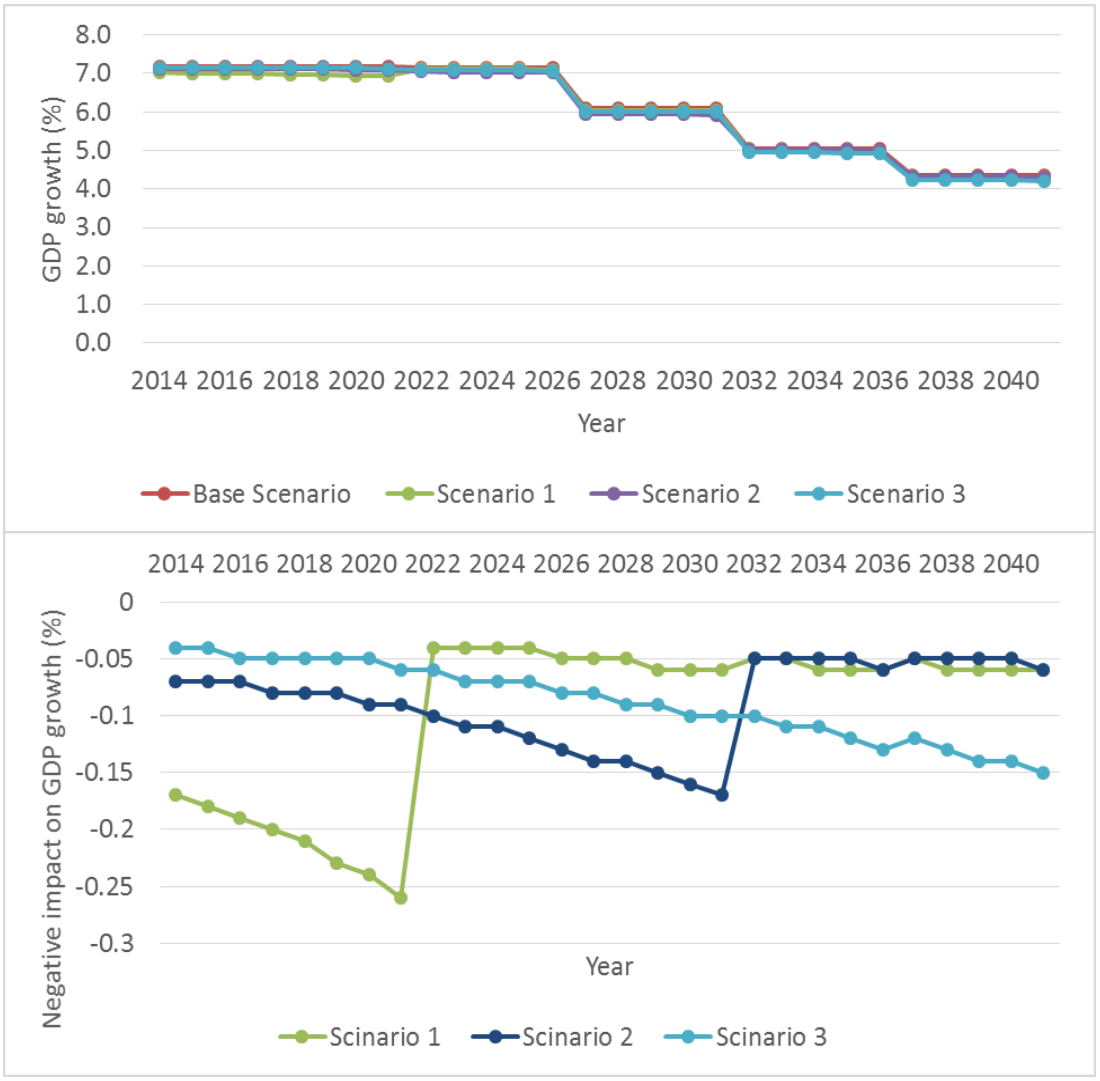
(2) Result of analysis: Impact on Bangladesh Economy

The result of GTAP analysis for Case 1 is summarized in Table 21-6 and Figure 21-3. Electricity tariff increase pushes down GDP growth by 0.26% in 2021 in Scenario 1, by 0.17% in 2031 in Scenario 2, and by 0.15% in 2041 in Scenario 3. Because the time-line analysis takes into account the economic growth in the future and the tariff increase is made along with the economic development, the negative impact on GDP is mitigated compared with the single-year analysis that assumes that the tariff increase occurs in a single year 2014.

Table 21-6 Impacts of Electricity Tariff Increase on Bangladesh National Economy (Case 1)

	2014	2021	2031	2041
Scenario 1	-0.17	-0.26	-0.06	-0.06
Scenario 2	-0.07	-0.09	-0.17	-0.06
Scenario 3	-0.04	-0.06	-0.1	-0.15

Source: JICA Survey Team



Source: JICA Survey Team

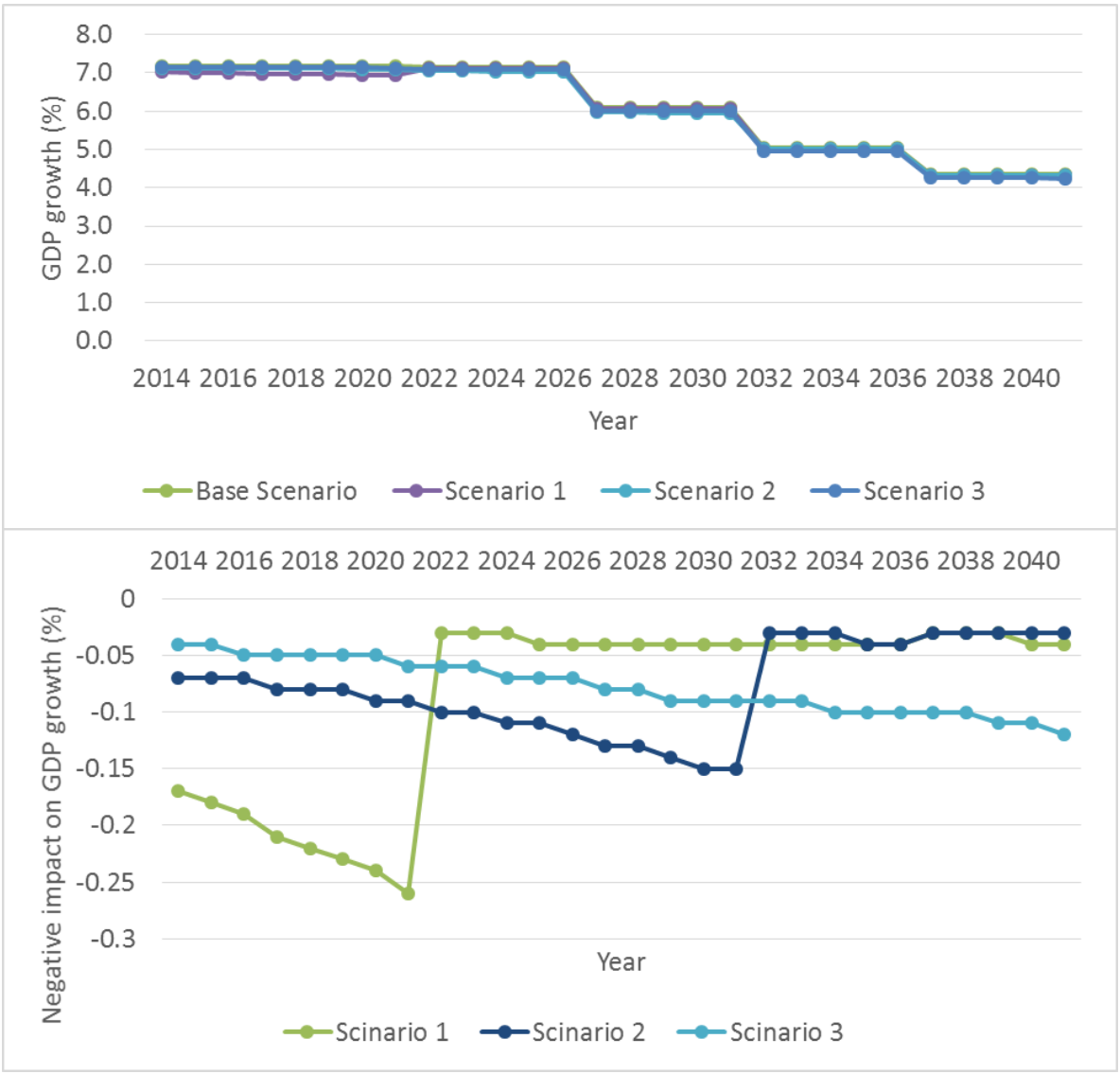
Figure 21-3 Impacts of Electricity Tariff Increase on Bangladesh National Economy (Case 1)

The result of the GTAP analysis for the Case 2 is summarized in Table 21-7 and Figure 21-4. The result is almost similar to that of the Case 1. Electricity tariff increase pushes down the GDP growth by 0.26% in 2021 in Scenario 1, by 0.15% in 2031 in Scenario 2, and by 0.12% in 2041 in Scenario 3.

Table 21-7 Impacts of Electricity Tariff Increase on Bangladesh National Economy (Case 2)

	2014	2021	2031	2041
Scenario 1	-0.17	-0.26	-0.04	-0.04
Scenario 2	-0.07	-0.09	-0.15	-0.03
Scenario 3	-0.04	-0.06	-0.09	-0.12

Source: JICA Survey Team



Source: JICA Survey Team

Figure 21-4 Impacts of Electricity Tariff Increase on Bangladesh National Economy (Case 2)

21.3 Analysis on Gas Price

In the same way, the analysis on the impact of gas price increase on national economy was conducted.

21.3.1 Single-year analysis

(1) Scenario setting

As the first step to analyze the economic impacts of gas price increase on the national economy of Bangladesh, impact of the price increase on the economy was analyzed by using the parameters as of 2014, which is the latest available data for GTAP. In this study, this is called “single-year analysis”

The following two scenarios were envisaged as for the increase of gas price.

- Scenario (a): average gas price increase by 50%
- Scenario (b): average gas price increase by 100%

Aforementioned increase rates are indicate in real price in USD. Considering the inflation rate in Bangladesh and depreciation of BDT against USD, the rate of price increase in nominal BDT become 62% in scenario (a), and 116% in scenario (b).

(2) Result of analysis: Impact on Bangladesh economy

The results of the GTAP analysis for increase of gas price are summarized in Table 21-8. 50% increase of gas price, which is the scenario (a) in the table, pushes real GDP downward by 1.26% (USD 1,407.9 million). 100% increase, which is the scenario (b), results in the decline of real GDP by 2.47%. The results show that the impact on nation economy is considerably huge especially in the scenario (b).
The results of sectoral analysis are shown in Table 21-9 and Table 21-10. If the gas price is increased by 50%, it will lead to the decrease of products in all sectors by between 0.5% and 2.9% except oil sector. Gas price increase by 50% also results in the decline in the consumption in all sectors by between 0.8% and 8.6%.
In Table 21-10, which shows the effect on import and export, the impact on gas sector is significantly high, if the international trade of natural gas is introduced without barriers in Bangladesh.

Table 21-8 Impacts of Gas Price Increase on Bangladesh National Economy (single year analysis)

	(a) 50% Increase		(b) 100% Increase	
	Change ratio (%) in real USD	Monetary value (million USD)	Change ratio (%) in real USD	Monetary value (million USD)
Impact on real GDP	-1.26	-1407.9	-2.47	-2759.1
Impact on real export	-0.72	-204.7	-1.35	-382.8
Impact on real import	-1.36	-472.6	-2.70	-937.7

Source: JICA Survey Team

Table 21-9 Impacts of Gas Price Increase on Each Sector

	Production		Private sector's consumption	
	(a) 50% Increase	(b) 100% Increase	(a) 50% Increase	(b) 100% Increase
Agricultural sector	-0.53	-1.04	-0.81	-1.59
Coal sector	-0.48	-1.03	-1.13	-2.22
Oil sector	0.25	0.49	-1.42	-2.78
Gas sector	-2.92	-5.40	-8.56	-14.47
Electricity sector	-2.28	-4.33	-4.08	-7.60
Industrial sector	-1.49	-2.93	-1.12	-2.19
Service sector	-1.15	-2.26	-1.41	-2.73

Source: JICA Survey Team

Table 21-10 Impacts of Gas Price Increase on Each Sector

	Real export		Real import	
	(a) 50% Increase	(b) 100% Increase	(a) 50% Increase	(b) 100% Increase
Agricultural sector	8.18	16.90	-5.28	-10.22
Coal sector	5.25	10.13	-2.45	-4.71
Oil sector	3.42	6.88	-1.5	-2.94
Gas sector	0	0.00	39,184	606,589
Electricity sector	-57.23	-79.29	49.18	110.79
Industrial sector	-1.46	-2.86	-0.74	-1.53
Service sector	5.1	10.67	-3.49	-6.93

Source: JICA Survey Team

21.3.2 Time-line analysis

(1) Scenario setting

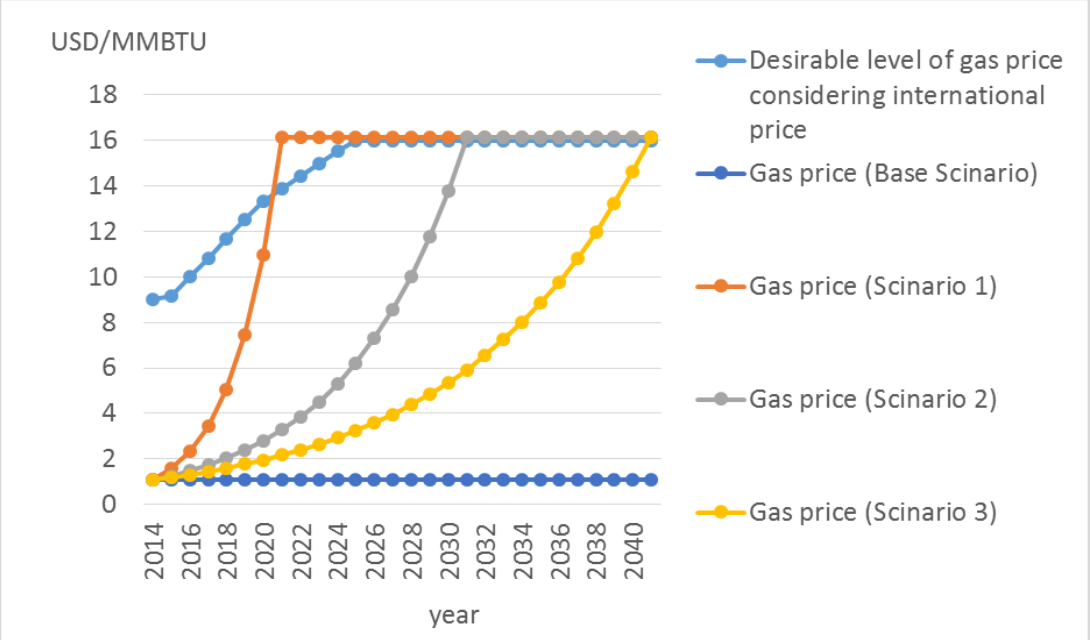
As the next step to follow the aforementioned single-year analysis, a time-line analysis was conducted to analyze the impact of domestic gas price increase on the national economy on a future timeline from 2014 to 2041. The Scenario 1 assumes that the increase of domestic gas price will come up with the progressively increasing international gas price by 2021, by 2031 in Scenario 2, and by 2041 in Scenario 3. As discussed in Chapter 8, CIF (cost, insurance and freight) price of LNG in Asia is expected to decline in the future but more conservative prospect is applied in this analysis so that the international gas price will become constant in the future.

Table 21-11 Scenarios of Gas Price Increase

Scenario	Annual Increase of Gas Price in real USD
Base Scenario	0%/year
Scenario 1	47.2%/year in real price (58.8% in nominal BDT) until 2021 0%/year from 2022
Scenario 2	17.3%/year (26.6%/year in nominal BDT) until 2031 0%/year from 2032
Scenario 3	10.6%/year (19.3%/year in nominal BDT) until 2041

Source: JICA Survey Team

Figure 21-5 summarizes these scenarios of tariff increase.



Source: JICA Survey Team

Figure 21-5 Scenario of Increase of Gas Price

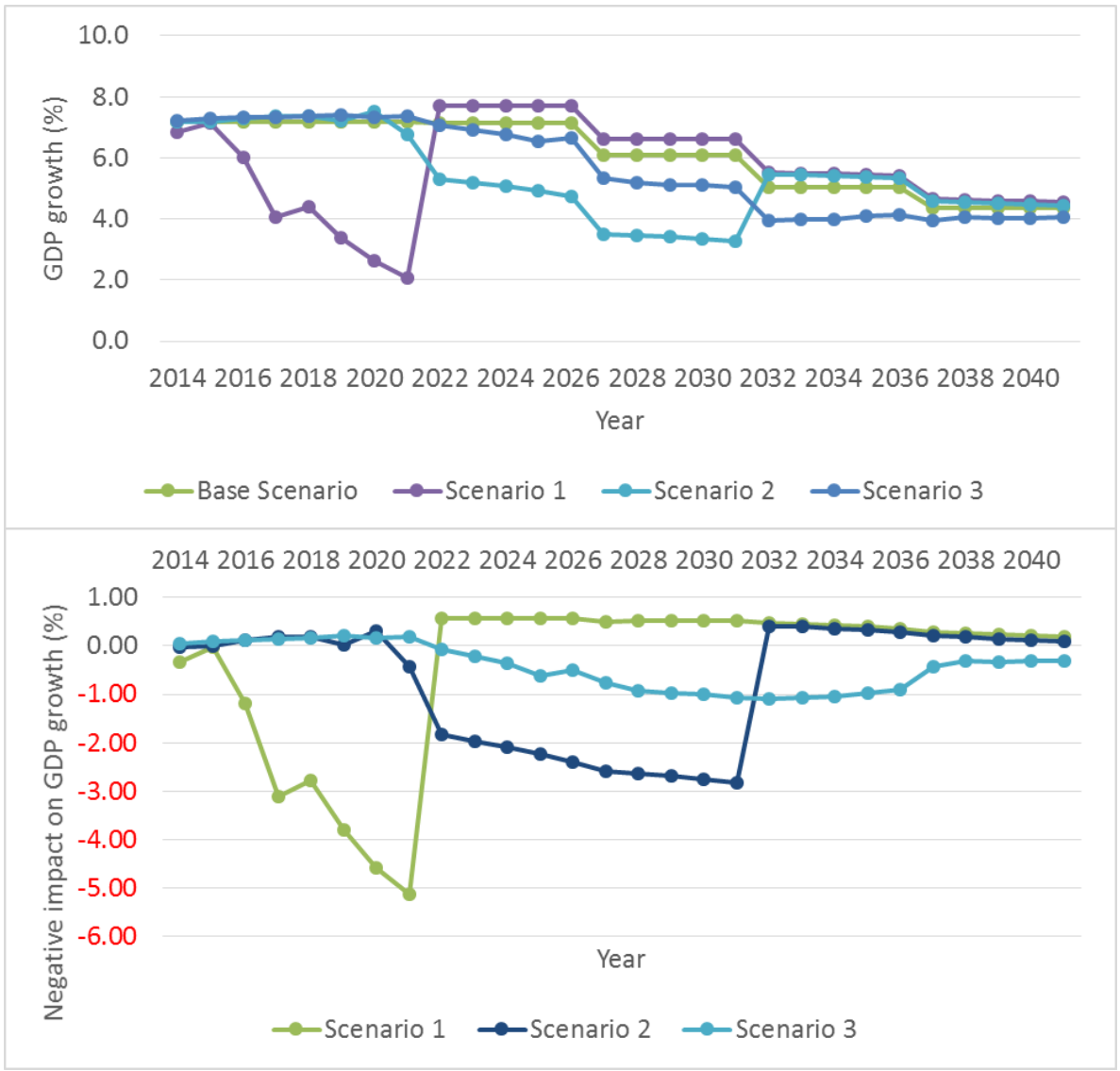
(2) Result of analysis: Impact on Bangladesh economy

The result of GTAP analysis is summarized in Table 21-12 and Figure 21-6. Gas price is dropped by 5.13% in 2021 in Scenario 1, and by 2.82% in 2031 in Scenario 2. The negative impact of gas price on the national economy is relatively large in Scenarios 1 and 2, in which the domestic gas price is raised rapidly to come up with the international price. The negative impact on the national economy is smaller in Scenario 3, which is the scenario of less-accelerated increase of gas price.

Table 21-12 Impacts of Gas Price Increase on Bangladesh National Economy

	2014	2021	2031	2041
Scenario 1	-0.33	-5.13	0.52	0.18
Scenario 2	-0.02	-0.43	-2.82	0.09
Scenario 3	0.04	0.19	-1.08	-0.32

Source: JICA Survey Team



Source: JICA Survey Team

Figure 21-6 Impacts of Gas Price Increase on Bangladesh National Economy

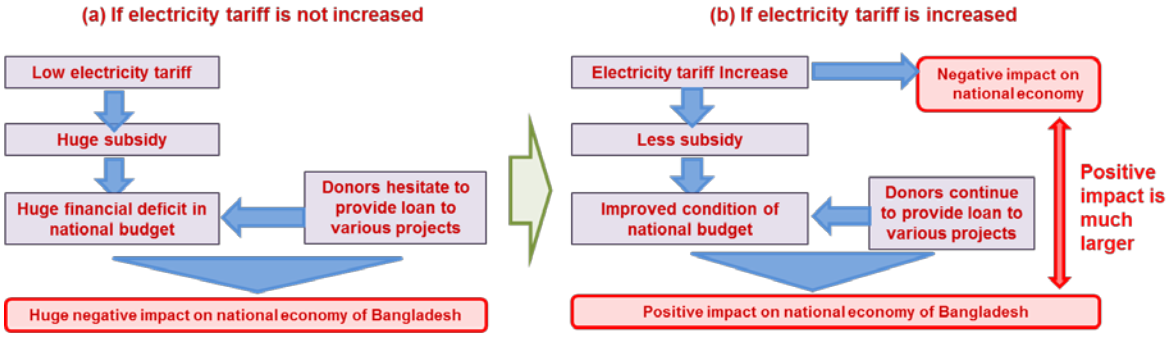
21.4 Policy Recommendations on Increase of Electricity Tariff

21.4.1 Electricity tariff reform

The analyses in Chapter 19 and Chapter 20 revealed that BPDB is facing a serious budgetary situation. Hence, raise electricity tariff in a planned way to ensure the budget to recover the cost of electricity supply needs to be formulated urgently. Both bulk supply tariff and retail tariff need to be increased appropriately so that the whole supply cost can be recovered without subsidies.

Unless appropriate measures to increase electricity tariff are not in place, more subsidies will need to be provided to BPDB which will lead to the growth of financial burden for the national budget of Bangladesh. In fact, international donor agencies have been more reluctant in providing loans to infrastructure projects in Bangladesh. As a result, development of infrastructure in Bangladesh might be delayed and the economic growth might be decelerated (see (a) in the following figures).

Raising electricity tariff may give negative impact on the growth of national economy, but improving the national budget will motivate international donor agencies to provide financial support to infrastructure development. In total, more positive effects on the national economy can be expected in the long term so that Bangladesh will be able to come closer to achieving the national target of economic growth.

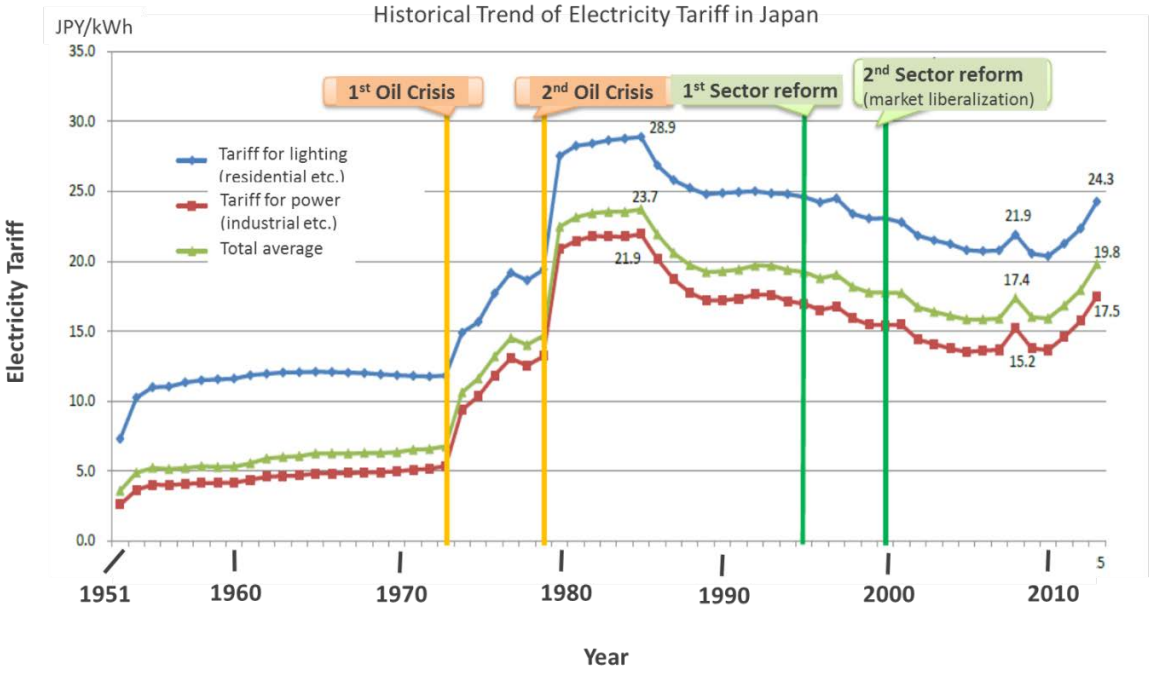


Source: JICA Survey Team

Figure 21-7 Positive Impact of Electricity Tariff Increase on National Economy of Bangladesh

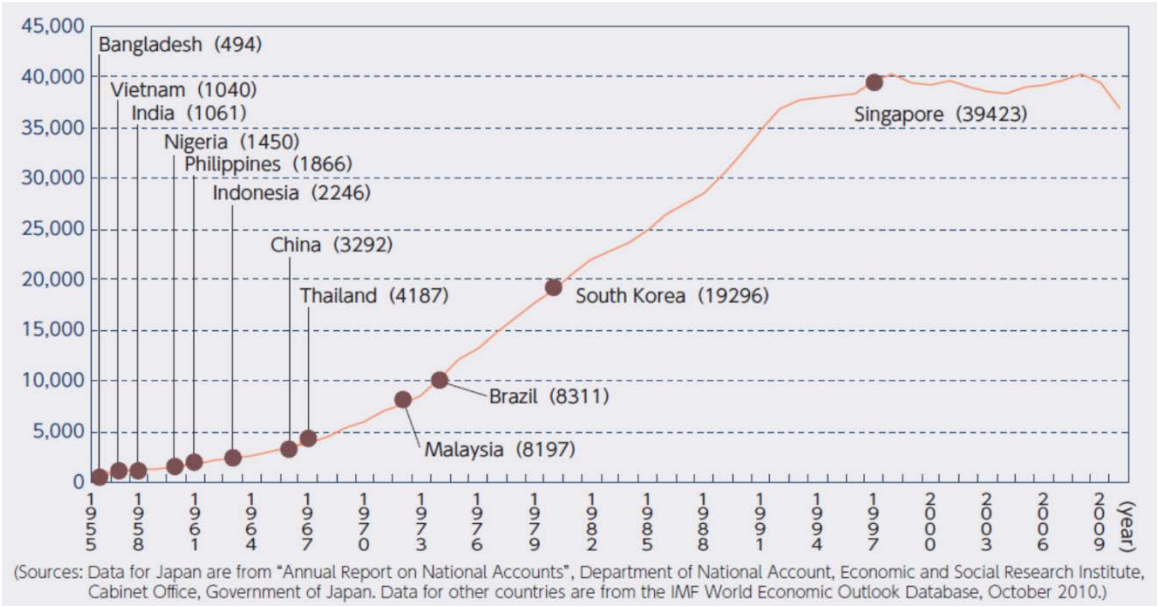
However, the result of GTAP analysis, especially conspicuous in the single-year analysis, revealed that a rapid increase of electricity tariff may trigger a serious negative effect on the national economy in Bangladesh. Therefore, a meticulous approach needs to be taken so that the electricity tariff is raised progressively.

Japan's experience in the past, i.e. during the period of rapid economic development, tells the importance of balancing between the energy price and the national economy. During the period of economic development in 1950's and 1960's, the electricity tariff was relatively stable, which is supposed to contribute greatly to the accelerated economic growth in Japan.



Source: Agency for Natural Resources and Energy, Japan

Figure 21-8 Historical Trend of Electricity Tariff in Japan

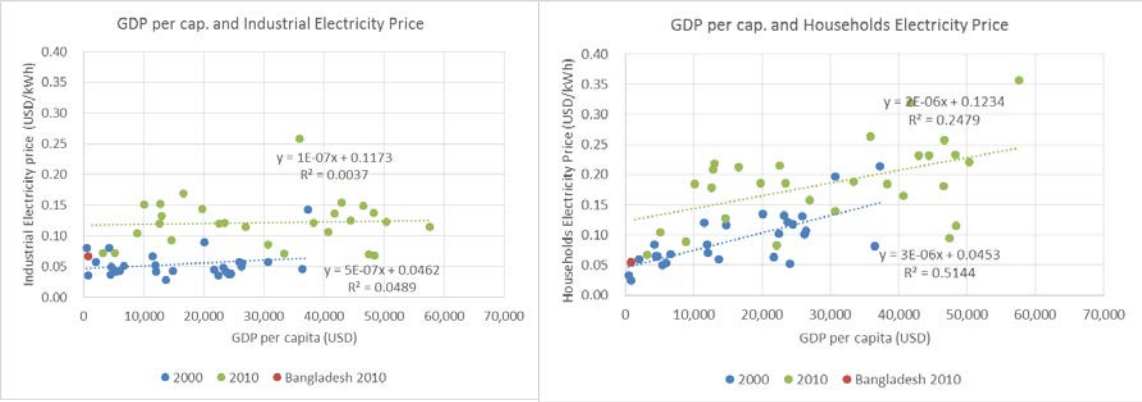


Source: Ministry of the Environment, Japan, "White Paper, Annual Report 2011"

Figure 21-9 Historical Trend of GDP per Capita in Japan

Also, it should be noted that current electricity tariff in Bangladesh is relatively low in comparison with that of other developing countries, though the disparity is not large.
Figure 21-10 shows the relation between GDP per capita and electricity tariff in selected OECD countries and major Asian countries such as China, India, Indonesia, Singapore, Thailand, and Bangladesh.

There seems to be no relation between GDP per capita and the electricity tariff for industrial sector. However, there seems to be some positive correlation between GDP per capita and electricity tariff for residential sector, at least looking at the data of the year 2000 (correlation coefficient is 0.72, p=0.000). This implies that electricity tariff for residential sector is apt to be low in developing countries but is gradually increased in accordance with the level of economic development to cover full supply cost. As indicated in Table 21-13, the current household electricity tariff in Bangladesh is still half that of Thailand.



*GDP per capita is nominal amount using OECD exchange rate.
Source: IEA Energy prices and taxes 2008 and 2012, and BERC

Figure 21-10 GDP per Capita and Electricity Tariff

Table 21-13 GDP per Capita and Electricity Tariff

Unit: USD/kWh

	Industry				Household			
	2000		2010		2000		2010	
	GDP per cap (2000)	Industry Electricity Tariff (2000)	GDP per cap (2010)	Industry Electricity Tariff (2010)	GDP per cap (2000)	Households Electricity Tariff (2000)	GDP per cap (2010)	Households Electricity Tariff (2010)
Australia	21,665	0.045	51,846		21,665	0.063	51,846	
Austria	24,517	0.038	46,660		24,517	0.118	46,660	0.258
Belgium	23,207	0.048	44,383	0.125	23,207	0.132	44,383	0.232
Canada	24,032	0.038	47,464	0.070	24,032	0.053	47,464	0.095
Chile	5,229		12,785	0.152	5,229		12,785	0.209
Czech Rep.	5,995	0.043	19,764	0.144	5,995	0.054	19,764	0.186
Denmark	30,744	0.058	57,648	0.114	30,744	0.197	57,648	0.356
Estonia			14,641	0.093			14,641	0.127
France	22,466	0.036	40,706	0.107	22,466	0.102	40,706	0.165
Germany	23,719	0.041	41,788	0.136	23,719	0.121	41,788	0.319
Greece	12,076	0.042	26,919	0.114	12,076	0.071	26,919	0.158
Hungary	4,620	0.049	13,009	0.133	4,620	0.065	13,009	0.219
Ireland	26,236	0.049	48,261	0.137	26,236	0.101	48,261	0.233
Israel			30,736	0.086			30,736	0.140
Italy	20,059	0.089	35,878	0.258	20,059	0.135	35,878	0.263
Japan	37,300	0.143	42,909	0.154	37,300	0.214	42,909	0.232
Korea	11,948	0.052	22,151		11,948	0.084	22,151	0.083
Mexico	6,650	0.051	8,851	0.104	6,650	0.068	8,851	0.089
Netherlands	25,921	0.057	50,341	0.123	25,921	0.131	50,341	0.221
New Zealand	13,641	0.028	33,394	0.071	13,641	0.060	33,394	0.188
Poland	4,493	0.037	12,598	0.120	4,493	0.065	12,598	0.179
Portugal	11,502	0.067	22,540	0.120	11,502	0.120	22,540	0.215
Slovak Rep.	5,403	0.042	16,555	0.169	5,403	0.050	16,555	0.213
Slovenia			23,439	0.121			23,439	0.186
Spain	14,788	0.043			14,788	0.117		
Turkey	4,215	0.080	10,112	0.151	4,215	0.084	10,112	0.184
UK	26,401	0.055	38,293	0.121	26,401	0.107	38,293	0.184
US	36,450	0.046	48,374	0.068	36,450	0.082	48,374	0.116
China	955		4,515		955		4,515	
India	452	0.080	1,388		452	0.033	1,388	
Indonesia	780	0.036	3,125	0.072	780	0.025	3,125	0.067
Singapore	23,793		46,570	0.148	23,793		46,570	0.181
Thailand	2,016	0.057	5,112	0.072	2,016	0.060	5,112	0.105
Bangladesh	407		760	0.067	407		760	0.054

Source: IEA Statistics, Energy Prices and Taxes, 2008, 2012

It is inevitably needed for Bangladesh to raise tariff to cover the cost of supply and to mitigate the subsidization to BDBP and raising the electricity tariff for residential sector rapidly also cannot be evaded.

In the meanwhile, the analyses in this chapter also revealed that a rapid increase of electricity tariff will cause huge negative impacts on the national economy in Bangladesh. An important lesson from these analyses is that the negative impacts on the Bangladesh economy can be mitigated if the electricity tariff is raised progressively.

Currently the decision on raising tariffs is made through the consultation among stakeholders such as

BERC and relevant ministries (i.e. Ministry of Power, Energy and Mineral Resources, Ministry of Planning etc.). Considering that the increase of prices of basic commodities such as electricity may cause serious effect on the living standard of the nation, especially that of lower-income people, it is recommended to consider a moderate increase in tariff rates for those in the residential sector who only consume the minimum volume of electricity to sustain their life, such as keeping the same rate of increase as that of general consumer price increase, i.e. 1.5% increase in real USD (9.5% increase in nominal BDT).

For other customer categories, it is recommended to increase tariffs to follow the proposed scenario in this study, i.e. 2.6% increase in real USD (10.7%/year increase in nominal BDT), until 2031 and then 1.5%/year in real USD (9.5%/year increase in nominal BDT) after 2032. However, this proposal is the minimum requirement of tariff increase. From the viewpoint that improving the financial situation as early as possible is desired, it is strongly recommended to increase the tariff as rapidly as possible if the negative effect on the national economy is accepted.

Table 21-14 Proposed Scenario of Electricity Tariff Increase

Customer Category	Range (KWH)	BDT/Kw SEPT	Scenario of price increase
Domestic-A	1-50	3.33	Keep minimum increase (e.g. 1.5%/year increase in real USD / 9.5%/year increase in nominal BDT*)
	1–75	3.53	
	76–100	5.01	Increase according to the scenario. (e.g. 2.6%/year increase in real USD / 10.7% increase in nominal BDT* until 2031, 1.5%/year increase in real USD / 9.5%/year increase in nominal BDT* after 2032) ＋the amount cover the price cost gap of lower categories
	101–200		
	201–300	5.19	
	301–400	5.42	
	401–600	8.51	
	Above 600	9.93	
Agricultural pumping-B	Flat	2.51	Keep minimum increase (e.g. 1.5%/year increase in real USD / 9.5%/year increase in nominal BDT*) or according to the scenario.
Small industry category-C	Flat	7.42	Increase according to the scenario. (e.g. 2.6%/year increase in real USD / 10.7%/year increase in nominal BDT* until 2031, 1.5%/year increase in real USD / 9.5%/year increase in nominal BDT* after 2032)
	Peak	6.64	
	Off peak	9.00	
Non-residential category-D		4.98	
Commercial category-E	Flat	9.58	
	Off peak	8.16	
	Peak	11.55	
Medium Voltage 11 KV General Category-F	Flat	7.32	
	Off peak	6.62	
	Peak	9.33	
Extra High Voltage Category (132KV)-G	Flat	6.96	
	Off peak	6.35	
	Peak	9.19	
High Voltage 33 KV General Category-H	Flat	7.20	
	Off peak	6.55	
	Peak	9.28	
Street Lights & Pump Category-J		6.93	

*If current inflation rate in nominal BDT is considered

Source: Developed based on document of BERC

In parallel with the retail electricity tariff for end-consumers, bulk supply tariff needs to be increased to cover the gap between supply cost and revenue. Bulk supply tariff is expected to be increased in accordance with the scenario similar to that of retail electricity tariff for end-consumers.

21.4.2 Capacity building of human resource for financial review

For gaining public acceptance on the drastic increase of electricity tariff, the electric power sector needs to show the efforts to reduce the cost of electricity supply. Therefore the power sector needs to take on a strong initiative to reduce the cost of supply, especially the cost of power generation, while proposing the increase of tariff.

Involvement of third parties in the process of cost reduction is a cogent approach. If this approach is not easy in terms of confidentiality because the most critical part in the cost of supply that needs to be reviewed is the procurement of wholesale generation and most of the PPA is a private contract, BPDB instead should take a strong initiative to launch a special task team for rationalizing the cost of supply. Then, if it is difficult to change the condition of the singed contracts, it should establish an external body to check the cost efficiency whenever BPDB sings a new contract. Support from international donor agencies for capacity development should be considered.

21.4.3 Gas price reform

As discussed in Chapter 8, it is expected that the supply of natural gas will fall much short of domestic demand in Bangladesh, and Bangladesh needs to expand gas supply through LNG import. If Bangladesh continues to fill the gap between domestic gas price and international gas price with subsidies, financial deficit of the Bangladesh government will be accumulated.

Like the case of electricity tariff, international donor agencies would be reluctant to provide loans to infrastructure projects in Bangladesh. As a result, development of infrastructure in Bangladesh would be delayed and economic growth will be decelerated. Raising gas price might have negative impact on the national economy, but it will motivate international donor agencies to continue providing loans for the development of infrastructure, an in total, a positive impact on the national economy can be expected in the long term so that Bangladesh will be closer to achieving the target of economic growth.

The Bangladesh Energy Regulatory Commission Act 2003 (BERC Act 2003), in its Chapter 6, article 34, paragraph 2(b), stipulates that it is necessary “to harmonize the tariff with the cost of production, transmission, marketing, distribution, supply and storage of energy”. This text does not seem to take into consideration the cost increase driven by LNG import. Hence, it is important to consider increasing the natural gas price progressively to meet the international market price of natural gas so that the further increase of financial deficit in the national budget is avoided. When Bangladesh revises the BERC Act 2003, the harmonization with international market price should also be considered.

According to the result of GTAP analysis, it is indispensable for Bangladesh to increase domestic natural gas price but it is recommended to achieve this gradually, since the rapid increase of gas price gives a huge negative impact on the Bangladesh national economy. Considering the prospects of LNG import and international gas price, continuous annual increase by 10%/year to 20%/year in real USD (19%/year to 29%/year in nominal BDT) would be appropriate.

PART VI TECHNICAL SUPPORT

PART VI TECHNICAL SUPPORT

Chapter 22 Recommendations on the Implementation & Monitoring of the Master Plan

The issues required to be addressed with a scope wider than the scopes of subject-specific development plans and those of individual sectors in the implementation of this master plan in future and the monitoring of its progress, including some recommendations made in the preceding chapters, are described in this chapter. The issues that were not considered to be the preconditions for the formulation of this master plan, but which have to be considered in the monitoring of its implementation and its revision in future are also described in this chapter.

22.1 Capacity building for master plan revision

22.1.1 Collaboration and Cooperation between Organizations involved in the Formulation of MP

In Bangladesh, the Power Division under the Ministry of Power, Energy and Mineral Resources (MoPEMR) is responsible for developing power development plan, and the practical works are done by the Bangladesh Power Development Board (BPDB). In the meanwhile, the Energy and Mineral Resource Division under MoPEMR is responsible for the energy supply plan other than electricity and the practical works are done by Petrobangla, Bangladesh Petroleum Corporation (BPC) and so on.
This study observed that, because of the separated administration between electricity and other energy sources, there is no organizational structure that supervises the overall energy supply and demand in Bangladesh comprehensively. As the domestic production of natural gas in Bangladesh is expected to deplete whereas the energy demand will continue to increase rapidly, the country will need to depend more on imported energy sources.
Considering this situation, the importance of developing an energy supply plan from a comprehensive viewpoint is expected to gain importance for determining how to appropriate the limited domestic energy production among various sectors and which energy sources to import for supplying to which sector and how much.
In developing the aforementioned power development plan and energy supply plan, a systematic relation among stakeholders is needed so that the responsibility of various data necessary for making future projection such as the actual operational data and facility development plan is identified and that these data are administrated in unity. Current status is that, as observed by the JICA Study Team, relations among the organizations responsible for administrating these data are not sufficiently established.
These power development plan and energy supply plan need to be updated regularly by reflecting the conditional changes. Therefore establishing an institutional framework is necessary to develop and implement both plans comprehensively by involving all the relevant stakeholders for these plans to share information.

22.1.2 Periodical Rolling Revision of the Milestone Plan

Although a PSMP has been formulated every five years as a milestone plan, its periodical revision based on a rolling plan has not been conducted appropriately. In principle, a power supply plan in a power development plan is formulated on the basis of demand projection and appropriate standards for ensuring the reliability of supply. However, as the proportions of the projects mentioned in power development plans that have reached the operation stage have been small, a list of prospective projects for investment tends to be included in a power development plan as it is. In principle, a power development plan has to be revised in accordance with power demand and the supply reliability standards as the planning and preparation for projects progress. It is also necessary to revise the power development plan and the energy supply plan formulated in this survey periodically, at least once a year, with changes in the situation including the state of the economy, supply/demand balance of energy sources including domestically-produced natural gas and power supply/demand balance taken into consideration.

22.1.3 Strengthening of integrated statistical processing functions

BPDB has a record of electricity sales to its customers and those wholesaling to other distributing companies. The total sum of them is the total volume of electricity sold by BPDB, but is not identical with the total volume of electricity that is sold by distribution companies including BPDB and used by end consumers. For analyzing the trend of electricity consumption in Bangladesh more specifically, grasping the electricity sales of all distribution companies to end-consumers with sectorial breakdown, such as residential, commercial, industrial etc., is more important. Power Division and/or BPDB is suggested to take an initiative to develop a database of nationwide electricity consumption uniformly as a routine.

The JICA Study Team also observed that there is no government agency responsible for grasping how each sector (residential, commercial, industrial, transport etc.) utilizes energy as the combination of various sources of energy supply such as electricity, natural gas, LPG, oil products, non-commercial fuel (bio fuel) etc. When the JICA Study Team interviewed with various organizations, there were some opinions that, in order to mitigate the increase of natural gas demand, new supply of natural gas to residential sector and transport sector should be restricted and these sectors should be induced to use LPG instead. However, if this idea is actually implemented without long-term perspective of energy supply and demand, it may result in the rapid increase of LPG procurement that is apt to be costlier than LNG, and the burden of nationwide energy cost may become heavier. In order to realize the long-term optimization of nationwide energy balances, GoB needs to strengthen the function to consider and coordinate the national energy policy comprehensively.

Although it should be the Government of Bangladesh that decides which organization is to be responsible for performing these integrated statistic processing functions, the Survey Team recommends the establishment of Integrated Statistics Bureau in MoPEMR for the centralized management of all the data from the organizations under the jurisdiction of the Power Division and the Energy Division with the need to revise the power and energy master plan periodically taken into consideration.

22.1.4 Introduction of Key Performance Indicators

Furthermore, GoB is suggested to set appropriate KPIs (key performance indicators) in the process of planning and to set quantitative target based on this, in order to indicate clearly the directions of energy policy of Bangladesh. Above all, as the country's energy demand is expected to increase rapidly, target setting for rationalizing energy supply and demand (energy efficiency) is indispensable. In addition, strengthening the capacity to analyze the effect of conditional changes on these KPIs and, if necessary, to adjust the targets and plans flexibly to reflect the changes is also required.

Examples of KPIs that serve for target-setting for the power and energy sectors are as follows.

- Energy efficiency: energy intensity per GDP (toe/million BDT), GDP elasticity of energy consumption etc.;
- Economy: cost per unit of energy supply (BDT/kWh) etc.;
- Environmental consideration: emission factor of greenhouse gas etc.;
- Stable supply of energy: energy security index (dependence on energy import, diversification of energy sources), average frequency and duration of power interruption (SAIFI, SAIDI) etc.;
- Optimized supply of energy: balance of aforementioned 3E (integrated indicator), composition of energy source mix etc.;

Currently the main stakeholder agencies in Bangladesh do not have sufficient organizational and staff capacity to deal with these new challenges and international support for improving the capacity of planning, policy implementation and monitoring/evaluation is also needed. Japan has also provided various kinds of assistance such as the dispatch of policy advisors, training programmes and capacity development support programmes. These kinds of assistance will still be needed for Bangladesh.

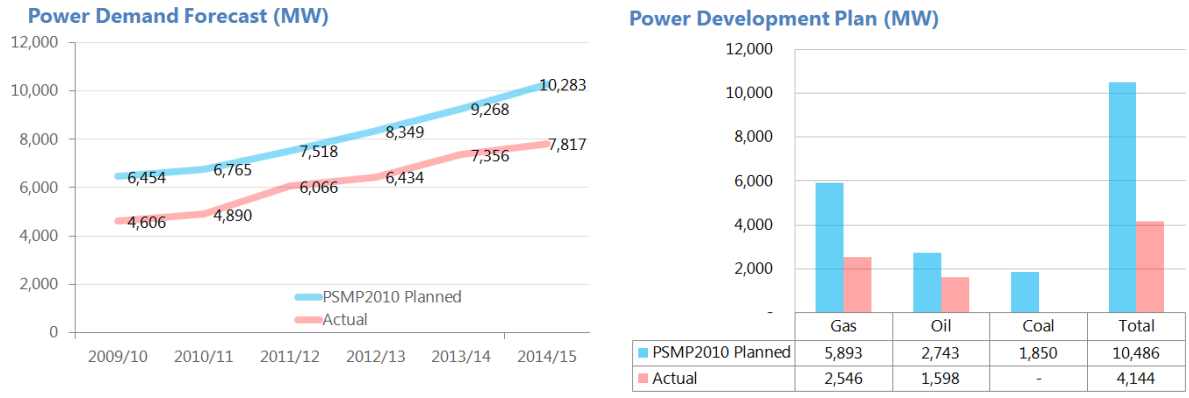
22.2 Measures to Facilitate Improvement of Investment Climate

22.2.1 Outline

As a rapid economic growth is expected in Bangladesh, a power development plan has been formulated to reinforce power generation facilities to meet the increasing power demand. However, as the construction of power generation facilities has not been progressing as planned in reality, as mentioned in detail in the chapter of the power development plan, the demand has been suppressed due to the limited supply and, therefore, the difference between the actual demand and the demand projection including potential demand has been large. This fact may have undeniably had negative impact on the economic growth in Bangladesh.

It is obvious that the milestones in a power development plan, however theoretically the plan may have been formulated, will be just empty theories in the current state in which various factors impede the construction of power source facilities.

Therefore, a discussion conducted on the way to create a climate that makes investment in power development attractive with opinions of investors taken into account is described in the following.



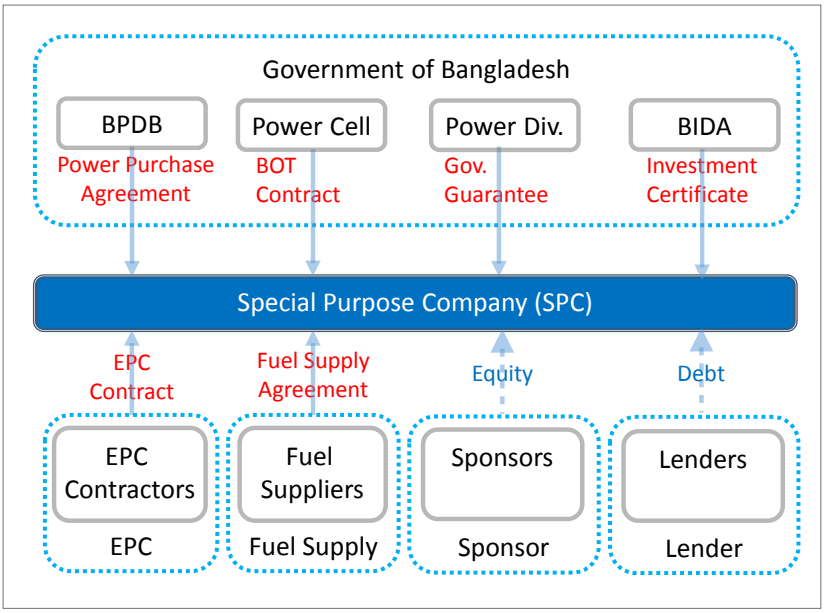
	Gas	Oil	Coal	Total
PSMP2010 Planned	5,893	2,743	1,850	10,486
Actual	2,546	1,598	-	4,144

Source: JICA Survey Team

Figure 22-1 PSMP2010 Review (Power Development Plan)

22.2.2 Project Implementation Structure

In addition to conventional loan projects implemented with public financing from international organizations, projects with PPP investment that utilize the technological capacity and capital of the private sector more than the loan projects are considered a promising means of power development in Bangladesh. The figure below shows a possible project implementation structure assumed for the implementation of IPP projects in Bangladesh.



Source: JICA Survey Team

Figure 22-2 Organaization of IPP

The sponsor of a project consisting of a contractor and an investor usually minimizes the project risk by establishing a special purpose company (SPC) and concluding contracts with various organizations to be involved in it through the SPC. The major project risks are summarized in the following.

- ■ Risks directly concerned with the Government
- ✓ Risks associated with power sales agreements and payment of electricity charges
- ✓ Foreign exchange and remittance risks
- ✓ Country and political risks
- ■ Risks to be controlled mainly by contractors
- ✓ Risks of delay and cost overrun
- ✓ Risks in fuel procurement
- ✓ O&M risks (including risks in the construction of power transmission, transforming and distribution facilities)

22.2.3 Risks directly concerned with the Government

In Bangladesh, an SPC and BPDP conclude a power purchase agreement (PPA) and the SPC becomes the only off-taker of the power under the PPA. Because this agreement provides long-term security, in principle, investors consider it an important agreement that promises profitability of their investment in the project life. Investors prefer a large proportion of the payment for electric power to be made in foreign currencies, while the investee prefers a large proportion of it to be made in the local currency, as they collect electricity charges from users in the local currency. This proportion of the payment in foreign currency has significant influence on investors' decision on investment. If there is a restriction on foreign exchange applicable to a case in which a SPC exchanges the profit from a project after deducting the local costs that it has saved in the local currency in a foreign currency and remits it to the country of the investor, such a restriction will also be an obstacle to the investment.

Power Division applies for the licenses and permits for the establishment of SPCs and construction of facilities with a consent of Power Cell and applies for a government guarantee with a consent of the Ministry of Finance. All the permission and licensing for investment in foreign currencies used to be controlled by the Board of Investment, Bangladesh, (BOI). However, it is currently controlled by Bangladesh Investment Development Authority, which was established recently as a one-stop center for foreign investors. The government's efforts in reorganizing itself in accordance with the needs of investors such as the case mentioned above should be highly appreciated. A contractor for the implementation of a project with foreign investment is required to be established as a joint venture (JV)

of a foreign investor and a local partner, and a foreign investor is not allowed to participate in such a project as its sole investor in many countries, including Bangladesh, in order to facilitate the development of domestic and local industries.
Successful project implementation naturally requires strict compliance with agreed rules and provisions of the agreement, which requires minimization of the country and political risks as the major precondition. These are the risk factors in the agreement directly concerned with the Government.

22.2.4 Risks to be controlled mainly by contractors

The risk of delay and cost overrun is a risk to be hedged by contractors. The conclusion of an EPC agreement between a SPC and an EPC contractor is a means to hedge such risk. The risk in fuel procurement, which may emerge in different forms in different projects, is considered a risk to be controlled by contractors. The O&M risk is also considered a risk to be controlled by contractors.
There is a risk that power may not be transmitted as planned when the power source facilities have been constructed and put in use as planned, if a project for constructing transmission lines and substations is delayed by various factors. If such a project is not in the scope of the investment in the power source development of an investor, it is considered extremely difficult for the investor to control the project concerned. Therefore, a mechanism that places the responsibility for the consequence of the delay of the project to its contractor has to be established.

22.2.5 Recommendations for Improvement

■ PPA

A PPA will stipulate the standards of tariffs that sufficiently accommodate various risks associated with foreign exchange and international remittance. The privileges to receive electricity tariffs in US dollars and transfer the revenue in dollars received from the sale of electricity overseas without restriction will be granted to investors.

■ Tax exemption for FDI

The tax exemption to be granted will include exemption from the customs duties on all the imported materials and equipment required for the plant construction, exemption from the corporate and personal income taxes for a certain period of time and exemption from the import tax on vehicles and heavy and specialized equipment to be used by contractors.

■ Streamlining of procedures

It is not sufficient just to establish better rules. It is also necessary to reduce the time required for the issuance of licenses and permits.

■ Credit enhancement to local enterprises by international organizations

A tripartite relationship of the political system, bureaucracy and private sector led by a local large-scale company has been formed in many of the successfully implemented IPP projects in Bangladesh. A foreign investor must form a JV with a local investor if the foreign investor intends to implement such a project because there is a law that does not allow purchase of land solely with a foreign currency in Bangladesh. Therefore, such a project will be implemented as a long-term joint investment project with a local company to ensure steady cash flow into the project and the financial credibility of such a local company may have significant influence on the decision of a foreign investor. For example, an international organization will enhance credit limit of a local company as a guarantor of its credit in order to improve its credibility in the local industry sector in a scheme to implement large-scale IPP project as a “model PPP project.” In practice, a mechanism that guarantees the payment of fees by guarantor in the case of breech of a provision in a PPA and fully covers damage to a developer will be established.

22.3 Economic Development

It has to be noted that the aforementioned economic projection is based on the assumption that the Government of Bangladesh (GoB) will implement appropriate policy measures for economic development. Currently, the economic development in Bangladesh is mainly driven by the steadily increasing export of ready-made garment (RMG) industry that takes advantage of low cost of labour. For achieving mid- and long-term economic development, it is indispensable that the national economy will shift from labour-intensive industries like RMG to more value-added industries, and it is necessary that policy support to promote these new industries.
Examples of policy support are the provision of incentives for promoting foreign direct investment (FDI) from overseas and the development of infrastructure like special economic zones. An example of soft measures to promote the development of high value-added industries is a capacity development programme for human resources in the industrial sector to help advanced technologies to take root in Bangladesh industries.

Following these observations, policy recommendations about economic development policy is summarized as follows.

(1) Infrastructure Development

1) Short term

In order to promote the high value-added of manufacturing, especially the advancement of industries through the attraction of FDI, development of fundamental infrastructure is indispensable, such as the utility structure like electricity, gas and water, and the public transport infrastructure for distributing materials and products. And the development and integration of production base that is equipped with these infrastructures is supposed to be the key factor of success. In addition, provision of incentives such as the waiver of tax and duty for mitigating the financial burden of huge amount of capital investment is also an effective tool. Development of production bases to promote these industries, such as EPZs (Export Processing Zones), SEZs (Special Economic Zones) and industrial parks is strongly desired.
In Bangladesh, development of PEZs started from 1980s for promoting export industries and currently right PEZs are in operation under the supervision of Bangladesh Export Processing Zones Authority (BEPZA). In addition, Bangladesh Economic Zones Authority (BEZA) was established in 2010 for fostering the development of SEZs eyeing for the diversification of Bangladesh industries. According to the JICA Survey Team's interview on BEZA in February 2016, there exist about 60 project plans of SEZs and BEZA has a target of developing 100 SEZs in 15 years. In order to realize these plans and targets effectively, this study suggests that a programme to develop the capacity of planning and policy implementation for government agencies like BEZA is also needed, which shall be discussed more in detail in the next section.

2) Mid/long term

Development of fundamental infrastructure for promoting industrial development may have limitations only with the "point-wise" development like SEZs, PEZs and industrial parks. Connecting these points into a trunk line, and then into a wide area, will enhance its effectiveness. Furthermore, improving the convenience of connection among production bases will also help improving the efficiency of supply chain in a manufacturing process and contribute to the "Banglazation" of supply chain of export industries (self-containment of value chain from material to final product).
From this point of view, it is strongly recommended to prepare plans of comprehensive wide-area infrastructure development that cover seaports, roads, railway, and energy supply and etc., and to implement these plans steadily.
In addition, reforms of economic structure will be indispensable for achieving long-term economic

development, such as further deregulation and liberalization of industries for simplifying the licensing process and for enhancing the mobility of human resources and capital funds.

(2) Capacity Development

1) Short term

In order to promote the development of manufacturing bases for the advancement of manufacturing in Bangladesh, such as SEZs, EPZs and industrial parks, it is necessary to make effective and realistic plans of development and to implement them steadily.
Because the skills and experience of government agencies responsible for that may not be sufficient to fulfill this, capacity development programmes to support this are also considered to be necessary.
Japan has provided assistance to Bangladesh in this field, such as "The Project for Development Study and Capacity Enhancement of Bangladesh Economic Zone Development Plan Authority" (2015-2016) and "Study and Verification Survey on the Comprehensive Development of Southern Chittagong Region in Bangladesh" (2015-2016) that are sponsored by JICA. Technical support from abroad like that will help enhancing the capacity development of government administration.

2) Mid/long term

For the long-term sustainable development of Bangladesh economy through the advancement of industries, an overall bottom-up of human capacity in the industrial sector is essential. Examples of supporting programmes are the establishment of facilities for technology education/training and the project to assist the efficient acquisition of technologies through OJT (on-the-job training).

22.4 Domestic Natural Gas [Gas]

(1) Infrastructure

Gas production from existing gas field will be peaking out in 2017-18 and declining, while gas import in a form of LNG is forecast to increase significantly in near future. Under the circumstances issues in terms of infrastructure development to be reviewed and studied are as follows:

- Domestic gas price will be linked with international gas price and more strict control and monitoring of gas in/out flow will be required to avoid "lost profit opportunities", and system loss and/or leakage from the system should be minimized.
- Gas flow will be changed from the east-west current to the south-to the rest of the nation, The large amount of imported gas will be coming from Maheshkhali and/or Payra. Gas transmission infrastructure will need to be reinforced and existing distribution system will also need to be reinforced and re-constructed.
- Operation mode will be shifting from "Gas Allocation" basis to "Customer Demand" basis, and required to supply gas to meet the profile of each customer's demand. Current supply system needs to be reviewed.

Currently the three layers organizations are involved in gas supply, i.e., Gas Production Companies (BAPEX, BGFCL, SGFL etc.), Gas Transmission Company (GTCL), and Gas Distribution Companies (TGTDCL, BGDCL, JGTDSL, PGCL, KGDCL, SGCL). There is no integrated operation system since there is no necessity under gas allocation system at this stage

In order to solve the above listed issues the well-planned and systematic approach will be required.

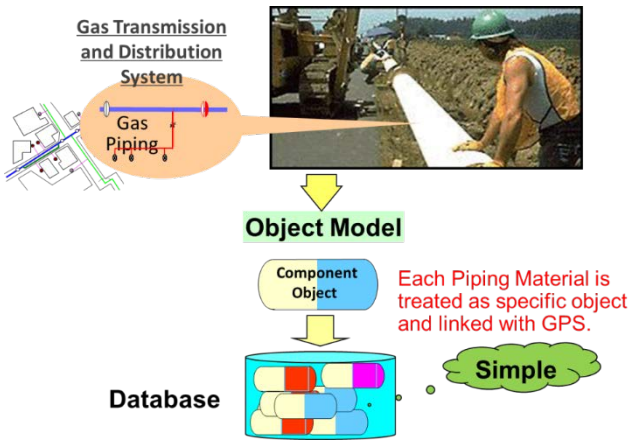
Industrial structure and lifestyle of people will be changing with development of economy. Role of gas based electric power generators will be changing from base load generation to middle/peak shaving generation, and numbers of new gas power plants will be constructed near metropolitan area (Dhaka). Gas infrastructure should be planned and installed to coincide with those power plant installation plans.

The most important is that Gas Sector and Power Sector should work together by organizing working group jointly and share issues and determine exact location of the power plant, and associated power grid and gas supply infrastructure.

On completion of gas and/or power infrastructure, more sophisticated operation system need to be in place and trained operator and maintenance personnel need to be ready for work. However, this capacity building task might not be easy. Assistance from Japan could be constructing and operating an "electronic gas infrastructure" which supports operation and maintenance of the infrastructure facilities, and transfer the system to the operating company at later stage (BOT). With this approach, project schedule will be shortened and more time can be used to train the staffs.

1) Short term

Most part of gas infrastructure will not be visible from surface because they are buried underground. Location of each gas piping components need to be identified by linking with GPS. First of all, object orientated advanced electronic mapping system need to be introduced, combined with appropriate SCADA (Supervisory Control and Data Acquisition) System. By this arrangement, Advanced Control, Preventive Maintenance, Operation Safety, Emergency Transaction, and Asset Management, will be attainable. Such system can be constructed and operated by Japanese entities and transferred at later stage (build-own-transfer: BOT). Technology transfer will be easily implemented under this proposed scheme.



Source: JICA Survey Team

Figure 22-3 Advanced Electronic Mapping - Object Model System

2) Mid term

As the imbalance of demand-supply situation improves with the increase of import LNG, operation mode is changing from "Gas Allocation" to "Customer Demand" basis. Gas supplier is required to supply gas to meet the demand profile of each customer. Gas supply source will be diversified. In addition to domestic gas, introduction of LNG via FSRU and/or Land LNG terminal and pipeline gas from India will be starting shortly. Gas customers will also be diversified with development of the economy. In order to manage such changes integrated supply system and central operation unit will need to be constructed. Current gas supply organization may need to be reviewed and re-organized.

Introduction of IT is accelerated in future and operation system will be improved and need to be more flexible based on advanced data acquisition, processing and control system. JICA has assisted in introducing pre-paid gas meter to domestic users as part of yen-loan financed project. This system would be integrated into part of IT system in future.

(2) Human capital development and supporting organization (capacity building)

1) Short term

Currently, it is understood that the numbers of gas leak incidents are reported daily (details are not precisely understood at a gas distribution company). Most of which presumably are caused by poor maintenance, use of low grade materials, and/or poor construction practice. To enhance the reliability and integrity of the gas infrastructure system, it is necessary to set up design standard (such include piping material standard, standard construction drawings), construction work procedure and maintenance/safety procedures.

In order to bring up staffs who are able to manage advanced operation and maintenance of gas infrastructure, knowledge and skill based qualification system should be introduced. Personnel system may also need to be reformed.

2) Mid/long term

In addition to manage advanced operation and maintenance of gas infrastructure, managers are required to promote efficient use of gas. Wide range of knowledge and practical skills are required to be a manager. It is important to bring up internationally recognized professional engineers in the organization. Professional engineers will take such responsibility as they are seen in major oil companies and utility sector of advanced countries. Chartered Professional Institution in UK may be able to support the education and training programs.

Responsibility of such engineers will be extended to prepare operation and maintenance manuals to suit by themselves.

22.5 LNG Import [Gas]

FSRU Project is under progress and study of land based LNG terminal project has also started. However, each has its own characteristics and need to understand the differences. Prior to develop LNG project, following matters need to be taken into consideration:

- Price formula of LNG Long term Take or Pay contract
- Use of LNG spot market
- LNG Freight and tanker size
- Storage/gasification service fee
- Construction schedule and risk
- Operational risk and energy supply security

Construction schedule of FSRU is 3years at the most and construction risk is considered low, and therefore FSRU is considered reliable source of supply. LNG supply to FSRU will be based on “take or pay” and risk of “quantity” should be beard by Bangladesh. FSRU require more than 60 times of LNG delivery by shuttle tankers. Operation of FSRU is vulnerable to Cyclone and/or rough wave conditions because of ship to ship transfer operation of LNG.

Land based LNG terminal will play a role of supply optimization between supply and demand. It also plays important role in securing energy supply if it is used as a strategic storage, and considered inevitable energy infrastructure in Bangladesh. Compared with FSRU, freight unit cost will be lower since larger vessel such as Q-Flex and Q-Max class can be used to deliver LNG. Initial storage and gasification service fee is higher since it should support the initial infrastructure investment cost, however the fee will be lower and competitive with the expansion of storage capacity to meet the increasing demand. Construction will take 7-10 years to complete before commencement of commercial operation.

LNG terminal operation will be assigned to RPGCL (CNG & LPG Company), if it is planned by Petrobangla (a LNG terminal project under Power Cell and BPDB supported by IFC would be operated by different scheme. Further detail is described in the “LNG” Chapter). Gas produced at the LNG terminal will be handed over to GTCL (Transmission Company) and transmitted and handed over to Distribution Companies for supplying to customers. Gas allocation system worked under such system for long time.

Once large amount of gas is started to be delivered from LNG Terminal, gas allocation system will need to be changed to new delivery system, i.e., customer demand based supply system. This new supply system will work under integrated operation system connecting among LNG terminals, transmission lines, and gas distribution systems. Central operation unit with the task of controlling and monitoring all the in/out gas flow will need to be constructed. Current organization may need to be reviewed and restructured.

(1) Infrastructure

1) Short term

Industry of Bangladesh has suffered from shortage of gas supply and adversely affected economic growth of the country. The first FSRU should be constructed soonest and associated transmission line t as well. Design of current transmission line under construction is 90 km long, 30 inch diameter with pressure rating of #600, capable of transmitting 500-700 mmcfd at normal operating pressure of 900 psig. However, this pipeline is considered too small to accommodate further future gas delivery. New transmission system should be studied by the working group organized jointly between Gas Sector and

Power Sector, and share issues and determine future delivery plan.

Advanced gas supply system can work only under the sophisticated pressure/flow control system. Changing pressure of the transmission pipeline system may adversely affect performance of condensate recovery unit at gas field, as well as the operation performance in the downstream distribution. This potential impact needs to be investigated further.

2) Mid/long term

Land LNG terminal require 7-10 years to construct. It will play a role of supply optimization between supply and demand. It also plays important role in securing energy supply if it is used as a strategic storage, and considered inevitable energy infrastructure in Bangladesh. LNG storage capacity will continue to increase with the increase of demand. Gas transmission and distribution infrastructure will also be reinforced and expanded. Mid/long term plan should be prepared to minimize future cost and avoid duplication of works. Joint working group between power and energy sector to be organized for this purpose also.

(2) Human capital development and supporting organization (capacity building)

1) Short term

On completion of gas infrastructure, operation system needs to be in place and trained operator and maintenance personnel need to be ready for work. Assistance from Japan could be constructing and operating an “electronic infrastructure” which supports operation and maintenance of the infrastructure facilities, and transfer the system to the operating company at later stage (BOT). With this approach, project schedule will be shortened and more time will be used to train the staffs.

2) Mid/long term

As stated in the previous paragraph, it is important to bring up internationally recognized professional engineers in the organization. Professional Engineers will take responsibility of managing advanced operation and maintenance of gas infrastructure, and promote efficient use of gas. Major oil companies and utility sector of advanced countries relies on their operation on this type of people. Chartered Professional Institution in UK may be able to support the education and training programs.
Responsibility of such people will be extended to prepare operation and maintenance manuals to suit by themselves.

22.6 Renewable Energy [Introduction of energy storage technology]

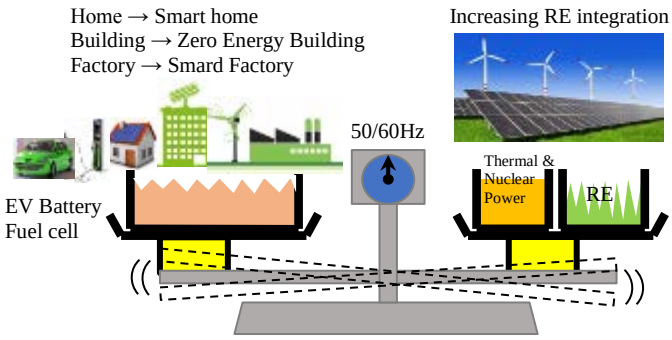
(1) Infrastructure

Integrating intermittent renewable energy resources, such as PV and Wind generation, to achieve CO2 emission reduction is a priority task for most countries worldwide. However, such renewable resources have high initial cost, low utilization rate and intermittent generation. Therefore, when integrated into the grid in large scale, they could put system frequency and voltage stability in jeopardy and cause technical problem.

On the other hand, in parts that have no access to the grid (off-grid areas), Solar Home System (SHS) or small-scale diesel generation provide electricity. However, SHS are expensive and cannot supply more than 3 to 4kW, also small-scale diesel generators have fuel running cost in addition to the initial cost. Therefore, off-grids areas have not only high failure rate but also a very high electricity cost.

To address such issues, increasing renewable energy integration while maintaining electricity supply stability, large-scale and safe energy storage technology is proposed as a supporting measure, and a practical introduction is highly expected.

< Frequency Fluctuation Image >



< Solar Home System (SHS) >

Source: JICA Survey Team

Figure 22-4 Introduction of energy storage technology (1)

1) Short term

- **Improved grid stability through integration of large scale and safe energy storage system**
  - ✓ As mentioned above, in case of integrating large scale intermittent renewable energy sources in power system, frequency and voltage fluctuations are anticipated.
  - ✓ Up to now, hydro pumped-storage units have been utilized to solve the above issues, however considering required construction cost, time and area, large scale energy storage systems have superior characteristics for absorbing power system fluctuation by electrical energy charge and discharge. Therefore, such solutions are being closely focused in North-America. A pivotal point in realizing large scale energy storage systems is its safety.
  - ✓ Considering above mentioned conditions, it is proposed to have a demonstration project F/S in order to connect safe large scale energy storage system to grid, develop operation and control technology and evaluate the integration effect.

- **Realizing safe, low cost and environment-friendly Off-Grid energy supply system through integration of large scale energy storage system**
  - ✓ In remote areas that don't have access to grid (off-grid), energy storage can be used to replace SHS and diesel generators through community energy schemes instead of providing energy system for each individual house. (Medium to large scale solar systems + large scale energy storage system for community). Using such scheme, it might be possible to addressee above mentioned issues. Therefore, F/S for evaluating the system integration effects is proposed.

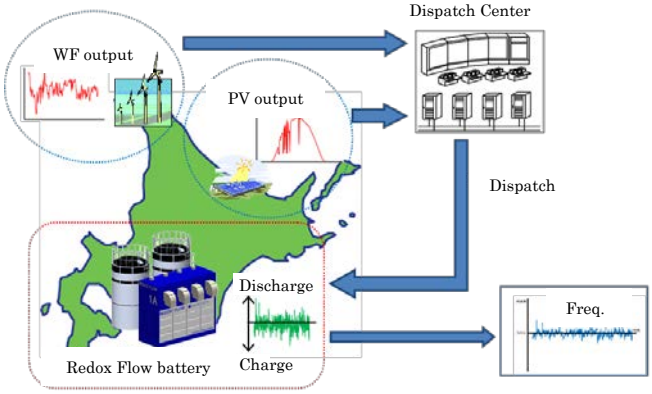
Redox Flow battery is one of the most well-known large-scale and safe energy storage technologies. Some of the application samples can be shown as follows.

[1] Improved grid stability

- METI's demonstration project from FY 2013 to FY2018
- Installation site : Minami-Hayakita Substation at Hokkaido Electric Power Co., Ltd
- Sytem : Redox Flow battery system 15 MW / 60 MWh
- Application : Frequency regulation (Short duration)
  Surplus power adjustment (Long duration)

< System appearance >

< Demonstration image >



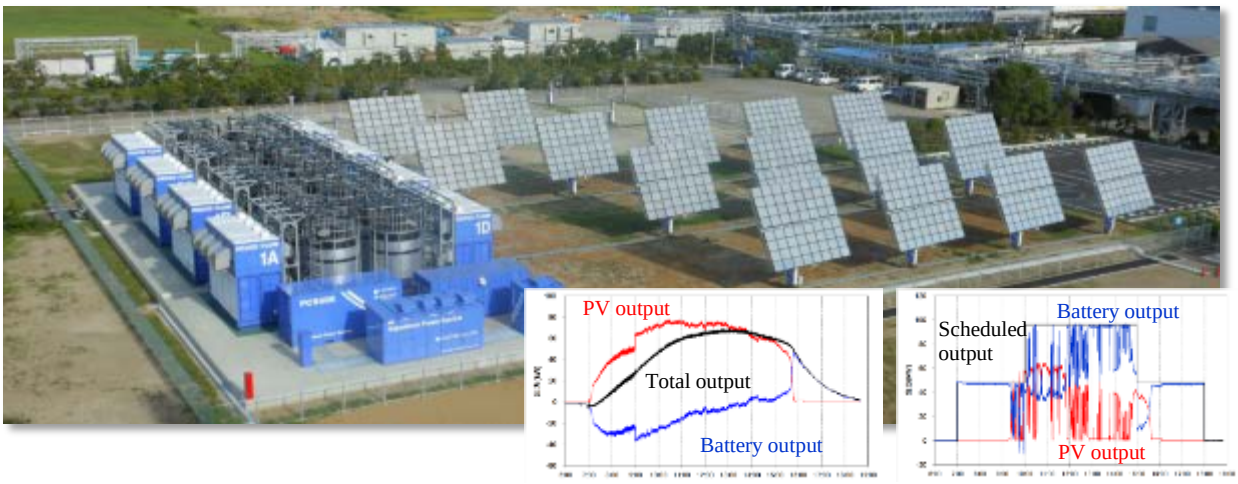
Source: JICA Survey Team

Figure 22-5 Introduction of energy storage technology (2)

[2] **PV + Large-scale energy storage**

- Sytem : Redox Flow battery system 1 MW / 5 MWh
- Application: Storage of PV surplus generation, PV output stabilization, etc.

Sysytem appearance



Source: JICA Survey Team

Figure 22-6 Introduction of energy storage technology (3)

2) Medium term
- Introducing large scale energy storage based on the F/S results

(2) Human capital development and supporting organization (capacity building)

1) Short term
- Training for operators and creating operational manuals

It is important for the large scale energy storage operator to have a sound knowledge about functions, responsibilities, operation and maintenance, economics of the systems and etc. Together with the above mentioned F/S study, there would be a training for the large scale energy storage operators and a manual would be provided form the achieved operation know-how. This will layout foundation for safe and low cost energy supply as well as suitable O&M support in Bangladesh.

2) Medium term
- Creating ancillary service market foundation

The need for ancillary services and large scale energy storage systems would be increased due to the expansion in renewable energy resources. To correctly evaluate this value and realize suitable balance of energy resources, creation of an ancillary service market would be necessary.

22.7 Power System Plan

(1) Infrastructure Arrangement

1) Transmission Plan

The projects listed in the table of on-going projects made by PGCB will be steadily implemented.
The funding sources should be identified soon for the projects that have not yet been funded, such as the expansion and strengthening of the network in DESCO's management area (400kV GIS substations and 230kV substations). Regarding the projects for the bulk power transmission system related to interconnections, such as Barapukuria, their funding sources should also be identified in adequate time, in cooperation with the progress of the discussions with the related neighboring countries. Regarding the projects for the transmission lines for power transmission from the large scale power stations in south Chittagong and Khulna that are identified in this MP, their FSs are implemented accordingly at suitable timings in order to match the construction schedule and urgent selection of the routes for transmission lines.

2) Rural Electrification

The projects listed in the table of on-going projects made by BREB will be steadily implemented. In the process, it is important that a distribution system which aims at high reliability in the future is constructed efficiently.

(2) Strong Institutional Arrangements

1) Transmission Plan

PGCB takes on the role of making plans for bulk power transmission lines and substations. Although consistency among the bulk power network plans and power demand forecasts, power generation plans and power distribution plans should be ensured, these plans and conditions are set by organizations other than PGCB. The power demand forecast for the whole of the nation is made by BPDB and the regional ones are made by power distribution companies. Power generation development plans are made by BPDB under the management of Power Division in MoPEMR. The power distribution plans are made by distribution companies such as DSCO and DPDC.
The results of the plan for the bulk power transmission system made by PGCB are reflected in the power transmission and distribution plans made by distribution companies and become the conditions for

planning the 132kV system. The appropriate feedback should also be given to BPDB and Power Division in MoPEMR on the power network plan made by PGCB, in order to reflect its results and correct information in the Government to Government projects. The following countermeasures should be implemented.

- The institutional frameworks should be established among BPDB, Power Division, Distribution Companies and PGCB to share the necessary information periodically in order to make the power network system plan.
- The reports on the power network system plan are published periodically (every half-year or annually) to share information on the status of making the plan among the abovementioned related organizations. PGCB reports on the future projects for transmission lines and substations required, from its technical viewpoint, to BPDB, Power Division and distribution companies.
- The rules for power network system planning should be clarified, published and open to the public as a part of the Grid Code.

2) Rural Electrification

In this sense, a good communication and coordination between BREB and IDCOL is required; however, it is observed that such communication or coordination is not taking place. IDCOL is communicating to BPDB for project planning, but BPDB seems not liaising with BREB properly. If the Government seriously pursue the achievement of “Electrification for All” by 2021, the good communication and coordination between BREB and IDCOL must be taken, and both parties (and BPDB as a coordinator too) need to improve in this area.

22.8 O&M Legal Framework [O&M]

(1) Human capital development and supporting organization (capacity building)

1) Short term

The Bangladeshi government would organize a specialized committee which legislate some act related O&M.

In terms of short term, the suitable method of bringing up talented person in specialized committee would be that they study to development some laws related to O&M under the specialist's instruction after the specialist for making O&M act in developed country, like Japan, invited from overseas to Bangladesh.

It is highly likely to be difficult to enact laws and regulations mandating regular inspection and to establish a system for the supervision of the facility maintenance by authorities in a short period of time. It is worth studying the feasibility of taking proactive measures such as introduction of various regulations and technical standards for the maintenance of power generation facilities used in Japan as the standards for the maintenance of power plants in Bangladesh and maintaining the plants using the introduced standards before the enactment of all the required laws and regulations. It is recommended that the power plants to be constructed, in particular, be operated in accordance with a schedule that includes the schedule for the maintenance from the beginning of their operation.

2) Mid/long term

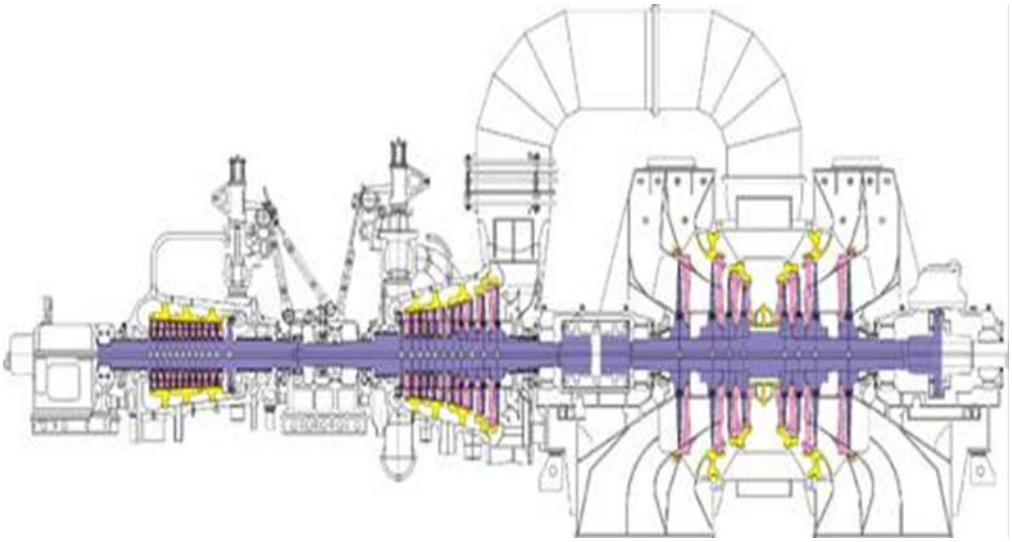
In terms of mid-long term, one of solutions developing human resources is that the members of legislation committee would be dispatched to developed foreign country to learn the real O&M legal framework and actual situation of O&M in a power plant, and the members might bring back knowledge of the useful laws to Bangladesh. In addition that is better to continuous study the operation status of power plant in developed nation, and also research the history of O&M act reformation, that would become to good samples for Bangladeshi O&M act.

22.9 Thermal Power Plant O&M [O&M]

(1) Infrastructure

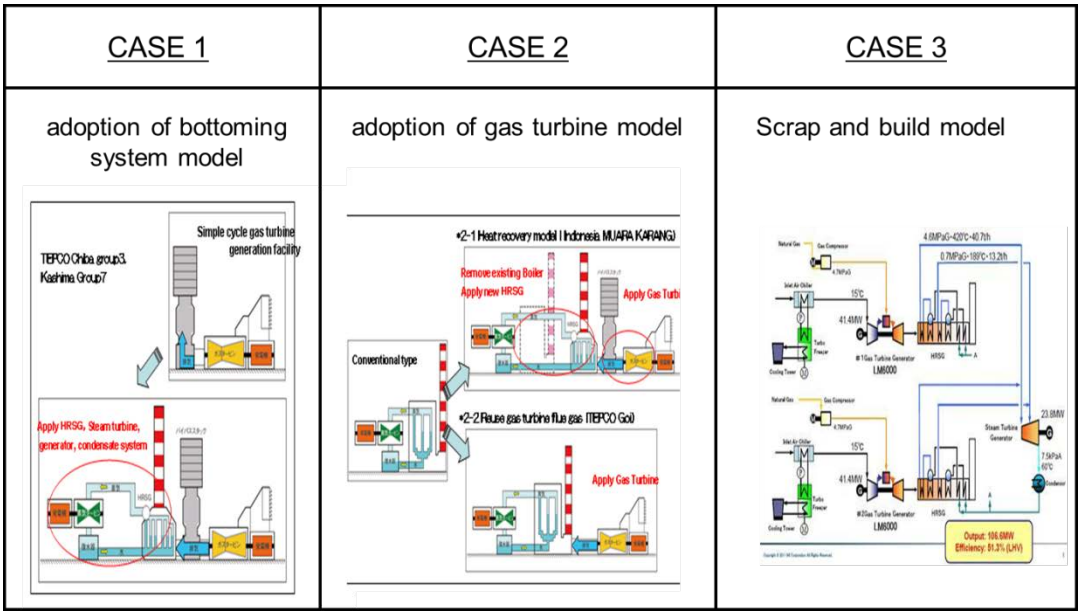
1) Short term

In the short term, we consider that enhancement of power generation capacity is a priority in order to meet the demand growth and requirements from the industrial sectors. In particular, some of the aging power facilities need to be replaced with, or converted into higher efficient units. The study team proposes two plans as power plant remodeling plans. One is a rehabilitation plan for old steam turbines which were built by Russia. The other consists of three different levels of conversion into combined cycle units. Those plans can be implemented with proven technologies of Japanese engineers.



Source: JICA Survey Team

Figure 22-7 Steam Turbine Rehabilitation Plan



Source: JICA Survey Team

Figure 22-8 Combined Cycle Power Generation Remodeling Plan

2) Mid/long term

Those proposals mentioned above can be a quick solution to the power shortage problem of Bangladesh for a short time period. After the completion of the remodeling works, application of proper maintenance is a key to successful capacity enhancement.

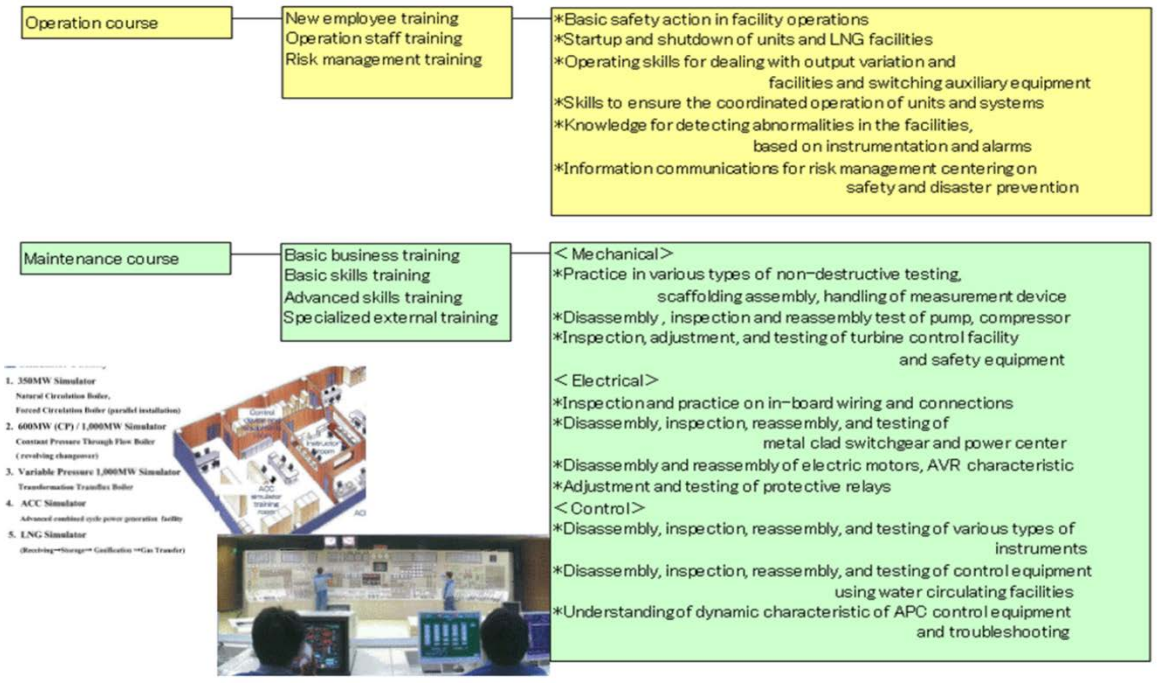
(2) Human Capital Development (capacity building)

1) Short term

In addition to measures to reinforce the capacities of power generation facilities, preventive maintenance of these facilities was considered important for the maintenance of their capacities and the maintenance and improvement of their operational efficiency in this survey. It is necessary to train maintenance engineers for the appropriate implementation of regular inspection as part of preventive maintenance. A study will be conducted on the possibility of establishing an independent organization specialized in the maintenance and repair of the facilities and using the human resource development service of this organization as a measure to cope with the problems of the shortage of the maintenance personnel and budget at the state-owned power generation facilities.

In general, the scarcity of skilled engineers undermines operational efficiency and lack of maintenance of facilities. To cope with this problem, the survey team suggests a training facility with equipment and materials which are actually used in power facilities, like a power plant silulator. While most of the trainings are carried out in a traditional classroom setting in Bangladesh, the proposal puts an emphasis on the practical exercises by using effective training materials. The proposed training has two main courses, one of which is a course for plant operators, and the other is a course for maintenance engineers. Both courses lead to certifications in the respective areas of the education. The proposals include the facility and training items described below.

A further study will be required before deciding whether such training will be provided by an independent organization to be established or by each power company.



Source: JICA Survey Team

Figure 22-9 Training Course Plan

2) Mid/long term
The training courses should be extended to higher levels of education for instructors. In the short term, instructors can be provided from other organizations; however, a scarcity of instructors will be the biggest problem in the future. In order to fill the gap between training demands and instructors provided, skilled workers at operating facilities can be utilized. A workforce rotation program should be introduced to enable new employees to learn from the skilled workers who have experiences with the actual equipment, while the career development plan for the instructors motivates them to take a leave from their positions at their power facilities. The introduction of job rotation is recommended as a measure to provide new employees with the opportunities both at power plants and at training centers to learn the practical work performed in power plants from engineers who have ample practical working experience.

(3) Thermal Power Plant O&M Information Management

1) Short term
After the completion of the development or enhancement works of power facilities, it is important to maintain their capacity and efficiency. The objective of the organization-wide information management system is to facilitate maintenance planning, budget control and procurement optimization. The functions of the system include the following.

- Maintenance Planning - To encourage plant managers to make feasible plans for maintenance.
- Budget Management - For prompt decision making on financial matters and reduction/removal of delay in maintenance activities.
- Maintenance Work Management - To keep maintenance projects within budget and timeframes.
- Failure History Management - To provide supporting data for budget and plans.

Expected results (Quantitative Effects) are:
- Reduction of maintenance cost
- Reduction of frequency of forced outage
- Reduction of forced outage hours

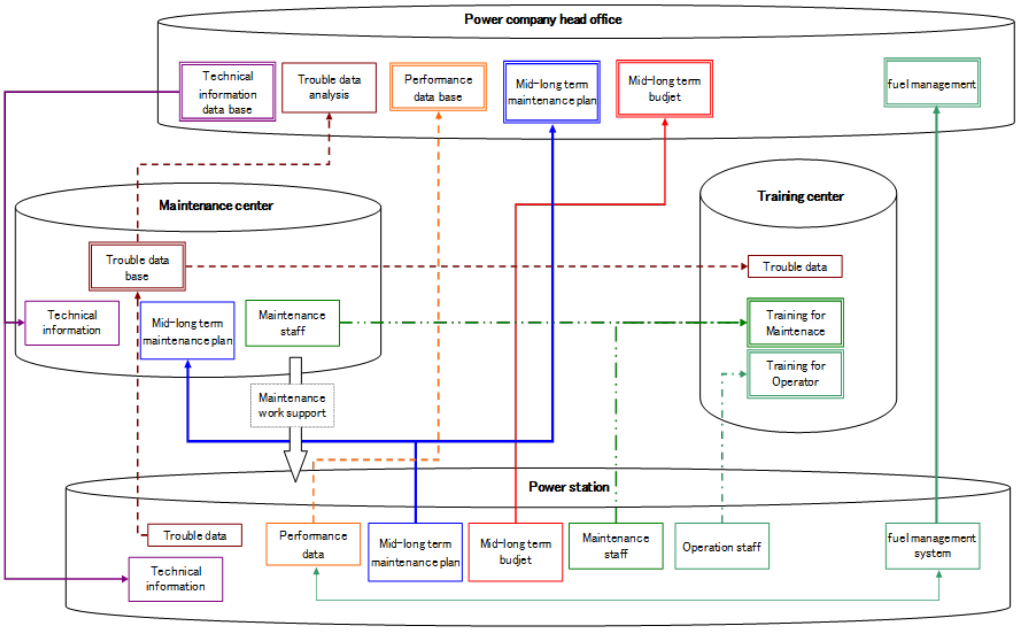
In order to maximize the effectiveness of implementation of information management, a feasibility study is expected to be carried out in pursuit of the following information items.

Table 22-1 Items Required in Feasibility Assessment

Category	Item	Details
Computer System and Network Infrastructure	Plant LAN	Local Area Network availability in power plants
	Enterprise network	Network availability, connectivity among business units and multiple locations, and its security, reliability and capacity.
	Data repository	Data center location, storage capacity and scalability
	Legacy systems and data integration	Legacy systems and legacy data.
Management	Business process	Business processes in Maintenance Planning, Budget Creation, Procurement, Work Planning, and their business requirements.
	Regulations and standards	Regulations, standards, public authority reporting guidelines.
Target Selection	Facility Requirement	Facility type/age/capacity, location, future plans for enhancement or replacement
		Connectivity between facility and data acquisition devices

Source: JICA Survey Team

The Information Management System connects the head office with power facilities and other related organizations such as Maintenance Center and Training Center. These organizations share facility information for analytical use which brings the power facility higher efficiency and reliability based on accumulation of historical data.



Source: JICA Survey Team

Figure 22-10 System Functions and Data Flows for a Power Plant in Bangladesh

2) Mid/long term

The scope of the Information Management System can be extended to Facility Management and Environmental Management. The functions of the system may contain:

- Facility Assessment - To optimize maintenance cost based on physical state of facilities.
- Procurement Management - To maintain spare inventory levels while reducing procurement cost.
- Tariff Management - To provide an accurate cost basis for appropriate pricing of electricity.
- Environmental Management - To ensure regulatory compliance while managing environment related cost.

Expected results (Quantitative Effects) are:
- Reduction of Total Ownership Cost of facilities
- Reduction of fuel cost
- Reduction of emissions, effluents and waste products
- Contribution to effective tariff setting

(4) Organization (capacity building)

1) Short term
To perform facility maintenance activities in compliance with laws and regulations, auditability of the work processes and work results, such as facility inspection reports, must be achieved. Maintenance crew must be familiar with the designated documentation and records, which need to be prepared in an accurate and timely manner when requested by the authority.
The maintenance planning processes require some knowledge in project management. Maintenance

managers will be advised to learn work process management and budget control.
Apart from the above, the information assets need to be properly maintained and protected. IT/ICT engineers are expected to keep the system fully operational; therefore, IT/ICT education is also important.

2) Mid/long term
As described in Chapter 19, the goal of this Study is to achieve a best practice in O&M in the power sector. Major power producers in Japan make use of a wide variety of software applications in daily operations of their facilities; however, their common focus is to maintain reliability of the facility with optimal cost. In the future, the education for plant workers may cover wider area which is more management oriented in terms of efficient use of organizational resources.

22.10 Tariff policy

(1) Human capital development and supporting organization (capacity building)

1) Short term
For implementing appropriate tariff policy including electricity tariff increase and gas price increase, capacity building for appropriate decision making of price level in consideration of accurate supply cost is required. Therefore donors are expected to provide capacity building support for BERC. In fact, ADB is considering to support BERC for capacity building. In addition, for grasping accurate supply cost, support of capacity building for each organization to develop sophisticated management plan is also important. Hence for enabling organizations such as BPDB to develop more sophisticated management plan and implement it, donors should support corporate management capacity building in them. Donors are expected to support BPDB, etc. to analyze financial situation in more detail, identify inefficient points, and remedy them.

2) Mid/long term
Above-mentioned support is expected to be continued until appropriate tariff level and ideal financial situation of BPDB, etc. are achieved.

22.11 Realization Of Low Energy Consumption Society

The target of energy projects in the developing countries is “stable supply of energy and electric power that meets the increasing demand for energy for the economic growth.” Therefore, they will need continuous power development. Meanwhile, the results of the analysis of the relationship between the economic and social activities and energy consumption was used for the projection of energy demand in the formulation of the supply plan in this master plan. The use of the technologies considered to be highly reliable in 2016 was assumed in the formulation of the supply plan. However, the validity of these assumptions is likely to change because the energy demand may not increase as projected and more advanced power generation technologies may be developed in future. These changes will be important factors to be investigated in the rolling monitoring of this master plan in future.

22.11.1 New Technologies for Power Generation with Different Energy Sources

The technological innovation in the energy and power sectors is advancing at a remarkable pace. A technology in the research stage at the time of the formulation of this master plan may become available for use in Bangladesh by 2041 with the progress of R&D in these sectors. The projects using such new technologies are classified into the two groups mentioned below and explained in the following.

(1) Energy Efficiency Project: EE
(2) Renewable Energy Project: RE

Table 22-2 Areas of research by type of energy

EE	Projects for the improvement of energy efficiency (EE)	
	Power generation	Power generation with the integrated coal gasification combined cycle, etc.
	Improvement and rehabilitation of power generation facilities	Renewal of the facilities for the improvement of power generation efficiency
	Power transmission and distribution	Establishment of power transmission and distribution facilities for the improvement of energy efficiency
	Activities for reducing power transmission and distribution losses	Renewal of the existing facilities for the improvement of energy efficiency
	Rural electrification	Conversion from the power generation with internal-combustion engines to more energy-efficient power generation, transmission and distribution facilities
	Demand side management (DSM) activities in the electric power industry	Introduction of energy-saving systems for the reduction of power consumption
	ESCO activities	Introduction of facilities and services for the improvement of energy efficiency through the ESCO activities
	Improvement of energy efficiency	Research for the improvement of energy efficiency and the development of energy-saving technologies
RE	Projects for power generation with renewable energy (RE)	
	Power generation activities (use of renewable energy)	Implantation of power plants using solar, wind, hydro, and geothermal energy and biofuel
	Hybrid power generation activities	Implantation of power plants that can be operated with both renewable energy and conventional energy sources
	Bio-energy activities	Implantation of power plants using bioenergy including biomass, biogas and biofuel for power generation
	Decentralized Energy Production & Distribution	Implantation of decentralized energy production systems using renewable energy
	Energy conservation	Research on the energy conservation technology

Source: JICA Survey Team

22.11.2 New technologies in the electric power infrastructure sector

Table 22-3Areas of assistance in research in the electric power infrastructure sector

Classification	Technology
Thermal power generation	Integrated coal gasification combined cycle (IGCC) power generation
Renewable energy	Biomass gasification power generation
	Power generation using the methane gas generated by fermenting biomass
Power transmission and transformation	Improvement of the power factor
	Improvement of the power flow (increasing the number of transmission lines)
	Increasing the diameter of power cables
	Introduction of an upper level voltage (increasing the transmission voltage)
	Superconducting cables
	Superconducting transformers
	Insulated strand cables
	Use of low loss transmission cables

Classification	Technology
Power distribution	Distribution loss reduction technology (improvement of power factors: reduction of lagging power factors)
	Distribution loss reduction technology (low-loss distribution transformers, "Top Runner Transformers")
	Distribution loss reduction technology (amorphous core transformers)
	Distribution loss reduction technology (improvement of measuring equipment)
	Distribution loss reduction technology (increasing the diameters of power cables)
DSM	Heat pump technology (Heat pump hot water supply systems with CO_2 natural refrigerant)
	Thermal storage air conditioning systems
	Electric automobiles
	Cogeneration systems (combined with thermoelectric systems)
	Fuel cells (polymer electrolyte fuel cells: PEFCs)
	Fuel cells (solid oxide fuel cells: SOFCs)
Energy conservation in storage batteries	Power storage technology (load-levelling)
	Energy conservation in battery cells
	Superconducting magnetic energy storage system (SMES)

Source: JICA Survey Team

22.11.3 Responsible Energy Consumption and Development of Bangladesh into a "Developed Country"

The record of energy consumption in Bangladesh in the past and the relationship between the economic development and energy consumption in the countries in Southeast Asia, especially the relationship in Thailand, in the past were used for the long-term projection of the energy demand in Bangladesh in the formulation of this master plan.

There is no doubt that Bangladesh has to develop its economy further in future. On the other hand, it is required to achieve the economic growth while saving the energy consumption (or, to achieve both development and environmental conservation simultaneously). In the formulation of this master plan, the 3E evaluation, more specifically, an analysis using the CO2 emission as a variable, of the power development plan was used for the quantitative evaluation of its commitment to the environmental conservation. If the environmental regulations in the international community become stricter and more diversified, Bangladesh will have to endeavor to comply with them as a responsible member.

In addition, a "developed country" in 2041 may not be a large energy consumer like the developed countries at present in 2016. Large energy demand has already been a condition for a developed countrysation in the past. In fact, as mentioned in Chapter 5, the *per capita* energy consumption of Bangladesh is smaller than those of Thailand, Indonesia and Vietnam. Meanwhile, the differences in the *per capita* energy consumption between Bangladesh and the three countries are larger than the difference in the *per capita* energy consumption per GDP between them. This observation indicates that Bangladesh consumes a smaller amount of energy than the other three countries to create the same economic value and that the economy in Bangladesh has grown with relatively small energy input. Although the changes in the industrial structure expected in future are predicted to increase the energy demand rapidly, Bangladesh can be proud of its more energy-efficient economic growth than the other Asian countries.

Furthermore, the government and the people of Bangladesh to develop their country into a developed country is to create an image of a "developed country" in 2041 including the scale of economy and the lifestyle of people that they aim at, prepare an ideal way to use energy resource for economic development that is efficient and energy-saving in the way like they have, as mentioned above, by themselves and realize the ideal way in a responsible manner.