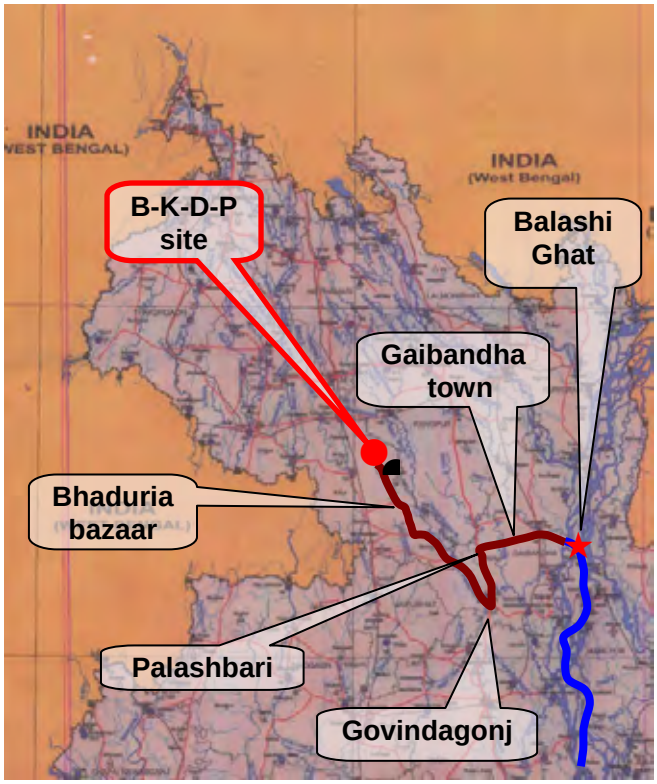
14.4.7 Overland route from B-K-D-P site to Balashi Ghat

B-K-D-P site is located Daudpur Bazar, Nababgonb upazila, Dinajpur.



Source: PSMP Study Team

Fig. 14-19 Transportation route to B-K-D-P site

(1) Maximum cargo loading

Following table shows the general regulations governing loading according to Roads & Highway Department;

Table 14-10 Maximum loading for general cargo

Type	Max. Length	Max. Width	Max. Height	Max. Loading	Remarks
	(m)	(m)	(m)	(t)	
Truck	7.0	2.3	3.5	10.0	
Trailer				25.0	Certificate required for over 10 ton

Source: PSMP Study Team

As per gazette notification of Bangladesh Govt. published on May 5, 2004 laden weight of vehicles with length more than 10m shall be limited to 44tons for plying over the highway of specific larger dimensions of cargo, prior permission of Roads & highway Department shall be required.

Maximum allowable weight limit for single rear axle with 4 tires is 10tons as per RHD regulation.

(2) Investigation of bridges on the route between B-K-D-P and Balashi Ghat

Following table shows the bridges on the route.

Table 14-11 Bridge list between B-K-D-P and Balashi Ghat

NO	Section		Length	Width	No. of Bridges/Culverts				Overall Condition
	From	To			Bridge	Baily Bridge	Culvert	Total	
			(km)	(m)					
1	B-K-D-P Site	Bhaduria bazaar	6.71	3.5			12	12	Needs to strengthen
2	Bhaduria bazaar	Govindagonj	34.47	5.5	3		21	24	Good except all bridges to be rehabilitated
3	Govindagon	Palashbari	16.99	7.2	6		4	10	Good
4	Palashbari	Gaibandha town	21.02	5.5	3	1	9	13	Good except Bailey bridge to be rehabilitated
5	Gaibandha town	Balashi Ghat	6.20	3.5	1		4	5	Needs to strengthen
Total			85.39		13	1	50	64	

Source: PSMP Study Team

(3) Road from B-K-D-P site to Bhaduria Bazar (6.71km)

This section is categorized as Zila Road of Roads & Highway (R&H) Department having average width of 3.5 meter. It is almost straight from B-K-D-P site to Bhaduria Bazar where it joined with Regional Highway (Gobondagonj to Dinajpur) of R&H Department. The total length of this section is 6.71km. There are 12 culverts of RCC in this section. The conditions of all culverts are in the good condition. The overall condition of this section is good to carry the normal cargoes say below 40tons. But for carrying heavy lifting cargoes, it is required to strengthen this road by widening and reconstructing all culverts. Moreover, this road at the Bhaduria Bazar Junction needs to bypass Bhaduria bazar area to join with Gobindagonj-Dinajpur highway to make bend within acceptable limit say 30degree.

(4) Bhaduria Bazar to Govindagonj (34.47km)

This section is categorized as Regional Highway of Roads & Highway (R&H) Department having average width of 5.5 meter with 2 lanes. It is almost straight from Bhaduria Bazar to Govindagonj where it joined with National Highway (Bogra to Rangpur) of R&H Department. The total length of this section is 34.47km. There are 21 culverts of RCC and three bridges in this section. The conditions of all culverts are in the good condition. One of the bridges at Khulshi is under construction. At present, the bridge under construction is being bypassed by bailey bridge with steel bed. The conditions of other two bridges are not in good condition. The overall condition of this section is good to carry the heavy cargoes above 40tons except the bridges to be rehabilitated. Moreover, this road at the Govindagonj Junction needs to bypass Govindagonj town to join with Bogra-Rangpur National highway at an acceptable bend to move the long trailers.

(5) Govindagonj to Palashbari (16.99km)

This section is categorized as National Highway of Roads & Highway (R&H) Department having average width of 7.2 meter with 2 lanes. It is almost straight from Govindagonj to Palashbari from where a side road was constructed towards Gaibandha Town. The total length of this section

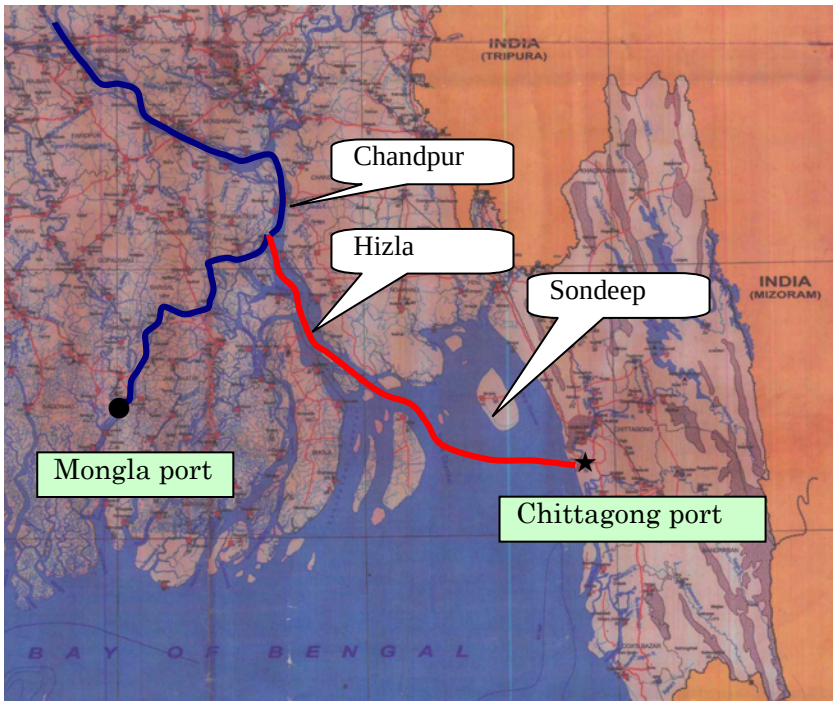
is 16.99km. There are 4 culverts of RCC and six bridges in this section. The conditions of all culverts and bridges are in the good condition. The overall condition of this section is good to carry the heavy cargoes above 40tons.

(6) Palashbari to Balashi Ghat (27.22km)

This section is categorized as Regional Highway of Roads & Highway (R&H) Department having average width of 5.5 meter with 2 lanes. It is almost straight from Palshbari to Balashi Ghat. The total length of this section is 27.22km. There are 13 culverts of RCC, four bridges and one bailey bridge with steel bed in this section. The conditions of all culverts between Palashbari and Gaibandha Town are in the good condition. But the narrow bailey bridge is not in the good condition. The culverts and bridges from Gaibandha Town to Balashi Ghat are not in the good condition and the width of the road is about 3.5m. The length of this narrow road from Gaibandha town to Balashi Ghat is about 6.2km. The overall condition of this road from Palashbari to Gaibandha Town is good. Only one bailey bridge in this section needs to be rehabilitated. But it is required to strengthen the road from Gaibadha Town to Balashi Ghat to carry the heavy cargoes. Moreover, at the Palashbari Junction, the road needs to bypass Palashbari town to join with Bogra-Rangpur National highway at an acceptable bend to move the long trailers.

14.4.8 River route from Chittagong port to Balashi Ghat and then overland route to B-K-D-P site

In this route, the equipment is unloaded at Chittagong port and transported to Balashi Ghat by barge, after that, the mean of land transportation remains the same.



Source: PSMP Study Team

Fig. 14-20 Transportation route from Chittagong to B-K-D-P

(1) Transportation

Barge (L38.5mxW20.0mxD2.13m capacity 600tons)	:	1 No.
Tugboats (Twin screw, 500hp)	:	2 Nos.

(2) Chittagong port

Chittagong Port [3] is the principal port of the People's Republic of Bangladesh. It is situated on the right bank of the river Karnafuli at the estuary of the river at Patenga Package, near the city of Cittagong at a distance of about 9 nautical miles from the shore line of the Bay of Bengal.

Table 14-12 Trend of cargo treatment amount of Chittagong port

(1,000 t)

FY	Import	Export	Total
1995	8,638	1,417	10,055
1996	8,738	1,451	10,189
1997	9,063	1,435	10,498
1998	7,295	589	7,884
1999	8,973	1,031	10,004
2000	12,675	631	13,306

Source: Chittagong Port Authority

Geographic location of Chittagong is at latitude 22019' N and longitude 91049'E. It is not a deep seaport but vessels up to 10,000QWT can berth at this port.

The way of export from Chittagong port is that, first to transport from Chittagong to Malaysia or Singapore by 10,000t class vessels, and then load to mother ship to transport Europe or America.

The economy of Bangladesh is currently developing. Textile as example, the ratio of textile out of whole export products is 80%, and export amount is 5,686 mil US$ for 2003-04 and 12,347 mil US$ for 2007-08, it means 2.2 times growth by 5 years.

For Bangladesh the development of transportation and power sector is very important.

The following facilities of Chittagong Port are available;

Table 14-13 Mooring facilities of Chittagong port

For ocean-going vessels	Amount
General Cargo Berths	12
Container Berths	8
Specialized Berth for bulk handling	3
Dolphin Oil Jetty for POL	1
Grain Silo Jetty	1
Cement Clinker Jetty	1
CUFL Jetty	1
KAFCO Urea Jetty	1
Ammonia Jetty	1
Repair Berths	
a. Dry Dock Jetty	2
b. Mooring Berths	5
For inland coasters & vessels	
Jetty Berths for POL	1
Concrete Berth for Grain handling	1
Pontoon Berth for POL	3
Pontoon Berth for cement	1
Single Point mooring	1

Source: Chittagong Port Authority

Table 14-14 Cargo handling equipment

Equipment	Capacity	Amount
Shore crane	2-3 tons	26
Mobile crane	10-50 tons	33
Forklifts	3-5 tons	29
Low mast forklift	2.5-5 tons	45
Industrial tractor	25 tons	16
Trailer	6-25 tons	39

Source: Chittagong Port Authority

Table 14-15 Container handling equipment

Equipment	Capacity	Amount
Ship to Shore quay gantry crane	50 ton	4
Ribber tyred gantry crane	40 ton	11
Straddle carrier	40 ton	19
Fork lift truck	5-42 ton	9
Fork lift truck (spreader)	16 ton	10
Fork lift truck	16 ton	3
Reach stoker	7-45 ton	21
Container mover	50ton	3
Tractor	50ton	64
Trailer	40ton	57

Source: Chittagong Port Authority

(3) Waterways from Chittagong port to Hizla

The waterways from Chittagong port to Hizla will pass through the Bay of Bengal, Sandeep channel, Hatiya channel and Meghna river. The distance of this route from Chittagong port to Hizla is about 160km. This water route is navigable throughout the year.

The heavy cargoes have to be offloaded by cranes overboard on to the barges in the outer anchorage from where the cargoes may be transshipped to Balashi Ghat by barges.

At during monsoon, the Bay of Bengal remains very rough and turbulent and there is very less possibility of having good weather. The barge shall have to pass through the Bay of Bengal and as such it should be designed especially so that it can withstand rolling and pitching. It is not advisable to carry such heavy equipment through the Bay of Bengal during monsoon.

14.5 Layout and bird-view image

14.5.1 Power station layout

Based on above study, the power station layout is concerned.

(1) Required area

Power station consists of 1) generation facility area, 2) coal stock and handling area, 3) ash handling area, 4) other utility area. The required area for the domestic coal-fired power station in this Master Plan is as follows:

Table 14-16 Required area for domestic coal-fired power station

Facility	Area
generation facility area	Approx. 210,000 m2（600MWx3）
coal stock and handling area	Approx. 50,000 m2（200,000 t、15 days）
ash handling area	（reference） for landfill Approx. 500,000 m2（1m of depth for 1 year）
other utility area	Approx. 200,000 m2
Total[1]	Approx. 460,000 m2 ＋ash area

Source: PSMP Study Team

Generation facility area include boiler building, turbine generator building, auxiliary equipment building, EP, desulfurization, denitrification, ash treatment, transformer.

The required area for the import coal-fired power station in this Master Plan is as follows:

[1] Residence area, co-existing area is also required.

Table 14-17 Required area for import coal-fired power station

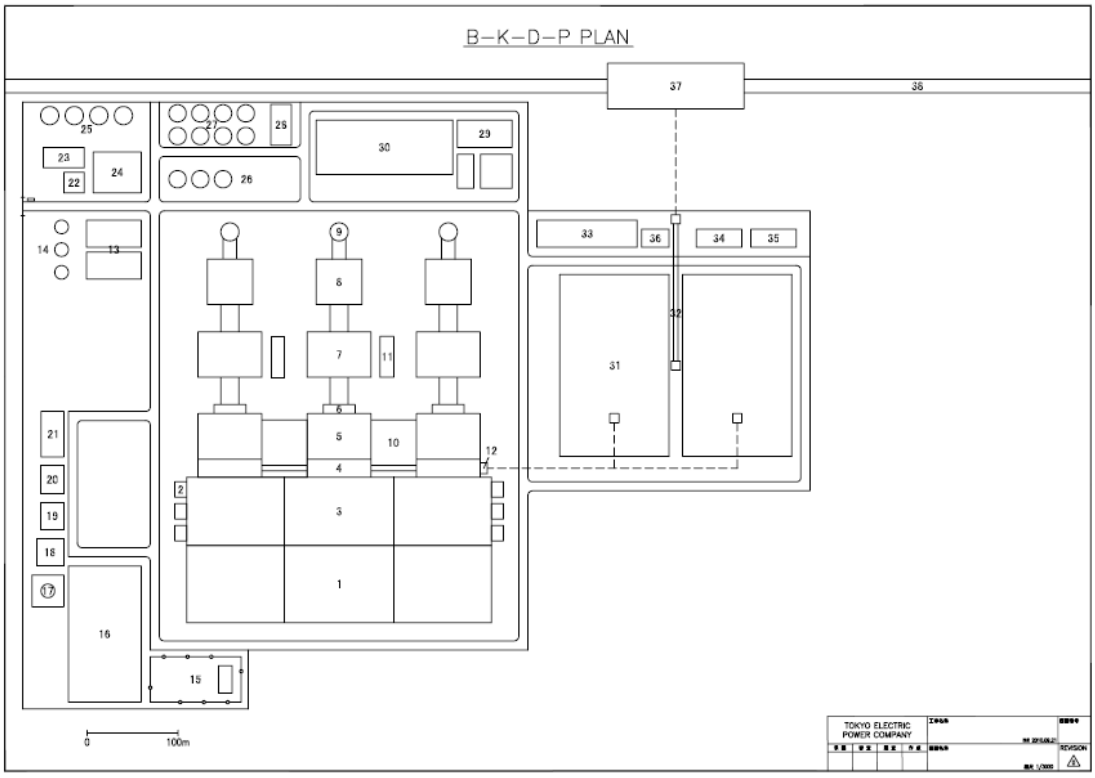
Location	Chittagong South	Meghnaghat
generation facility area	Approx. 140,000 m2（600MWx2）	Approx. 140,000 m2（600MWx2）
coal stock and handling area	Approx. 150,000 m2 （600,000 t）	Approx. 100,000 m2 （400,000 t）
ash handling area	（reference） for landfill Approx. 500,000 + 250,000 m2 （1m of depth for 1 year）	（reference） for landfill Approx. 500,000 m2 （1m of depth for 1 year）
other utility area	Approx. 200,000 m2	Approx. 200,000 m2
Total[1]	Approx. 490,000 m2 ＋ash area	Approx. 440,000 m2 ＋ash area

Source: PSMP Study Team

In this Master Plan, considering power development planning to 2030, 600MWx1 of facility would be installed for Chittagong South, however in the future both of power station is considered to expand to 600MWx2, the study is based on 600MWx2.

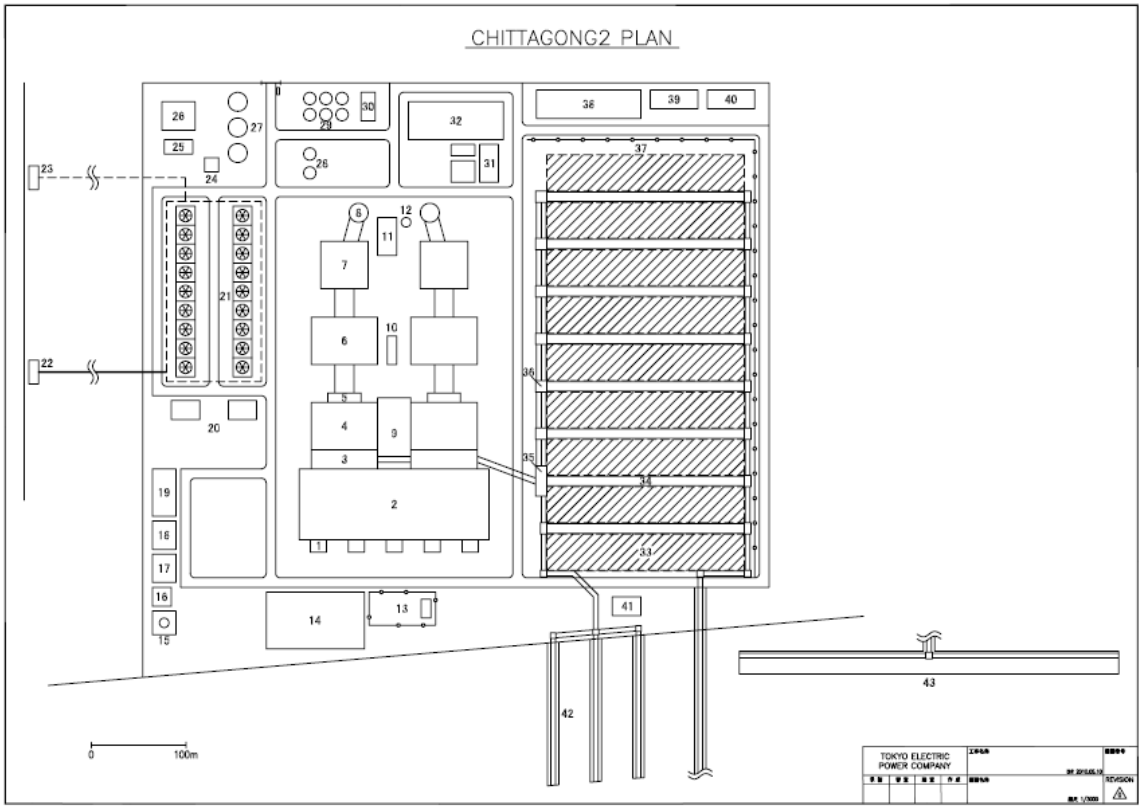
(2) Layout plan

Following shows the layout plan of B-K-D-P and Chittagong South.
The equipment layout plan of Meghnaghat is almost same as Chittagong South.



Source: PSMP Study Team

Fig. 14-21 Layout plan of domestic coal-fired power station (B-K-D-P)



Source: PSMP Study Team

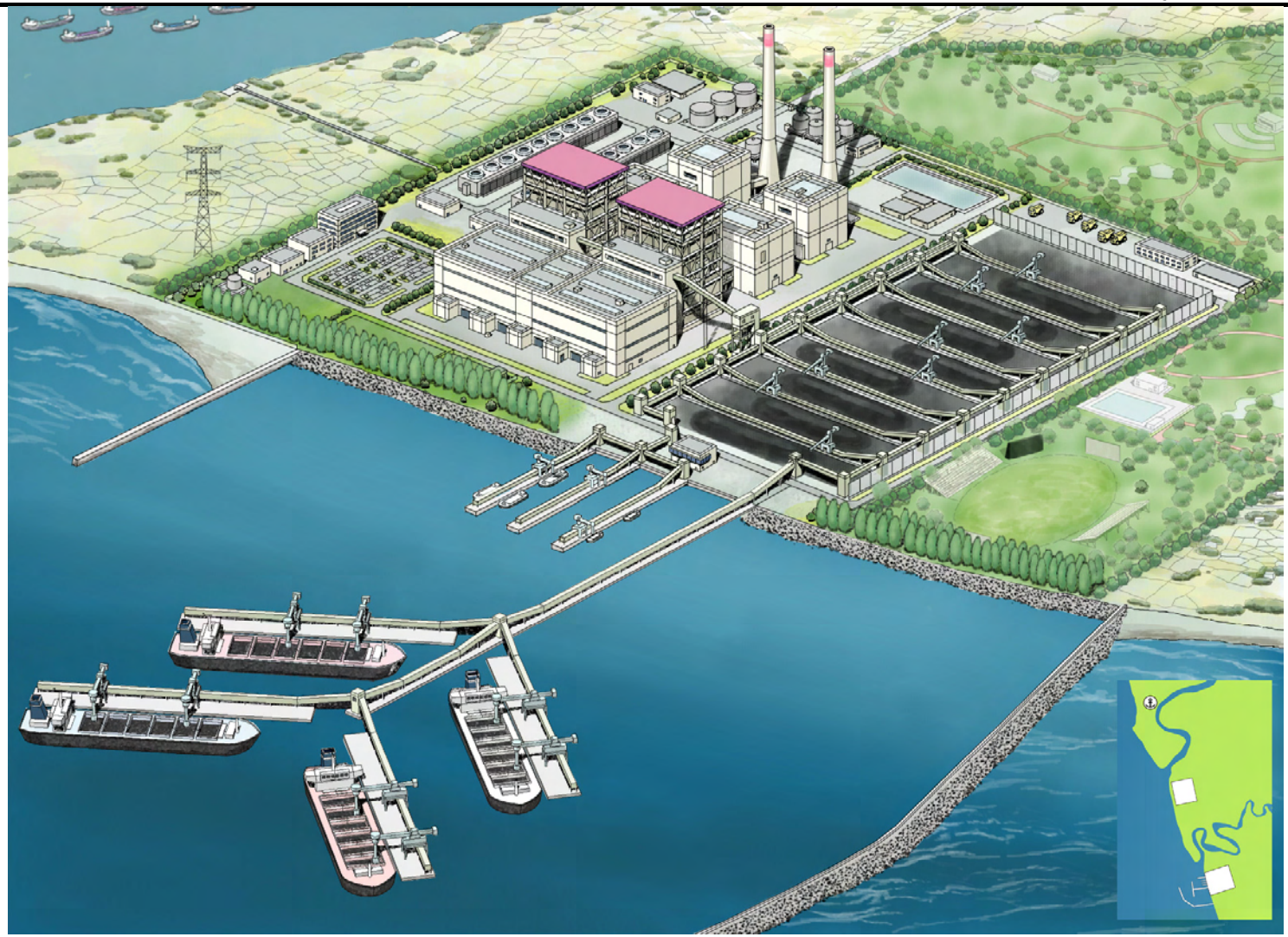
Fig. 14-22 Layout plan of import coal-fired power station (Chittagong South)

14.5.2 Bird-view image

Following shows the bird-view image of B-K-D-P and Chittagong South.
And image of Matarbari is added for reference.

Source: PSMP Study Team

Fig. 14-23 Bird-view image of B-K-D-P power station (600MW x 3)



Source: PSMP Study Team

Fig. 14-24 Bird-view image of Chittagong South power station (600MW x 2)

Source: PSMP Study Team

Fig. 14-25 Bird-view image of Matarbari power station and coal center (600MW x 4)

Chapter 15 Construction Schedule and Estimated Costs

15.1 Construction schedule

15.1.1 Summary

In planning the high prioritized project, the construction is broadly divided into two stages. The first stage comprises those things that need to be accomplished prior to project launch such as F/S, subsequent detail designs, election of contractors, and concluding contracts etcetera. This takes about 32 months. The second stage comprises the duties from the beginning of construction to operational commencement and takes about 48 months per each generator. The commencement work for the second generator is delayed six months and when the commencement for the first generator finally gets underway, it takes 54 months in total.

15.1.2 Procedures prior to construction launch

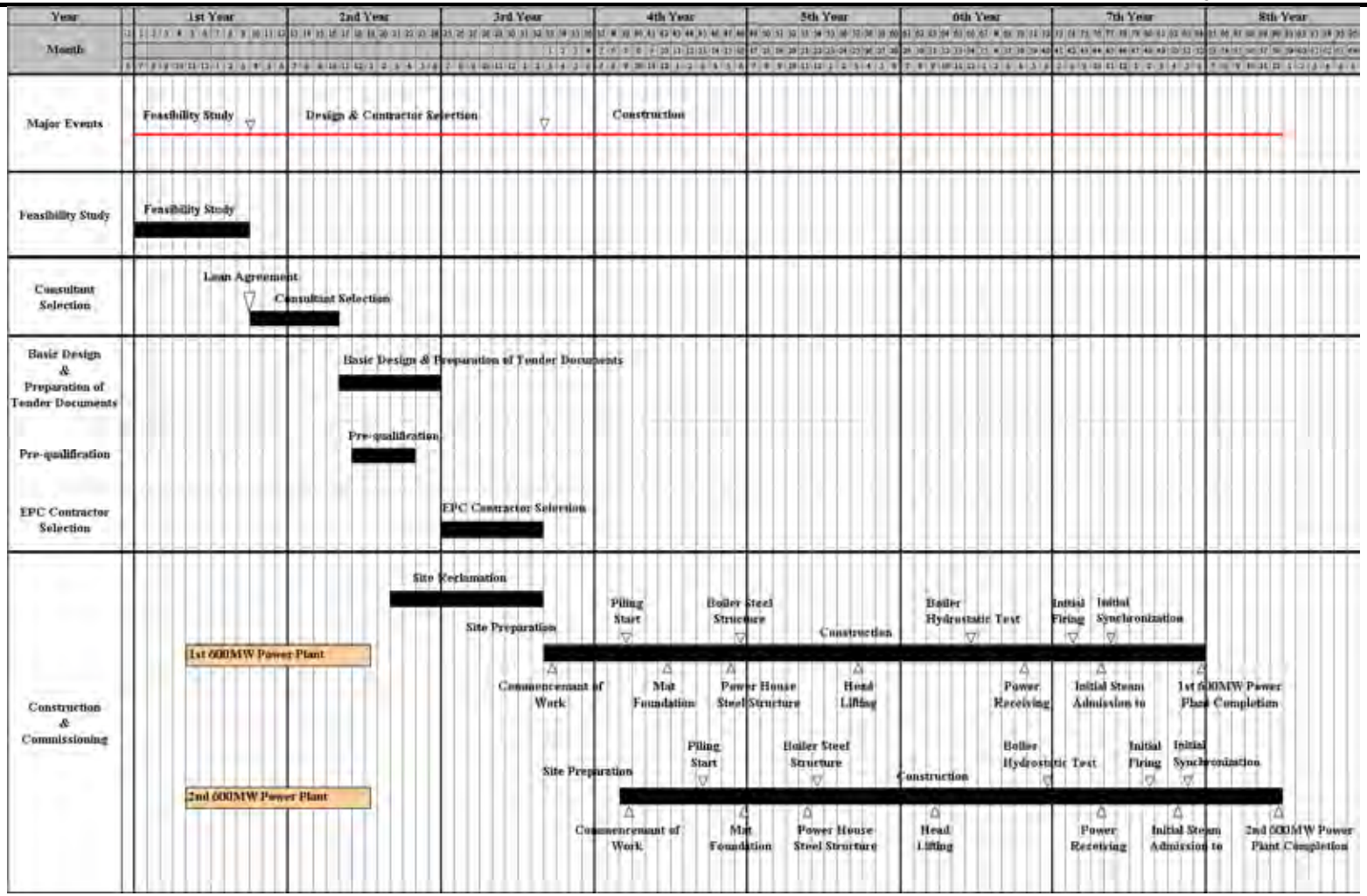
The following duties have to be accomplished prior to construction launch.

(1) Feasibility study (F/S)
(2) Site acquisition
(3) Capital Procurement and Financing approval
(4) Create a bid form
(5) Consultant selection
(6) Contractor selection

In order to initiate early implementation of this plan, out of the pre-construction procedures deemed necessary, the smooth implementation of the following is considered to be of vital importance. The first step is capital procurement. After the project feasibility via the F/S has been established, it is important that the government procure the necessary amount of capital financing as soon as possible. The second step is the selection of contractors. In order to ensure the smooth and swift execution of this plan, full-turn key implementation is non-negotiable prerequisite.

15.1.3 Construction process

After the contract(s) have been concluded, the construction schedule will be provided (attached).
This schedule will take into account both Japan’s domestic and import coal fired power station project achievement record.



Source: PSMP Study Team

Fig. 15-1 Construction schedule

15.2 Estimated construction costs

15.2.1 Summary

The construction costs for this high prioritized project are based on past similar projects. A breakdown of the costs with estimated amounts is provided in Table 15-1 below:

Table 15-1 Estimated construction cost breakdown

(unit 1,000USD)

	Domestic Coal P/S 2x600MW			Import Coal P/S 2x600MW		
	Foreign	Local	Total	Foreign	Local	Total
Direct	1,430,026	252,920	1,682,946	1,508,856	285,636	1,794,492
Indirect	95,335	234,357	329,692	100,590	250,771	351,361
IDC	54,477	7,226	61,703	57,480	8,161	65,641
Total	1,579,838	494,503	2,074,341	1,666,927	544,568	2,211,494

Source: PSMP Study Team

Direct Expenses consist of costs connected to EPC contracts and consulting fees
Indirect Construction Expenses comprise reserve funds and import taxes, VAT

15.2.2 Construction expenses and calculation methodology

(1) Construction expenses can be divided into domestic and foreign currency. Domestic currency comprises domestic labor wages, domestically procured construction materials, value-added tax etcetera while everything else is allocated as foreign currency.

(2) Construction expenses are based on the value of prices in September of 2010 of which there is no fluctuation expected.

(3) Direct construction costs are those expenses deemed necessary to the construction of the power generating equipment and environmental countermeasure equipment etcetera. (However, fuel equipment (including port facilities) and ash disposal equipment are considered separate). The following conditions are based on EPC contract(s).

- The fuel costs for test run are not allocated as they are balanced out by electricity fees.
- Power and water used for construction is not included.
- Regarding transmission facilities, the point until the switchyard of the power station is taken into account.

(4) Consulting service costs are 5% of the EPC price for both foreign currency and domestic currency. These are consultant expenses hired to assist in the supervision of design implementation (manpower costs, miscellaneous overhead, technical fees, travel expenses, communication fees etcetera.)

(5) Regarding reserve funds and physical contingencies, from an engineering perspective, 5% of the EPC price applies to both foreign currency and domestic currency. The domestic currency amount is the same as the domestic currency amount of which each is allocated 5%. For price contingencies, the foreign currency portion is based on overseas market conditions of which the EPC foreign currency price is 2%, the domestic currency portion is based on CPI data and 5%, the same foreign currency portion.

(6) Import tax (VAT) adheres to the nation's legal provisions, and as it shall be settled by the said business entity, the necessary tax rate shall be accounted for.

(7) Construction expense interest adheres to the payment plan applied to construction

term (period)

(8) The conditions governing construction expense payments are contingent on forecasted need on a year-by-year basis as follows:
1st year: 15%, 2nd year: 30%, 3rd year: 35%, Final Year: 20%

Further, in terms of primary generation facilities, in comparing domestic coal-fired power station with imported coal-fired power station, there is hardly any difference. However, since imported coal-fired power station involves the necessity of having port facilities, costs connected to fuel facilities (coal storage and handling) and ash treatment facilities will differ between domestic coal and imported coal.

Table 15-2 lists a breakdown of construction expenses.

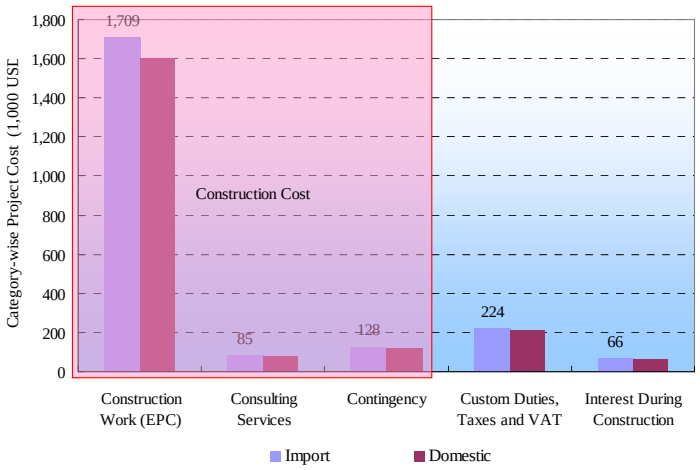
Table 15-2 Project cost detail (unit 1,000 USD)

Item	Domestic Coal Power Station (Minemouth)					Import Coal Power Station (with Port Facility)				
	Foreign Portion	Local Portion		Total		Foreign Portion	Local Portion		Total	
	(1,000 USD)	(1,000 TK)	(1,000 USD)	(1,000 TK)	(1,000 USD)	(1,000 USD)	(1,000 TK)	(1,000 USD)	(1,000 TK)	(1,000 USD)
A. Construction Work (EPC)										
A1.Power Station Installation & Related Works										
FOB Price of Imported Equipment										
1. Boiler Equipment	781,000			53,170,480	781,000	859,100			58,487,528	859,100
2. Turbine / Generator and its accessory	219,200			14,923,136	219,200	219,200			14,923,136	219,200
3. Environment Equipment	163,000			11,097,040	163,000	83,000			5,650,640	83,000
4. Coal,Ash Handling (Import: Port Facility)	0	0	0	0	0	147,000	4,289,040	63,000	14,296,800	210,000
5. Coal,Ash Handling (Domestic)	73,500	2,144,520	31,500	7,148,400	105,000	0	0	0	0	0
6. Construction, Erection, Commissioning & Insurance	90,148	14,254,318	209,376	20,391,594	299,524	90,001	14,231,035	209,034	20,358,286	299,035
Sub Total of A1	**1,326,848**	**16,398,838**	**240,876**	**106,730,650**	**1,567,724**	**1,398,301**	**18,520,075**	**272,034**	**113,716,390**	**1,670,335**
A2. Transmission Line	**35,081**			**2,388,342**	**35,081**	**38,705**			**2,635,043**	**38,705**
Sub Total of A	**1,361,929**	**16,398,838**	**240,876**	**109,118,992**	**1,602,805**	**1,437,006**	**18,520,075**	**272,034**	**116,351,433**	**1,709,040**
B. Consulting Services	**68,096**	**819,942**	**12,044**	**5,455,950**	**80,140**	**71,850**	**926,004**	**13,602**	**5,817,572**	**85,452**
C. Contingency										
Physical Contingency	68,096	819,942	12,044	5,455,950	80,140	71,850	926,004	13,602	5,817,572	85,452
Price Contingency	27,239	819,942	12,044	2,674,345	39,282	28,740	926,004	13,602	2,882,631	42,342
Sub Total of C	**95,335**	**1,639,884**	**24,088**	**8,130,295**	**119,423**	**100,590**	**1,852,007**	**27,203**	**8,700,203**	**127,794**
Total Construction Cost (A+B+C)	**1,525,361**	**18,858,664**	**277,007**	**122,705,236**	**1,802,368**	**1,609,447**	**21,298,086**	**312,839**	**130,869,207**	**1,922,286**
Per Unit Construction Cost (USD/kW)					**1,500**					**1,600**
D. Custom Duties, Taxes and VAT										
D1. Custom Duties & VAT (% of A1+A2 (Foreign) & C1)		12,169,520	178,753	12,169,520	178,753		12,840,366	188,607	12,840,366	188,607
D2. VAT & Income Tax on EPC Contractor (% on A1+A2 (local) & C2)		1,463,596	21,498	1,463,596	21,498		1,652,917	24,279	1,652,917	24,279
D3. VAT & Income Tax on Consultant (% of B)		681,994	10,018	681,994	10,018		727,196	10,681	727,196	10,681
Sub Total of D		**14,315,110**	**210,269**	**14,315,110**	**210,269**		**15,220,479**	**223,568**	**15,220,479**	**223,568**
E. Interest During Construction (IDC)	**54,477**	**491,965**	**7,226**	**4,200,771**	**61,703**	**57,480**	**555,602**	**8,161**	**4,468,857**	**65,641**
TOTAL PROJECT COST (A+B+C+D+E)	**1,579,838**	**33,665,739**	**494,503**	**141,221,117**	**2,074,341**	**1,666,927**	**37,074,167**	**544,568**	**150,558,543**	**2,211,494**

Source: PSMP Study Team

As shown in Table 15-2, the unit price of project cost is about 1,500USD/kW as domestic coal-fired power stations, 1,600USD/kW as import coal-fired power stations.

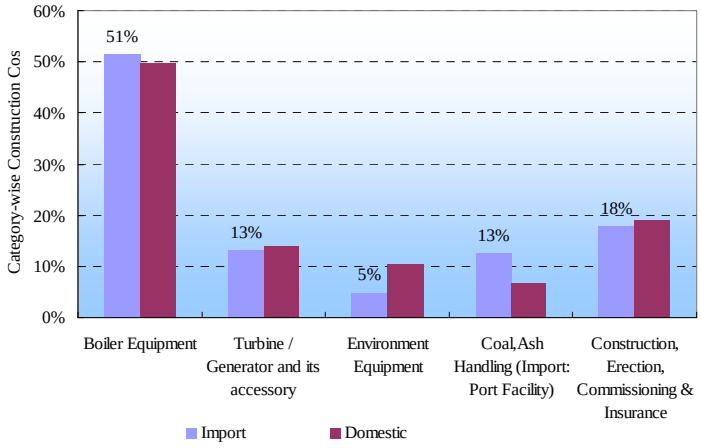
Each item rate of construction cost is shown as follows. Construction cost (EPC) has 70% of all. The remained cost is import tax, VAT(10%), contingency (6%), consultant cost (4%), interest during the construction (3%).



Source: PSMP Study Team

Fig. 15-2 Each item rate of construction rate

Each item rate of EPC cost is shown as follows. The boiler has 50%.



Source: PSMP Study Team

Fig. 15-3 Each item rate of EPC cost

15.2.3 Construction costs and adequacy evaluation

In order to conduct an adequacy evaluation of the aforementioned construction costs, a survey was conducted of the results of a similar project. According to a World Bank report titled, “Study of Equipment Prices in the Power Sector (2008), it was reported that in India 300MW～800MW of contracted coal power yielded 1,290～1,690 USD/kW. In reviewing the results of conditions connected to this area, in the said nation, 1,600 USD/kW was considered to be a reasonable level.

Table 15-3 Track record of coal-fired power station projects

Year/month	Country	Project name	Capacity	Type	Contract Price [Mil USD]	Unit Price [USD/kW]	Scope of contract
2010.6	Viet Nam	Nghi Son (1)	600MW (300MWx2)	Sub Critical	1,076	1,792	Overall construction
2009.11	Viet Nam	Van Phong	1320MW (660MWx2)	Super Critical	2,390	1,810	Investment
2007.5	Belgium	3 sites of Electrabel	2400MW (800MWx3)	Super Critical	3,586	1,494	Overall construction
2007.3	Canada	Keephills #3	450MW	Super Critical	598	1,328	Overall construction
2004.12	India	Bakreswar	420MW (210MWx2)	Sub Critical	478	1,138	Overall construction

Source: PSMP Study Team

Chapter 16 Economic and Financial Analysis of the Most Prioritized Projects

16.1 Economic analysis

16.1.1 Methodology

Whereas financial analysis focuses on the viability of the project from the perspective of the project sponsor, economic analysis considers and evaluates the optimal and/or efficient allocation of the resources utilized for the sake of the national economy. The methodology of the evaluation compares the economic benefits that will result from the resources input into the project under an environment of "With Project" as opposed to "Without Project" through which the economic internal return (EIRR) is to be drawn. The analysis verifies whether the EIRR is sufficient in covering the opportunity cost of the capital mobilized.

16.1.2 Assumptions

(1) Implementation schedule and period of the project

The implementation schedule and period of the project has been examined in the preceding Chapter. The economic analysis follows, in principle, the schedule that has been described but adjusts slightly to match the fiscal years of the country for the sake of simplifying the analysis. The schedule adjusted for the analysis assumes that the construction of the project shall commence in July 2014 and be commissioned in July 2018. The project is expected to operate for 30 years up till June 2030. The economic analysis has been applying a consistent price as of FY 2010.

(2) Inflation

Whenever it becomes necessary, the cost data that is expressed in terms of the constant prices of the fiscal years other than FY 2010 shall be used upon being converted to the constant prices of FY 2010 by the inflation indexes.

(3) Foreign exchange rate

For the data of various currencies, the conversions have been made utilizing the average exchange rates released by Bangladesh Bank for fiscal years. For future data, the forecast has been made by the Study Team, similar to what has been done for inflation, through which the past trend of foreign exchange rates has been reviewed to obtain future rates through extrapolation. It has been learnt that the past trends of the exchange rate between the U.S. Dollar and the Bangladeshi Taka is expressed by the linear function of $Y=-1.18547X + 53.03$ and the one for Japanese Yen and Taka is $Y=0.0335X + 0.4$, whereas Y represents the exchange rate and X represents the number of years that have elapsed starting from 1999. By using the functions, the analysis shall assume the exchange rates for the years to come.

(4) Fund raising

The analysis assumes that the project will be financed partly by donors and partly by the government of Bangladesh (GOB) through equity and loans. The loans from the donors will be lent to GOB and on-lent to the executing agency. The standard terms and conditions of on-lending within Bangladesh are established in the Guidelines issued by the Ministry of Finance[1] which prescribes that the GOB funds shall be provided in the combination of the equity and debt = 60:40; the terms of the loan are 25 years including a 5-year grace period; the rate of interest is to be 4.0% p.a. for the foreign currency and 3.0% p.a. for the domestic currency. The percentage of financing by the donors varies. The analysis assumes that 70% of the total costs shall be financed by the donors while the remaining 30% shall be provided by GOB.

[1] Ministry of Finance, "Lending and Relending Terms of Local Currency and Foreign Loans", March 2004

(5) Interest on loans

The interest accrued during construction shall be booked into the account of the capital project in progress and shall be capitalized at the time of the account transfer to the fixed assets upon completion of the project. The rate of interest to be applied during the construction is the same with the rates stated above. The interest during construction constitutes a part of the capital cost of the project and is counted as the economic cost whereas the interest to be paid during the operational phase shall not be counted as the economic cost.

(6) Revenue

The economic analysis adopts the quantified amount of the willingness-to-pay (WTP) as the measure of the economic value of the benefits instead of utilizing the actual tariff revenue from the project. The methodology for quantifying WTP will be elaborated on later.

(7) Useful life and depreciation

The analysis assumes the adoption of straight line depreciation while setting up the residual value of 10% and the useful life span of 30 years. The depreciation shall not be counted as the economic cost in the economic analysis.

(8) Contingencies

The project cost presented before contains both the physical and price contingencies. The price contingency shall be disregarded from the economic analysis whereas the physical contingency shall be included in the project cost because the physical contingency is to cover any of the project plan's shortcomings that has to be complemented with additional material, parts of works before the project could be completed as has been designed. Such parts of the project are found to be vital and indispensable to the project and, therefore, should be incorporated as an integral part of the project.

16.1.3 Cost

(1) Scope of project

The analysis focuses on typical coal-based thermal power stations that constitute the core parts of the Master Plan, out of which one of each plant of the generation projects based on imported coal and the one based on the mine mouth of a domestic coal mine. The project for the imported coal incorporated in the scope of the project the construction of a port importing the coal and a coal center for handling the imported coal. The generation plants are to be connected to a nearby transmission grid and the facilities for such connection shall be included within the scopes of both projects.

(2) Project cost

The costs of the projects are estimated in terms of the constant price of FY 2010 as enumerated below;

Table 16-1 Project cost for economic analysis（constant price of FY 2010）[1]

	Imported Coal P/S(2 X 600MW)			Domestic Coal P/S (2 X 600MW)		
	F.C. (US$ million)	L.C. (Tk million)	Total (Tk million)	F.C. (US$ million)	L.C. (Tk million)	Total (Tk million)
EPC Contract	1,437	19,042	119,043	1,362	16,861	111,636
Engineering	72	952	5,952	68	843	5,582
Contingencies						
Physical Contingency	72	952	5,952	68	843	5,582
Interest During Construction (IDC)						
Foreign Loan		5,852	5,852		5,546	5,546
GOB Loan		143	143		127	127
Total Cost	1,581	26,941	136,942	1,661	24,220	128,473

Source： PSMP Study Team

(3) Fuel price

The fuel prices have been reviewed earlier in Chapter 10. The economic analysis adopts the fuel prices described in the Chapter, as the prices that are based on the long term development plan of the Master Plan has been established to achieve the “least cost development” in meeting the forecasted demand. The analysis assumes that the fuel cost will remain constant after 2030 when the Master Plan ends and the years beyond are out of the scope of the Master Plan.

(4) Operation and maintenance cost

The operations and maintenance cost which has also been described in Chapter 10 has been adopted for the economic analysis.

(5) Taxes and fiscal levies

The taxes and fiscal levies have been deemed as the domestic unrequited transfer of revenues that plays no contributory function of the project to the national economy and are now disregarded in conducting the economic analysis.

16.1.4 Economic benefit

(1) Definition of economic benefit

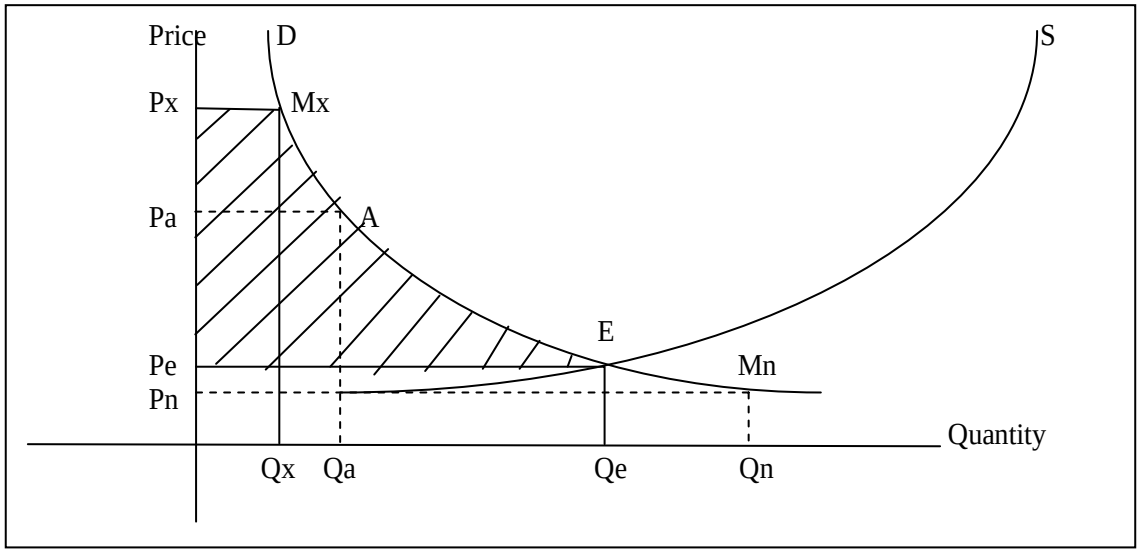
The economic analysis compares the economic costs and benefits in an environment with “With Project” versus “Without Project”. The parties to benefit from the project are defined as; (i) those who are not presently connected to electricity but will become electricity users owing to the implementation of the project; (ii) those who are connected to electricity but are not able to use the power as much as they need due to the supply constraints connected to expanded consumption. The benefit of the project will be composed of the incremental volume of power supplied to those beneficiaries.

[1] F.C. stands for Foreign Currency and L.C. stands for Local Currency. US$ 1 = Tk 69.59 (actual for fiscal year 2010)

The contemporary method of economic analysis is to define and quantify directly in monetary terms and evaluate the benefits arising from the project which is compared against the economic cost of the project in obtaining the economic internal rate of return. In those instances where the measurement and quantification of benefits are difficult, an analysis adopts an alternative method of assuming an alternative project which might generate the same quality and amount of benefit but could be constructed at the least cost next to the project under appraisal. Traditionally, in the power sector, the least cost alternative method used to be the predominant methodology but has changed during the past decade into adopting the direct method of quantifying benefits through the measurement of the Willingness-to-Pay (WTP) of the consumers for the purchase of electricity. The Study Team has delved into the pros and cons of the different methodologies to adopt. After reviewing the different methodologies, the Study Team has decided to adopt the direct quantification method.

(2) Willingness-to-Pay (WTP)

The Willingness-to-Pay (WTP) is the maximum amount consumers are prepared to pay for goods or services. WTP represents the economic value that consumers assess in their consumption pattern. The following figure illustrates the WTP in relation to the demand and supply curve;



Source: PSMP Study Team

Fig. 16-1 Willingness-to-Pay

In the above graph, the curve D represents the demand curve and the curve S the supply curve. At the crossing point of both curves, E represents the equilibrium where the supply and demand balances and Pe represents the level of electricity price that is currently paid, as the average billing price. The maximum price that consumers are willing to pay is represented by Px which should match with the long run marginal cost in the country. The area below the demand curve D and the line Px-Mx and above the line Pe-E represents the range of those consumers who are willing to pay in excess of the prevailing tariff and is called “Consumer surplus”. WTP is the aggregate of the total amounts that are currently paid by the consumers and the consumer surplus. WTP can be calculated by using the following formula. The curvature of the demand curve, which is the elasticity of demand, varies among different analysts and there is no standard number which has been theoretically established. General observation witnesses the curvature varying between 1/2 – 1/3. The analysis takes the conservative approach in adopting the curvature at 1/3.

WTP（average） ＝ WTP minimum ＋ 1/3 X (WTP maximum － WTP minimum)

There exist different methodologies for calculating the maximum and minimum of WTP. With respect to the minimum value, most analysts rely on the average billing rate of electricity. The PSMP Study Team, too, follows and adopts the methodology as its own. The average billing rate is the price consumers are actually paying for electricity and the fact that it averages the amount that consumers are willing to pay is obvious. The rectangle with the corner points; Pe, E, Qe, 0 represents the aggregate amount consumers are paying at present. Should the price fall below Pe to Pn for example, the demand will expand so far as to Qn of which the supply cannot meet and no equilibrium is to be reached. For the analysis, the average bulk selling rate of BPDB in 2008-09 is known to be Tk 2.37/kWh[1] and is treated as the minimum value of WTP for FY 2009.

Contrary to the above, there exists a variety of methodologies for obtaining the maximum of WTP. The most solid but conservative approach is found to pick up the highest tariff to the consumers that is applied by any of the electricity providers at retail level. The price to be found there is the amount that is actually accepted by the consumers and can be deemed as a solid and reliable indicator although the methodology shall not be able to deny the probable existence of the higher level of WTP. In the above graph, the point Pa typically represents such a level. Pa is located at a higher level than Pe but consumers evidently expressing their readiness to pay through the actual purchasing of electricity. Other consumers are demonstrating their willingness to pay for the electricity at a much higher level such as Px by running the captive diesel generation at a much higher cost than the price of electricity at Pa. The efforts searching for the maximum is equivalent to ultimately determining the value of Px. The second of the methods to calculate the WTP maximum is to rely on the Long Run Marginal Cost (LRMC) for the supply of power theoretically established for the country. The general consensus of theory is that the LRMC can be deemed as the WTP maximum. Having no LRMC ever established for the country, it is not possible to adopt an alternative. In the absence of such, a second alternative is found in the consumers' behavior operating the captive diesel generation. The consumers who fail to obtain a sufficient volume of electricity turn to captive diesel generation. The consumers are paying for the captive cost, operating expenses as well as the fuel cost for such operations. Consumers' action for paying for them evidently demonstrates the willingness-to-pay.

The WTP maximum can be obtained in the operating cost of captive diesel generation plants through the following steps. It is assumed that consumers will resort to diesel generation, should they fail to obtain a sufficient supply of power from the grid. For such operations, they are paying for the capital costs, fuel costs, operation and maintenance of diesel equipment. There exists an evident case of consumer willingness to pay for such costs and expenses. The size of the captive generation plants varies from large to small; such as 1MW, 500kW, 100kW, 5kW, etc. The generation cost is generally understood to be following the economy of scale in which the larger ones are of smaller cost. The analysis follows the conservative approach in taking the case of smaller costs for analysis. To be a good example for such analysis, BPDB owns and operates small isolated diesel power stations running detached from the grid at Kutubudia, Sandip and Hatiya. Actual costs and expenses can be learnt from the operational records of those power stations as described below;

[1] Interviews with BPDB and BERC in October 2008 at the time of last bulk tariff adjustment

Table 16-2 Generation cost of isolated diesel plants of BPDB

	Actual for FY 2008-09
Capacity（MW）	6.5
Net Annual Output（kWh）	1,721,963
Fuel Consumption per 1kWh（lit/kWh）	0.403
Unit Price of Fuel（Tk/lit）	42.71
Fuel Cost（Taka/kWh）	17.21 (66.6%)
Variable Operational Expense（Taka/kWh）	0.79 (3.1%)
Fixed Expense incl. Administrative Overhead（Taka/kWh）	7.83 (30.3%)
Total Generation Cost (Taka/kWh)	25.83 (100%)

Source： BPDB, “BPDB Generation Cost for the Year 2009-10”

The examples referred to above are the three isolated power stations having a total capacity of 6.5 MW, in an average of 2 MW per station that can be deemed similar to the captive generation prevailing in the private sector and their operating cost is surmised to resemble that of captive generation. The predominant part of the generation cost of diesel generation is composed of the fuel costs occupying approximately 67%, in particular 80% at the Hatiya Power Station, of the total generation cost. The analysis takes into account the fuel cost and only disregards the capital cost and other expenses for the calculation of the WTP maximum in consideration of the following background and conditions;

(1) Many of the consumers have acknowledged that they have owned diesel generators for a considerable time prior to the present. The capital costs of the diesel generators vary depending upon the timing and scale of the investment;
(2) Consumers might have made investment decisions based on cheaper fuel and intend to operate the equipment while paying for the higher cost of fuel but have no intention to renew such investments, meaning that its owner has no intention of bearing the capital costs under the current environment; and
(3) Other expenses such as administrative expenses arise at large institutions but do not arise during small scale diesel generation.

Based on the above, the analysis treats the investment cost as the sunk cost and assumes expenses other than fuel as zero. From the table above, the fuel cost is referred to as the WTP minimum at the constant price of FY 2009. WTP has been obtained in the following equation;

WTP = Taka 2.37/kWh + 1/3 X (Taka 17.21/kWh – Taka 2.37/kWh) = Taka 7.32/kWh

The PSMP Study Team have now obtained WTP Tk 7.32/kWh in its hands at the constant price of FY 2009. The figure obtained is converted to the constant price of 2010 which turns out to be WTP=Tk 7.85/kWh. Using the figure obtained as the unit price of the economic benefit and multiplying the total volume of generation can quantify the value of the generated electricity. The quantified benefits are compared to the capital cost and the operational cost calculated by the international price of natural gas for the ultimate purpose of calculating EIRR.

(3) Economic evaluation

The Study Team has developed an analytical model incorporating the basic assumptions, inputs of cost and benefits through which the PSMP Study Team obtain the EIRR, the ultimate products of the analytical work. To begin with, the following table shows the EIRR for the Imported Coal Generation Plant;

Table 16-3 Economic internal rate of return (EIRR) ＜imported coal＞

(Taka Million)

Fiscal Year	Economic Cost (A)			Economic Benefit (B)	(B) - (A)
	Capital	O&M	Total Cost		
2015	19,879		19,879		-19,879
2016	41,357		41,357		-41,357
2017	46,677		46,677		-46,677
2018	29,029		29,029		-29,029
2019		32,235	32,235	66,634	34,400
2020		33,007	33,007	66,634	33,627
2021		33,780	33,780	66,634	32,855
2022		34,552	34,552	66,634	32,082
2023		35,302	35,302	66,634	31,333
2024		36,027	36,027	66,634	30,607
2025		36,753	36,753	66,634	29,881
2026		37,479	37,479	66,634	29,155
2027		38,158	38,158	66,634	28,477
2028		38,860	38,860	66,634	27,774
2029		39,539	39,539	66,634	27,095
2030		40,218	40,218	66,634	26,416
2031		40,218	40,218	66,634	26,416
2032		40,218	40,218	66,634	26,416
2033		40,218	40,218	66,634	26,416
2034		40,218	40,218	66,634	26,416
2035		40,218	40,218	66,634	26,416
2036		40,218	40,218	66,634	26,416
2037		40,218	40,218	66,634	26,416
2038		40,218	40,218	66,634	26,416
2039		40,218	40,218	66,634	26,416
2040		40,218	40,218	66,634	26,416
2041		40,218	40,218	66,634	26,416
2042		40,218	40,218	66,634	26,416
2043		40,218	40,218	66,634	26,416
2044		40,218	40,218	66,634	26,416
2045		40,218	40,218	66,634	26,416
2046		40,218	40,218	66,634	26,416
2047		40,218	40,218	66,634	26,416
2048		40,218	40,218	80,328	40,111
EIRR	**17.69%**				

Source： PSMP Study Team

Similarly, EIRR has been calculated for the domestic coal-fired power plant as shown in the following table;

Table 16-4 Economic internal rate of return（EIRR）＜domestic coal-fired power plant＞

(Taka Million)

Fiscal Year	Economic Cost (A)			Economic Benefit (B)	(B) - (A)
	Capital	O&M	Total Cost		
2015	18,644		18,644		-18,644
2016	34,948		34,948		-34,948
2017	39,262		39,262		-39,262
2018	20,714		20,714		-20,714
2019		29,982	29,982	66,634	36,652
2020		30,601	30,601	66,634	36,034
2021		31,219	31,219	66,634	35,416
2022		31,837	31,837	66,634	34,798
2023		32,436	32,436	66,634	34,198
2024		33,017	33,017	66,634	33,618
2025		33,597	33,597	66,634	33,037
2026		34,178	34,178	66,634	32,456
2027		34,721	34,721	66,634	31,913
2028		35,283	35,283	66,634	31,351
2029		35,826	35,826	66,634	30,808
2030		36,369	36,369	66,634	30,265
2031		36,369	36,369	66,634	30,265
2032		36,369	36,369	66,634	30,265
2033		36,369	36,369	66,634	30,265
2034		36,369	36,369	66,634	30,265
2035		36,369	36,369	66,634	30,265
2036		36,369	36,369	66,634	30,265
2037		36,369	36,369	66,634	30,265
2038		36,369	36,369	66,634	30,265
2039		36,369	36,369	66,634	30,265
2040		36,369	36,369	66,634	30,265
2041		36,369	36,369	66,634	30,265
2042		36,369	36,369	66,634	30,265
2043		36,369	36,369	66,634	30,265
2044		36,369	36,369	66,634	30,265
2045		36,369	36,369	66,634	30,265
2046		36,369	36,369	66,634	30,265
2047		36,369	36,369	66,634	30,265
2048		36,369	36,369	80,328	43,959
EIRR	**22.10%**				

Source： PSMP Study Team

The above tables show the EIRRs at 17.69% for the Imported Coal Generation Plant and 22.10% for the domestic coal-fired power plant. The outputs obtained are not lower than any of the prevalent criteria for feasibility; the opportunity cost of capital typically represented by a long term

government bond of the country, currently yielding 8-9% as of June 2010[1]; the threshold of feasibility perceived as common sense (10-12%); and the discount rate guided by GOB for preparation of the Development Project Proposal (12%). In particular, the EIRR turned out to be at a very high level of 22.09% at the domestic coal-fired power plant. PSMP Study Team now conclude that there are no existing doubts as to the economic viability of the two Projects selected.

(4) Sensitivity analysis

The analysis moves to the next task should any of the basic assumptions adopted for the project happen to change due to a significant extent, the extent of the impact to be felt by EIRR, is examined. The factors considered here are; (i) capital costs; (ii) operation and maintenance expenses; (iii) plant factors, (iv) fuel costs; and (v) WTP. The following table summarizes the impact on EIRR;

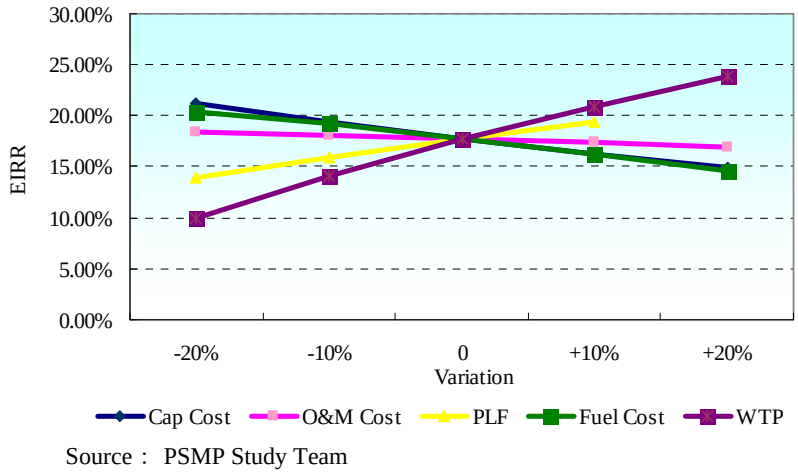
Table 16-5 Sensitivity test of EIRR

Parameter	Deviation	EIRR		Parameter	Deviation	EIRR	
		Imported Coal	Domestic Coal			Imported Coal	Domestic Coal
Capital Cost	▲20%	21.14%	26.36%	Fuel Expense	▲20%	20.45%	24.64%
	▲10%	19.39%	24.04%		▲10%	19.16%	23.40%
	0%	17.69%	22.10%		0%	17.69%	22.10%
	+10%	16.24%	20.44%		+10%	16.18%	20.73%
	+20%	14.99%	19.01%		+20%	14.56%	19.30%
O&M Exp.	▲20%	18.38%	22.81%	WTP	▲20%	9.95%	14.28%
	▲10%	18.04%	22.46%		▲10%	14.11%	18.43%
	0%	17.69%	22.10%		0%	17.69%	22.10%
	+10%	17.34%	21.73%		+10%	20.90%	25.42%
	+20%	16.98%	21.37%		+20%	23.84%	28.49%
PLF	▲20%	13.88%	17.79%				
	▲10%	15.84%	20.00%				
	0%	17.69%	22.10%				
	+10%	19.46%	24.09%				

Source： PSMP Study Team

Among the five parameters selected for analysis, there is no one whose changes deprive the projects of their economic viability, so long as the changes remain within 20% of the base case conditions. Viewing the Imported Coal Plant first, the fluctuation in WTP swings the EIRR to the most extent. The deterioration of WTP by 20% lowers EIRR to 9.95%, slightly undermining the 10% level but maintains a healthy level. The EIRR manages to stay at 14.11%, when the WTP falls by 10%. Next to WTP, the fluctuation of fuel cost affects EIRR. Should it increase by 20%, its EIRR goes down to 14%. The deterioration of the capital cost and the plant factor by 20% [2]lowers their EIRRs to 13-14%. The impact is found to be least from the fluctuation of O&M cost. Its changes of ±20% affects EIRRs only with a small margin of 1.4%. Moving to the domestic coal-fired power plant, for all of the selected parameters, the project maintains high EIRRs and a strong resilience against their fluctuations, endorsing lasting economic viability of the project. The movement of parameters and resultant EIRRs are illustrated in the following figure for easy reference;

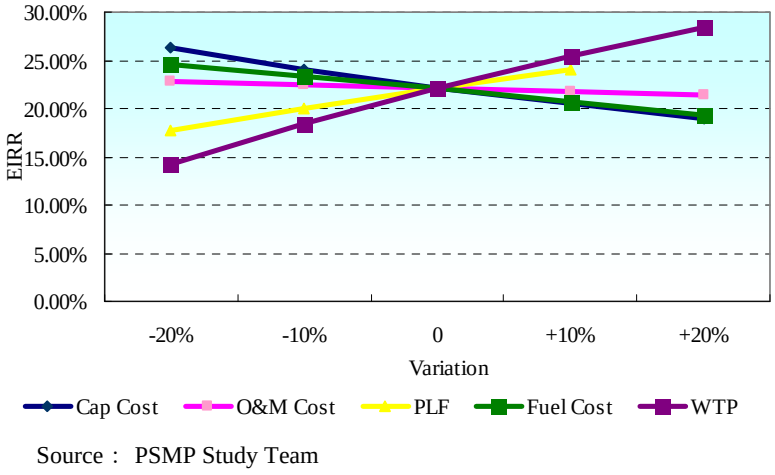
[1] Bangladesh Bank, "Major Economic Indicators: Monthly Update", June 2010.
[2] The plant load factor assumes the basic rate of 80% and its deterioration by 20% means the PLF to be 64% (=80% X 0.8).



Source： PSMP Study Team

Fig. 16-2 Sensitivity test of EIRR ＜imported coal＞

At the Imported Coal Project, should the WTP fall by 20%, the EIRR will turn out to be slightly below 10% while maintaining a healthy level. For the deterioration of the parameter by 10% and other parameters by 20%, the EIRR manages to stay above 13%.



Source： PSMP Study Team

Fig. 16-3 Sensitivity of EIRR ＜domestic coal＞

At the domestic coal-fired power plant, the EIRR maintains a high level of EIRRs regardless of the parameter changes within 20% in any of the items. The project is evaluated to be sufficiently viable and resilient in all cases.

16.2 Financial analysis

16.2.1 Criteria for financial evaluation

The financial evaluation aims to assess project profitability from the points of project entity – BPDB. The financial costs include the capital costs and its relevant O&M costs (including fuel costs), while financial benefit/ values consist of the power generation portion of domestic retail tariffs. According to the study results, the following three power plants are the most prioritized projects:

Domestic coal-fired power plant: (1) B-K-D-P 1,600 MW #1&#2, COD of FY2019.

Import coal-fired power plant: (1) Chittagong South 600 MW #1&#2, COD of 2017,

(2) Meghnaghat 600MW #1&#2, COD of 2022.

The financial analysis here covers one case each from domestic and imported coal-fueled power plants. The financial viability of the Project is assessed by comparing the financial internal rate of return (FIRR) of the Project with the weighted average cost of capital (WACC), or the fee to finance the Project's cost. For this purpose, the WACC is set at 4.28%[1].

The following are the assumptions to estimate the FIRR of the Project.

(1) Both costs and benefits will be expressed in real terms valued at June 2010 constant prices.

(2) Like the economic analysis, the evaluation will be carried out for thirty four years in economic terms of the Project facilities, including detailed designing and the construction period of four years (FY 2015 to FY2018). All costs will be discounted to those as of June 2010. For reference, the fiscal year of Bangladesh starts in July and ends in June.

(3) The financial costs include:
   (a) The financial analysis of this study assumes the Ultra-super-critical type coal-fired thermal power plant which operates as a base load supplier of Bangladesh. The plant's land has been provided by BPDB's property. For the related facilities, power plants fueled by domestic coal would utilize coal mines next to its plants, while power plants fueled by imported coal would utilize port facilities. Electricity generated at the plants will be transmitted via the close electricity grid. This prioritized project covers the cost of transmission facilities necessary to connect with the existing grid.
   (b) The construction costs of this power generation project are the same as those estimated in Chapter 15 of "Construction Progress and Estimated Costs", including physical contingency. Different from economic analysis, the value of the local currency portion can be used without any adjustments.
   (c) The annual operation and maintenance costs of the Project facilities are estimated to be 5% of the investment costs.
   (d) Depreciation, interest charges, other taxes and duties are excluded
   (e) The fuel costs are cited from the values in the fuel scenario which are used in power development planning in the earlier section of this report. The value remains constant after the year 2030.

(4) The financial benefits include:
   (a) The financial benefits are defined as the incremental energy sales revenue obtained by the Project. The current domestic retail tariff (average retail tariff) is employed as the financial value of this evaluation. Because the Project covers only power generation facilities, the corresponding portion of the tariff is used as a financial value. This study used the Utility Tariff for this purpose. The total project benefit has been led by multiplying the average Utility Tariff with the annual power generation amount.
   (b) The annual power generation amount is calculated as 8,488GWh per power station (2 units, 1200 MW) based on the input such as the installed capacity, plant factor, and in-house use.
   (c) The average Utility Tariff is cited from that as of August 2010 ((2.73 Tk/ kWh). The annual incremental rate is assumed to be zero in real terms, a similar approach as the recent World Bank's study[2]

[1] The calculation of WACC
In general, WACC is led by the following equations:
WACC = {equity cost * equity / (equity + debt)}+{debt cost*debt / (equity + debt)}
The calculation assumes no tax involved because BPDB and the government – project investors – are exempt from tax.
The financing ratio of donors to the Government is set as 7 to 3. Among the amount from the Government, its 60 % (18% of the total cost) come as equity, while the rest come as loan from the Government. The dividend of the Government's equity is set as 6%, while the interest of donors' loan is set as 4%, and the one of the Government as 3%. From those assumption, the value of WACC is calculated as 4.28%.

[2] "Power Sector Financial Restructuring and Recovery Plan," IDA, August 2006.

16.2.2 Results of evaluation

The study team calculated the FIRR of the Project in accordance with the above premise to obtain the following results:

- Domestic coal) FIRR: not available. NPV: - 4,469 million USD (discount rate of 4.28%).
- Import coal) FIRR: not available. NPV: - 5,8212 million USD (discount rate of 4.28%)

The cash flow is shown in Table 16-6 for domestic coal and in Table 16-7 for imported coal. Both of the prioritized Projects are concluded to be financially not-viable under the assumed conditions, based on the fact that both FIRR values fall below its benchmark of WACC, 4.28.

Table 16-6 FIRR calculation for the most prioritized project (domestic coal)

(1,000US$)

Fiscal Year	Financial Cost (A)			Financial	Net
	Capital	O&M	Total Cost	Benefit (B)	(B)-(A)
2010					
2011					
2012					
2013					
2014					
2015	311,151		311,151		-311,151
2016	622,302		622,302		-622,302
2017	726,019		726,019		-726,019
2018	414,868		414,868		-414,868
2019		409,506	409,506	295,499	-114,007
2020		418,455	418,455	295,499	-122,956
2021		426,893	426,893	295,499	-131,393
2022		435,330	435,330	295,499	-139,830
2023		443,767	443,767	295,499	-148,268
2024		451,949	451,949	295,499	-156,449
2025		459,875	459,875	295,499	-164,375
2026		467,801	467,801	295,499	-172,301
2027		475,727	475,727	295,499	-180,227
2028		483,141	483,141	295,499	-187,642
2029		490,812	490,812	295,499	-195,312
2030		498,226	498,226	295,499	-202,727
2031		505,641	505,641	295,499	-210,142
2032		505,641	505,641	295,499	-210,142
2033		505,641	505,641	295,499	-210,142
2034		505,641	505,641	295,499	-210,142
2035		505,641	505,641	295,499	-210,142
2036		505,641	505,641	295,499	-210,142
2037		505,641	505,641	295,499	-210,142
2038		505,641	505,641	295,499	-210,142
2039		505,641	505,641	295,499	-210,142
2040		505,641	505,641	295,499	-210,142
2041		505,641	505,641	295,499	-210,142
2042		505,641	505,641	295,499	-210,142
2043		505,641	505,641	295,499	-210,142
2044		505,641	505,641	295,499	-210,142
2045		505,641	505,641	295,499	-210,142
2046		505,641	505,641	295,499	-210,142
2047		505,641	505,641	295,499	-210,142
2048		505,641	505,641	295,499	-210,142
Total	2,074,341	14,563,020	16,637,360	8,864,984	-7,772,377

Source: PSMP Study Team

Table 16-7 FIRR calculation for the most prioritized project (import coal)

(1,000US$)

Fiscal Year	Financial Cost (A)			Financial	Net
	Capital	O&M	Total Cost	Benefit (B)	(B)-(A)
2010					
2011					
2012					
2013					
2014					
2015	331,724		331,724		-331,724
2016	663,448		663,448		-663,448
2017	774,023		774,023		-774,023
2018	442,299		442,299		-442,299
2019		492,812	492,812	295,499	-197,312
2020		503,997	503,997	295,499	-208,498
2021		514,544	514,544	295,499	-219,045
2022		525,091	525,091	295,499	-229,591
2023		535,637	535,637	295,499	-240,138
2024		545,864	545,864	295,499	-250,365
2025		555,772	555,772	295,499	-260,273
2026		565,679	565,679	295,499	-270,180
2027		575,587	575,587	295,499	-280,087
2028		584,855	584,855	295,499	-289,356
2029		594,443	594,443	295,499	-298,944
2030		603,711	603,711	295,499	-308,212
2031		612,980	612,980	295,499	-317,480
2032		612,980	612,980	295,499	-317,480
2033		612,980	612,980	295,499	-317,480
2034		612,980	612,980	295,499	-317,480
2035		612,980	612,980	295,499	-317,480
2036		612,980	612,980	295,499	-317,480
2037		612,980	612,980	295,499	-317,480
2038		612,980	612,980	295,499	-317,480
2039		612,980	612,980	295,499	-317,480
2040		612,980	612,980	295,499	-317,480
2041		612,980	612,980	295,499	-317,480
2042		612,980	612,980	295,499	-317,480
2043		612,980	612,980	295,499	-317,480
2044		612,980	612,980	295,499	-317,480
2045		612,980	612,980	295,499	-317,480
2046		612,980	612,980	295,499	-317,480
2047		612,980	612,980	295,499	-317,480
2048		612,980	612,980	295,499	-317,480
Total	2,211,494	17,631,627	19,843,122	8,864,984	-10,978,138

Source: PSMP Study Team

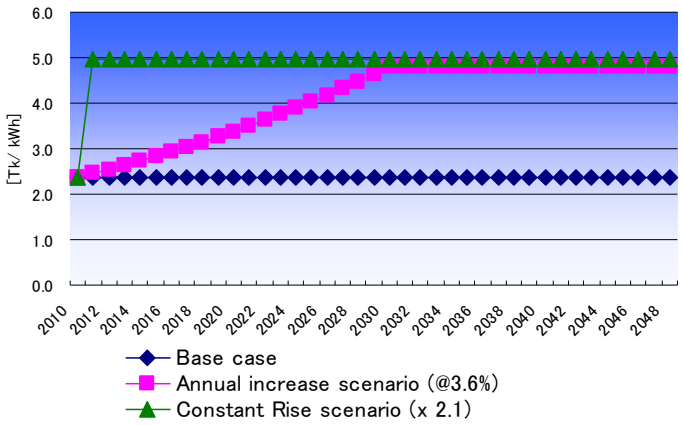
16.2.3 Sensitivity analysis

The financial viability of both prioritized projects would not be predicted under the above conditions (hereafter called the "current case"). This subsection aims to find the break-even conditions for the prioritized projects to be financially viable (hereafter called the breakeven case. Once the breakeven case is identified, its sensitivity analyses are followed. Like the economic evaluation above, the sensitivity analyses are to measure the impact caused by future uncertainties. The analyses examined four scenarios taking into account the variables of construction cost, fuel cost, O&M cost, and plant factors.

(1) New tariff case (breakeven case)

Following the previous results, revenue increase would be essential for the prioritized project to be financially viable, assuming that no more significant cost reduction can be expected. Because the plants are assumed to be operated as base load supplier, the increase of the annual generation amount is not to be expected. Therefore, the Study Team analyzed the project's breakeven point to set the average utility tariff, which is the unit value of the benefit, as a variable.

As a result, the project of the domestic coal-fired plant would be financially viable in either case that the average utility tariff increases at an annual rate of more or equal to 4.5 % since FY 2011, or that the tariff would become more than 2.1 times as high as the current tariff level (4.98 Tk/kWh). Fig. 16-4 shows the assumed future tariff projection. Like the case of fuel cost, the tariff stays constant after FY 2030. For the case of imported coal-fired plants, the project would be financially viable when the tariff-rise-rates would be equal to or more than 5.5 % or when the tariff level becomes more than 2.5 times as high as the current one.



Source: PSMP Study Team

Fig. 16-4 The projection of utility tariff used for this financial analysis (domestic coal)

The followings are the sensitivity analyses conducted that defines the base case as the breakeven case which raises the tariff at a constant annual rate.

(2) Capital cost increase scenario

The first scenario assumed that future capital investment, or construction costs, expands by 15% due to events such as global market fluctuations of construction material and the volatility of the currency exchange rate.

(3) Fuel cost increase scenario

The second scenario assumed that the procurement costs of fuel, coal, would be raised/ lowered by 10%.

(4) O&M cost increase scenario

The third scenario assumed that the O&M cost rises/ lowers by 50%, predicting the increase/ decrease of maintenance material costs and labor costs.

(5) Low plant factor scenario

The original case assumes the plant's annual plant factor to be 85%. This scenario examines the case of 60% and 95%.

Table 16-8 shows the result of those sensitivity analyses.

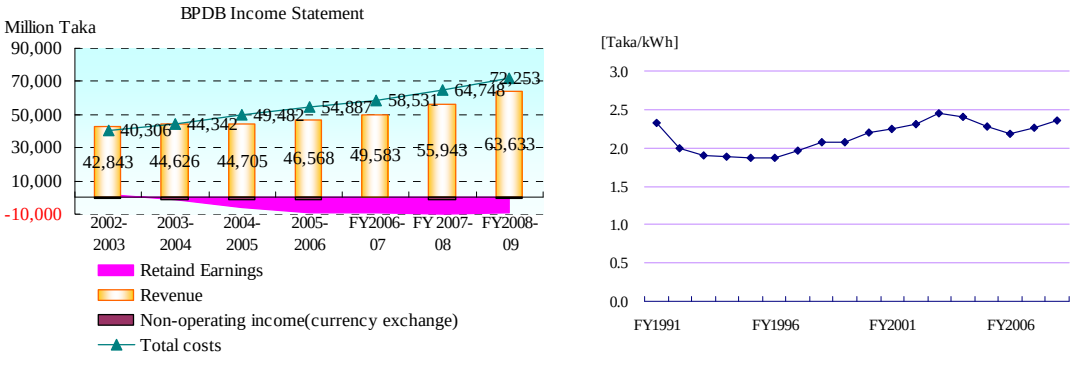
Table 16-8 Results of financial analyses[1]

Scenario	FIRR (%)		NPV 2010 (Million USD) 4.28%	
	Domestic coal	Import coal	Domestic coal	Import coal
Current case	NA	NA	-3.907	-5,270
1) Breakeven case - Tariff incase by constant annual rate. (base case)	4.4	4.4	67	55
- Tariff increase at a time	5.1	5.7	175	297
2) Capital cost increase scenario	NA/6.2	NA/ 5.9	-374/ 509	-417/ 526
3) Fuel cost increase scenario	NA/ 6.0	NA/ 6.1	-400/ 534	-529/ 639
4) O&M cost increase scenario	NA/ 6.6	NA/ 6.4	-583/ 718	-640/ 749
5) Low Plant factor scenario	NA/ 5.9	NA/ 5.9	-2,194/ 519	-2,603/ 586

Source: PSMP Study Team

16.3 Financing plan of the most prioritized project

The Study Team concludes that an appropriate financing scheme for the Project is to receive long-term loans from overseas development agencies, taking into account the BPDB's financial status as well as the Government's policy to keep electricity tariffs low (Fig. 16-5).



Source: Developed by PSMP Study Team based on BPDB Annual Report

Fig. 16-5 The trend of revenues and expenses of BPDB (left), and the trend of the average billing rate.

[1] As for values divided by slash in the column of 2) to 4), the value in left stands for the result applying larger or positive figure as variable, while the one in right stands for the result applying smaller or negative figure as variable. All the cases of 2) to 4) result in "not available" in case of cost-increase. Likewise, the case of 5) returns "not available" results in case of lower plant factor as variable.

The following summarizes the necessary financing amount of these power plant projects:

- Total capital cost: 1) Import coal-fired plant: 2,211 million USD.
  2) Domestic coal-fired plant: 2,074 million USD.
- Financing amount to be procured (external source): over 70% of the total capital cost.
- Financing plan: 4 years (From June 2014 to July 2018)

This study assumes that the loan conditions will follow the standard conditions stated in the country's loan guidelines developed by the Ministry of Finance. Therefore, a Japanese Yen loan would cover 70 % of the total capital cost, while the rest, 30%, would be provided by the Government as mixture of loans and investments.

Table 16-9 summarizes the sub loan conditions:

Table 16-9 Sub-loan condition

	Undertaking Share	currency	Rate of interest	Repayment period	Grace period
Japanese Yen Loan	70%	JPY	4.00%	25 years	5 years
Government loan	12% (=30%X40%)	Taka	3.00%	25years	5years
Government investment	18% (30%X60%)	Taka	—	—	—

Source： Ministry of Finance, "Lending and Relending Terms of Local Currency and Foreign Loans", March 7, 2004

The rest of the total capital cost subtracting the Japanese Yen loan amount would be provided by the Government. Of the amount, 60 % would be as an investment, while the 40% would as a loan.

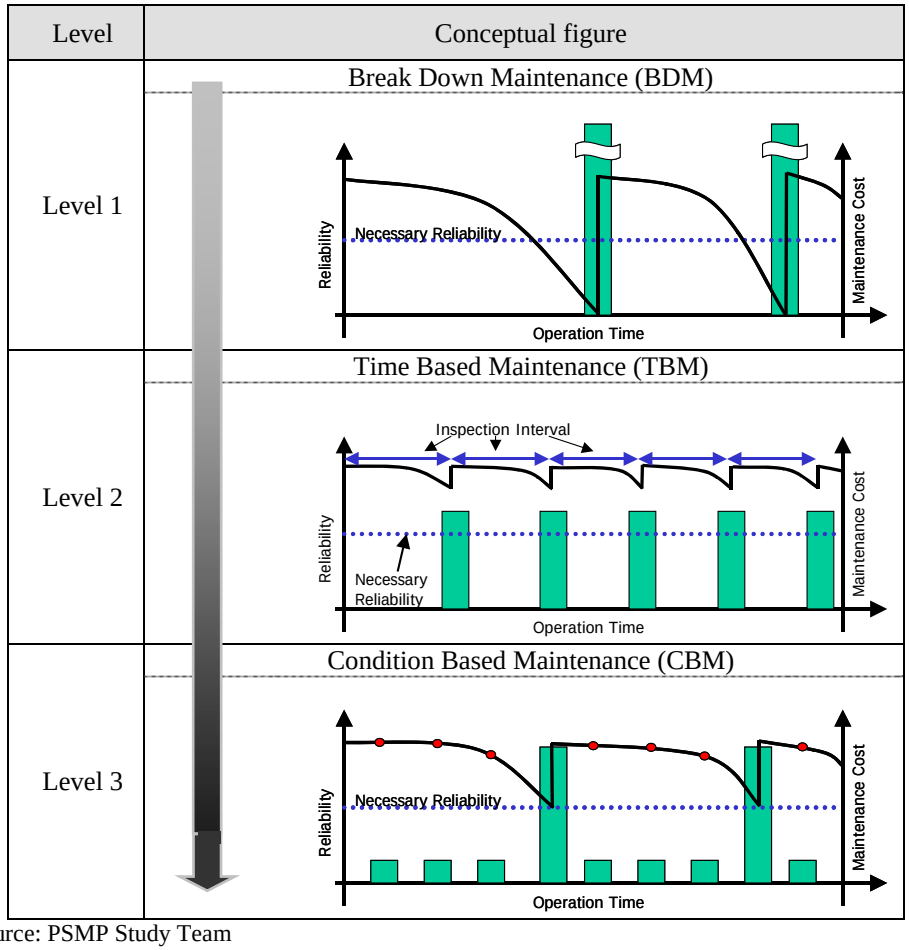
Chapter 17 Operational Execution System Analysis to the Most Prioritized Project

In this chapter, the operational execution system has been examined for the most prioritized project. When examining it, the problem of the current state of the maintenance system at the existing power generating plants in Bangladesh needs to be understood and remedial measures need to be examined while a proposal for the execution system of the most prioritized project needs to be newly set up. A proposal for the organizational structure that concerns environmental management and fuel procurement should be forthcoming.

17.1 Operation and maintenance control system

17.1.1 Selection of maintenance control level

In general, maintenance is categorized into the three levels shown in the following figure. Each character is described as follows:



Source: PSMP Study Team

Fig. 17-1 Concept of maintenance control

Level 1 breakdown maintenance: Method of repair after equipment breakdown. Because the repair period and cost cannot be predicted, it is impossible to arrange a plan beforehand.

Level 2 time-based maintenance: Method of regular inspection and repair regardless of the condition of the equipment. The operational efficiency is low because it needs to be renewed

and repaired at the stage where the lifetime remains depending on the equipment's condition, while the calculation of the repair period and the cost are set up easily.

Level 3 condition-based maintenance: Method of repair at the appropriate time by monitoring the condition of the equipments. Maintenance engineer worker skill is required most in order to judge the equipment condition while the equipment is used most efficiently, and the repair period and cost calculations are relatively easy.

17.1.2 Current state at maintenance level in existing gas-fired station

This examination is for the service record of the main gas-fired station in Bangladesh during the past ten years. The result is shown as follows;

Table 17-1 Maintenance record of existing gas power station (last 10 years)

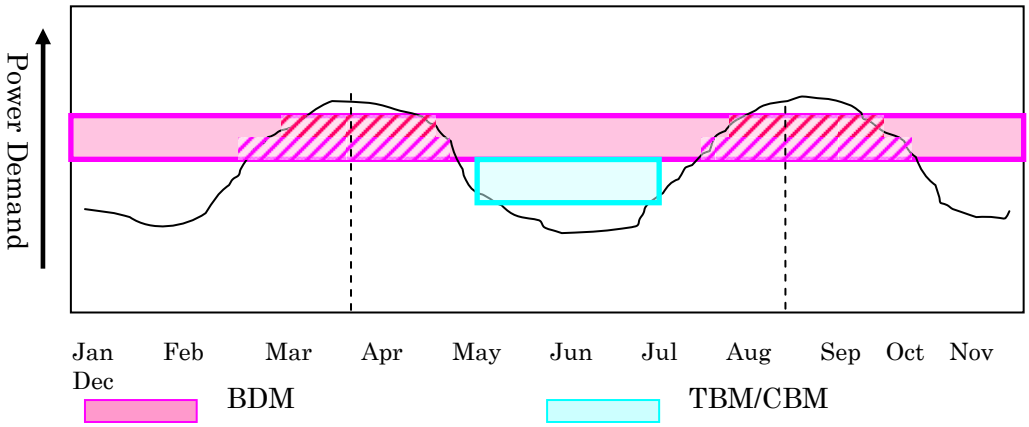
Power Station	Maintenance Record
Rauzan 210MW ST #1	2000.9 – 2001.2 (6 months)
Rauzan 210MW ST #2	2004.1 – 2004.5 (5 months)
Shikalbaha	2002.9 – 2003.9 (12 months)
Ghorasal 210MW ST #4	2002.6 – 2003.1 (7 months)
Ghorasal 210MW ST #6	2003.3 – 2003.5 (3 months)
Haripur 33MW GT #1	2005 5 – 2008.1 (32 months)
Haripur 33MW GT #2	2006.3 – 2007.5 (15 months)
Haripur 33MW GT #3	2005.5 – 2008.6 (37 months)
Ashuganj 150MW ST #3	2002.10 – 2003.10 (13 months)
Ashuganj 150MW ST #5	2007.7 – 2008.1 (7 months)
Baghabari 71MW GT	2005.11 – 2008.1 (27 months)

Source: BPDB Annual Report, PSMP Study Team

According to the result of the survey, it shows that service is not regularly executed, there are those which are not implemented at all even during the past decade, and some of them take about 60 days to three years or more.
It is apparent that a lot of power stations in Bangladesh operate under "operate until breakdown" philosophy without regular inspections. (Please refer to chapter 8 for details) It is categorized in the under the level 1 maintenance method or the so-called "Breakdown maintenance". The figure below shows the image of the difference between the BDM and the TBM/CBM at the regular service period. The mal-effect of the BDM might be to reach the maintenance scope wider than that assumed, so that the repair period will often be longer. It happens because it keeps operating without regular inspections, and when it breaks down, then inspection and repair begins. As a result, the maintenance period extends over the peak demand months of April and September, and influences supply capability.
On the other hand, it is possible for the TBM/CBM to match the regular service at a time when the demand is low, and to minimize the impact to low power supply, because the repair period is limited between the peak to peak period (about 60 days) which the maker recommends beforehand, and the possibility of the prospect for the repair scope and the cost within the expected range is high.

It is apparent that a lot of power stations in Bangladesh country operate under the "Operate until breakdown" minus regular service. (This is also stated in chapter 8) It is the so-called level 1 maintenance method "Breakdown maintenance ". The figure below shows the image difference between BDM and TBM/CBM during the regular service period. The bad effects of the BDM might be to reach the service range more than initially assumed, so that the repair period will be long. It happens because it keeps driving minus regular service, and when it breaks down, then it stops and begins service.
As the result, the regular service period reaches peak demand during the months of April and September, and it influences the supply capability.

On the other hand, it is possible for the TBM/CBM to match the regular service at a time when the demand is low, and to control the influence to low power supply, because the repair period is limited to the over haul period (about 60 days) which the maker recommends beforehand, and the possibility of the prospect for the repair range and cost is high.



Source: PSMP Study Team

Fig. 17-2 Maintenance period for BDM and TBM/CBM (Image)

17.1.3 Conclusion and proposal

In Japan, regular inspections are required by law, and it was a state of "Time-based Maintenance" (level 2) regularly inspected according to the law, However, it has improved to its present "Condition Based Maintenance" (level 3) that extends the regular inspection interval while monitoring the equipment condition as a result of vigorous discussion between the electric power utilities and the regulator in recent years.

It is preferable to shift from present breakdown maintenance to time-based maintenance first, and then condition-based maintenance in Bangladesh. To achieve those levels, the necessary steps are as follows;

- Development of legal systems that decide the regular inspection interval and scope
  In the current state in Bangladesh, there is no established law regarding regular inspections, so inspection is executed independently. However, it tends continue operations until break down due to the difficulty of a shut down in light of the supply and demand situation.
- Skill improvement of the maintenance work for monitoring equipment conditions adequately
  (Qualitative diagnosis (leakage, allophone, corrosion, transformation, discoloration, and expansion) by the working five senses (sight, aural, and sense of smell) at patrol.)
- Condition monitoring based on data
  (Not only is operational data and the maintenance data, etc., collected but also the operating condition and the standard condition (temperature, pressure, current, and vibration, etc.), are also compared and the condition is read from data by observing the tendency.)
- Quantitative diagnosis skill during the regular inspection

Prior capacity building is effective because it needs some lead time to obtain the skill for the setting of a regular inspection period and scope, the capability improvement of equipment conditions, and the method of observing and states of need of the knowhow respectively.

Moreover, there is nondestructive testing as a quantitative diagnosis technology that can judge the operating conditions adequately. The non-destructive testing is as follows;

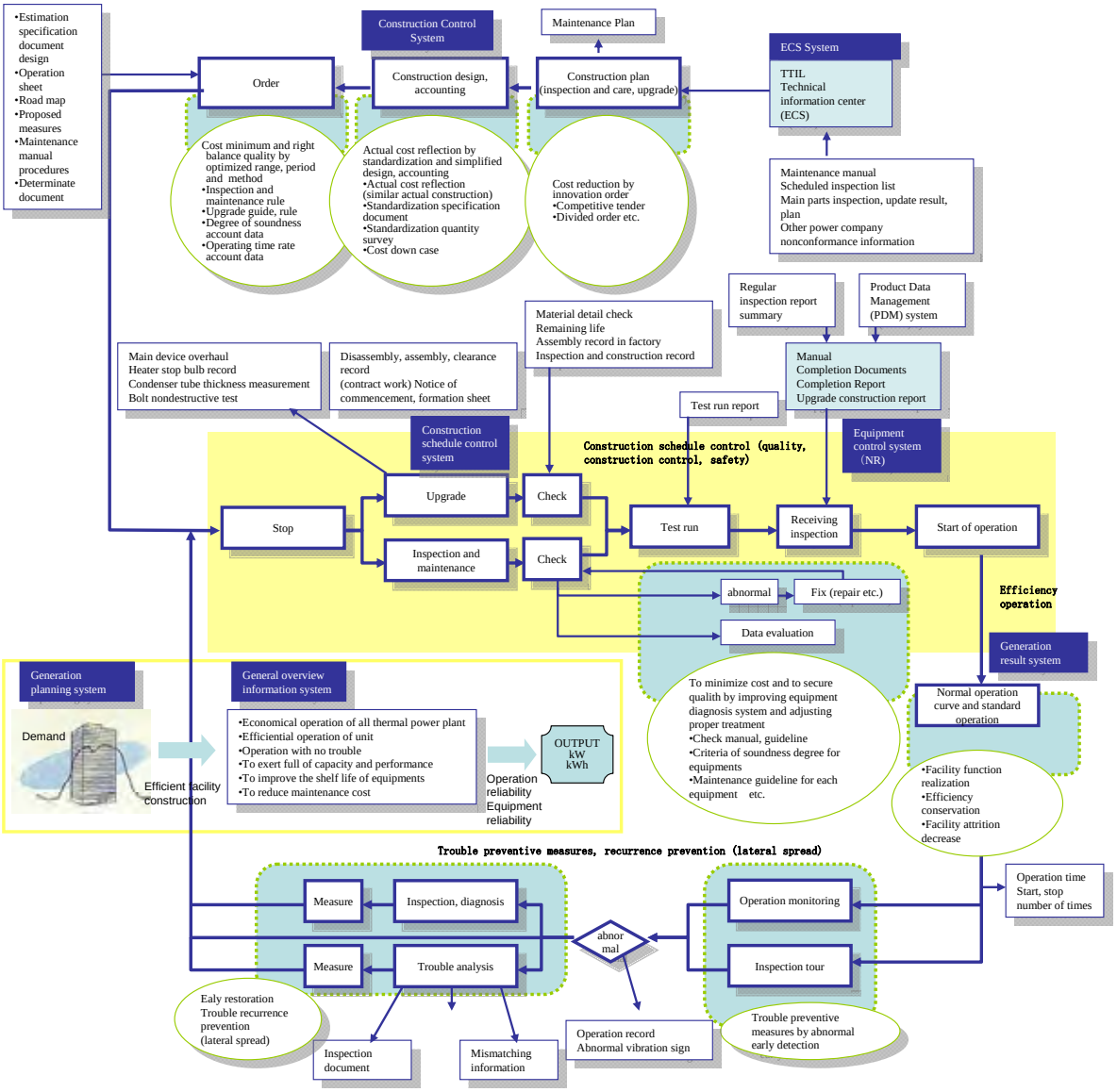
- Liquid penetrate test (Surface defect about 20μ detection limit)
- Magnetic Particle test (Depth about 0.5mm detection limit)
- Ultrasonic test (0.2 – 0.3mm immanence defect detection of thickness material)

At present, only the Liquid penetrate test is used frequently in Bangladesh among these. As for these nondestructive testing engineers, they have to take state examinations for each inspection technique, and in Japan all inspectors undergo certification.
It seems that a similar qualification system will be just as effective.

The figure below shows an example of the operational maintenance scheme in Japan.

At present, only the Liquid penetrate test is used frequently in Bangladesh among these.
As for these nondestructive testing engineers, they have to take state examinations for each inspection technique, and only certified persons are engaged in inspections in Japan.
It seems that a similar qualification system will be just as effective.

The figure below shows an example of the operation maintenance system in Japan.



Source: PSMP Study Team

Fig. 17-3 PDCA cycle for operational maintenance diagram

Before the regular inspection is executed, all work content should be executed when stopping, including the regular content works and the repair for the discovered abnormal equipment when operating, and when the elaborate work plan needs to be made, and arranging beforehand if there are necessary parts etc. (P: Plan).The inspection is executed according to schedule (D: Do). After the inspection, the settlement of abnormality which occurred before the inspection (C: Check) needs to be confirmed. Abnormalities found during the inspection is basically repaired during the regular inspection and repair time, however the measures (emergency measures or permanent measures) are decided with the estimation of the degree of severe abnormality and the lead time for parts procurement. The small-scale abnormality which carries over to the next regular inspection and the abnormality which is repaired by emergency measures are treated with a special measuring instrument by monitoring the condition of abnormality as pending issue management (A: Act). The execution record and the measurement result of the inspection are used for the remaining life assessment by using the prescribed format, and monitoring the trend at each inspection. The aforementioned PDCA cycle is utilized, and always aims at quality improvement.

Further, also, there is the TQM (Total Quality Management) method as a strategic tool to improve operations and maintenance quality improvement via daily inspection.
In the results executed by TQM as JICA technical projects, there is a case in the Bagabari power station where about 20MW output improves by repairing the heat insulator peeling off, and the output decrease was prevented by regular washing of the gas turbine air filter. These good cases illustrate that it is possible maintain performance minus excessive costs.

17.1.4 Proposal for operation and maintenance system for USC coal thermal power station

Because Bangladesh has minimum coal fired power station experience and severer control is required for USC plant operation, it is necessary to set up a fundamental operation and maintenance system.

17.1.5 Feature of coal thermal power station equipment

Because most of power stations in Bangladesh are gas fired power stations, it is necessary to understand how coal thermal power generation equipment is different from gas fired ones. Coal fired power station has different equipment from the gas fired one, since coal is a solid phase so that there are a lot of impurities (ash etc.), and it is burned as pulverized coal.
The main peculiar equipment in a coal fired power station is shown below.

Table 17-2 The main peculiar equipment of coal-fired power station

Equipment	Purpose	Peculiar points
coal transfer and stock system	to storage fuel (coal) and transfer to boiler	attention lake of coal storage at banker due to not continuous but intermittent supply
pulverizing mill	to pulverize the coal for boiler combustion	more frequent inspection required than other equipment due to severe wear and tear
soot blower	to blow the ash adhesive to boiler furnace	appropriate interval of soot blower for ash not to adhere to inside the boiler
ash treatment (boiler bottom)	scrape away bottom ash (clinker) from bottom of boiler (wet type is common)	to operate to prevent not to scrape away due to accumulation
electric precipitator	collect the ash in exhaust gas （fly ash）	necessary to manage the fly ash
ash treatment (storage, carry out)	storage and discharge of coal ash (fly ash, clinker) for utilization	enough capacity needed in the case of discharge delay

Source: PSMP Study Team

17.1.6 Notes for operational management

As coal fired power station normally operates a base load operation, it is basic to operate the plan within a standard operational range at all the times. In addition, the heating surface of the coal fired power station becomes dirty over time due to coal ash. A usual method to dealing with the dirt via regular operations of the soot blower (steam atomization), and partial dirt is dealt with a soot blower via temporary operation at the appropriate position and extending the operation time. In the case of low-grade coal and low melting point ash coal, there is a case where the water gun is used permanently. In particular, in order to prevent the growth of the adhesive at a boiler fire wall, there is also the case of dropping the clinker where the boiler load is lowered to the half loading on the weekend and causes temperature change.
As noted in the operation, the key points are to keep the fired condition, flame of the coal burner and proper maintenance of the angle of the frame steady. (The flame is neither a long flame, a short flame nor a wide angle flame.) In the case of changing the coal type and the coal mixed rate, combustion adjustment of the flame propriety maintenance is necessary.

Another subject of the combustion maintenance is to maintain the granularity of pulverized coal within the design range all the time.
In so doing, regular mill maintenance is executed on a per plan basis. (the inspection of maintenance parts by every fixed time according to the OEM recommendation, the repair of worn-out parts, and the parts replacement)
If the metal temperature of each pressure part material exceeds the design range, phenomenon such as high temperature creep deterioration, and high temperature corrosion, steam oxidation, and an increase of scale generation speed leads to accidents like the boiler tube leak.
Especially for the USC boiler, superior material with strength at elevated temperature is adopted, however, for the large-scale boiler, the design margin adoption by the boiler maker (concept of minimum thickness in the strength calculation) and the selection of boiler material will influence boiler performance since the imbalance of steam flow in the tube and the exhaust gas flow is unavoidable.

The material for the turbine adopted can be endured against the high temperature and high pressure. If the entrance steam temperature exceeds the design limitation, it will accelerate the high-temperature creep and the thermal fatigue, which influences the remaining lifetime.
To avoid them, it is necessary to completely maintain the various safety prevention devices and the protection instruments. The turbine type adopts one axis. Especially the axis and the bearing vibration management abide the turbine generator vibration protection device.

17.1.7 Difference between sub-critical equipment and ultra super-critical equipment

The main equipment difference between the USC (ultra super-critical) which is introduced in this master plan and the Barapukuria power station (sub-critical) is shown as follows.

Table 17-3 Major difference between Barapukuria power station (sub-critical) and USC

	Barapukuria (sub-critical)	USC (ultra super critical)
Capacity	125MW	600MW
Main Steam Pressure	16MPa	25MPa
Main Steam Temp.	538 degree	600 degree
Thermal Efficiency	31%	45%
Boiler Type	drum type	once-through type
De-SOx facility	none	equipped
De-NOx facility	none	equipped

Source: PSMP Study Team

From these differences, the following can be concluded.

- The boiler is not a drum type in the USC but a once through type. As for the once through type, the operating methodology and the characteristics are greatly different from the drum type. However, the burden to the operator can be mitigated by introducing an automated system. For the preparation for troubles, it is essential to acquire the operational characteristics of the once-through boiler, the purpose of each equipment, and the knowledge of the feature for the operator.

- Because the steam temperature/pressure condition is higher in USC, the material that endures high temperatures and high pressures such as the high Cr-Mo steel and the SUS material, etc is used for the boiler tube and other high temperature part. During construction, a special welding technique is necessary, however, because it is believed that a person who has advanced welding skill is limited in Bangladesh, it is necessary to secure a certain number of qualified welders. In addition, in order to maintain the quality and the safety of the welding point, the engineer who is able to conduct a

non-destructive test and post-welding evaluation is needed.

- Because Bangladesh doesn't have any experience introducing desulphurization and denitration equipment as environmental equipment, the capacity building from construction to operations & maintenance is necessary.

As mentioned above, it is necessary to overcome some subjects to maintain and operate the USC coal thermal power generation facility proposed in this Master Plan. To build the necessary technical capacity, the following operations & maintenance system is proposed.

17.1.8 Proposal of concrete method

(1) The operation & maintenance engineer's training through construction work

During the construction period, it is necessary to organize a candidate engineer who will become a key person regarding operations & maintenance after commercial operation are allocated to the corresponding section for each engineer's occupation, and to establish a scheme which acquires the necessary professional skill. As Bangladesh doesn't have enough experience to introduce environmental equipment (the desulferization and denitration equipment), particular attention should be paid to it from an understanding of the basic mechanism to practical operation & maintenance skill to be fully obtained.

(2) Construction of operation historical data processing system by introduction of management system supported by computer

From the trial operation stage, the operator should gather operational data, such as operational conditions within the main standard range, the plant performance, water quality trend, and the performance test data. The data accumulated is used as operational management know-how.

(3) Capacity building for training advanced technological acquirer who has special welding skill

Because advanced welding skill talent of high temperature high-pressure parts and nondestructive testing is needed, the capacity building for the qualification system for such welding skill should be carried out.

17.2 Environmental management on existing coal-fired power station and recommendation

17.2.1 Current environmental management

Barapukuria's existing coal-fired power station's current coal-fire practices were examined in Bangladesh. BCFTPP operates with around 280 people, but there is no environmental manager in full service. Further, a safety manager serves concurrently to conduct the necessary plant technical work. Nevertheless, it can't be said the organization puts priority on safety issues. So, there are some non-conformances, especially in terms of environment and safety management. Table 17-4 shows concrete examples of such cases.

Table 17-4 Example of un-conformance in environmental and safety management

Example	Impact
Environmental management	
No ESP out let damper	Ash scattering with ESP hammering
No de-SOx and de-NOx	Large amount of pollutant emission compare with world standard
No cleaning of discharged ash under ESP hopper	Ash scattering
No cleaning of leaked ash such as boiler soot blower nozzle	Ash scattering
Large amount of under ground water pumping (around 32,000m3/day)	Decreasing under groundwater level, impact to water usage of local area
No analysis of effluent	Fear of pollutant effluent
Spillage of water containing coal dust (coal mine, coal storage yard)	Coal dust water spillage to local irrigation
Safety management	
Workers don't put helmets, safety shoes, work suit.	Fear of injury accident
Ash cleaning workers don't put dustproof musk.	Fear of arising heal problems

Source : PSMP Study Team

On the other hand, Meghnaghat gas combined power station (MPL) which is Malaysian capital IPP decides their own Occupational Health and Safety & Environmental (OHS&E) policies in addition to adopting the ISO14001 and OHSAS18001 system. There are no environmental and safety management problems because all employees comply with this policy. In terms of environmental and safety conditions, there is clearly a large difference between these two power stations due to management, though MPL uses fuel gas which is more environmental friendly than coal as fuel.

17.2.2 Objective of the Environmental Management Plan (EMP)

The Environmental Management Plan will be settled to implement mitigation measures that are described in the EIA. The EIA will be submitted to DOE when the entrepreneur acquires an Environmental Clearance Certificate (ECC). Concretely, it stipulates implementation of avoidance and mitigation measures, and plant monitoring to confirm implementation measures. The EMP should be a realistic plan that considers each site's conditions to conduct proper environmental measures. Further, in order to continue proper operations, it will adopt the ISO system.

17.2.3 OHS&E management organization and role of QHSE manager

The OHS&E management organization stipulates a concrete organizational structure, staff numbers , and job descriptions to conduct EMP which is submitted to DOE. In a coal-fired power station, the job description of each post is quite broad due to the various work duties involving environmental controls such as environmental monitoring during daily operations, operation of environmental facilities (FGD and ESP etc), coal handling, ash handling, and waste water treatment. The QHSE Manager unifies these environmental and safety works as his duty. Further, the QHSE manager has a responsibility to report the monitoring results to DOE. The Plant organization should be intent on realizing continuous improvement from the early stages of operation by adopting ISO14001, OHSAS18001system. Table 17-5 shows the necessary manuals needed to organize ISO1400 and OHSAS18001systems. The QHSE Manager has a responsibility to maintain the system and operate the Deming cycle smoothly which consists of the Plan (Management review by the plant manager, planning) – Do (implementation, operation) – Check (Data analysis, audit, nonconformance management) – Action (improvement, modification, prevention). Table 17-6 shows the main environmental related roles at each part

that appear in Fig. 17-4. In the table, the bold letters refer to an important part of the environment management system. On the other hand, safety management will be conducted at all parts of the safety related manuals. The QHSE Manager and staff always monitor the conditions of safety management implementation to later be systematically reported to the Plant Manager.

Table 17-5 Example of environment and safety management manual

No.	Document title
ISO14001	
E-1	Environmental Management System Manual
E-2	Environmental Policy
E-3	Identification of environmental aspects and Impacts
E-4	Identification and follow up of legal and others requirements
E-5	Organization of the Environmental Management System
E-6	Environmental Communication (Internal communication / Awareness , External Communication)
E-7	Environmental Management System Operational control
E-8	Waste Management
E-9	Effluent Discharge Management
E-10	Emission Management
E-11	On-Site Emergency Response Procedure
E-12	Environmental Monitoring and measurement
E-13	Issuance and handling of non-conformance report
E-14	Environmental Management System Internal Auditing
E-15	Environmental Training
OHSAS18001	
S-1	OH&S Management Manual
S-2	OH&S Policy
S-3	Hazard identification and Risk Assessment
S-4	Identification and follow up of legal and others requirements
S-5	Organization of the OH&S Management System
S-6	OH&S Training and Awareness
S-7	OH&S Communication, Participation, and Consultation
S-8	OH&S Management System Operational Control
S-9	Fire Fighting Plan
S-10	Work Equipment Control
S-11	Monitoring, Evaluation, and Audit of Health & Safety Performance
S-12	On-Site Emergency Response Procedure
S-13	Typhoon and tropical storm preparedness procedure
S-14	Issuance and handling of non-conformance report
S-15	Incident / Accident Reporting and Investigation

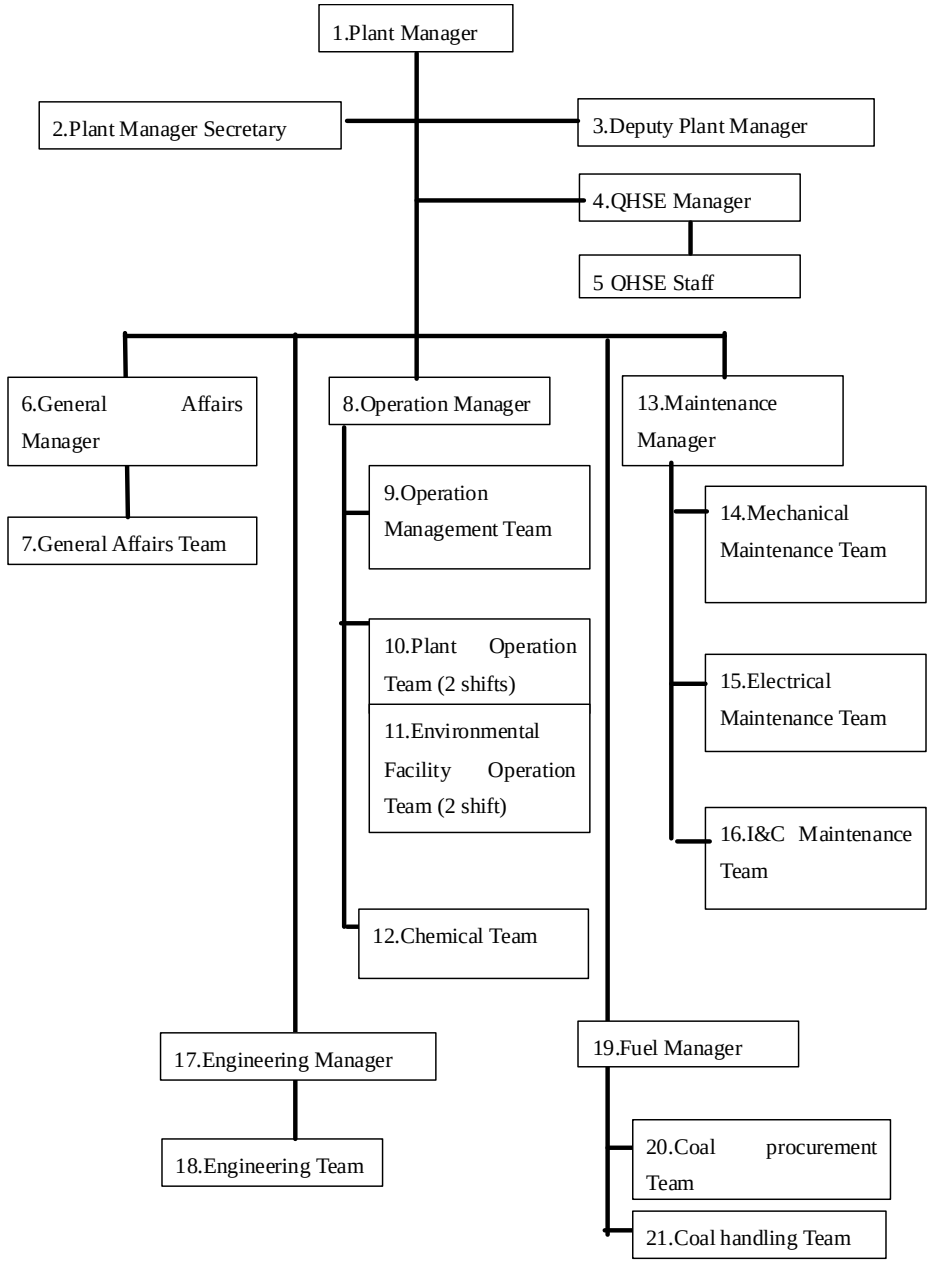
Source: PSMP Study Team

Table 17-6 Environmental related roles

No.	Position	Role
1	Plant Manager	Top management of environmental management system (EMS)
2	Plant Manager Secretary	-
3	Deputy Plant Manager	Depute the Plant Manager responsibility
4	QHSE Manager	Unify implementation of EMS
5	QHSE Staff	Supporter of QHSE Manager Implement EMS
6	General Affairs Manager	Budget management regarding environment issues. Public relations
7	General Affairs Team	
8	Operation Manager	Generation plant operation
9	Plant Operation Management Team	
10	Plant Operation Team	Monitor flue gas and waste water emission
11	Environmental Facility Operation Team	Environmental equipment operation(FGD, ESP etc). Monitor flue gas and waste water emission
12	Chemical Team	Chemical analysis flue gas, effluent, waste

No.	Position	Role
13	Maintenance Manager	Environmental facilities Maintenance
14	Mechanical Maintenance Team	
15	Electrical Maintenance Team	
16	I&C Maintenance Team	
17	Engineering Manager	Trouble shooting and measures study at environmental facility trouble
18	Engineering Team	
19	Fuel Manager	Environmental accident prevention when coal and oil handling
20	Coal procurement Team	
21	Coal handling Team	

Source: PSMP Study Team



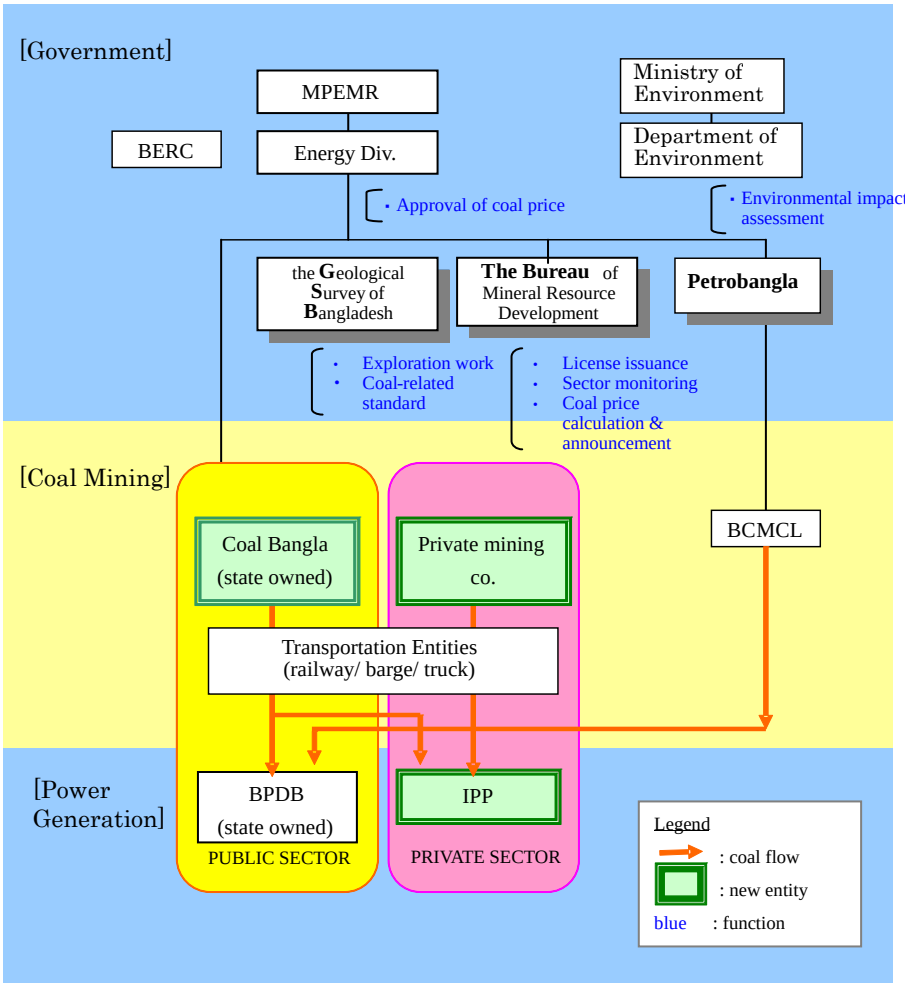
Source: PSMP Study Team

Fig. 17-4 O&M Organization (sample)

17.3 Institutional arrangement for coal procurement

17.3.1 Current situation and issues

This section studied the appropriate institutional arrangement to implement the master plan. It identified the current as well as the anticipated issues, and proposed the solutions. The master plan will cover the development of coal-fired thermal power plants which Bangladesh has had little experience with. To accomplish this goal, it is essential to restructure the current coal sector's institutional structure, e.g. the addition of new function/ role. The Study Team made some suggestion on the future image of the Bangladesh's coal sector like the degree of the government's involvement, taking into account the current and expected scale of the country's coal sector, and the sector's growth speed. Its basic approach is based on literature review – mainly the country's Draft Coal Policy, and interview with the JICA study's counterpart staff. Further, the Study Team made a visit to India's coal-fired thermal power sector in order to find out any international best practice which can be applicable to Bangladesh. Finally, the Study Team identified three major issues from institutional point of view and gave some recommendation to improve the situation. Fig. 17-5 shows the institutional arrangement and each organization's function, which is proposed in the Draft Coal Policy.



Source: Developed by the PSMP Study Team
Note: the Draft Coal Policy does not mention the institutional arrangement for power generation field by imported coal.

Fig. 17-5 Institutional arrangement in coal sector proposed in the Draft Coal Policy

Table 17-7 shows the fuel supply approach by public/ private and coal source.

Table 17-7 Fuel supply approach

	Domestic coal	Imported coal
State-owned power plant (BPDB)	Fuel supply agreement (FSA) between the government entities.	Procured by the power plant.
Privately owned power plant (IPP)	Fuel supply agreement (FSA) with state-owned mining companies. Or procured by the power plant.	Procured by the power plant.

Source: PSMP Study Team

For reference, the prioritized projects assume to be constructed and operated by public sector in both of domestic coal case and imported coal case. The Study Team identified the following three major institutional issues and proposed their countermeasure.

Issue 1: Procurement of imported coal for BPDB-owned power plants
Issue 2: Supply security of domestic coal
Issues 3: Government's implementation capability

Issue 1: Procurement of imported coal for BPDB-owned power plants

Currently, the government assumes that power companies which aim to operate power plants fueled by imported coal procure their fuel by themselves in principle. That is, it is not assumed that the government guarantees the fuel supply to the power companies – the scheme employed in the case of power plants fueled by domestic coal. The challenge, however, is that the country's state-owned-enterprise, BPDB has not imported coal for power generation. Because the Draft Coal Policy does not mention how to import coal from institutional perspective, the Study Team analyzed the issues based on the outcome obtained from the interview with relevant organizations to reach the following three solutions.

One solution would be for BPDB to procure coal by itself, same approach as that of IPP with power plants fueled by imported coal. There might be several options for this scheme. Taking into account that BPDB is the state-owned company, it might be the appropriate way to follow the case of Bangladesh Petroleum Corporation (BPC), the state-owned enterprise which has firm experience and knowledge in oil fuel import. BPC procures oil by floating international tender, calling not only for domestic but also for overseas procurement business entities. Regarding the concern about BPDB's credit on coal import, it would not be a significant matter because BPDB has accumulated its credit as a payer to IPPs based on power purchase agreement, proving little delay of payment. This fact would contribute to building the credit for coal import, too. In fact, according to BPC, they have rarely faced difficulties in procuring oil because they secure the payment to importers by issuing Letter of Credit. In order to realize this measure, BPDB would need to establish a coal procurement unit in their organization, providing capacity building and securing necessary human resources.

The second countermeasure would be similar to the first solution - to outsource the procurement task to external organization like trading companies under a long-term contract. Most Japanese and Indian power utilities adopt this approach to procure fuel, though the measure might not come true as long as BPDB stays as a state-owned enterprise. BPDB would need to float an international tender to procure imported coal because the Board is a state-owned-company. As anticipated, the whole procedure would consume a certain period of time, including a long appraisal time. Different from the tender scheme, it is expected that BPDB could save time in more efficient manner with this second solution. With this methodology, since there are few large-scale trading companies which have sound record of importing coal for power generation, BPDB would start building relationship with international trading companies which have experience in importing coal like MMTC of India.

The third measure would be that of Coal Bangla, which would be responsible for domestic coal handling, would also handle imported coal for power generation. This would enable BPDB to secure imported coal under FSA with Coal Bangla. In this case, it is recommended for Coal Bangla to provide capacity building in the procurement to its staff as well as to secure necessary human resources.
Table 17-8 summarizes the proposed recommendation.

Table 17-8 The major recommendation toward the issues on Procurement of imported coal for BPDB-owned power plants

- The creation of a unit responsible for the procurement of imported coal in BPDB. It is recommended for BPDB to implement capacity building on tender procedure of imported coal and to secure necessary human resources.
- The establishment of business relationship with international trading companies which handle coal. It is recommended that the government rules on international procurement by state-owned-enterprises would be operated flexibly.
- To add a task to procure imported coal to Coal Bangla. It is recommended for BPDB to implement capacity building on tender procedure of imported coal and to secure necessary human resources.

Those discussions are for cases when BPDB outsources the procurement task to external organizations. The other approach is the one that BPDB directly handles every stage of procurement by itself, such as negotiation with coal mining companies and shipping arrangement (DIY plan). For now, however, the outsourcing plan would be appropriate for BPDB because the plan would put less burden to BPDB than DIY plan (Table 17-9).

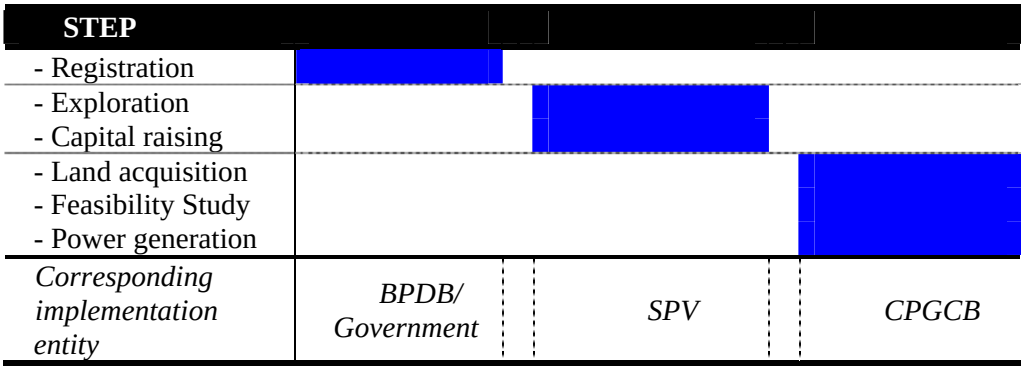
Table 17-9 Comparison of the plans

	Advantage	Disadvantage
1) Outsourcing plan	Comprehensive service including procurement of coal is attractive.	The plan requires commission charge.
2) DIY plan	No commission charge. IPPs can manage every step of the coal supply chain.	IPPs need to pay more transaction cost compared to Outsourcing plan.

Source: developed by PSMP Study Team

In case of imported coal base IPP (the case of Chittagong North Power station) as reference, BPDB has formed a joint venture (JV) with NTPC, the Indian state-owned-thermal power generation company. The JV plans to import coal through NTPC's resources. If this framework works smoothly, this would be likely to be the role model for Bangladesh's IPP with imported coal. The interview with NTPC found that NTPC has long procured imported coal through an external trading company like MMTC, while it plans to expand its procurement channels including its direct procurement. For the power company's direct fuel procurement, the company might need to invest in the upper fuel supply chain like the production right of coal mines in the exporting countries. Because such investment would costly, BPDB needs to investigate its cost performance when the Board plans for the direct procurement.
After the interview with BPDB as well as the scrutinized review of relevant literature, the PSMP Study Team found that a coal fired thermal power company exclusively for imported coal as fuel is scheduled to be established by the Government. The company's tentative name is Coal Power Generation Company of Bangladesh (CPGCB). Significant difference from the case of domestic coal is that the Government does not assume public sector participation in the power generation stage. Although the designed power company may be established as a subsidiary company of BPDB initially, the company is supposed to be owned and operated fully by private sector in future.
In order to assist the take-over process for potential investors of CPGCB, a shell company (SPV) is designed to be formed initially for preliminary work. The work would include appointment of

consultants for the project's feasibility study as well as an environmental impact assessment, land acquisition, and documentation related to RFP (request for proposal) and PPA (power purchase agreement). It is also recommended for the CPGCB's appraisal team of international tender to include knowledgeable sponsors which are familiar with technical aspects so that the team can eliminate non-eligible bidders. Fig. 17-6 shows the individual steps to establish CPGCB and corresponding entities.



Source: developed by PSMP Study Team

Fig. 17-6 The process toward the establishment of CPGCB.

Issue 2: Supply security of domestic coal

Domestic coal supply security depends on the sustainability of the domestic coal mining business. One of the major challenges is how to let the coal sector, currently only one company, grow from now on. There is only one state-owned-enterprise which runs coal mining business in Bangladesh, BCMCL. Taking the BCMCL case as reference, the Study Team analyzed the coal supply security in future of Bangladesh, identifying currently anticipated issues and making recommendations on the corresponding countermeasures.

First of all, coal mining business needs to be attractive from commercial aspects, if the Government wants its coal sector to develop further. After interviewing BCMCL, it turned out that there are large gap in the price of coal between the one for power generation and the one for the other use (the former is 85.5$/ metric-ton, and the latter is 111.37$/ metric-ton). In order to improve the profitability, further price raise of coal for power generation would be necessary, which means to raise electricity tariff further. This might have resulted from the national policy which has placed priority of the use of domestic coal on power generation. On the other hand, the interview with the relevant entities has found that there is more number of applicants of coal exploration/ marketing business license than expected now. This fact may implicate that the coal business in Bangladesh would be attractive. In fact, Petrobangla and some local enterprise have received new exploration license in KDP area according to the Bureau of Mineral Dept. (BMD). The Draft Coal Policy welcomes the participation not only from public sector but also from private sector. The Policy has proposed to establish Coal Bangla which imitates the function of Petrobangla in natural gas sector so that the Government shows the public sector commitment. In this case, several measures such as capacity building and securing human resource would be essential as the Coal Bangla would be the first state-owned coal company in addition to BCMCL. One concern is the outlook of the policy implementation. The policy had developed under the previous government regime, whole process related to the Draft Coal Policy have been delayed since the birth of new government regime in the end of 2008. Under such uncertain outlook, there still some possibility to show public sector commitment by expanding the business coverage of BCMCL, the only state-owned coal company. In summary, the Study Team recommends two points. Firstly, it would be effective to establish Coal Bangla to show public sector's commitment in the country's coal sector. Secondly, it is recommended to make regulated price of coal for power generation more attractive together with

electricity tariff. This could be achieved by transferring the coal tariff setting task from Energy Division to Bangladesh Energy Regulatory Commission (BERC).
Besides the difficulty of commercial viability, the social and environmental matters are another challenge. It is said that compensation negotiation with local communities have been stacked for several years to explore coal mining areas not only Barapukuria area but also the adjacent Phulbari area. This kind of conflict can generally be solved by mutual understanding. BCMCL also acknowledges the importance to add an exclusive unit to promote communication with local community. They expect that building good relationship with local communities would result in smooth operation of coal mining business. Until now, there has been no exclusive unit for public communication in BCMCL and most relevant unit has treated matters case by case. Therefore, the Study Team recommends the creation of public communication unit in the above domestic coal supply organizations.
Finally about human resource aspects, it turned out that the capacity building of mine workers has achieved a certain level of success through OJT and in-house training center, while it is hard for the company to raise the skill of management level engineers through institutional arrangement only. BCMCL has studied on capacity building of their employees, whose plans include outsourcing to external entity. This is mainly because OJT would not be enough for higher level engineers to raise their capability. It will not be easy to solve this problem only by institutional approach. One possibility would be for the government to have a section which manages capacity building programs for domestic coal suppliers in the early days of the country's coal sector.
Table 17-10 summarizes the above recommendations.

Table 17-10 The major recommendation toward the issues on Supply security of domestic coal

- To develop a framework in order to make the regulated coal price more attractive. This could be efficiently achieved by transferring the coal tariff setting procedure from Energy Division to BERC. It is recommended to review the current regulatory framework on coal price setting.
- The establishment of Coal Bangla, or the government's approval on the expansion on the business coverage of existing state-owned-enterprises (BCMCL and Petrobangla) so that the government can show the commitment from public sector.
- The creation of a public communication unit in the aforementioned state-owned-enterprises, which will be responsible for social matters with the mines' surrounding community. It is recommended to secure necessary human resources and to have capacity building.
- Enhancing training program for management level engineers. This could be facilitated by the government's involvement, e.g. the creation of a unit for training program management. It is recommended to study the overseas best practices and/ or to import training program from overseas firms.

Issues 3: the Government's implementation capability

As the Draft Coal Policy mentions, one of the major institutional challenges to secure the future coal supply is capacity building of the existing government bodies such as the Geological Survey of Bangladesh (GSB) and BMD. The interview with relevant entities shows that there would be no need to establish new government organization for this purpose, while it is recommended to reinforce the existing government organizations. The major points are as follows:

(1) Strengthening of the implementation capability of the coal industry administration agencies: the Bureau of Mineral Dept. (BMD) supervises Bangladesh's coal sector, which is equivalent to the Ministry of Coal in India. The current issue is the size of the organization (14 members as of October 2010). The interview to BMD found that they do not plan to establish the Ministry of Coal, taking into account the scale of future coal industry in Bangladesh. Although BMD plans to expand its size to 40 members in near future, because BMD is responsible not only for coal

but also for other minerals, it is recommended that the organization increases its size more to prepare for future expanding coal sector.

(2) The agency of price regulation: Currently, Energy Division under MPEMR has been responsible for the approval of coal price. Some interviewees suggest that the independent energy price regulator, BERC, would be appropriate organization for this purpose because the bureau is responsible for tariff setting of other energy services such as electricity and gas. Considering that most developed coal would be used for power generation, it would be efficient that one administration body supervises both electricity and coal. In this case, it would need to provide capacity building to BERC and to secure essential human resources for this purpose.

Box. 17.1 International Best Practice

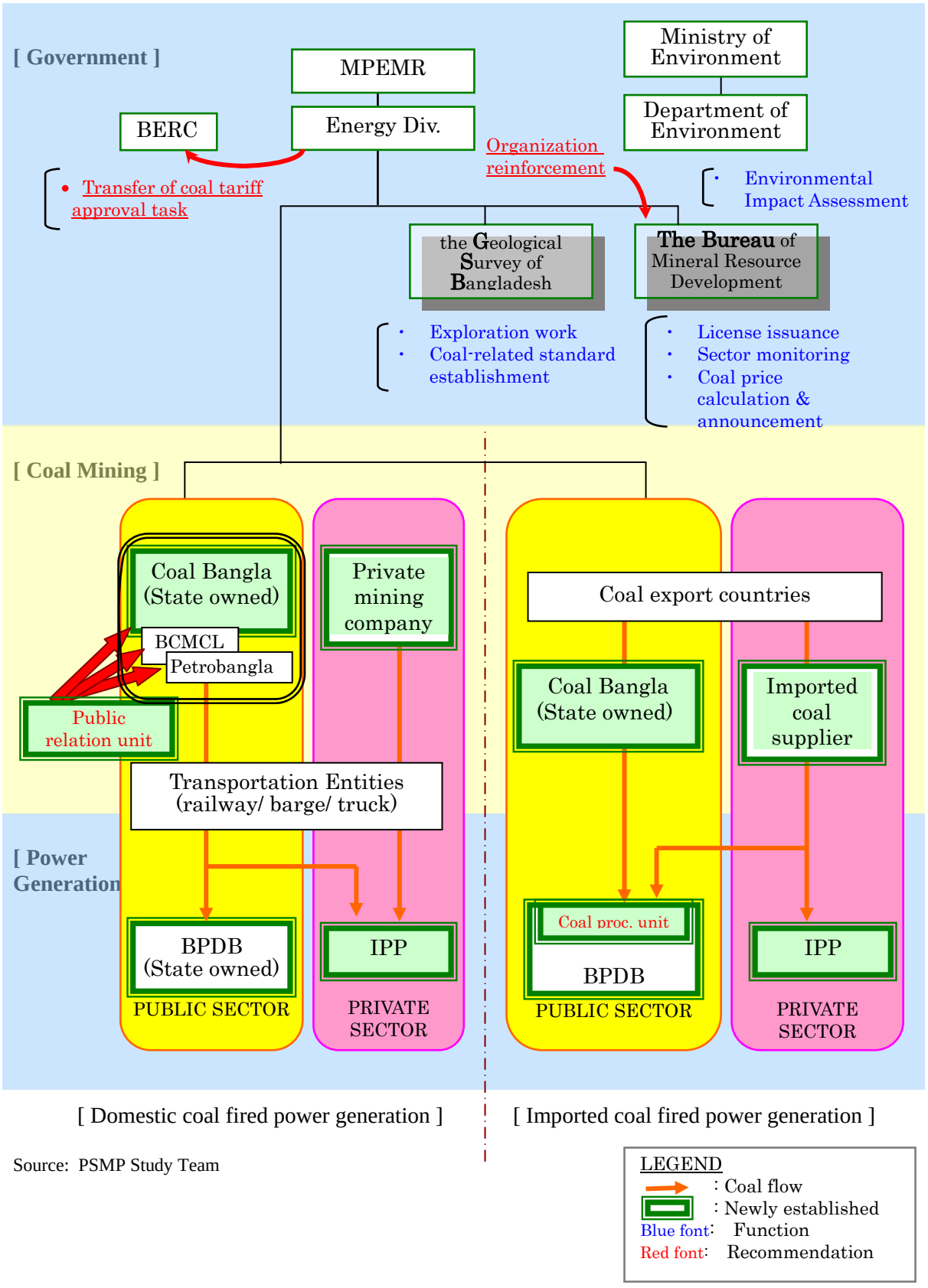
The best practice review tells that the degree of the Government intervention varies in accordance with the maturity of coal sector. For example, in India, because the coal development was implemented by small/ medium scale business entities in its early era, the development was the inefficient. Therefore, the Government has decided to aggregate those business entities, establishing a state-owned enterprise, Coal India Limited (CIL), to promote the sector's growth. The Government also established the Ministry of Coal in their body, too. Thanks to this decision, the nation's coal business has been streamlined and succeeded in increase of production. In UK after the World War II, then Government body, the National Coal Board (NCB) (currently the Coal Authority) had nationalized the coal industry taking into account the fact that coal business is national industry and the fact that the business had been less profitable for private sector to run. On the other hand, in Netherlands, the Government let private sector fully handle the coal business. Regarding Bangladesh, because the scale of its coal industry would not be as large as that of other nations like India, most interviewees answered that the significant degree of the Government intervention would not be necessary for Bangladesh's coal sector, the answer which the Study Team also agrees with.

Table 17-11 summarizes the above recommendation**.**

Table 17-11 The major recommendation toward the issues on the Government's implementation capability

- Capacity building to the government staff, e.g. GSB, BMD, and the Ministry of Environment, which are responsible for coal administration.
- The increase of members who will be in charge of coal sector administration in BMD.
- The transfer of the task related to coal price approval from Energy Division under MPEMR to BERC in near future. It is recommended for BERC to secure necessary human resources and to provide capacity building to its staff on matters related to coal.

Fig. 17-7 summarizes the recommended image of future coal sector in Bangladesh.



Source: PSMP Study Team

Fig. 17-7 The recommended institutional map of future coal sector in Bangladesh

Chapter 18 Environmental and Social Examination on the Most Prioritized Projects

18.1 Study methodology

18.1.1 Study objective

The objective of the environmental and social survey in this MP Study is to predict future adverse impacts caused by development projects that emerge from the Study and examine effective measures including examination of the alternatives to avoid or minimize such impact.

The Team has introduced in this Study the concept of strategic environmental assessment (SEA)[1]. SEA is conducted in the "strategic decision making stage", preceding individual projects in which wider variety of potential impacts on the environment are assessed from early stages of making policies, programs, plans and projects and the assessment outcome is reflected into the decision making to ensure that the said plan has taken the environment into appropriate consideration. The JICA's Guidelines for Environmental and Social Consideration endorse that JICA urges the host countries to introduce the concept of SEA when conducting MP studies and to address a wide range of environmental and social factors from an early stage[2]. Legislation in Bangladesh also requires that an initial environmental examination (IEE) be conducted for location clearance certificate (LCC), prior to conducting an environmental impact assessment (EIA).

18.1.2 Study method

The study team has assisted the Government of Bangladesh in examining the environmental and social viability of coal fired power projects among all potential sites, for power plant construction in order to short-list them by analyzing existing secondary data. The whole process of selecting the three most prioritized sites, among all others, taking viability of other aspects also into consideration, can be referred in the Chapter 12 and its APPENDIX.

Further, the future environmental and social impacts in the three most prioritized sites have been examined by conducting the IEE level studies. Local consultations were conducted to share the study outcome and collect their views on the construction of coal-fired power plant, project design and specifications[3]. Their opinions have been reflected in examining mitigation measures in this report.

Intensive discussions have been conducted, throughout this study, among government stakeholders by holding task team meetings in Dhaka. The task team has kept directing the above examination on the right track and contributed to its quality improvement. Specific assessment items (such as air pollution, resettlement and etc.) have been identified in the discussions which are to be more focused than the rest ('scoping'), and recommendations have been drawn in this report for further examination in future studies, such as feasibility study.

Relevant laws and regulations on environmental and social issues enacted in Bangladesh, outlines of each prioritized site and the summary of simple diffusion calculation can be found in the APPENDIX of this chapter.

[1] SEA has been already introduced in the United States, Canada and 25 out of 27 EU countries. (Ministry of Environment, Japan. "Outlines of SEA Introductory Guidelines". January 2009)
[2] This MP Study has applied the JICA Guidelines for Environmental and Social Considerations issued as of April 2001.
[3] Local stakeholder meetings, focus group discussions among male groups and female groups, household interviews, and in-depth interviews with local authorities have been conducted.

18.2 Impact analysis for new power plant development

18.2.1 Situation analysis

First, the current situations of the three most prioritized sites are described below. The relevant data and further information are referred to in the APPENDIX to this chapter.

(1) B-K-D-P site

Nawabganj Upazila, where the B-K-D-P site is located, has 314.68 km^2 of area, in which there is a population of 204,351, composed of 46,435 households as of 2001. The literacy rate is rather low at 38.4 percent[1].

The majority of the Upazila population is involved in agriculture with the main staple products being rice, wheat, jute, mango, banana etc. Within a distance of 500m from the proposed power plant site, there are villages named Rahimapur (500 households); Nandanpur (350 households) and Joydebpur (400 households). These villages are within the agricultural zone and the proposed site maintains a certain distance from the important facilities, commercial centers or local communities. There is not even a hotel or restaurant in the area. There is a ruin named Seeta Kuthuri, which has been preserved by the Archaeological Department close but outside of the site. In and around the B-K-D-P site, there is a farming area and the ambient air condition is not severe in its totality.

The proposed site is situated in the middle of domestic coal mines: Barapukuria, Khalaspir, Dighipara, and Phulbari. In Barapukuria, the Barapukuria Coal Mine Company Limited and the Barapukuria Coal-fired Power Plant are already in operation. There are ground subsidence, mainly caused by the intake of underground water, which has brought damages on houses in the neighboring area. In addition, severe water shortage is observed due to the lower water level in their wells[2].

Source: PSMP Study Team

Fig. 18-1 Damages on houses in neighboring villages to Barapukuria coal mine

In the site survey, it has also been observed that ash from exhaust of the existing Barapukuria Power Plant has deposited on plant leaves[3]. The EIA for the Barapukuria Power Plant (implemented in 2000) estimated at that time that the NOx and SOx concentration would become higher than the current ambient air standard. Hence, exhaust gas concentration can still increase locally and adverse impact to the environment can be caused by the NOx and Sox from the proposed power station.

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1 Bangladesh Bureau of Statistics, “the Area, Population and Literacy Rate by Upazila/Thana-2001” http://www.bbs.gov.bd/dataindex/census/ce_uzila.pdf (accessed in April 2010)

2 See detailed data in APPENDIX of this chapter.

3 It was also observed when PSMP Study Team visited the site in November 2009.

Source: PSMP Study Team

Fig. 18-2 Plant leaves with scattered dust from debris of power plant

The BCMCL has already taken actions to cope with such damages due to subsidence and ash deposit. They have spent 21 million Taka during five years up to 2010 to compensate for the damages on crops and houses, to build new houses, renovate the existing roads and to compensate by cash. They are now requesting allocation of government budget equivalent to 3.2 billion Taka for new land acquisition and resettlement, that will include new house construction, job creation and livelihood improvement activities[1].

In Phulbari, the Asia Energy Corporation (present GCM Resources) proposed an open pit coal mining development plan, which faced massive local resistance from anticipated 50,000 people to be involuntarily relocated and 300,000 indirectly affected by the project[2]. Three people died and 100 were injured in a protest gathering of over 50,000 people in 2006. The local resistance still remains up to present and there was a long march to Phulbari Coal Mine in October 2010 demanding proper utilization of natural resources for the development of the country[3].

(2) Chittagong site

Banskhali Upazila, where the Chittagong South site is located, has 376.9 km2 of area, consisting of a population of 391,320 comprised of 71,229 households as of 2001. The average size of one household is 5.5 people and the literacy rate is 29.5 percent[4]. There is no major industry in the Upazilla. As the Upazila is close to the center of Chittagong District and the Chittagong Port, not much population is involved in agriculture, except the service industry and the fishery industry. As the site is located close to the sea, the land is mainly used for non-agriculture purpose. The primary agricultural products are rice, potatoes, chilies and vegetables.

Two fertilizer factories located in the neighboring Anwara Upazilla are causing noise and air pollution. Respiratory illnesses, headaches, diarrhea and eye diseases are considered to be health hazards influenced by ammonia gas emitted from the fertilizer factories.

(3) Meghnaghat site

Sonargaon Upazila of Narayaganji District where the site is located has 171.66 km^2 of area. It has a population of 305,562 people comprised of 60,805 households as of 2001. The average size of one

[1] Information provided by the Barapukuria Coal Mine Company Limited staff (as of November 2009).
[2] Information provided by the BCMCL staff.
[3] http://www.demotix.com/news/484975/long-march-phulbari-coal-mine (accessed in December 2010)
[4] Bangladesh Bureau of Statistics, "the Area, Population and Literacy Rate by Upazila/Thana-2001" http://www.bbs.gov.bd/dataindex/census/ce_uzila.pdf（accessed in April 2010）

household is 5.0 people, and the literacy rate is 47.0 percent[1]. The area is both agricultural and residential. There are few hotels and restaurants in the area. The tombs of Sultan Giasuddin and Shah Abdul Alla are situated in Sonargaon Upazilla, which is about 4 km away from the site. There are considerable number of factories in the Meghnaghat Newtown area, which causes noise and air pollution in the area.

Source: PSMP Study Team

Fig. 18-3 Meghnaghat industrialized area

There is a 450MW combined cycle power plant located near the proposed site[2]. They organized local stakeholder meetings prior to the power plant construction, held a well-received presentation on potential future pollution with prevention measures and land acquisition. Assistance for local residents has been continued even after the power plant launched its operation. They spend upward of US$ 30,000 to 40,000 annually for their corporate social responsibility (CSR) activities such as school construction, distribution of rice and blankets for the destitute during winter time. They have Health, Safety and Environmental Managers as permanent posts and they deal with any environmental or social issues which emerge during discussions. There have been no health or environmental problems reported so far and the local people do not have anxiety or perceive that there are any noise pollution and/or air pollution risks.

Source: PSMP Study Team

Fig. 18-4 Meghnaghat combined cycle power plant

[1] Bangladesh Bureau of Statistics, “the Area, Population and Literacy Rate by Upazila/Thana-2001” http://www.bbs.gov.bd/dataindex/census/ce_uzila.pdf (accessed in April 2010)

[2] Owned by the Power TEC, Malaysia. They launched the operation in November 2002.

When interviewed[1], the gas-turbine power plant staff showed their concern about noise and air pollution, which may be caused by the operation of coal-fired power plant, especially for clogging of gas turbine inlet air filters by fly ash. In addition, they are concerned that the local people may develop a negative impression about the power plant, if the environmental management of the coal-fired power plant is inadequate.

18.2.2 Problem analysis

A problem analysis has been carried out on the potential impact, that the 600 MW-class coal-fired power plant construction at the B-K-D-P, Chittagong and Meghnaghat sites can bring in terms of pollution and its effects on the natural and social environment. Items for analysis were identified in the preparatory study conducted by JICA in 2009[2]. Potential impacts during the construction and operation stages have been examined separately. For further detail, see AP Table 18-28 to 18-30, AP Table 18-45 to 18-47, and AP Table 18-62 to 18-64.

(1) Pollution and its effects on natural environment

- Common issues

The common assessment result, among the three sites, of the problem analysis on pollution of natural environment is shown in Table 18-1. More attention should be paid to the noise, vibration and potential accidents that could occur during the construction period. Attention must also be paid to air pollution, water contamination, noise and vibration, waste, subsidence and water usage during the operation period.

Table 18-1 Problem analysis: assessment results on environmental impact (common issues)

No.	Item	Impact during Construction Stage	Impact during Operation Stage
1	Air Pollution	Air pollution can be caused by exhaust gas from transportation vehicles and construction machinery. And dust particles may be scattered near the construction site and road for construction vehicle.	Planned coal-fired power plant burns coal as the main fuel. And it burns light oil as auxiliary fuel (fuel for starting up). NO_X, SO_X and soot will be generated due to the combustion of these fuels.
2	Water Contamination	Drainage caused by rainfall, equipment washing and sewage will be generated during the work. And if waste management is not appropriately conducted, effluents from waste may be generated.	Thermal discharge will be produced when using river water for cooling. If cooling tower is used, effluent from condenser cooling water will be generated. Plant effluent and domestic waste water will be generated through plant operation. In case waste management methods aren't appropriately conducted, effluents from waste water may be generated.
3	Soil pollution	Soil pollution can occur due to lubrication oil or fuel oil spillage from transportation vehicles and construction machinery.	Soil pollution can occur due to lubrication oil or fuel oil spillage from unit operations.
4	Noise and vibration	Noise and vibration arise due to vibrations from transportation vehicles and construction machinery. AP Table 18-67 shows the list of the general noise level of transportation vehicles and construction machinery. Steam blowing during commissioning will also generate significant noise.	Noise and vibration will be generated through the operation of power facilities. If a cooling tower is used, there is significant noise and vibration from the cooling fan of the tower. For periodic inspections, noise and vibration may arise due to vibration from transportation vehicles and construction machinery. When using vehicles or conveyor for coal transportation, noise and vibration may occur.

[1] Interviewed with Plant Manager, February 2010.

[2] These are same items with the JICA's Guidelines for Environmental and Social Consideration.

No.	Item	Impact during Construction Stage	Impact during Operation Stage
5	Offensive Odor	If the domestic waste management isn't applicable at worker stations, offensive odor may be generated due to waste decomposition.	If ammonia which is used at Selective Catalytic Reduction (SCR) leaks, it may be a source of offensive odor. If the domestic waste management is not applied at worker stations for maintenance work etc., offensive odor may be generated due to waste decomposition.
6	Waste	Construction work will generate metal chips, waste plastic, wood shavings, waste glass and waste oil. Domestic wastes such as cans, bottles and food residue will be generated by construction workers at their work stations.	By-products generated through the operation of coal-fired power plant are coal ash, gypsum (if limestone-gypsum Flue Gas Desulfurization (FGD) is used), sludge from waste water treatment facility and cooling water canal fouling (if the river water or sea water is used for cooling purposes). These by-products will be wasted if they are discarded without recycling. Maintenance work will generate metal chips, waste plastic, wood shavings, waste glass and waste oil. And domestic waste such as cans, bottles, and food residue will be generated at the workers' stations.
7	Biota and Ecosystem	There is a possibility of endangered species existing in the site which is categorized as CR[1] in IUCN Red list.	There is a possibility of endangered species existing which is categorized as CR in IUCN Red list.
8	Accident	Construction accidents may be caused due to defects of health and safety management of construction work. It is necessary to pay attention especially to high altitude areas where accidents from falling may occur as well as construction vehicle road accidents and electricity accident.	There is possibility of accidents occurring such as fires due to oil spillage or instantaneous combustion of coal, accidents due to leakage or spillage of chemicals like caustic soda and sulfuric acid, accidents or incidents involving maintenance work.
9	Global Warming	-	It is estimated that approximately 3.54 to 3.79 million tons of CO_2 will be emitted from each 600MW unit per year through operation of coal-fired power plant.

Source: PSMP Study Team

■ Specific issues to each site

Taking specific features of each site into consideration, there are critical issues that need to be paid high attention for mitigation measures.

(1) B-K-D-P Site

- Long distance land transportation of domestic coal is needed during operation and it may generate coal dust and noise.
- If underground water is used for cooling, there is a large possibility of ground subsidence, impact on water usage in surrounding area.
- There is a possibility of Painted Roofed Turtle existing which is categorized as CR in IUCN Red List. Scattered reserved forests in Dinajpur District may be affected by power plant or transmission line.
- As observed in Barapukuria Coal Mine, issues such as the i) decrease of the underground water level due to underground water usage, ii) ground subsidence caused by underground water usage and falling rocks, iii) noise and vibration caused by drilling and coal handling and iv) air pollution caused by coal transportation

[1] Critically endangered

vehicles are potential incidences that occur in domestic coal development prior to power plant construction.

(2) Chittagong Site

- There is a possibility of bottom sediment accumulation, if plant effluent and domestic waste water is discharged to Bay of Bengal and Sangu River after inadequate treatment.
- There is a possibility of Painted Roofed Turtle which is categorized as CR in IUCN Red List and Fishing Cat which is categorized EN[1] in IUCN Red List existing around the site. Around sea area, Ganges River dolphin and Blue Whale which are categorized as EN in IUCN Red List, may exist.

(3) Meghnaghat Site

- If there are no adequate measures taken for coal dust and fly ash, operation of adjacent Meghnaghat CCPP will be affected due to clogging of the gas turbine inlet filter.
- There is a possibility of bottom sediment accumulation if plant effluent and domestic waste water is discharged to Meghna river after inadequate treatment.
- There is a possibility of Red Headed Vulture and Painted Roofed Turtle categorized as CR in IUCN Red List and Fishing cat categorized as EN in IUCN Red List existing around the site.
-

(2) Social environment

■ Common issues

The common assessment result among three sites of the problem analysis on social environment is shown in the Table 18-2.

[1] Endangered

Table 18-2 Problem analysis: assessment results on social impact (common issues)

No	Item	Impact during Construction Stage	Impact during Operation Stage
1	Involuntary Resettlement	Land acquisition is associated with involuntary resettlement.	Damage to houses and health hazards can be caused by smoke exhaustion, noise pollution, water pollution and land subsidence when the resettlement action plan is not appropriately planned and implemented. Political intervention and/or local movement against the operation of the power station can occur when adverse impacts on local residents' lives and livelihoods are severe.
2	Local Economy such as Employment, Livelihood etc.	Loss of employment and livelihood can be caused by temporary loss of agricultural lands during the construction period. Bangladesh regulations stipulate that displaced persons are entitled to compensation for loss of land, property and standing crops in monetary terms at fixed rates. It however does not compensate for loss of employment or livelihoods. The destitute, poor and landless farmers, agricultural laborers and wage laborers can therefore become further distressed if the construction period becomes too long.	Permanent loss of employment and livelihoods can be caused by land acquisition due to power station construction and surrounding areas. Bangladesh regulations stipulate that displaced persons are entitled to compensation for loss of land, property and standing crops in monetary terms at the fixed rates. It however does not compensate for loss of employment or livelihoods. The destitute, poor and landless farmers, agricultural laborers and wage laborers can become further distressed when job opportunities or at least skill training opportunities for them are not secured.
3	The Poor, Indigenous and Ethnic People	The destitute, poor and landless farmers can lose their jobs when agricultural land is temporarily lost due to the construction of power station. There are no ethnic minorities living on site grounds.	The destitute, poor and landless farmers can become further distressed when job opportunities or at least skill training opportunities for them are not secured. There are no ethnic minorities living on site grounds.
4	Misdistribution of Benefit and Loss	In case an ample number of job opportunities and skill training opportunities are not provided to meet the demand, the disparity between those with such opportunities and those without and that between the land owners and the rest (landless farmers, wage laborers etc.) can be widened.	Landless farmers and wage laborers can become further distressed and the disparity between the land owners and them can be widened if job opportunities and skill training opportunities are not given to them. Local livelihoods can be affected and health hazards can be caused by land subsidence, smoke exhaustion, noise pollution, water pollution and water shortage in case the environmental management plan is not appropriately planned and implemented.
5	Local Conflict of Interests	Local conflict can occur between the relocated people and the host community if there is a relocation required. Excessive interventions by various stakeholders can trigger local conflict among residents, and disruption of the local community.	Local conflict between the relocated people and the host community can continue during operation period also.
6	Gender	Appropriate information and knowledge may not be properly disseminated to the illiterate, particularly women. Gender gaps can occur in job opportunities.	Appropriate information and knowledge may not be properly disseminated to the illiterate, particularly women.

No	Item	Impact during Construction Stage	Impact during Operation Stage
7	Children's Rights	Child labor may occur due to their parents' loss of job. Children may lose education opportunities, and playgrounds for them may be lost. They may catch infectious diseases triggered by outsiders' entry into the community.	Child labor may occur due to their parents' loss of job. Children may lose education opportunities. They may catch infectious diseases triggered by outsiders' entry into the community and exhaustion of NO_x, SO_x.
8	Land Use and Utilization of Local Resources	Temporary loss of present land use pattern and/or economic infrastructure may occur.	Permanent loss of present land use pattern and/or economic infrastructure may occur.
9	Social Institutions such as Social Infrastructure and Local Decision Making Institutions	Disruption of local community can be caused via a conflict of interests among politicians, government offices, and residents. It might cause a delay in procedures of land acquisition and resettlement.	-
10	Existing Social Infrastructure	Temporary loss of existing social infrastructure can occur due to the construction works.	Traffic to/from power station may become heavier. Social services may become insufficient.
11	Cultural Heritage	There is no cultural heritage existing in the three sites.	-
12	Infectious Diseases such as HIV/AIDS	Infectious diseases may be spread via the construction workers into the community.	Infectious diseases may be spread via the operation workers into the community.

Source: PSMP Study Team

■ Specific issues to each site

Taking specific features of each site into consideration, there are critical issues that need to be paid high attention for mitigation measures.

(1) B-K-D-P Site

- 200 acres of land acquisition is anticipated that requires resettlement of population of approximately 1,250 households. Local residents and local government officers of B-K-D-P site are well aware of the incidences and social impacts caused by the operation of the Barapukuria Coal Mine and Power Plant. They are also aware of the social protest against the coal mine development in Phulbari. High attention should be paid to their genuine feeling toward not-well-planned development projects.
- Ground subsidence, noise and vibration, and air pollution may occur in case the domestic coal mine, which is to be established prior to the power plant, is not properly designed. Adverse impacts on lives of local residents can be immense in that case, which will lead to negative feeling toward the power plant development and its operation.
- Excessive interventions by various stakeholders and political people can trigger disruption of the local community and local residents can be influenced.
- The site is well known for its affluent rice production by farmers, who are the majority of its population. The local economy is poor and the adverse impact, on socially vulnerable people, caused by the loss of lands and cropping land can be immense. Equal distribution of benefits among the residents will therefore be essential.
- The present potential site is away from the city center, residential areas, local markets and protected forests. Land use and utilization of local resources, however, may be affected by the selected location and transmission line route.

(2) Chittagong Site

- Acquisition of government land and private land is anticipated with small-scale involuntary resettlement. Entry of illegal squatters should be prevented until the construction is complete.
- The present potential site, that has been selected, is away from the city center, residential area, local market and the protected forest.
- Warm effluent water, plant effluent and sewage according to plant operations and domestic effluent water can adversely affect local fishery industry and their livelihoods, in case they are not properly treated.

(3) Meghnaghat Site

- Involuntary resettlement due to the land acquisition can occur. The potential site is however located in the sandbank of Meghna River, which can minimize the number of directly affected people.
- Waste water from construction work, plant effluent and sewage according to plant operations and domestic effluent water can adversely affect local fishery industry and their livelihoods, in case they are not properly treated.

18.3 Local consultation

18.3.1 First meetings with local stakeholders

Household interviews and focus group discussions (FGD) targeting local residents and in-depth interview (IDI) with the Upazila local officers were conducted at B-K-D-P site, Chittagong site and Meghnaghat site in order to acquire snapshots of life quality there. As the study team saw severe time constraints and the fact-finding and collection of local information was the primary objective of this first consultation, the local consultants commissioned by PSMP Study Team organized the meetings.

(1) Local consultation at B-K-D-P site

(a) Overview

The following table shows facts of interviews with fifteen male and female local residents, focus group discussions with male group and female group and in-depth interviews with local officers in Nawabganj Upazila. Further details of participants are referred to in the APPENDIX to this chapter.

Table 18-3 Facts of first local consultations (B-K-D-P Site)

Mode of Consultation		Number of Interviewees	Date	Venue
Household Interview				
	Male interviewees	7	4-7 Jan 2010	Rahimapur and Nandanpur Villages under Nawabganj Upazilla
	Female interviewees	8	4-7 Jan 2010	
Focus Group Discussion				
	Male Group	12	4 Jan 2010	Rahimapur village, Nawabganj Upazila
	Female Group	8	5 Jan 2010	Nandanpur Village, Nawabganj Upazila
In-Depth Interview				
	Upazila Nirbahi Officer	1	6 Jan 2010	Nawabganj Upazila Nirbahi Office
	Upazila Nirbahi Officer	1	7 Jan 2010	Phulbari Upazila Nirbahi Office
	Agriculture Officer	1	4 Jan 2010	Office of Agriculture Officer, Nawabganj
	Fisheries Officer	1	4 Jan 2010	Office of Fisheries Officer, Nawabganj
	Education Officer	1	5 Jan 2010	Office of Education Officer, Nawabganj

Source: Household interview, focus group discussions and in-depth interviews

(b) Discussion points

- Expectations for New Power Plant Construction (Electrification)

  The proposed site and surrounding areas are electrified, but the power supply does not yet meet the demands. Only half of the areas of male FGD participants have been electrified, and the other half could not be electrified although they are ready to pay for the connection. Female FGD participants believe that electricity is absolutely essential for the better education of their children and development of agriculture and industries. They urged local public representatives to take necessary actions for electrification, but no subsequent actions were taken. All of them appreciated the initiative for establishing a new power plant at the proposed site as the electricity shortage could be overcome by its construction.

- Concerns for New Power Plant Construction

  Participants are well conversant with the existing ground subsidence, cracking of houses and crop damages etc. in the villages adjoining Barapukuria, caused by the coal-fired power plant and the coal mine. They are afraid that similar adverse environmental impacts might occur, although they are interested in a new power plant in their area.

  The participants emphasized on appropriate mitigation measures for the environmental and social impacts if the new power plant is constructed at the proposed site. They also strongly recommended that the affected people be properly compensated. They feel that housing damage due to ground subsidence is a terrible social loss and think that the local authority should be careful in this regard and the affected landowners must be properly compensated.

  Local officers interviewed were all well aware that people nearby the coal-fired power plant and coal mine in Barapukuria are suffering from noise pollution, ground subsidence, cracks in houses, and damage to the paddy fields which have been drowned by water. They mentioned that the local people in Barapukuria believe they had been attacked with asthma, diarrhea, etc. because of the flying ashes from the power plant although no

statistical health data was available to buttress such a claim. For this reason, the local people were against the extraction of coal from the upcoming Phulbari coal mine as they knew the entire Phulbari town had to be resettled. As it is the local government who should take initiatives in land acquisition and resettlement, they suggested the construction period should be shortened to minimize affects to the local people and that all affected people must be properly compensated.

Source: PSMP Study Team

Fig. 18-5 Local consultations in B-K-D-P Site

(2) Local consultation at Chittagong site

(a) Overview

Fifteen local residents were interviewed in Anwara Upazila, which is a neighboring Upazila to Banskhali. Focus group discussions (FGD) and an in-depth interview (IDI) with local officers were also conducted. Facts on each consultation are described below. Further details of participants are referred to in the APPENDIX to this chapter.

Table 18-4 Facts of first local consultations (Anwara)

Mode of Consultation	Number of Interviewees	Date	Venue
Household Interview			
Male interviewees	8	28-30 Dec 2009	Gobadia and Dudhkumra Villages, Anowara Upazila
Female interviewees	7	29-30 Dec 2009	
Focus Group Discussion			
Male Group	8	29 Dec 2009	Gobadia Village, Anowara Thana
Female Group	6	28 Dec 2009	Dudh Kumra Village, Anowara Thana
In-Depth Interview			
Upazila Nirbahi Officer	1	29 Dec 2009	Anowara Upazila Nirbahi Office
Fisheries Officer	1	28 Dec 2009	Office of Upazila Fisheries Officer, Anowara
Agriculture Officer	1	28 Dec 2009	Office of Upazila Agriculture Officer, Anowara
Educational Officer	1	28 Dec 2009	Office of Upazila Education Officer, Anowara
AC Land	1	28 Dec 2009	Office of AC Lands, Anowara
Public Health Engineering Officer	1	28 Dec 2009	Office of Upazila PHE Officer, Anowara

Source: Household interview, focus group discussions and in-depth interviews

(b) Local views on power plant development

- Expectations toward New Power Plant

  Although they have no idea what a power plant is like, male participants were very interested in the new power plant as they believe it would be useful for agriculture, industry, household and securing employment. Female participants also welcomed the idea as they thought local people would find employment while local electricity demands would be met resulting in the town's enhanced development.

  Local government officers extremely welcomed the idea of these lands being used for coal-fired power plant construction, as they thought electrification is essential for the national interest of the country, as economic and national development would be impossible without electric power. They said that the country's industries, offices, educational institutions and irrigation facilities will all come to standstill without electricity. They also pointed out that importing coal through waterways could save fuel cost.

Source: PSMP Study Team

Fig. 18-6 Local Consultations in Chittagong Site (Anwara)

- Low Knowledge on Power Plant

  Both male and female participants had no knowledge about the environmental effects caused by a coal-fired power plant and health hazards which these pollutions may ultimately cause. They suggested planting a lot of trees and neat and clean living, when asked how they should conserve the environment.

- Concerns for New Power Plant

  Local government officers opined that the environmental aspects should be put on an agenda by the Government and investment companies, when building a coal-fired power plant. A power plant can cause noise, smoke, waste, etc. and might bring various damages to crops, river water and human health. They said everything must be protected from such damage and standard guidelines must be followed. All participants opined that scientific methods should be used for environmental preservation. Besides, landowners must obtain proper compensation and should also have access to advantageous employment opportunities at the power plant.

(3) Local consultation at Meghnaghat site

(a) Overview

Fifteen local residents were interviewed regarding their livelihoods and accompanying life quality in Sonargaon Upazila. Focus group discussions (FGD) and an in-depth interview (IDI) with local

officers were also conducted. Facts on each consultation are described below. Further details of participants are referred to in the APPENDIX to this chapter.

Table 18-5 Facts of First Local Consultations (Meghnaghat Site)

Meeting		Number of Interviewees	Date	Venue
Household Interview				
	Male interviewees	15	17-19 Dec 2009	Ganga Nagar Village and Islampur Village, Sonargaon Upazila
	Female Interviewees	-	-	
Focus Group Discussion				
	Male Group	6	18 Dec 2009	Islampur Village, Sonargaon Upazila
	Female Group	8	19 Dec 2009	Islampur Village, Sonargaon Upazila
In-Depth Interview				
	Upazilla Nirbahi Officer	1	17 Dec 2009	Sonargaon Upazila Nirbahi Office
	Social welfare Officer	1	20 Dec 2009	Office of Upazila Social Welfare Officer, Sonargaon
	Agriculture Officer	1	21 Dec 2009	Office of Upazila Agriculture Officer, Sonargaon
	Senior Fisheries Officer	1	22 Dec 2009	Office of Upazila Fisheries Officer, Sonargaon
	Education Officer	1	18 Dec 2009	Office of Upazila Education Officer, Sonargaon
	Chairman and Members of Sonargaon	2	19 Dec 2009	Office of Upazila Chairman, Sonargaon

Source: Household interview, focus group discussions and in-depth interviews

(b) Local views on power plant development

- Expectations toward New Power Plant

  Participants did not believe that new power plants would cause any harm, such as smoke and noise to the environment, as the existing combined cycle power plant of 450MW did not create any such disturbances. Male participants thought that a new power plant would help in solving the scarcity of electricity. The combined cycle power plant nearby led to the employment of some people from surrounding villages and female participants, therefore, welcome the new initiative as their husbands or children may find jobs at the new power plant.

  Most of local government officers opined that it would be better if a new power plant was constructed just beside the existing power plant. There are no specific diseases caused by the existing power plant, and they expect that the new power plant will also be a pollution-free one.

Source: PSMP Study Team

Fig. 18-7 Local consultation at Meghnaghat site

- Awareness toward Environmental Conservation
  Villagers is just aware that they should keep the surrounding area clean.

18.3.2 Second meetings with local stakeholders

In addition to the first local consultations conducted in December 2009 and January 2010 as described above, another round of local consultation was organized in October and November 2010, after the project design of power plants became more specific. It was the Power Division that organized the meeting and PSMP Study Team supported the same.

The venue for the meeting with B-K-D-P local stakeholders was Dhaka in consideration of the security situation in Dinajpur. For the meeting with Chittagong local stakeholders, the venue was also Dhaka for the same reason. Land acquisition was one of the crucial issues raised in the Chittagong program. The facts about local stakeholder meetings at each site are as described in the following table. Further details of participants are referred to in the APPENDIX to this chapter.

Table 18-6 Facts of second local consultations (all sites)

Date and Time	Venue	Participants		
		Local Stakeholders	GOB	PSMP Study Team
B-K-D-P Site				
11-30AM to 2PM, 14 November 2010	Power Division (Bidyut Bhaban), Ministry of Power Energy & Mineral Resources	9 males: (Union Chairman, Union staff, Professor, Imam (religious leader), farmers, merchants etc.)	2 males (Joint Chief and Assistant Chief)	7 (out of whom 6 are local consultants)
Chittagong Site				
11-30AM to 1-30PM, 7 November 2010	Power Division (Bidyut Bhaban), Ministry of Power Energy & Mineral Resources	10 males (Upazila Chairman, Upazila Nirbahi Office staff, Agriculture Officer, Forestry Officer, Principal, Union Chairman, villagers etc.)	4 males (Additional Secretary, Assistant Chief and task team members from EGCB and BPDB)	7 (out of whom 5 are local consultants)
Meghnaghat Site				
11-30AM to 1-30PM, 3 November 2010	Conference Room, Sonargaon Upazila Nirbahi Office	31 males (Assistant Commissioner [Land], Upazila Chairman, Statistical Officer, Union Vice Chairman, Fishery Officer, Credit Officer, teacher, Education Officer, Resettlement Officer, Imam [religious leader], villagers etc.)	3 males (Assistant Chief and task team members from EGCB and BPDB)	9 (out of whom 7 are local consultants)

Source: Minutes of local stakeholder meetings

(1) Main points of discussion at B-K-D-P local stakeholders' meeting

Power Division, who chaired the meeting, introduced the background of the MP Study, and explained that no more new gas fields are expected to be discovered and that the GOB was thinking of coal as fuel for power generation. He requested that the participants provide opinions without hesitation, which would be reflected into the study report, and to request others, who were unable to join the meeting, to extend their cooperation. Power Division also stressed that the MP Study has been developed for the benefit of the entire nation.

(a) Environmental Issues

Participants asked questions regarding ash treatment and the PSMP Study Team replied that there are many precedents in recycling of fly ash and landfilling by bottom ash in Japan.

(b) Social Issues

Participants mentioned that the situation in Phulbari was still not good. It must be fully explained to the local people about the necessity of developing another coal-fired power plant there. It should also be explained that there will not be other health hazards, such as those the local people faced in Barapukuria. The payment process of compensation would be easy and simplified and payment will be made to the right people. Job opportunities would be created for those who are to be involuntarily relocated.

The Chairman of Daudpur Union mentioned that he would welcome establishment of the coal-fired power plant in Bhagabanpur, which is almost at the center of the surrounding coal deposits and close to Barapukuria, Phulbari, Dighipara and Khalaspir coal fields and also Madhypara Hard Rock Mine. He said that his people would not object to the project if Bhagabanpur was selected as the site and they would extend their cooperation.

Participants welcomed the opportunity to attend the local stakeholder meeting in Dhaka.

Source: PSMP Study Team

Fig. 18-8 Second local consultation with B-K-D-P local stakeholders

(2) Main points of discussion at Chittagong local stakeholders' meeting

Power Division chaired the meeting. A visual presentation was made by the local consultant: EAL. It was the Additional Secretary who answered most of the questions raised by the participants.

(a) Environmental Issues

Participants proposed that construction of the embankment against Cyclones is desirable before the power plant. Participants also said that warm draining water will be cooled naturally if it remains in a pond for a certain period of time. The Power Division replied that he welcomed the proposal and he wanted understanding that there was the possibility of inevitable air pollution.

Source: PSMP Study Team

Fig. 18-9 Second local consultation with Chittagong local stakeholders

(b) Social Issues

The participants welcomed the initiative of power plant construction, since there was no other major industry in Banshkhali Upazila. They requested that certain benefits be given to the local people such as construction of school and hospital. They mentioned that there are people residing in the proposed site (both government land and private land). The Power Division mentioned that proactive efforts should be to ensure that the local people are gainfully employed. To this end, the livelihood recovery will be considered and examined at the implementation stage of the project.

(3) Main points of discussion at Meghnaghat local stakeholders' meeting

The meeting was presided over by the AC Land of Sonargaon Upazilla. BPDB, one of the task team members, made visual presentation. The GOB representative answered to all the questions raised by the participants.

(a) Environmental Issues

Participants pointed out the warm effluent's impact to river fish and the possibility of spontaneous ignition at the coal stock pile. In response, the BPDB replied that proper environmental protection measures such as cooling tower usage or coal stockpile sprinkling could solve these problems.

Source: PSMP Study Team

Fig. 18-10 Second local consultation with Meghnaghat local stakeholders

(b) Social Issues

Participants requested that acquired land should be used correctly, the officers in charge of redress of grievances should be identified, the land price should be evaluated correctly and job opportunities should be created for the local people. They mentioned that local people lost their jobs when the gas turbine combined cycle power plant acquired their private land and no proper compensation was paid.

Participants did not deny the necessity of developing power generation facilities, but they stressed that land to be acquired should be at a minimum, proper compensation should be paid, and there should be no in-between broker. They also requested establishment of schools to improve the education level of the local people.

GOB representative explained that recommendations, such as organizing a committee for transparency, providing positions of non-technical staff at the new power plant for the local people, acquiring a minimum amount of land and contributing to local benefits via power plant construction, would be incorporated into the Master Plan Study Report.

18.4 Problem solution for the new coal power plant construction and operation

Measures have been examined for solving likely specific items of critical problems raised above, based on the primary and secondary data collection and analysis and the outcome of local consultations.

18.4.1 Examination for problem solution: environmental pollution and natural environment

(1) Common issues

Table 18-7 shows the possible solutions commonly identified for all three sites during construction and operation.

Table 18-7 Mitigation measures for environmental impact (all sites)

No.	Item	Mitigation measures during Construction Stage	Mitigation measures during Operation Stage
1	Air pollution	As for the reduction of exhaust gas from transportation vehicles and construction machinery, idling stops and keeping proper exhaust condition by routine inspection of vehicles are to be applied. As for countermeasures for dust scattering, load cover, periodical vehicle washing and periodic peripheral road cleaning are to be applied.	Conducting flue gas treatment by system including FGD, SCR, Electrostatic precipitator (ESP) etc., attention will be paid to mitigation of coal dust scattering. It is desirable to apply covered conveyer to prevent coal dust with coal transfer.
2	Water contamination	Countermeasure for water contamination due to excavation waste soil outflow is suitable via a fence installation utilizing sandbags etc. As for the effluent due to equipment washing, it is suitable to install a temporary precipitation tank and to drain the supernatant water. As for sewage, it is suitable to put up septic tanks. In addition, as for waste, water contamination can be prevented if waste treatment is conducted promptly and the waste is not left for long time.	There will be no warm effluent water generation since cooling tower or air cooled condenser will be adopted as cooling system. Plant effluent and sewage according to plant operations will be discharged after waste water treatment, including coagulating sedimentation, neutralization and oil separation. Appropriate capacity design for waste water treatment is needed, especially if air cooling tower is adopted as condensed cooling water blow a large amount of effluent.
3	Soil pollution	Periodic maintenance of transportation vehicles and construction machinery and conducting pre-operational machinery checks are judged important.	Oil and grease treatment procedures are important to prevent the spillage of lubrication oil or fuel oil. In addition, management organization has to be established to implement works according to designated procedures. And action procedures should be prepared in order to not to spread the adverse impact in case of an oil spillage occurrence. An oil dike has to be set around oil storage tanks. It is necessary to dump ash only in dumping sites with water proof seal to prevent bottom sediment leakage out of the ash pond.
4	Noise and vibration	Streamlining the construction process, using low-noise machinery and lowering vehicle speed in residential areas are judged to be proper countermeasures. As for countermeasures for noise due to steam blowing during commissioning, the establishment of a work schedule, not to blow steam during the night time is judged to be applied.	Developing a green belt along the site border is a lowcost and effective way to mitigate noise and vibrational impact. To avoid noise and vibration due to coal transportation, use of covered conveyor is desirable. If the boundary noise simulated in the detail EIA exceeds the noise regulations which is decided on each category, introduction of a green belt, sound insulating material and a sound insulating wall will be examined.
5	Offensive odor	Offensive odor caused by domestic waste decomposition from workers camps can be prevented by separate collection and periodic disposal of waste.	NOx mitigation without SCR which uses ammonia is effective measure against offensive odor. When using ammonia, storage tanks, pipes, and valves must be inspected periodically. In addition to preventing operational mishaps, operation of ammonia facilities are to be managed by the person in charge. With regards to garbage treatment, it is suitable to dump it periodically and not have it in storage for a long time.

No.	Item	Mitigation measures during Construction Stage	Mitigation measures during Operation Stage
6	Waste	Reduction of waste amount can be conducted by establishing a waste management program including reduction, reuse and recycling (3R). Introduction of a separate procedure for collection of waste, especially for paint sludge and batteries will be required. These items should be collected separately and disposed of only in designated areas.	Reduction of waste amount can be conducted by establishing a waste management program including reduction, reuse, and recycling (3R). Because amount of by-products due to plant operations are large, they should be recycled as much as possible (AP Table 18-77 shows examples of by-products recycling). A separate collection of industrial waste should be thoroughly conducted. Especially paint sludge and batteries should be suitably collected separately and disposed of in designated areas, since they have potentially large impact on the environment. Domestic waste from the workers camp must also be collected separately and garbage should be dumped immediately to prevent the source of odour and contaminated effluent.
7	Biota and Ecosystem	Nest building by endangered species should be examined in detail EIA. Nest relocation should be conducted if there are any. Careful attention should be paid to existence of each endangered species during construction stage and necessary protective action should be conducted, if there are any.	Careful attention should be paid to each existing endangered species during operation stage and necessary protective action should be conducted, if there are any.
8	Accidents	A suitable OHS organization (policy, manual, announcement of policy, safety training and safety patrol) should be established to prevent accidents. It is also important to conduct quality control in construction work to prevent accidents during commissioning and operation period.	A suitable OHS organization (policy, manual, announcement of the policy and manuals, safety training, safety patrols) should be established for accident prevention. It is also important to conduct quality control in maintenance work in order to prevent accidents.
9	Global warming	-	Due to introduction of an ultra-super critical boiler with high efficiency unit, emission of CO_2 will be reduced by 1.07 million tons to 1.15 million tons for each 600MW unit per year compared to the case of Barapukuria class unit. These figures are calculated based on designed values. It is important to keep designed output and efficiency from adequate O&M.

Source： PSMP Study Team

(2) Specific issues to each site

Taking specific features of each site into consideration, possible problem solutions for critical issues are as the following:

(1) B-K-D-P Site

- It is desirable to apply covered conveyer for long distance land transportation of domestic coal to prevent air pollution and noise.
- Air cooled condenser or cooling tower will be adopted as cooling system. Underground water drawdown for power plant operation should be prevented by

using river water even by adopting cooling tower. At the time of pilot mining, mitigation measures for ground water drawdown should be confirmed by reinjection of drainage,

- In order to avoid protected forests, attention should be paid to selection of site location and transmission line route.
- It is desirable to conduct proper environmental control in domestic coal mine development. For environmental control, it is also desirable to apply EIA Guideline for Coal Mining issued by Department of Environment (DOE) in 2009.

(2) Chittagong Site

- Measures for water contamination described in Table 18-7 are to be implemented to prevent bottom sediment accumulation.
- The embankment against Cyclones may be constructed along plant border.

(3) Meghnaghat Site

- It is needed to be studied whether construction of wind break fence is necessary to prevent spreading of coal dust.
- Bottom Sediment: Same as Chittagong.

18.4.2 Examination for problem solution: socio-economic and cultural aspects

(1) Common issues

Possible mitigation measures against social impacts common for all sites, which may be caused by the proposed power plant are given in Table 18-8. In relation to environmental management, prevention measures for health hazards caused by the environmental impact are also referred here. Responsible agencies and monitoring agencies are also mentioned in the table, as clear definition and identification of responsible organizations can contribute to the smooth construction and operation of power plants.

Table 18-8 Mitigation measures for social impact (all sites)

Impact	Mitigation Measures	Responsible Agency	Monitoring Agency
Pre-Construction			
Occupational health hazards from dismantling of existing facilities and equipment	- Proper safety measures should be examined to raise awareness and take required actions - Safety education should be provided to all for proper knowledge and risk perception toward potential risks, which may be caused by the project	- Planning and Design Section of BPDB - Consultants	- Project Director (PD)
Land acquisition and involuntary resettlement[1]	- Proper Land Acquisition Plan (LAP) and Resettlement Action Plan (RAP) must be developed and examined prior to the construction - Prompt procedures for application and approval of site clearance certificate (SCC) followed by land acquisition. - Betterment of living condition, livelihood and job opportunity creation should be examined in LAP and RAP	- Planning and Design Section of BPDB - Consultants - Ministry of Land - DOE - Upazilla Nirbahi Office	- PD - BPDB - Consultants - Upazilla Nirbahi Office
Construction phase			
Unhygienic condition created at solid waste disposal site	- Use safe waste disposal techniques and land filling by waste may applied be	- Contractor	- PD - BPDB - Consultants
Deterioration of hygienic condition due to workers' careless behaviors	- Forewarn workers from roaming around - Proper health and sanitation facilities and education	- Contractor	- PD - BPDB - Consultants
Deterioration of local environment caused by wastes from construction works	- Safe disposal of construction wastes - Proper health and sanitation education for local people	- Contractor	- PD - BPDB - Consultants
Possibilities of accidental events during construction	- Place adequate warning signs and posts and training for people's awareness raising - Announcements to make communities understand the risks of accidental events (using microphones and loud speakers etc. for effective announcement) and training	- Contractor	- PD - BPDB - Consultants
Fire hazards	- Fire fighters and adequate equipment should be kept as stand-by and periodic drill	- Contractor	- PD - BPDB - Consultants

[1] The land prices are indicative only. The actual land prices may be estimated based on the actual requirement of land for the project. According to the Bangladesh regulation, displaced persons are entitled only to compensation for loss of land, property and standing crops in monetary terms at the rates fixed by GOB. According to JICA guidelines, compensation for losses must be based on the amount that require for re-purchase.

Impact	Mitigation Measures	Responsible Agency	Monitoring Agency
Possibilities of accidents from hazardous materials and non-use of personal protective equipment (PPE)	- Make the workers aware of the hazardous materials and proper handling methods - Set-up warning signs, labels and signals - Provide helmets, safety shoes and other PPE for workers in accordance with accident prevention and work safety procedures and make them use these	- Contractor	- PD - BPDB - Consultants
Post-construction/ Operation phase			
Degradation of air quality	- Gaseous pollutant emission control measures should be adopted to reduce air pollution - Periodic measurement of air quality - Air quality information should be properly delivered to the local community	- Plant Owner	- PD - BPDB - Consultant - Department of Environment (DOE)
Deterioration of water quality	- Proper wastewater treatment measures should be ensured to reduce adverse effects on river water quality - Water quality information should be properly delivered to the local community	- Plant Owner	- PD - BPDB - Consultant - DOE
Increase of Sound/ Noise	- Efficient sound control system should be ensured to reduce noise levels at the power plant site - The progress of sound control should be well informed to the local community	- Plant Owner	- PD - BPDB - Consultant - DOE
Pilferage	- Proper security measures and monitoring - Patrol for prevention of security deterioration	- Plant Owner	- BPDB

Source: PSMP Study Team

In addition to the issues raised in the above table, there are some other social components to be considered for the benefit of the local people as given in Table 18-9.

Table 18-9 Measures for improvement of local situation (all sites)

Social Components likely to be Impacted	Areas for Improvement	Mitigation Measures / Enhancement
Information, Education and Communication	- Low education - Limited access to information due to low literacy rate - Female low literacy	- Awareness program for raising proper knowledge on power plant construction - Visual aids (posters, leaflets, fliers with pictures and signs) are to be developed to deliver proper information - A team comprised of communication officer, rural development officer and engineer should be organized to prepare and implement action plans for local livelihood development
Health and Living Condition	- Poor housing conditions - Poor sanitary conditions	- Proper Land Acquisition Plan (LAP) and Resettlement Action Plan (RAP) must be examined and prepared prior to the construction - Betterment of living condition and livelihood, and job opportunity creation should be examined in LAP/RAP - Awareness program for improving health and sanitation condition should be implemented
Employment	- Increasing unemployment - Limited job opportunities - Low skill	- Skill development should be examined in RAP - Local people should be affirmatively employed in the power plant
Income Level	- Lower income than rural average	- Advanced agricultural methods can be introduced to further income generation - Ensure stable power supply to local offices, factories and irrigation facilities for effective work which helps increase local income

Source: PSMP Study Team

(2) Specific issues to each site

Taking specific features of each site into consideration, possible problem solutions for critical issues are as following:

(1) B-K-D-P Site

- There can remain particular residents who are too cautious and skeptical toward development projects. Communication tools should be well designed to prevent them from being misguided. The tools should be informative even for the illiterate to deliver proper knowledge on environmental mitigation measures.
- Amusement facilities open to the local residents can be allocated along with the power plant construction. Equal distribution of benefits to the local community should be well designed. Information on the new power plant should be kept open to the public, keep transparent and accountable not to cause any doubts.
- As the local awareness on diseases and their prevention measures is low, detailed program for improving health and sanitation condition should be carefully designed. Contribution to securing safe and sufficient water supply can be considered through providing safe wells.

(2) Chittagong Site

- There seems to be no prior knowledge on power plant among local residents. Awareness raising program should be developed very carefully in order to convey proper knowledge and acquire good understandings from them.

- Currently people in Anwara Upazila (next Upazila to the site) suffer from diseases which are likely caused by the nearby fertilizer factories. Detailed program for improving health and sanitation conditions should be carefully designed to create awareness of local residents and their behavior change.

(3) Meghnaghat Site

- Local residents are too optimistic toward power plant construction without knowing difference between combined cycle and coal-fired power plants. The possible environmental impacts and potential risks such as health hazards likely to be caused by the coal-fired power plant must be fully addressed and environmental mitigation measures be fully explained. As the local residents are not advanced in terms of education opportunities, the communication tools should be well designed even for the illiterate.
- Taking good practices and lessons learnt from CSR activities conducted by the combined cycle power plant into consideration, the new power plant should keep itself transparent and accountable to the local community.

18.5 Study items with high priority in future F/S

18.5.1 Environmental management and consideration

(1) Common issues among three sites

(a) Construction stage

- Noise and Vibration

  Streamlining of the construction process, usage of low-noise machinery, and lower vehicle speed in residential areas are the measures to be taken.

- Accident

  Establish suitable OHS organization (policy, manual, announcement of policy, safety training and safety patrol), and conduct quality control of construction work.

(b) Operation stage

- Air pollution

  Measures for SOx emission

  The Environmental Conservation Rules of Bangladesh stipulates the stack height according to the generation capacity, as the SOx emission regulation. It stipulates 275m of stack height above the 500MW class thermal power plant. However SOx emissions concentration can be reduced by FGD and it is not always necessary to use a very high stack. It is recommended that Bangladesh formulate regulations governing SOx emissions for both the effective stack height and the total amount of SOx emissions.

  Measures for NOx emission

  The reduction over-rich-air ratio, low NO_X burner, two-stage combustion, and flue gas recirculation have been adopted in many large-scale boilers as a combustion improvement technology. There are many precedents of the use of SCR as denitrification equipment for power plan boilers. However, NOx concentration can be reduced to around 300mg/Nm3 without SCR which uses ammonia. Mitigation measures for NOx emission should be decided when considering the risk and cost of handling ammonia.

  Measures for soot emissions

  A low temperature ESP or a low-low temperature ESP is suitable for the mitigation of soot emissions during the operation stage. The high temperature ESP has been designed at

around 350 °C of the gas temperature (upstream of the air heater), low temperature ESP is designed at around 140 °C of the gas temperature (downstream of air heater), and the low-low temperature ESP is designed at around 80 °C of the gas temperature (intermediate of each gas-gas heater of the limestone gypsum FGD). The selection of the flue gas treatment system is carefully conducted for the whole system, including desulfurization and denitrification. AP Fig.18-14 shows an example of the flue gas treatment system. Further, the evaluation items for flue gas treatment system selection may be found in AP Table 18-71.

Measures for coal dust

The adoption of sprinkler equipment is effective for coal dust scattering. To reduce water usage and prevent water contamination, it is necessary that the effluent form coal storage yard be collected and reused after sedimentation.

- Water contamination
  Equip the plant with waste water treatment facilities (coagulating sedimentation, neutralization, and oil separation).

- Noise and Vibration
  Develop green belt along the site border.

- Waste
  Establish waste management program (reduction, reuse and recycling: 3R)

(2) Specific issues at B-K-D-P

- Air pollution
  If the Sulphur content of coal is under 0.4%, it is possible to achieve world environmental standards with a planned stack height of 275m as stipulated in the Environmental Conservation Rules of Bangladesh for coal-fired power plants exceeding 500MW. Further, it is possible to reduce the stack height to around 140m[1] with an FGD installation.

- Ground subsidence, Water usage
  Ground water pumping won't be conducted in order to prevent subsidence and impact to water usage. If cooling tower make up water cannot be supplied from river in detail EIA, air cooled condenser is planned to be installed. There are precedents of installing air cooled condenser to 600MW class thermal power plants. AP Table 18-78 shows example of air cooled condenser precedents to 600MW class thermal power plants in China. Study of possibility for recycling discharged water from coal mine to plant service water is recommended.

- Environmental consideration in domestic coal development
  Furthermore, environmental and social considerations for domestic coal mine development which precedes power plant construction is indicated in EIA Guideline for Coal Mining. AP Table 18-79 shows the environmental consideration for mine development. Reinjection of the prior drainage of the aquifer is recommended to be examined, as a countermeasure for ground subsidence via ground water pumping.

[1] Local stakeholder's requirement

(3) Specific issues at Chittagong and Meghnaghat

- Air pollution

  Chittagong site is located 12 km away from Chittagong Airport. Even if it is outside the height regulation area from the airport, it is not suitable for high structure construction from the perspective of aviation security. The Meghnaghat site is located near Dhaka and it is not suitable either to construct a very high structure in view of aviation security (see AP Fig.18-13). A detailed confirmation of the EIA is required because the stack height can be reduced to around 140m[1] via FGD installation.

  However, the sulfur content of the imported coal is estimated to be quite high. It is necessary to set both the FGD and 275m height stack which is stipulated in the ECR. If a low height stack is used, the performance of the FGD should be at its highest and a higher gas temperature and a faster gas flow rate at a stack outlet is needed. The best solution should be examined in the detailed EIA in consideration of cost and efficiency.

- Water contamination, Ground subsidence, Water usage

  In order to prevent adverse impact on local fishery, ground subsidence and underground water level decrease, cooling tower is needed to be adopted as a cooling system, while makeup water will be supplied from rivers. Further, the cooling water effluent needs to be discharged after proper waste water treatment (coagulating sedimentation, neutralization and oil separation).

- Coal dust

  Mitigation of coal dust impact during the operation stage is important in the Meghnaghat site which is next to the combined cycle power plant. The application of a windbreak fence is desirable to be examined in the EIA in detail, even if the installation cost is large.

18.5.2 Social consideration

- Environmental mitigation and prevention measures should be thoroughly taken up and reflected in the project design, which will also lead to mitigation of social impacts

  Land acquisition and involuntary resettlement will be the only major social issues that cannot be avoided even in case environmental consideration is properly reflected into the project design, i.e., mitigation facilities to prevent air pollution, noise, vibration, ground subsidence etc.

  In other words, it is recommended that the Government of Bangladesh fully recognizes the importance of installing such environmental protection measures, in order to mitigate (or reduce) the degree of social adverse impact caused by the power plant construction and operation.

  It is also recommended that such prudent actions be legalized as the responsibility of the project proponents to synchronize the national environmental arrangements with international ones.

- Appropriate actions should be taken for land acquisition and involuntary resettlement in a timely manner

  Proper LAP/RAP must be fully examined and prepared prior to start of construction work. Upon issuance of the SCC, after careful consideration on the site selection, it is strongly recommended that the Project Owner work intensively on the application procedure of

[1] Local stakeholder's requirement

land acquisition along with the implementation of EIA followed by ECC issuance and approval of development project proposal (DPP). It will help to minimize time until the operation of the power plant starts.

- Resettlement action plan (RAP) should be thoroughly examined and elaborated from mid-term and long-term perspective.

  Legislation on resettlement has not been promulgated in Bangladesh as of November 2010. Donors' guidelines on environmental and social safeguards are, instead, applied when the GOB receive finance provided by them.

  Not only additional land acquisition for people's relocation and construction of their houses, it is essential that education on hygiene, sanitation, and environment, measures for betterment of livelihoods and living environment and skill training program should be incorporated in the RAP for the benefit of the affected people. Since these will involve additional cost, these should be incorporated in the DPP also. Job opportunities should be affirmatively offered for the affected people at the newly constructed power plant. It not only helps them generate their income but increase their understanding toward the power plant operation.

- Awareness raising and knowledge sharing is the key element for proper risk communication

  Incidences occurring in Barapukuria have been well known at national level in Bangladesh. People of local communities in Barapukuria and Phulbari may have strong skepticism toward coal-fired power plant construction and coal mine development and protests against such development activities might be faced.

  It is recommended to spend time and budget for information sharing on new power plant construction and local consultations in order to achieve understanding from the local people. Environmental protection measures should be examined, reflected into the project design and explained to the local people, which will help ease their feelings.

  Formal public consultations should be conducted in the EIA study in order to disclose detailed project activity and the potential impact and to obtain public opinions. Public consultations and disclosures should also be conducted during the construction phase to raise local awareness. Project information and impact should be disclosed to the public through all kinds of media: newspapers, announcements via microphones or loud speakers at the project site, posters, leaflets and cards with visual messages. Well-experienced environmental management specialist should work closely with social development specialist to develop the best tools that interpret complex technical issues into plain expression for the local people to understand well.

- Supports and collaboration from civil society organizations, local NGOs, government institutions and administrative bodies are essential.
  It is desirable that the opinions of NGOs such as BRAC, ASA, CCDB, CARITAS, UDP, TMSS and Pallibandhu Parishad should be collected in Barapukuria, BRAC, ASA, Grameen Bank and Proshika in Chittagong, and BRAC, ASA, Proshika, VARC and VOSD in Meghnaghat. These NGOs have profound local experiences in the areas and can contribute as facilitators to active dialogues with local people, and can promote an awareness-raising campaign together with the project owner. Their support is essential to implement the comprehensive RAP.
  **ITALICS part will increase cost.*
  Since the official procedures for land acquisition are handled mainly by the Deputy

Commissioner's Office, Upazila Nirbahi Office and Union Parishad Office, it is strongly recommended to work closely with these offices in order to promote further understandings in local community.

- It is recommended that the Project Owner creates an environmental and social unit and allocate experienced personnel
  The application for the approval of land acquisition can be submitted before having the approval of EIA (ECC) and the DPP. In order to avoid effects on the project implementation schedule, such approval process should be started as soon as the project site is finally identified. It is recommended that the Project Owner establishes a unit exclusively dealing with environmental and social safeguards to promote the procurement procedures for consultancy contract and other official procedures required according to the Bangladeshi legislations.

18.6 Environmental management plan, resettlement action plan and indigenous people plan

The Terms of reference (TOR) for the resettlement action plan has been drafted in the APPENDIX. The RAP will be elaborated on when the detailed EIA is formulated.

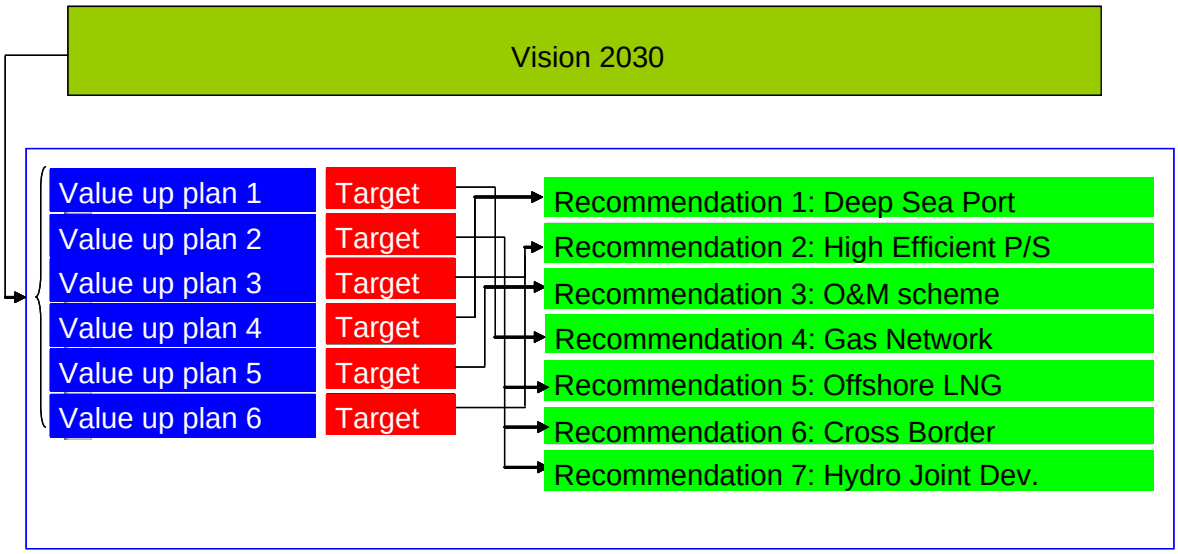
Environmental Management Plan has been drafted in the chapter 17.2 and the TOR for EIA has been drafted in the APPENDIX. Indigenous and ethnic people plan is not drafted in this Master Plan since there are no such people identified in the three most prioritized sites.

Volume 3　Recommendations for Future Support Measures

Chapter 19 Recommendations

In this chapter, the recommendations have been submitted based on knowledge acquired by investigation so far.

As mentioned in Chapter 2, this MP has developed the vision of the MP as the prioritized goal, and has set the value-up plans and targets in order to achieve the goal. The following describes the detailed recommendation to attain those targets. The following figure summarizes the target with the corresponding recommendations.

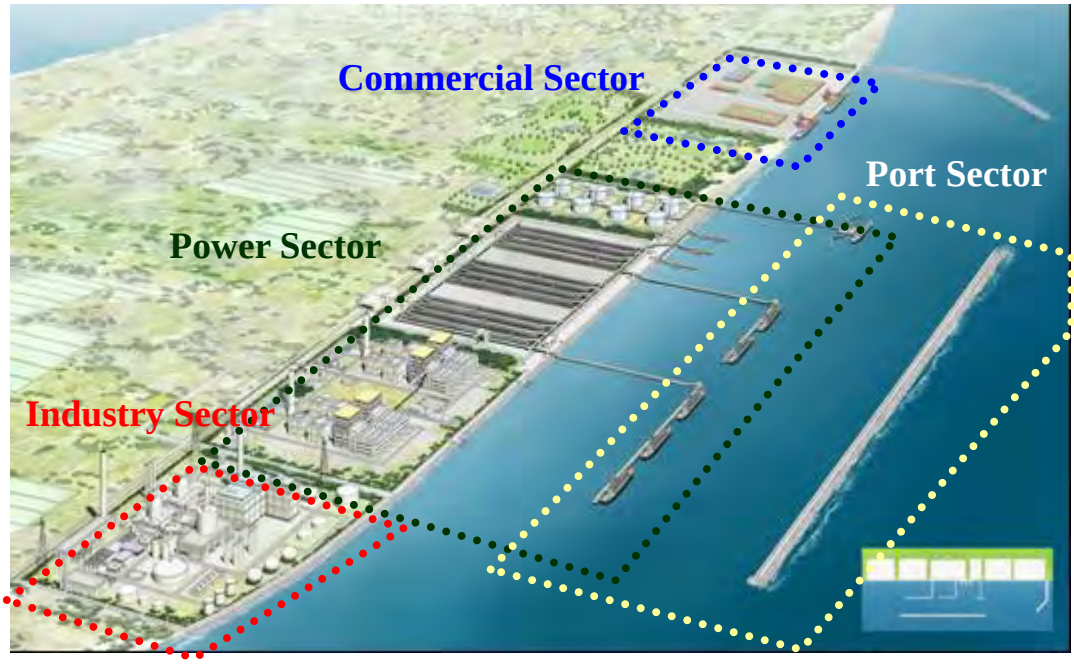


Source: PSMP Study Team

Fig. 19-1 Relationship between each target and recommendations

19.1 Study for basic design regarding deep sea port development (F/S, D/D)

In order to receive import coal ships, and for the industrial structural development of Bangladesh towards processed exportation and to export products, the necessity for a deep sea port continues to grow the economy. Because it needs a huge amount of investment for the development of deep seaports, it is difficult for the power sector to proceed alone. Hence, it should proceed with the coordination of other sectors such as commercial sector, industry sector and other financing from international organizations. The PSMP Study Team recommends a study for deep sea ports and the related conditions of import coal, oil, and gas.



Source: PSMP Study Team

Fig. 19-2 Image of deep sea port development by multi-sector in Matarbari

19.2 Study for the basic design of coal-fired power plant applied high efficiency generation technology (F/S, D/D)

In this study, from the optimum power generation plan and transmission network development plan which were formulated based on the results of the investigation in the 2nd year, after proceeding with the technical, economic, environmental and social analyses, to prioritize projects with high development possibility and create a short list with three sites and proceed to a rough technical study.

For the construction of a power station, based on the aforementioned technical study, the feasibility study (F/S), detailed design (D/D) reflecting the local characteristics is needed. The main study contents are; securing of ground, generation facilities, cooling water and fuel, transportation, capacity of fuel, treatment of coal ash, methods for the prevention of air pollution, methods of environmental conservation, the selection of the main equipment, water systems for the power station, coal handling facility, port infrastructure, ash treatment facility, heavy equipment and material during construction, packing for transportation, transportation restrictions, transportation methods for heavy equipment during maintenance etc.

Through application of the USC coal-fired power plant equipments, enhanced generation efficiency becomes possible and reduction of CO2 emission is also realized in order to contribute to adaptation of climate change problems. Further, although coal-fired power plants generally emit more NOx, SOx and dust than gas-fired ones, emissions can be reduced drastically by applying state-of-the-art denitrification, desulphurization and dust collection facilities or technology. This also means that the construction of environmental-friendly coal-fired power plants can also be attained. As the next step, the PSMP Study Team recommends conducting a feasibility study based on the needs of Bangladesh and the donor.

Source: PSMP Study Team

Fig. 19-3 Bird-view plan of power plants (L: Domestic coal: Import coal)

19.3 Support project for the enhancement of O&M organization and human education in thermal power generation (Technical support)

Based on the results of investigations of existing gas-fired power plants, it became clear that a majority of the plants are incapable of reaching designated performance levels of capacity and efficiency. The main reason is that these inspections are more restorative than preventive which means most repairs take place after something breaks down.

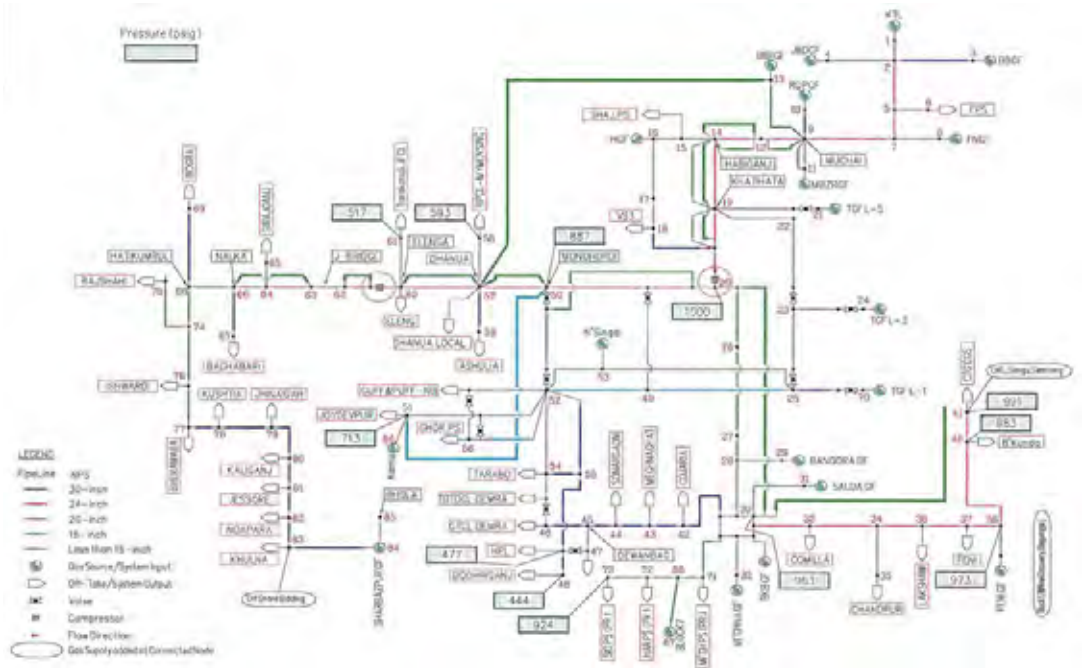
Since power demand will increase in the future, ensuring a stable power supply will require that generation facilities perform according to original specifications. In order to meet these requirements, it is important to change over to the concept of “take care before break down” instead of the current “repair after break down”. In other words, proceed with regular inspection regardless of whether something is broken or not such as (Time Based Maintenance (TBM))” or heeding to equipment predictors during monitoring (Condition Based Maintenance (CBM)”.

In order to taking root of TBM and CBM in Bangladesh, it is possible to teach by incorporating CP training into Japan to transfer maintenance know-how, etc. Moreover, one other effective means is to provide technical assistance in proceeding with the equipment diagnosis for individual plants which carries out aged deterioration together with the CP in order to judge the validity to proceed with rehabilitation.

19.4 Support project for enhancement of gas network (F/S, D/D)

The reason underlying the gas shortage in Bangladesh is the shortage of supply from the gas fields. In addition, the combined factor of the weakness of the existing gas pipeline does not make things better. On the other hand, in order to improve the gas network, a huge amount of investment is needed. It is difficult for Bangladesh given that support from international organizations like ADB is not sufficient.

One more purpose would be to make a promise to supply gas for Haripur P/S and Bheramara P/S for which Japan would provide financing, maintenance or upgrades for gas networks would be necessary in the future, the PSMP Study Team recommends in proceeding with the development study to secure gas supplies especially in the west side.

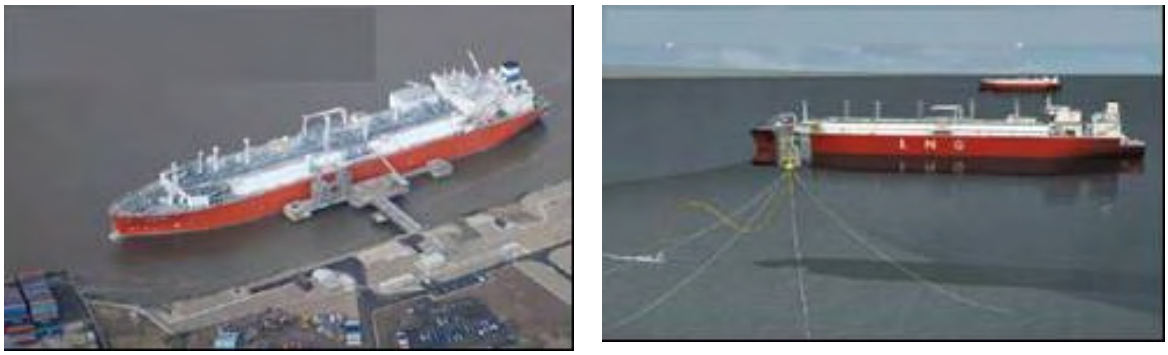


Source: PSMP Study Team

Fig. 19-4 Map of major gas network

19.5 Project for offshore re-gasification facilities (F/S)

Since natural gas demand is already larger than its supply, the introduction of LNG would be the practical option to fulfill this demand-supply gap. Establishing the LNG chain is essential for the introduction of LNG. The LNG receiving facilities must be constructed in Bangladesh. The constructions of proven onshore facilities require a great amount of cost and time. As the offshore gas receiving facility technique has developed and does not need so much cost and time, the offshore gas receiving facility has attracted attention. The PSMP Study Team recommends a study in order to stabilize the supply of LNG in the future.



Source: NIKKISO CO., LTD study data (2010)

Fig. 19-5 Type of mooring（Left: Jetty type, right: Buoy type）

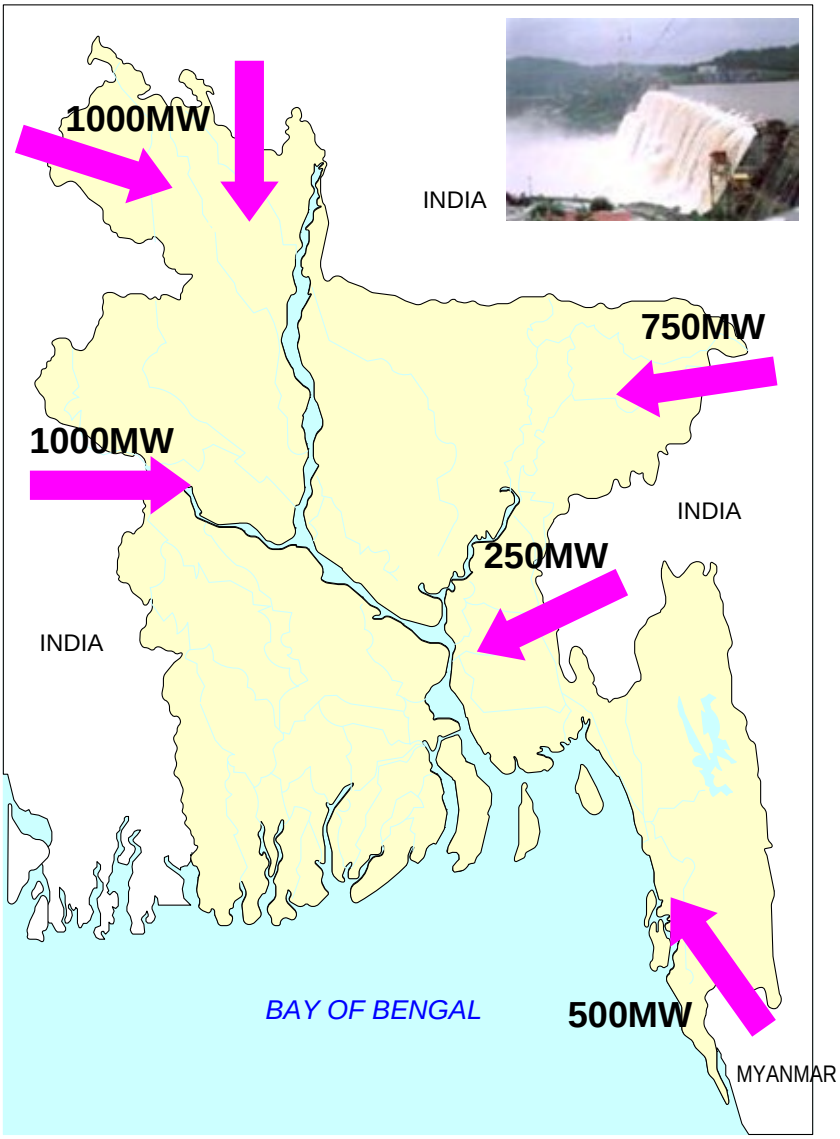
19.6 Technical support project towards the realization of cross border trading of electric power as a target (F/S)

The country surrounding Bangladesh, India, Nepal, and Bhutan possesses a vast potential of hydro power resource capability (assuming that potential hydro power is set in India at 148,700MW, Nepal at 44,000MW, and Bhutan at 30,000MW). It not only contributes to the development of these regions, but by using these abundant resources effectively within the countries in South Asia including Bangladesh, it also contributes to alleviating climate change via renewable energy conversion and large-scale CDM (Clean Development Mechanism) project development is also expected in the future. Moreover, hydro-power generation is excellent in load following capability since it is rich in frequency adjustment functions; there are various advantages for countries in South Asia to establish a firm electric power network in the future.

The South Asia broadband electric power network basic study is mainly implemented by USAID (SARI=South Asia Regional Initiative). Cross border trading has already been implemented between India and Bhutan and India and Nepal.

As for the possibility of cross border trading between India and Bangladesh, the cross border trading between the Bengal province in India and West Bangladesh is recommended by USAID in its basic study. In the short term, the power flow in Bangladesh is from east to west. Since power flow is mitigated by cross border trading, this cross border trading is efficient. But in the mid and long term, since power flow has changed from west to east, the cross border trading at East and North-east Bangladesh would became efficient. In addition, existing hydro-power resources are especially abundant in Bangladesh and in the border of the Eastern or North-east Indian area. Hence, for a certain period of time, this area will be targeted for development. The potential for cross boarder trading has been determined for the following reasons; a good supply-demand balance when surplus hydro power is off-peak during the rainy season is expected to be supplied to Bangladesh where there are power shortages. On the contrary, during the dry season, the electricity from Bangladesh to India and electric power accommodation is based on the time difference between both countries as well as holiday differences etcetera. Since the reinforcement of the power system in India is required, in order to proceed with electric power trading, it should be determined whether or not there is any

interest between the countries, in alignment with expectations that these activities will be conducted by an international organization. The PSMP Study Team recommends to conduct a developmental study in order to search for an efficient potential electric power trading scheme from the perspective of the power development plan and power system plan.



Source: PSMP Study Team

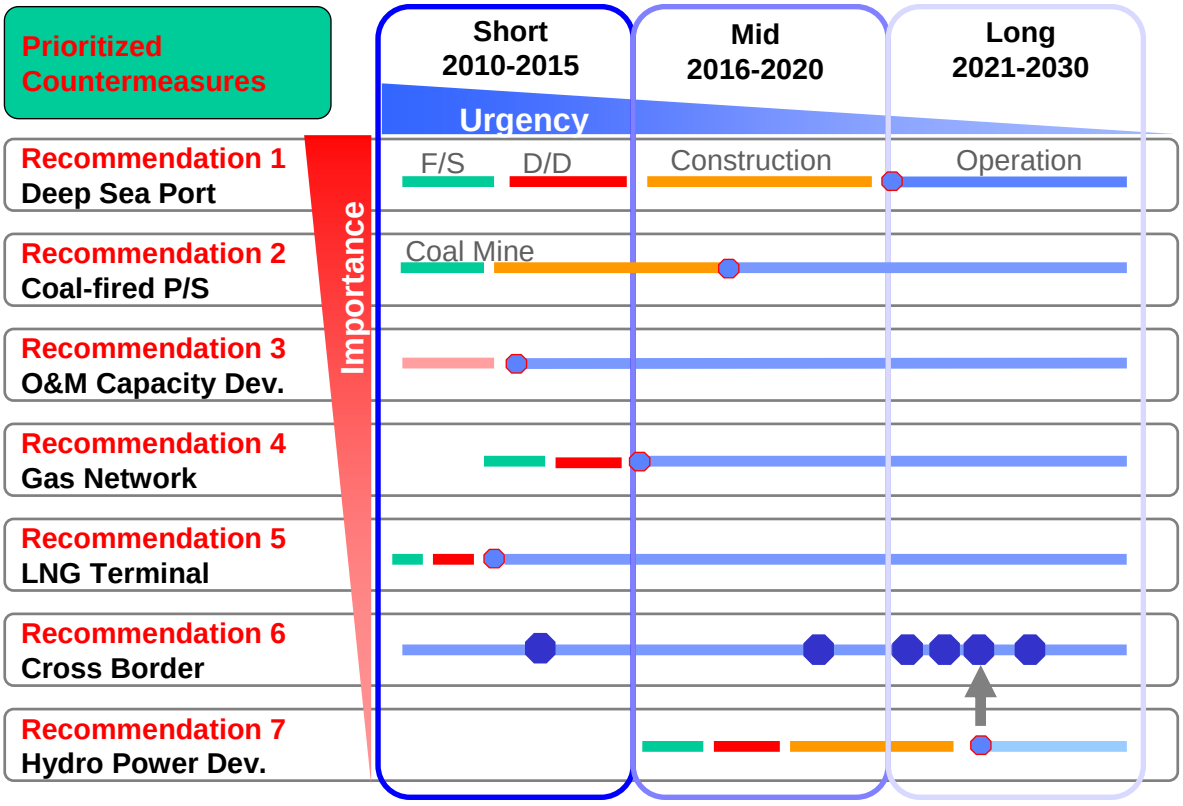
Fig. 19-6 Cross border trading of electric power plan

19.7 Support project for the joint development of a hydro power station with neighboring countries (F/S)

Although there is some possibility of an interconnected system between Bangladesh, Nepal or Bhutan, in order to realize such an interconnection that will have a network pass through India, there are some political difficulties that must be surmounted. It is clear that priority should be given to an interconnection system with India first. There is another possibility to develop not only an interconnection system but the joint development of the hydro power station in Assam State, Northeast India. On the stage of joint development, PSMP Study Team recommends proceeding with an investigation of the concerned technical, environmental and social, economic issues.

19.8 Priority of recommendations

The following figure shows the importance and urgency of recommendations.



Source: PSMP Study Team

Fig. 19-7 Priority of recommendations

In order to implement the development of coal-fired power stations which are the core of this Master Plan smoothly, it is essential to secure fuel supply, prioritizing the development of port facilities for import coal and the development of domestic coal mines. The PSMP Study Team recommends the Bangladesh government to implement some measures to strengthen the O&M ability of power companies so that the increasing newly developed power stations would keep them full performance for long time.