People's Republic of Bangladesh
Ministry of Power, Energy and Meneral Resources

THE STUDY FOR MASTER PLAN ON COAL POWER DEVELOPMENT IN THE PEOPLE'S REPUBLIC OF BANGLADESH

Power System Master Plan 2010 (PSMP2010)

FINAL REPORT

Appendix

February 2011

Japan International Cooperation Agency (JICA)

Tokyo Electric Power Company, Inc.

Volume 1 Power System Master Plan 2010

Volume 2 Technical Study for the construction of Coal-Fired Power Station

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Volume 1 Power System Master Plan 2010, Figure and Table List

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Chapter 4 Coal Sector APPENDIX

4.1 APPENDIX – 1 Brief summary of Coal Policy

(1) Introduction (Energy condition of Bangladesh)

About 73% of Bangladesh's commercial energy needs are met by natural gas. On the other hand, about 50% of this gas produced is used for power generation and 12% for the production of fertilizer. Further, approximately 90% of the country's power generation is presently dependent on gas. According to recent projections, the quantity of proven and probable remaining gas reserves till 2006 is 13.75 Tcf. If no new gas fields are discovered, according to demand, it is apparent that a shortage of gas will become a problem during the periods subsequent to the year 2011.

Apart from power generation, gas is the main ingredient of Urea fertilizer and CNG. Moreover, as a result of utilization of CNG in the transports, as a fuel alternative to imported oil, on the one hand, foreign currency is being saved and on the other, the number of CNG-driven vehicles is increasing fast, which is playing an important part in creating an environment free from pollution. If the GDP of the country becomes 7% or more, according to projections, at least an additional 26 Tcf gas will be required by the year 2025, which is equivalent to about 1,000 million tons of coal, according to heat value.

Under this situation, it is extremely necessary to preserve gas in order to supply it on a long term basis for fertilizer production, CNG, domestic fuel and for the existing power plants. Therefore, in order to ensure long term energy security in the country, the coal usage has to be gradually increased by limiting gas usage by the power and other sectors. It may be mentioned that, among the coal fields so far discovered in the country, since the depth of the other four fields is more than Jamalgonj field, the in-situ proven geological reserves in the four fields (Barapukuria, Khalashpir, Phulbari and Dighipara) is 1,168 million tons.

(2) Background and current status[1]

Power System Master Plan (Nexant) in 2006 states that if the GDP is 5.2%, 19,312 MW of power generation will be required and if the GDP is 8%, 41,899 MW of power generation will be required by 2025. In 2025 out of a total electricity generation of 41,899 MW, 32,837 MW will be generated with coal; for this purpose 75 million tons of coal will be required. 825 (= 450 +375) million tons will be required during 2005 and 2030 and 1,200 million tons will be required during 2005 and 2035.

On the other hand, the Gas Sector Minster Plan (Wood and Mackenzie) in 2006 states that natural gas can't supply enough energy if it is a high case of GDP. It will be necessary to initiate planning and construction of coal-based power plants on an urgent basis from now on, keeping in mind the country's energy security.

(a) Aims and objectives of the coal sector

The "Coal Policy" shall be guided by the Mine and Mineral Resources (Control and Development) Act-1992 and Mine and Mineral Resources Rules-1968 (revised up to date).

(b) Ensure energy security by development the coal sector[2]

- If it is possible to extract a maximum of 90% of coal from these mines with open mining method, about 1,050 million tons of coal may be available. According to Nexant projection, if required 75 million tons of coal in the year 2025 is considered as stable for

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[1] In case of an 8% GDP, domestic coal supply will be over 30 million tons/year in 2019 and 75 million tons/year in 2025. These numbers are only attributable to power generation excluding other industries and coming from only four fields. If there are no new shallow coal fields, the achievement of this amount of domestic coal supply will be difficult because of technical and social hurdles needing to be surmounted.

[2] Present coal recovery ratio by O/C is over 90% in many cases in the world and almost mines start production from outcrop lines or sub-outcrop lines in shallow area. In deep area U/G is adopted because of no-economic method by O/C. In Bangladesh limited depth of O/C is not clear for economical mining, in case of the geological condition of Bangladesh

power generation and if no new coal-based power plant is established, it will be possible to generate electricity up to the year 2033 only from coal-based power plants.

- If it is possible to extract a maximum of 20% of coal with underground mining method, about 235 million tons of coal may be available. According to Nexant projection, with this amount of coal, only power can be generated up to 2022.
- It may be possible to extract 788 million tons of coal with open mining method from shallow coal fields. On the other hand, only 60 million tons coal may be available, if coal is extracted with underground mining method from medium deep (from 250 meters to 500 meters) coal fields. This means that a total of 848 million tons of coal may be available from the 4 mines. According to the projection of the same study, it will be possible to generate power up to 2030 with this coal (if no new coal-based power plant is established after the year 2025 and this estimate has been prepared considering 75 million tons to be used in the year 2025 as steady).

(3) Use of coal as commercial fuel for energy security

(a) Coal as commercial energy

Coal will be developed as an alternative commercial energy in order to reduce the growing demand on natural gas and reliance on imported fuel for power generation, other industrial and commercial uses.

Many countries in the world generate between 40% and 60% of electricity with coal. Considering this fact, after 2010 power generation in the country, have to be coal based, in the interest of enhancing the energy security. The domestic use of coal is to be encouraged to replace fuel wood and imported fuels such as kerosene and LPG.

(b) Coal sector master plan

Considering increasing demand of energy in the country and in order to ensure energy security in the country for 50 years, a Coal Sector Master Plan is to be prepared for development of this industry through Coal-Bangla (proposed)/BMD, according to use of coal in coal-based power plants and in other sectors. The Coal Sector Master Plan is to produce a long term coal sector development strategy with due clarity on the following:

(1) Roles of various parties (including GoB and institutions) to be involved in coal regulation, mining, financing, environmental and social protection,
(2) Profitability analysis of coal showing various cost to each party and the benefits,
(3) Nature of involvement of each,
(4) Country benefit including economic rent GoB can extract,
(5) Regional development in north-western Bangladesh that can take place,
(6) GoB investment needs.

The Energy Division is to initiate developing and implementing such a Master Plan keeping consistency with local demand of coal for power generation.

(c) Regulation of coal production

Considering the present recoverable coal resources of Bangladesh and fixing the target of energy requirement for the next 50 years, GSB has to be strengthened and modernized for boosting up its exploration, since coal discovery is a profitable sector. In order to achieve the target of rapid development of coal sector, the Bureau will issue Exploration Licenses and Mining Leases in such a way that coal production is consistent with energy demand projected in the Energy Policy.

(d) Other coal uses

Under the Coal Sector Master Plan, all kinds of coal use will be encouraged in all other sectors, apart from power sector

(1) Coal as an Alternative Fuel

(2) Small Scale Power Plants
(3) Coal Dust
(4) Support Services
(5) Steel and Re-rolling Mills
(6) Coal Gas.
(7) Coal to Liquid, Fuel Oil and Other Matters

(e) Regulation of coal export

In case of GDP 8 %, 825 million tons of coal will be required only for power generation till the year 2030 and 1,200 million tons till the year 2035. As a result, it will be difficult to keep even the existing power plants in the country in operation. Under such circumstances, it appears that there will remain no opportunity to use coal for any other purpose or to export coal.

However, as a result of discovery of new coal/gas fields in the country, opportunities for export of coal, in excess of obligatory coal-based power generation, may be given on the basis of recommendations of Sector Development Committee and on approval of the government, after keeping provision of energy security for 50 years and after formulation of Coal Sector Master Plan on the basis of determination of overall energy requirement. Quantities of this export shall, under no circumstances, exceed the quantity to be used in obligatory power plants in a year.

The Lessee will have to take leading roles for assisting other entrepreneurs in establishing coal-based power plants, apart from obligatory power plants, considering demand for industrial development, for marketing Bangladesh coal locally.

(4) Infrastructure development

(a) Coal Zone

The coal basins discovered in the north-western area of Bangladesh and the areas with potential basins of coal will be declared as Coal Zone. Government can alter, extend and refine the limits of this map, as required.

The following matters of the region will be taken into consideration, after reviewing the entire socio-economic structure in the Coal Zone**:**

(1) Physical infrastructure e.g. railway, roads, power transmission, ports, waterways, water reservoir etc.
(2) Social infrastructure e.g. villages, towns, educational institutions, industries, commerce and service organizations
(3) Agricultural land use patterns
(4) Water bodies, underground aquifer movements
(5) Matters relating to bio-diversity of the proposed zone.

(b) Coal Zone Report

Government organizations (Coal-Bangla/BMD) will prepare a Coal Zone Report for overall development of the entire Coal Zone. The study is to be supported by other Government organizations.

For development of the coal sector, transportation sector in Coal Zones will be developed. In this respect, other ministries and executing agencies will ensure timely construction and operation of Coal Related Infrastructure.

The Coal Zone will be developed as a major power producing block in Bangladesh based on mine mouth coal fired power generation and from here different load centers of the country will be directly connected by transmission lines.

The Coal Related Infrastructure will be developed in the public and private sectors with assistance from development partners on conditions of a long term business plan and realization of appropriate price from those who will use the facilities.

(5) Consideration of coal related technical aspect

(a) Extraction of coal

The long-term energy security in the country will be ensured through extraction of justified quantity of coal considering energy security of the country and consistent with Energy Policy projection. Established and proven technologies suitable in the context of socio-economic condition of Bangladesh, considering geological structure, nature and condition soil, are to be employed.

Mines are to be planned and developed for achieving targets of coal extraction, complying with health, safety and environmental regulations and keeping coal prices at reasonable rates. The feasibility study is to include a detailed economic analysis that will provide the Government with the costs and benefits of coal extraction on different methods of mining.

(b) Method of mining

The investors will have to propose the mining method based on geological structure, hydro-geological level, soil/rock mechanics, environmental impact study etc., to be included in the techno-economic report. While approving such proposal, the Bureau will keep in mind the energy security of the country. U/G planned for development in Bangladesh is to take cognizance of the earlier experiences and adopt proper pre-cautionary measures during the exploitation phase.

Coal extraction from Open mines is to be under strict surveillance for mitigation measures relating to techno-economic, social, environmental and land reclamation issues.

Since there is no experience on open mining in Bangladesh and if coal is to be extracted with this method, experience has first to be gained on the following matters through development of one mine with this method and if the results are found satisfactory, arrangements for commercial extraction may be made from other mines:

(1) Order to extract coal.
(2) Determination of effects on underground water level through Computer Simulation and study the results of its recharge through water Injection method.
(3) Mitigation of environmental pollution.
(4) Effect on environment as a result of pumping out water for keeping the mine dry, in Land reclamation and study of its fertility.
(5) Rehabilitation of displaced persons and their income restoration.
(6) Socio-economic condition
(7) Increase in public awareness.

(c) Coal reserves

GSB is to set standard procedures, compatible with international standards, such as JORC (Joint Ore Reserve Committee)/ASTM to define various types of coal reserves, such as measured reserve, indicated reserve and inferred reserve. [1]

(d) Quality gradation of coal

For commercial purposes, the Bureau, in association with BSTI/GSB with the support of specialists from Institute of Fuel Research and Development (IFRD) of BCSIR and BUET is to establish standards for quality gradation of both Steam Coal and Coking Coal, following as much as possible, international standards. For being followed by the Lessee, the Bureau will decide the coal gradation for meeting the demands of customers.

[1] Khalashpir and Dighipara in the 4 coal fields are not enough for exploration boring. More exploration works are required to catch detailed geological conditions,

(6) Environmental aspects for considerations

(a) Environmental safeguards

In the light of relevant law and rules, Department of Environment (DOE) will take all necessary actions for minimizing the impact to the environment, while mining, beneficiation, coal-based power generation or any other related work is performed.

The Equator Principles/ World Bank Guidelines on environmental safeguards will be applicable on an interim basis. These guidelines will be rigorously followed while mining, storing, transporting and utilizing coal.

The Government may seek guarantees from the Lessees on critical environmental impact items, @ 1.5% of the estimated cost of the project, in the light of Environmental Impact Assessment and the Environmental Management Plan. [This will be in addition to 3% mentioned in clause 39(c) of Mines and Minerals Rules-1968 (amended up to date)].

(b) Environmental impact assessment (EIA)

The Licensee/Lessee is to undertake an Environmental Impact Assessment (EIA) in accordance with guidelines provided in the Equator Principles/World Bank Environmental Guidelines and DOE regulations. The EIA Report will be considered as a document open to all.

Decision on leasing of mine will be taken in accordance with Mines and Minerals Rules-1968 (amended up to date), after scrutiny of all documents submitted by the bidder and, if necessary, after taking assistance from experts.

(c) Social impact assessment (SIA)

The Licensee or Lessee is to prepare a comprehensive Social Impact Assessment (SIA) through community and stakeholders participation. Opportunities have to be provided to the local communities to participate, through complete disclosure of EIA and Environmental Management Plan (EMP), in the consultative process, in order to enable them to have greater control over the environments in which they live.

(d) Environmental management plan (EMP)

The Licensee/Lessee is to prepare an Environment Management Plan (EMP), along with EIA, following Equator Principles/ World Bank Environmental and DoE guidelines. A set of mitigation management, monitoring and institutional measures to be taken during the implementation and operation of the project, in order to eliminate adverse environmental and social impacts, offset or reduce them to minimum acceptable levels, will be included in the EMP.

(e) Ground water management and aquifer structure

In order to keep the mine pits dry, while working on underground or open mining, some operations involve dewatering of ground water in a large scale from the pits. As a result of large scale dewatering from the pits, the cone of depression may extend over several kilometers. The influence on underground water table during mine development has to be determined even before such development through Computer Modeling/Simulation.

Large scale extraction of ground water for a prolonged period may cause surface subsidence. As a result of the above situation and in order to protect the houses, buildings, reservoirs, railway lines, canals and land drainage around the mine, mitigate measures have to be included in the mining design, while selecting mining process.[1]

[1] There is very thick Upper Dupi Tila formation saturated by water over coal seams in Coal Zone and this formation becomes big obstacle. So maybe this clause is mentioned especially. Before O/C operation, conducting not only simulations via computors but also field tests of bench slope stability and other measures are desirable for control of the Upper Dupi Tila formation. Therefore, it is better to conduct trial mining or test mining in order to maintain safety and stable production

(f) Environmental preservation costs

The Licensee/Lessee is to bear all Environmental Costs associated with the implementation of the Project.

(g) Environmental impact research

Long-term impact to the environment arising from mining operations will be assessed by engaging a research team consisting of appropriate experts (which is not a committee), on payment of appropriate remuneration. The Government will realize compensation from the Lessee, in accordance with Mine and Mineral Resources Control and Development Law 1992 and Mines and Minerals Rules-1968 (amended up to date).

(7) Land reclamation, rehabilitation and utilization

(a) Reclamation and Rehabilitation of Land

As most of the coal resources of Bangladesh have been discovered under populated and high-grade agricultural land, the Lessee is to undertake phased reclamation and rehabilitation of lands affected by exploration/mining operations and is to complete this work before the abandonment of the area/mine.

(b) land utilization

The Licensee and Lessee are to prepare, even before start of mining works, a special plan for achieving desired targets and an EMP in accordance with Equator Principles/ World Bank Environmental and DOE guidelines, along with details of steps to be taken for land re-use, at the end of different stages of exploration and mining activities.

An action plan of land use for minimizing adverse environmental impacts from the proposed mining activities is to be prepared for different phases of mining. The best safety measure of international standard has to be taken so that no harm occurs to lives and properties in and around the mine

(c) Overview of land reclamation

Mining and civil engineers, architects, soil scientists, hydro-geologist etc., will be formed under the Bureau, which will carry out close technical supervision of gradual rehabilitation and reclamation of pits created by mining activities by the Lessee.

(d) Compensation for resettlement of inhabitants and structures

In accordance with Equator Principles/ World Bank Environmental and DOE guidelines, compensation acceptable to the owners, for rehabilitation, land and structural losses will paid.

Mine and Mineral (Control and Development) Rules 1968 and the kinds of laws will be properly adhered to during development of mine and production.

(8) Investments in the coal sector

(a) Physical & institutional infrastructure development

Apart from coal exploration, Development and Production, investment will be done in the following sectors:

(1) GSB activities on initial exploration and discovery of coal basins, exploration data management, technical standards;

(2) Establishment of Coal-Bangla and improvement of efficiency (if required) for overall development of coal sector;

(3) Enhancement of Coal R&D activities;

(4) Institutional development and capacity building for Bureau, GSB, BCMCL, Petrobangla, Energy Division, DOE, Ministry of Agriculture, Ministry of Water Resources; Ministry of

Land, Ministry of Communications, Ministry of Shipping, Bangladesh Railway, Port Authority and Land Acquisition offices of proposed coal mine area;

(5) Coal Related Infrastructure;

(6) New technologies such as coal bed methane, peat development, coal gasification (underground and surface);

(7) Rural and domestic use of coal for poverty alleviation, rural based power generation.

(b) Investment

Priority will be given to Government sector for coal exploration, development, production and marketing. But private investment will be encouraged on urgent basis if required for ensuring adequate supply of energy taking into consideration of energy security.

The licensee or Lessee cannot transfer license or lease or assign to those persons or organizations that are inexperienced in mining, bankrupt or financially insolvent.

(c) Exploration of Coal basin

1) Exploration of new areas by the Private Sector

Bureau of Mineral Resource development will invite proposal/Expression of Interest (EOI) from interested firms through international advertisement for exploration of coal in the new areas. Bureau is to assess the qualifications of the tendered to ensure that the tendered has sufficient experience in mining, is solvent and is able to carry out the planned exploration activities.

But statutory organization or authority will get priority in this case.

2) Discovered coal basins

Coal basins are to be released to the private sector for investment or retained by the Government for public sector investment. But the applicant/tendered may collect data/information from GSB on payment before issuance of license or lease for coal basins discovered by GSB.

(d) Process of investor selection for GSB discovered coal basins

The selection is to be done through tendering by invitation of proposals through press media, other websites including websites under CPTU**.**

(e) Other awards for Mining

1) Peat Coal Blocks
2) Coal Bed Methane
3) Other Precious Minerals
4) Underground Coal Gasification

(f) Coal field development program and budget

(9) Coal-fired power generation

(a) Establishment of coal based power station

In accordance with Power System Master Plan-200 (Nexant), if the GDP growth rate is 5.2%, power generation will be required 9,786MW in 2015, 13,993MW in 2020 and 19,312MW in 2025. If GDP 8%, power generation will be required 13,408MW in 2015, 24,445MW in 2020, 41,899MW in 2025. In 2025 out of a total generation of 41,899 MW of electricity, 32,837 MW will be generated with coal; for this purpose 75 million tons of coal will be required.

There will be shortage in supplying gas to the existing running power stations and fertilizer industries in 2011 onwards. So, planning of coal based power generation as alternative source of energy should be undertaken right now.

The proven underground geological reserve is 1168 million tons in Bangladesh except Jamalgonj. 90% of reserve by open mining method is about 1,050 million metric tons. On the other hand, 20% of reserve by U/G is about 235 million metric tons. Refer to Table 3-2-1, Table 3-2-2.

(b) Mandatory power station

It is to be a condition of the Mining Lease that all Lessees will construct one mine mouth power station as a Mandatory Power Station, operate the station and sell electricity to the grid, under a long-tern power purchase agreement.

The broad Parameters of a Mandatory Power Station are to be:

(1) The commercial operations date for the station is to be within one year forcibly of the date of commercial operation of the mine. But the priority will be given to award lease to the proposer / investor who will go for commercial operation of stations from the date of commercial operation of mine forcibly. Priority will be given to the proposer who will produce the highest power for mandatory power station.

(2) The lessee must establish Mandatory Power Station of capacity at least 500MW for extraction of 3 million tons coal annually from the mine during development of coal field.

(c) Coal-fired IPP

Public sector power generation agencies alone would not be able to cope up with the huge mine produce in Coal Zone. Private sector power generation must be encouraged as coal-fired independent power producers (IPPs) to set up coal based power plants in the vicinity of the coal mines. The broad parameters of coal-fired IPPs are to be:

(1) The stations are to be competitively tendered by the host power utility (BPDB or a relevant Governmental Authority) in a manner similar to the gas-fired combined cycle IPPs;

(2) There is to be a coal supply agreement entered into between the Lessee and the IPP investor. The price of coal to the power plant is to be fixed in Bangladesh Taka in this case.

(3) Coal-fired IPPs are to be given IPP status under the 1996 Private Sector Power Generation Policy and amended in 2004. But the electricity generated in these coal-fired IPPs will be sold in Bangladesh Taka.

(d) Public sector generation

BPDB has constructed a 250 MW power plant adjacent to the Barapukuria coal mine and may construct coal-fired plants in future with public sector financing. The broad parameters of public sector coal-fired stations are to be:

(1) There is to be a coal supply agreement entered into between the Lessee and BPDB or the appropriate Governmental Authority;

(2) The price of coal to the power plant is to be negotiated between the Power Division and the Lessee;

(3) The Government may choose to take all Royalties from the Lessee in kind as coal and supply it to the public sector power stations.

(e) Captive power generation

A true captive power station by coal is to use power for internal only. Excess power is to be exported to the grid, and then the price is to be mutually negotiated between the Lessee and the BPDB or power sold as per the Captive Power Policy

(10) Commercial aspects

(a) Coal prices

On a quarterly basis, the Bureau is to calculate and publish at its web site and news media, the export coal price (ECPt) that is based on the International Coal Price Index. Export coal price (ECPt) per ton will be expressed in US Dollar, which will be calculated the average of the last three months' international coal price. The price of local use coal will be ECPt x0.7 at mine mouth

(b) Royalty

Royalty is payable by the Lessee to the Government for all Local Use Coal and Export Coal produced from the Lease Area. Royalty is to be paid by the Lessee to the Government on a quarterly basis, calculated on coal production returns certified by the Bureau. The Government may choose to take the Royalty either in cash or kind.

1) Royalty of export coal

The rate of Royalty for Export Coal is to comprise of two components, a Fixed Royalty Component and a Variable Royalty Component and is to be based upon the following formula:

$$Rt = FRC + (ECP_t - ECPb)*10/ECP_b$$

Where,

Rt represents the rate of Royalty in percentage of Export Coal during the quarter at any time t

FRC represents Fixed Royalty Component that will be 6% for Opencast Mines and 5% for Underground Mines

The term $(ECP_t - ECP_b)*10/ECP_b$ represents the Variable Royalty Component in percentage, as the premium for exporting coal, and shall not be less than zero

ECP_t is the export coal price represented by the average of International Coal Price Index for the preceding 3 months, at any time t, in $/ton

ECP_b is the base year coal price, and is to be taken to be US$ 25/ton

The quarterly Royalty payment for Export Coal shall be calculated based upon the following formula:

$$QRP = R_t * EC_q * [\, 0.90*ECP_t \,]$$

Where

- **QRP** represents the quarterly Royalty payment in US$
- **EC_q** is the Export Coal in tons, during the quarter

In the above formula, the QRP for Steam Coal and QRP for Coking Coal are to be calculated separately, with the appropriate numbers in ECP_t, ECP_b and EC_q. If the ECP_t values for Coking Coals are not available, then it is to be taken as 50% higher than that for Steam Coal i.e. ECP_t of Cooking Coal =1.5x ECP_t of Steam Coal

2) Royalty of local use coal

The quarterly Royalty payment for Local Use Coal shall be calculated based upon the following formula:

$$QRP = R * LUC_q * \text{Applicable coal price}$$

Where

QRP represents the quarterly Royalty payment in Taka

R represents the fixed rate of Royalty in percentage for Local Use Coal

LUC_q is the Local Use Coal in tons sold or consumed internally during the quarter

The rate of Royalty for Local Use Coal is to be the **Fixed =0.7*ECP_t**

(The rate of Royalty for Local Use Coal is to be the Fixed in local currency converting US$ at exchange rate fixed by Bangladesh Bank as ECP_t is in US $).

(c) Coal marketing

The Lessee is to engage distributors for the distribution of coal throughout Bangladesh. These distributors are to be responsible for the transportation of coal from the mine to the distribution centers located throughout the country. Such coal is to be sold at the retail level, at the price determined by the Mine Mouth Coal Price, plus the applicable transportation charges.

Excess Coal (if any) may be exported subject to approval of Government if the Coal Sector Development Committee recommended to export excess coal after meeting the long term demand as per Master plan and ensuring 50 years energy security of the country. The amount of this export will no way exceed the annual requirement of coal for mandatory power stations. i.e. the ratio of coal use for mandatory power station and the maximum coal export is 1:1.[1]

(d) Fees

All fees related to Exploration License and Mining Lease is to be reviewed and renewed time to time as per rules of Mines and Mineral Resource Rules and published by the Bureau.

(e) Coal fund

A Coal Fund is to be created with an immediate contribution of Taka 100 million, as a grant for carrying out the Immediate Development Works. The fund is to be maintained in a separate bank account for administering the payments from it, as per the decisions of the Coal Sector Development Committee.

(b) The fund is to be utilized by the concerned public sector organizations for the purposes such like Institutional capacity building, Manpower development, Reconnaissance survey by GSB, Higher training for concerned officials of GSB and BMD, Coal Sector Master Plan, Coal Zone Study, Peat and CBM development, Coal gasification and others.

Coal Bangla (Proposed)/BMD will be responsible for management of the above fund for overall development under supervision of Coal Committee

(f) Fiscal incentives

During the exploration phase of coal, any equipment, machinery, supplies, spares, and consumables etc. imported by the Licensee is to be exempt from customs duties and VAT;

For other matters such as corporate tax, income tax & VAT etc, the Investors will receive the benefits as applicable under the present regulations in Bangladesh at the time of contract signing, No Tax holiday facilities will be provided.

The feasibility study and development of CBM, Peat Coal, Coal to Liquid, Coal Bed Liquefaction & in-situ gasification etc are to receive similar fiscal incentives as above.

(11) Institutional development and framework

(a) Institutional development and framework

The Government is to utilize the 5-year period from July 2007 to June 2011 to consolidate the sector by undertaking Preparing a Coal Industry Master Plan(under supervision of Coal Bangla/BMD), Undertaking a Coal Zone study, Training and capacity building of government officials for planning, evaluating, negotiating and soliciting functions (Bureau) and etc.

(b) Change in law

The Licensee or Lessee is to abide by the laws, decrees, rules, regulations and ordinances on the mining industry, industry in general and environment protection, existing at the moment or to be adopted by the Government in future. Any costs related to the changes are to be borne by the Investor as a normal business risk. The Government may review this regulation time to time.

(c) Strengthening of existing organizations

1) Geological survey of Bangladesh

GSB is to bear responsibility for carrying out investigations and surveys for the discovery of coal resources. GSB is to be equipped with suitable manpower and latest technology for efficient performance of the following:

(1) To carry out geological, geophysical surveys in green fields to discover and delineate new basins

[1] There are many descriptions of the case of DDP @8% in this draft coal policy and domestic coal production is calculated by coal power generation. All produced coal is for domestic power plants so that domestic coal can not export only but also supply to domestic other industry. One idea is high price coking coal is for export and gets foreign currency, then Bangladesh import much more steaming coal.

(2) Confirm commercial coal reserve in a basin through exploratory drilling of sufficient number of boreholes
(3) Set standards to quantify coal resources in terms of measured, indicated, and inferred reserves;
(4) Set standards to define and differentiate steam coal and coking coal;
(5) Set standards for quality gradation of coal for commercial purposes;
(6) Prepare, update and maintain a data bank of mineral resources of the country;
(7) Data management and marketing to attract potential Investors in the coal sector
(8) Participate and contribute with all recent data for the creation of Coal Zone.

2) Bureau of Mineral Development

The Bureau is to assume responsibilities as follows:
(1) Selection of investors for exploration and development activities for mineral resources;
(2) Monitor development, production and marketing of coal;
(3) Regulate the macro aspects of the coal industry;
(4) Issue Coal Export Certificates;
(5) Publish export coal price (ECP_t) on a quarterly basis;
(6) Regular Inspection;
(7) Environmental protection monitoring activities etc. of the Licensees and Lessees through its Land Reclamation Wing.

3) Department of Environment

The DOE is to review the exploration, production, exploitation, storage and transportation of coal, reclamation of land etc, identify the areas that need improvement and on an urgent basis, carry out the work such that the coal sector can be developed in an environment friendly and responsible manner.

An arrangement will be taken to establish permanent office of DOE in the Mine zone to ensure the application the existing environmental laws.

4) Coal Sector Development Committee

1	Minister, Ministry of Power Energy & MR Division	Chairperson
2	Secretary, Finance Division, Ministry of Finance	Member
3	Secretary, Energy Division	Member
4	Secretary, Power Division	Member
5	Secretary, Ministry of Home	Member
6	Secretary, Ministry of Communications	Member
7	Secretary, Ministry of Land	Member
8	Secretary, Ministry of Forest & Environment	Member
9	Secretary, Ministry of Commerce	Member
10	Commissioner, Rajshahi Division	Member
11	Chairman, Petrobangla	Member
12	Chairman, BPDB	Member
13	Director General, Geological Survey of Bangladesh	Member
14	Specialists in the related field (3 Nos.)	Member
15	Director, Bureau of Mineral Development	Member

The committee may co-opt other members from private sector, civil society and experts as may be necessary from time to time. The committee is to use the Coal Fund for carrying out its activities.

5) Coal Bangla

The Government may create an institution “Coal Bangla” under the EMRD, to ensure public sector investments and participation in the coal sector. Employees will be appointed as per requirement for its efficient operation and training will be arranged for the employees on priority basis

6) Chief Inspector of Mines

An office of the Chief Inspector of Mines is to be created.

7) Mining Educational Institutions

BUET and RUET will start a degree course in mining engineering. The education and research program on geology will be strengthened in Rajshahi University, Dhaka University and Jahangirnagar University. Diploma level mining courses are to be introduced in the polytechnic institutes within the Coal Zone for creating midlevel supervisory technical personnel. Similarly, mine vocational training courses are to be introduced at the vocational training institutes within the Coal Zone, aiming to supply trained and skilled craftsmen, operators, and technicians for the industry.

8) Human Resource Development

All Lessees are to operate training in their training centers before appointment of the technical manpower and mine workers for extraction works.

The Government is to initiate action on urgent basis to train local technical personnel on short and long term basis in countries because of the need of immediate manpower requirement in the coal sector.

The Licensee and lessee will have to apply modern technology for exploration and development of coal and make the Bangladeshi manpower trained in modern technology. During construction period of mine development, the Lessee is to engage trained Bangladeshi personnel to work side by side with foreign expatriate and ensure transfer of technology.

(Note): In order to implement clause 11.3.7and11.3.8 many high level personnel are required. It is to make clear the source of personnel.

In Japan only qualified workers did important works in coal mine. In Bangladesh also this system will be required.

9) Research and Development

All different universities in Bangladesh will be encouraged to conduct mining research programs under grants of Energy & Mineral Resource Division to start coal mine development. The centre is to work in close collaboration with the mining industry, public organizations and provide technical advice to industry in matters relating to improvements in safety and health measures and prevention of occupational diseases.

The centre is to conduct researches on beneficiation, carbonization, briquetting and gasification of coal, and utilization of its bye-products. The centre is to take initiative to attract private investment in liquefaction process to convert coal into liquid fuel.

(12) Compensation, 1nsurance and settlement of disputes

(a) Compensation & insurance

The lessee will be bound to pay compensation as per Rule-18 of Mines and Mineral Resources Regulation 1968 (Amended recently) for any damages including roads, physical infrastructure, rivers, khal-beels, underground cables, telephone line, gas pipeline, drinking water sewage pipeline etc. due to insincerity or non-precautions or mechanical faults or electrical faults. The lessee will have to bear all assets & liabilities for insurance as per Rule-27M of the above Regulation if any person injured or died or any loss of properties occurred due to accident.

(b) Settlement of disputes

Any disputes found in future after signing of the contract between the Lessee and the Bureau will be settled in this country under the existing law in Bangladesh. Bangladesh Arbitration Act 2001 (Amended) will be applicable for arbitration.

Bangladesh Coal Policy Draft (1)

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Bangladesh Coal Policy Draft (2)

4.2 APPENDIX – 2 Potential coal export countries

(a) Indonesia

Oil, natural gas, and coal consumption in Indonesia for 2007 respectively accounted for 47.5%, 26.5%, and 24.3% of the country's primary energy consumption. The Government of Indonesia has retained the policy of boosting coal consumption to 33% by 2025 for alternative domestic fuel. Coal is also regarded as a resource to earn foreign currencies and production has been increasing rapidly. Indonesia is the largest steam coal exporter in the world.

Although the nation's energy policy (2004) pointed out the significance of the transportation infrastructure, it is an inadequate transportation infrastructure, including river transportation and shipping facilities that have led to supply constraints.

The nation's coal reserve is 4.33 billion tons (anthracite and bituminous coal: 1.72 billion tons; sub bituminous coal and lignite: 2.61 billion tons), which is small in terms of production volumes. According to the energy statistics (2009) and the Geological Bureau of the Indonesian government, the nation's coal reserve is 5.3 billion tons, and the probable reserve is 18.7 billion tons. Among the different coals, lignite accounts for 58.7% of the nation's coal reserves; this is the largest ratio. Hence, technology for utilizing low-grade coal has become increasingly important in terms of a stable supply of energy.

Regarding coal deposits in Indonesia, at present the Indonesian government is setting up a database of coal resources and reserves in conjunction with NEDO (Japanese organization).
APTable 4-1 has been created from Indonesia Coal Book 2008/2009, but Hypotheses have been excluded.

APTable 4-1 Coal resources and reserves in Indonesia

Quality	kcal/kg	Resources (Million tons)			%
		Indicated	Measured	Total	
Low	＜5,100	3,652	5,750	9,402	27.20
Medium	5,100 6,100	9,041	10,867	19,908	57.58
High	6,100 7,100	963	3,870	4,833	13.98
Very High	＞7,100	6	423	429	1.24
Total		13,662	20,910	34,572	100.00
Quality	kcal/kg	Reserves (Million tons)			%
		Probable	Proven	Total	
Low	＜5,100	4,292	1,105	5,397	28.84
Medium	5,100 6,100	8,214	2,971	11,185	59.78
High	6,100 7,100	671	1,276	1,947	10.41
Very High	＞7,100	73	109	182	0.97
Total		13,250	5,461	18,711	100.00

Source: IEA Coal Information 2008

The above Table shows that Total Resources are 34.5 billion tons and the Total Reserves are 18.7 billion tons. Each number shows 85% and 89% which of coal is less than 6,100kcal/kg and occupies a large proportion of coal deposits. At many remote inland areas in coal producing provinces there are many unexplored areas. When exploration works progress, these numbers will increase.

Although exploration works are at remote inland areas in Central Kalimantan and East Kalimantan, Projects for high calorie and high priced coal for steel mills are in progress. Many coal deposit areas are known in remote inland areas, but exploration works for around 5,000kcak/kg of coal are not conducted due to low prices. This area will be one of the candidates to acquire a stable coal supply for Bangladesh. APTable 4-2 shows production, consumption and trade of Indonesian coal.

APTable 4-2 Changes in coal production, consumption, and trade (unit: million tons)

Year	2003	2004	2005	2006	2007
Production	119.7	142.1	171.1	221.2	259.2
Coking coal	15.1	9.2	10.7	24.5	31.5
Steam coal	81.6	109.9	134.7	168.9	199.7
Lignite	23.0	22.9	25.7	27.8	28.0
Consumption	29.6	36.2	41.1	49.0	57.0
Export	90.1	105.5	129.2	171.6	202.2
Coking coal	15.1	9.3	10.8	24.6	31.5
Steam coal	75.0	96.2	118.4	147.0	170.7

Source: IEA Coal Information 2008

The table lists 259 million tons of coal production and 202 million tons of export for 2007. Statistics of the Ministry of Energy and Mineral Resources (MEMR) describe 193 million tons of coal production for 2006, 217 million tons for 2007, 229 million tons for 2008, and 230 million tons of production forecast for 2009.

Domestic coal consumption stood at 54 million tons for 2007, including 32.40 million tons for power generation and 6.50 million tons for cement production. In coming years, consumption of coal of low calorific value (5,100kcal/kg or below) is going to increase rapidly when the operation of the 10,000MW Coal-Fired Thermal Power Project ("Crash Program") is commenced commercial operation in 2010.

(b) Australia

Coal has accounted for 43.6% of the primary energy consumption in Australia. Domestic coal consumption for 2007 stood at 78.41 million tons, 84% of which was used for power generation. Coal production for 2008 reached a record-setting 402 million tons (fourth largest in the world) despite the abnormal climate at the beginning of the year.

The nation's coal reserve stands at 76.2 billion tons, or a decrease of 400 million tons since the end of 2005. However, Australia's exploration investment for FY 2007/2008 increased to AUD235 million from AUD 193 million for FY 2006/2007. According to some Australian statistics, the measured minable reserves are reported as 71.8 billion tons in total, including 35.5 billion tons by underground mining and 36.3 billion tons by open-cast mining.

Australia is the largest coal exporter in the world. The country exported 138.2 million tons of coking coal and 112.2 million tons of steam coal for 2007. The trade accounted for some 30% of the coal trades in the world. Japan imported 113 million tons of Australian coal (equivalent to approx. 1,087.1 billion yen), and its dependency accounted for 60.8%. The nation's coal export to

Japan has accounted for 45%, and Japan has been the largest coal importer for Australia. APTable 4-3 lists changes in coal production, consumption, and trade.

APTable 4-3 Coal production, consumption, and trade (unit: million tons)

Year	2003	2004	2005	2006	2007
Production	341.7	352.2	367.3	367.5	395.6
Coking coal	113.0	117.8	129.3	125.2	141.9
Steam coal	161.8	168.0	170.9	174.6	181.1
Lignite	66.8	66.3	67.2	67.7	72.3
Consumption	129.2	131.3	140.1	141.4	147.9
Coking coal	4.7	5.1	5.4	4.7	6.0
Export	208.7	218.4	231.3	231.3	243.6
Coking coal	107.8	111.7	124.9	120.5	132.0
Steam coal	101.0	106.7	106.4	110.8	111.6

Source: IEA Coal Information 2008)

(c) China

Coal has accounted for 70% of the primary energy consumption in China. Coal-fired power generation accounts for 80% of the power generation in the country. Coal production stood at 2.5 billion tons in 2007. In other words, China has been and is the largest coal producer and consumer in the world. According to the National Bureau of Statistics of China, the nation's coal production for 2008 was 2.62 billion tons. Although, the national development 11-5 Plan sets a production goal for 2010 as 2.6 billion tons, the production volume was achieved two years ahead of the scheduled target year.

Domestic coal prices are more expensive than those in the international market. For example, the trading prices of Shanxi steam coal and Datong coal at Qinhuangdao were respectively at 560RMB/t and 600RMB/t in March. Since the domestic demand for coal turned tight in 2004, the Government of China has implemented export constraint measures. As a result, exports peaked in 2003, reaching 93.02 million tons. Since then, exports continued to decrease to 45.43 million tons in 2008. Meanwhile, coal imports increased, especially from Vietnam, reaching 40.40 million tons. Since coal imports exceeded coal exports in the first quarter of 2009, China is expected to become a net importer of coal.

The coal reserve in China stands at 114.5 billion tons. The reserve ranks third place in the world, following the United States and Russia. In general, geological conditions in China are complicated. Besides, coal seams occur in deep underground. Hence, underground mining has accounted for 96% of the coal mines. APTable 4-4 lists changes in coal supply and demand as well as export and import.

APTable 4-4 Changes in coal supply and demand and import and export in China (unit: million tons)

	2003	2004	2005	2006	2007
Production	1,670	1,956	2,159	2,320	2,549
Consumption	1,582	1,886	2,099	2,305	2,543
Export	94.0	86.6	71.7	63.2	53.7
Import	11.1	18.6	26.2	38.1	47.6

Source: IEA Coal Information 2008

Although demand has grown, inland production areas are far distant from coastal consumption areas, bringing about many constraints in domestic distribution. Domestic transportation cost is comparatively expensive. Railway transportation is also facing some constraints. There is concern that as domestic demand for coal increases, volumes of coal import are also likely to increase in China in the future.

(d) India

Coal has accounted for 51.4% of the primary energy consumption in India. The nation's coal production for 2008 stood at 512 million tons and ranked third place in the world and the nation's coal reserve is 58.6 billion tons, also ranking third place in the world. According to a revision made by the Ministry of Coal (MOC) of India, the coal reserve includes 54.0 billion tons of bituminous coal and anthracite (92.2%) and 4.6 billion tons of lignite (7.8%). Although it is said that India can be self-sufficient in terms of coal supply, the nation has already become a coal importer. The coal industry in India has failed to catch up with rapid increases in domestic demand for coal.

Coal-fired power generation has accounted for 69.8% of the power generation in India. Although the Government of India has set up a large-scale coal-fired power station construction project ("Ultra Mega Power Project" (UMPP): 4GW x 9=36GW), the government decided on only three sites. APTable 4-5 lists changes in coal production, consumption and trade. APTable 4-6 lists the demand and supply plan announced by the Government of India. According to the plan, coking coal accounts for a major portion of the coal to be imported to India, and the nation intends to be self-sufficient in thermal coal. In reality, however, India imported 28 million tons of coal for 2007, resulting in a pessimistic view in terms of achieving self-sufficiency in meeting domestic demand with domestic resources. Although the nation exported 1.6 million tons of coal for 2007, India is unlikely to increase future exports.

APTable 4-5 Changes in coal production, consumption, and trade in India (unit: million tons)

	2003	2004	2005	2006	2007
Production	386.4	410.5	434.7	459.5	484.4
Consumption	400.1	441.3	460.9	490.6	537.3
Export	1.6	1.3	2.0	1.6	1.2
Import	21.7	28.5	38.6	43.1	54.1

Source: IEA Coal Information 2008

APTable 4-6 Demand and supply plan in India

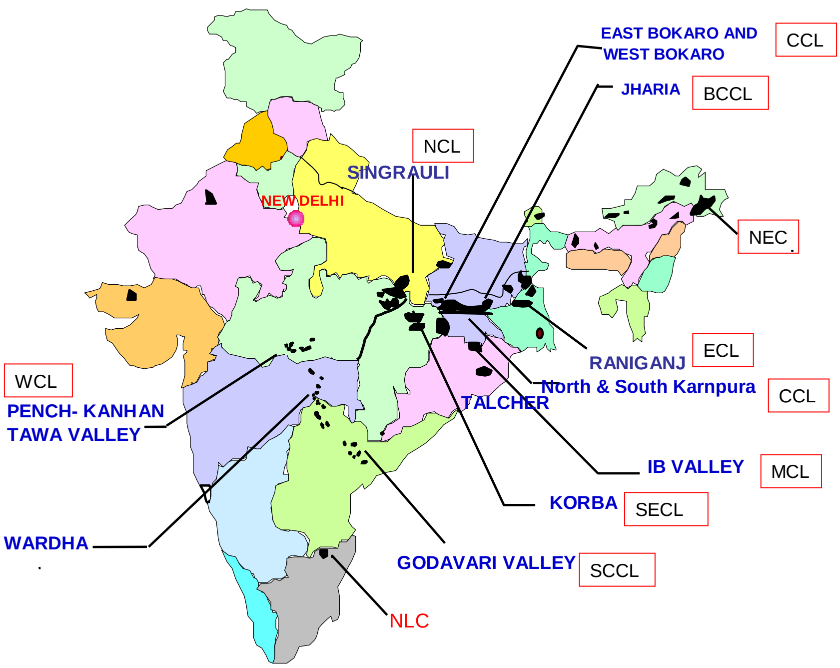
		XI Plan (2011-12)	XII Plan (2016-17)	XIII Plan (2021-22)	XIV Plan (2026-27)
Demand	Coking	69	104	125	150
	Non-Coking	662	1021	1267	1573
	Total	731	1125	1392	1723
Production		680	1060	1282	1538
Gap (Import)	Coking	41	70	85	105
	Non-Coking	10		25	80
	Total	51	70	110	185

Source: By Shri S. Chaudhuri & A. K. Wahi of CMPDIL, the 2nd Coal summit, 2007 & Coal Directory of India 2007-2008 by MOC of GOI)

Coal India Limited (CIL) has accounted for an oligopolistic 80% of the domestic coal production. CIL owns seven coal-producing companies and a design company. In addition, other companies are also being operated, including NLC, which produces lignite under the umbrella of the Ministry of Power, and SCCL, a public coal-mining corporation. India has 549 coal mines where 600,000 workers engage in mining. Annual sufferers in mine accidents are 85 on average. The number of deaths per million tons is 0.21, which is 1/6 of that of China.

Gondwana coal in the Indian Continent contains low sulfur and phosphor content but high ash content including silicic anhydride. Gondwana coal is characterized as being abrasive. Removing ash content from Gondwana coal is relatively difficult because mineral matters are closely distributed in coal composition. Coal for power generation in use has CV 3,500 kcal/kg or so, containing 38 to 40% ash content. As demand for coal increases in the future, grade of coal to be used is likely to be lowered. Moreover, thermal power stations that receive domestic coals of different calorific values, ash contents, and grain sizes are facing a low performance and working rate because such coals are different from the coals in the designed specifications. Furthermore, coal utilization has posed diverse environmental problems, including handling during transportation, low combustion efficiency, soot and dust, ash treatment, and so on.

APFig. 4-1illustrates a map of the coal fields in India. According to the map, the coal fields in Bangladesh are on the borderline extending to the Raniganji Coal field in India. Hence, it is very apparent how Bangladesh can easily import coal from the Indian coal mines surrounding Bangladesh. The NEC coal fields of the Tertiary Era in the eastern area of the country contain high sulfur content.



Source: CIL document modified by PSMP Study Team

APFig. 4-1 Map of coal fields in India

(e) South East Africa Region

1) Summary

In South East African Countries, at present The Republic of South Africa exports coal and it is also probable that, the People's Republic of Mozambique and the Republic of Botswana may also export coal in the future. A brief summary of every country has been provided below along with the detailed conditions of South Africa.

2) The Republic of South Africa (South Africa)

Recoverable coal reserves is about 31 billion tons and is the 6th largest South Africa produced 245 million tons of salable coal, marking it as the 5th largest country in the world to do so. Coal export was 73 million tons and this is 5th large country next to Australia and Indonesia, this number is close to China and Russia. Domestic coal consumption was 173 million tons, a number close to representing the amount of Japanese consumption.

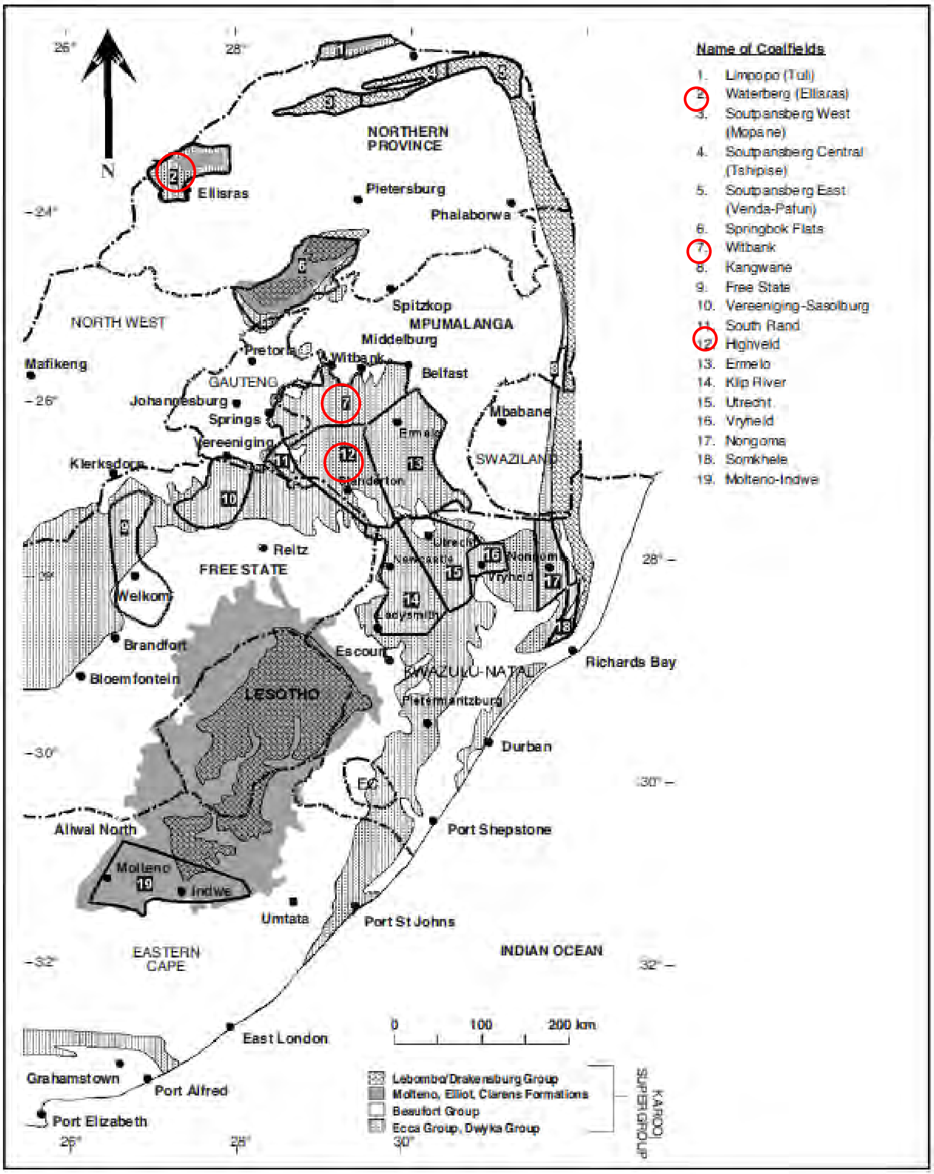
Most of the exported coal is shipped through Richards Bay Coal Terminal (RBCT). In 2006, the 5th construction work was started to increase its export capacity to up to 91 million tons per year. In the future, exported coals were mainly for Europe and are expected to increase.

3) The People's Republic of Mozambique (Mozambique)

Coal production in 2006 was about 100,000 tons and the recoverable coal reserves are estimated to be around 3 billion tons. In 2004 the government started the Moatize coal project which is expected to produce more than 9 million tons of coking coal per year and around 2 million tons of steaming coal per year. And rail roads to Beira port and the repair and expansion of port facilities would be completed by 2009.

4) The Republic of Botswana (Botswana)

The oil resources institute is an estimated 20 billion tons. Only the Morupule coal mine at the east part of the country is operated and produced 1 million tons in 2005. Most of coal was consumed for domestic purposes and a part of the coal was exported. Exploration work and development to investigate the region’s export capability are underway due to the recent high price of coal. This region has a high potential to become a coal export country/



Source： Characterization of the coal resources of South Africa by Layer

APFig. 4-2　Coal fields in South Africa

South Africa mainly produces bituminous and anthracite coal and these coals are in the Ecca Series of the Karroo System. There are some Cenozoic lignite and peat in various areas, but these coals are not counted as resources. All high quality bituminous coal in Africa is in the Ecca Series of the Karroo System. The Karroo System is a formation corresponding to the Gondowana System in India. This formation is terrestrial sediment and had been formed in the Gondowana Continent and consists of thick sediment from the Upper Carboniferous to Permian. The Karroo System is distributed throughout South Africa. Except the Southern part, this System horizontally lies over the Pre-Cambrian basement without folding movement. This System is classified as follows.

Karroo System	Stormberg Series	7,000 ft		Drakensberg Volcanic Rocks Moletono formation (Alternation of sandstone and shale, some coal seams)
	Beaufort Series	≧10,000 ft		Alternation of sandstone and shale
	Ecca Series	≦6,000 ft		Main coal seams, Alternation of sandstone and shale
	Dwyka Series	3,000 ft		Permian conglomerate, Shale

Coal Quality : Coal is classified to 4 kinds as followings in South Africa.

Ⅰ). High class coal ≧about 7,000 kca1/kg : Coals fields in KuaZulu-Natal

Ⅱ). Middle class coal 7,000～6,470kcal/kg : Witbank -Middleburg coal field

Ⅲ). Low class coal ≦4,850kcalkcal/kg : Coal fields in Mpumalanga, Free State

Ⅳ) Anthracite ≧ 7,000 kca1/kg : Coals fields in KuaZulu-Natal

There are coking coals at Waterberg coal field and others in Mpumalanga and the coal fields in KuaZulu-Natal. There are anthracite at Vryheid and other coal fields.

Coal in South Africa has more ash content and a lower heating value compared to Paleozoic coal in Europe.

APTable 4-7 Coal quality of main coal fields in South Africa

Coal Field	Moisture %	Ash %	Volatile %	Fixed C %	Sulfur %	Kcal/kg	Ash F/T ℃	Note
Witbank -Middleburg	2.5	13.2	27.4	56.9	1.0	6,790	1,390	—
Witbank –Middleburg (south)	3.5	19.7	26.2	50.6	1.2	5,980	1,350	—
Witbank -Middleburg	2.5	11.0	32.0	54.5	0.6	—	—	Caking
Ermelo - Breyton	3.2	15.4	31.3	50.1	1.4	6,414	1,330	Non caking
Heiderberg	7.2	20.9	25.1	46.8	1.0	5,282	+1,400	Non caking
Veyheid (Natal)	1.6	9.5	9.3	79.7	0.9	7,546	+1,400	Anthra cite
Veyheid (Natal)	1.5	16.7	19.0	62.8	0.8	6,953	+1,400	Caking
Klip River (Natal)	1.5	17.4	22.9	58.2	1.9	6,790	1,400	Caking

Source : Coal resources in Africa (volume-1) by INOUE and SOGA)

There are three famous main coal fields in South Africa, Waterberg (Limpopo Province), Witbank (Mpumalanga Province), Highveld (Mpumalanga Province)

Regarding the coal reserves there are various views, 30 – 90 billion tons.
The next table is one of them.

APTable 4-8 Estimated recoverable remaining coal reserves at the end of 2000 in South Africa

Coalfield	Reserves (million tons)		
	Recoverable (Bredell[16])	ROM production (1982-2000)	Remaining (2000)
Witbank	12460	2320.23	10139.77
Highveld	10979	972.49	10006.51
Waterberg (Elistras)	15487	384.00	15103.00
Vereeniging-Sasolburg	2233	334.91	1898.09
Ermelo	4698	101.11	4596.89
Klip River	655	85.26	569.74
Vryheid	204	81.80	122.20
Utrecht	649	64.47	584.53
South Rand	730	22.03	707.97
Somkhele & Nongoma	98	15.18	82.82
Soutpansbefg	267	6.11	260.89
Kangwane	147	0.96	146.04
Free State	4919	0.22	4918.78
Springbok Flats	1700	0.00	1700.00
Limpopo (Tuli)	107	0.00	107.00
Total	55333	4388.77	50944.23

Source： Characterization of the coal resources of South Africa by L.S. Jeffrey）

Coal production is concentrated mainly at the Witbank coal field and its surroundings. These mines are near consumer areas. Most of the coal seams are of a depth of less than 200 m from the surface, have a mild inclination and few faults. Hence, they are prime geological conditions for mining. Both O/C and U/G have been operated on. The Room & Pillar is the main method in U/G.

Two ports, Richards Bay and Durban are famous in South Africa. Most of the export coal which was mainly produced at the three coal fields as mentioned above are transported to Richards Bay Coal Terminal by trains exclusively utilized to deliver coal (1 train＝200 wagons, 16,800 tons, rail gage : 1,025 mm) and then are shipped.
In 2008, the port handled 82.7 million tons of cargo, of which 62 million tons was exported coal.
At present, ships are handled at five berths each 350m in length with a 19m water depth alongside and a permissible drought of 17.5 m.
The majority of South African coal is steaming coal for Europe. Recently, the press has reported that the coal for China and India has increased. Export coal was 67 million tons in 2004, 73 million tons in 2005, 69 million tons in 2006, 67 million tons in 2007 and 62 million tons in 2008 respectively. After the peak in 2005, export coal did not increase.
Now the coal terminal is undergoing refurbishments to increase its capacity to 92 million tons per year. After this is completed, coal exports are expected to increase.

(f) United States of America

Coal has accounted for 24.3% of the primary energy consumption in the USA and is a major source of energy, following oil and natural gas. Coal production stood at 1,052 million tons for 2007, whereas coal consumption stood at 1,029 million tons (both ranked second place in the world). Coal production for 2008 was a record-setting 1,063 million tons. Coal for power generation has accounted for 93% of the domestic consumption, and 49.8% of the power sources in the United States.

Coal exports stand at 83 million tons, while imports stand at 31 million tons. Hence, the United States is a coal exporter. The EIA (Energy Information Administration) forecasts that the nation is likely to become a coal importer in the latter half of the 2010s. APTable 4-9 lists changes in coal production and consumption of the United Sates.

APTable 4-9 Changes in Coal Production and Consumption in USA (unit: 100 million tons)

Year	2000	2004	2005	2006	2007
Production	9.72	10.19	10.39	10.68	10.52
Consumption	9.66	10.11	10.30	10.17	10.29
Thermal coal	7.796	9.219	9.412	9.313	9.493
Coking coal	0.263	0.215	0.214	0.208	0.206

Source: IEA Coal Information 2008

The nation possesses a coal reserve of 238.3 billion tons, which is the largest in the world. The minable reserve in the existing coal mines stands at 16.86 billion tons. There are 1,374 coal mines where 81,000 workers engage in mining. The number of employees including subcontractors stands at 122,900. The underground coal recovery rate is 31.0%, while the production stands at 319 million tons. For underground mining, longwall mining produces 160 million tons and chamber and pillar mining produces 1.57 million tons of coal.

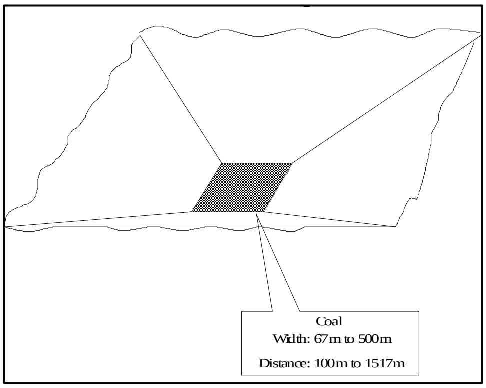
4.3 APPENDIX-3 Pilot O/C coal mine

4.3.1 Proposing site and connectional layout

As a plan, Barapukuria area is taken as an example, before mining works, the slope stability of the Upper Dupi Tila and the water table around the mining area needs to be confirmed These are very important items for technical matters,
For example, a Box-Cut is made near point and the surroundings which are closest to the top of the coal seam. Then the Lower Dupi Tila is exposed to a plane of 100m×100m squares in order to observe and measure multiple phenomenon. Further, safety measures will be made to prevent slope land slides while the technology for water table stability will be confirmed.

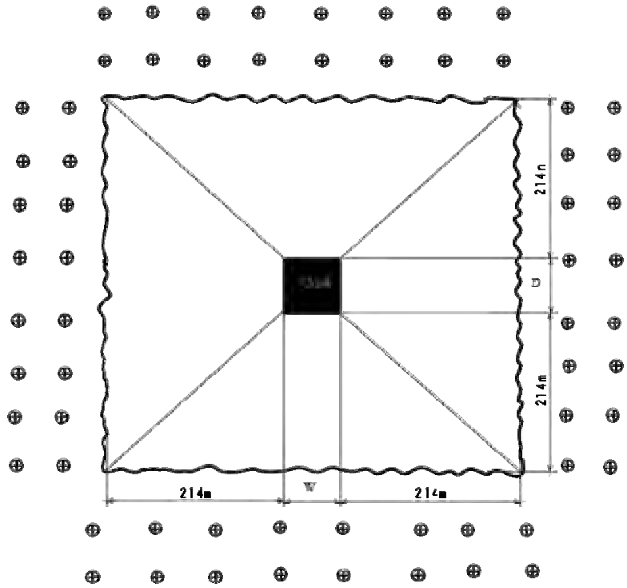
At a bird's-eye view in APFig. 4-3, the coal seam is shown in black color at the bottom.
APFig. 4-4 shows a top plan view, width and length of the coal seam is shown W& D respectively. Boring holes for dewatering and water-reinjection are arranged at the area around O/C. Each position of the hole is determined after the Hydro-Geological Study, but the two boring holes each 200m deep with a 50m span are supposed to be a cost estimation. APFig. 4-5 shows the cross-section view and here the average slope inclination is temporally 35 degrees. The normal O/C slope inclination is about 45 degrees; here the slope inclination is 35 degrees due to the weakness of the highwall. Determining the slope inclination has a big influence on the mining cost.

APFig. 4-6 shows the pilot plan at the site. This plan is suggested as a connectional one based on the production plan. Practically, a geological survey including the coal seam condition, Hydro-Geological Study, Impact area to inhabitants, pre-F/s to minimize impact to existing facilities and F/S to make a detailed plan for construction are required. Here PSMP Study Team offer partial information to assume the practical conception as material that will serve as the basis for judgments for the pilot mine.



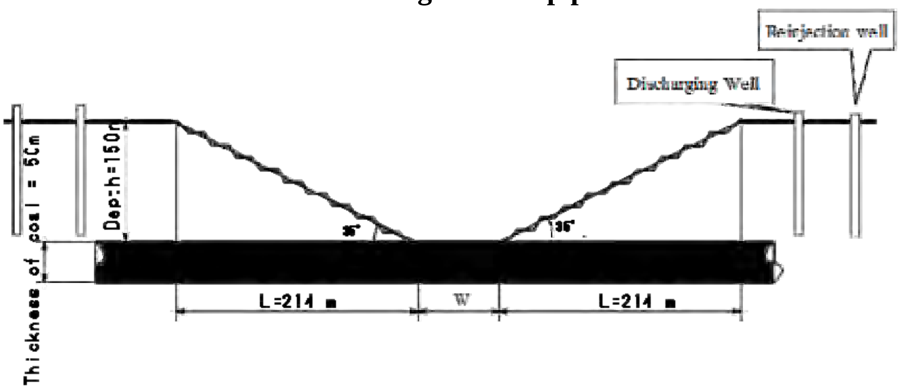
Source: PSMP Study Team

APFig. 4-3 Birds-eye view of pilot O/C coal mine



Source: PSMP Study Team

APFig. 4-4 Top plan view



Source: PSMP Study Team

APFig. 4-5 Cross-section view

4.3.2 Production Plan

(1) The calculated result of over burdens, production, mining costs are shown in APTable 4-10 shows the preliminary calculation result of the observation, production and mining costs every year. The mining cost will be budget figures and does not include the inhabitants' compensation expense or unexpected expenses after implementation of the pilot O/C coal mine.

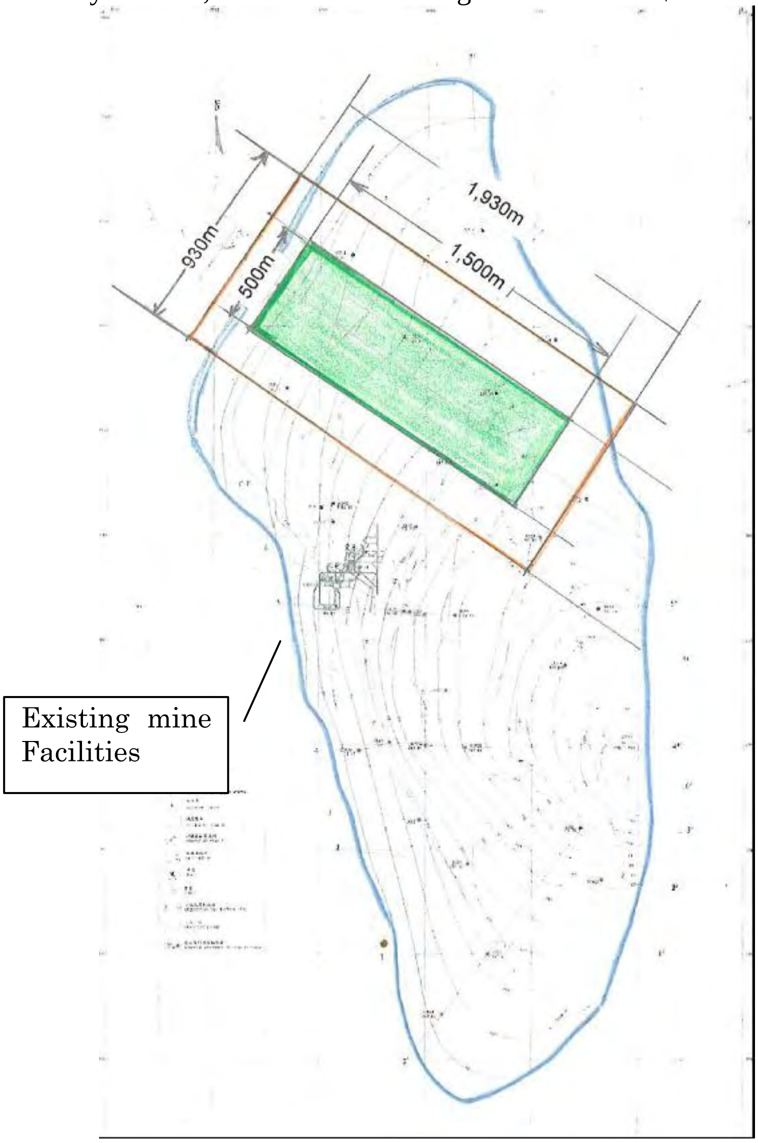
(2) The factors for preliminary calculation are used in the following Indonesian figures.

- Unit cost for stripping 2.3 US$／$m^3$
- Unit cost for coal extract 1.5 US$／t
- Truck cost for coal transport 0.14 US$／t・km

(3) The basic mining plan produces a total of 2million tons of coal for two years after the preparation works and then it will be decided whether the O/C operation continues or not after evaluating the result of the O/C mining method. It will be decided by the Bangladeshi government how much coal should be produced at the pilot O/C coal mining. However, the PSMP Study Team may suggest that the production of 2 million tons will be considered reasonable and proper because the mining cost will be US$ 75 million, a total of US$166 million including a reclamation fee and when produced coal is sold by US$ 85, the

sales income will be US$ 170million. These production figures are included in the Table 4-6.

(4) When the pilot O/C coal mining continues until 2030 and produces 53million tons, it will be economically feasible, since the total mining cost will be US$ 25.9 including reclamation.



Source: Barapukuria Coal Mine

APFig. 4-6 Working plan at the Barapukuria license area

APTable 4-10 Production plan and mining cost

Item	Unit	Formula	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Av. angle (degree)			35	35	35	Evaluation of Trial O/C and preparation period of expansion of O/C area.		35	35	35	35	35	35	35	35	35	35	35	35	35
Coal seam thickness	(m)		50	50	50			50	50	50	50	50	50	50	50	50	50	50	50	50
Depth	(m)		150	150	150			150	150	150	150	150	150	150	150	150	150	150	150	150
Distance	(m)		1	100	100			100	124	154	247	400	554	708	862	1,016	1,170	1,324	1,478	1,632
Width	(m)		1	154	308			462	500	500	500	500	500	500	500	500	500	500	500	500
Length	(m)		214	214	214			214	214	214	214	214	214	214	214	214	214	214	214	214
S1	(m2)		1	15,400	30,800			46,200	62,000	77,000	123,500	200,000	277,000	354,000	431,000	508,000	585,000	662,000	739,000	816,000
S2	(m2)		184,041	307,296	388,608			469,920	512,256	540,096	626,400	768,384	911,296	1,054,208	1,197,120	1,340,032	1,482,944	1,625,856	1,768,768	1,911,680
① Total Over Barden	(1,000 m3)		9,224	19,574	26,441			33,173	37,623	41,051	51,402	68,020	84,536	100,955	117,321	133,655	149,968	166,266	182,553	198,833
② Total Coal	(1,000 m3)		0	770	1,540			2,310	3,100	3,850	6,175	10,000	13,850	17,700	21,550	25,400	29,250	33,100	36,950	40,800
③ Total Coal*1	(1,000 t)		0	1,001	2,002			3,003	4,030	5,005	8,028	13,000	18,005	23,010	28,015	33,020	38,025	43,030	48,035	53,040
④ Total Stripping Ratio		①/③		19.6	13.2			11.0	9.3	8.2	6.4	5.2	4.7	4.4	4.2	4.0	3.9	3.9	3.8	3.7
Mining Cost																				
⑤ Stripping cost	(1,000US$)	①*2.3 US$/$m^3$	21,214	45,021	60,813			76,298	86,534	94,418	118,224	156,446	194,433	232,197	269,839	307,406	344,926	382,411	419,872	457,315
⑥ Coal mining cost	(1,000US$)	③*1.5 US$/t		1,502	3,003			4,505	6,045	7,508	12,041	19,500	27,008	34,515	42,023	49,530	57,038	64,545	72,053	79,560
⑦ Coal transportation fee	(1,000US$)	③*0.14US$/t*10km		1,401	2,803			4,204	5,642	7,007	11,239	18,200	25,207	32,214	39,221	46,228	53,235	60,242	67,249	74,256
⑨ Total mining cost	(1,000US$)	⑤+⑥+⑦	21,214	47,924	66,619			85,007	98,221	108,932	141,504	194,146	246,647	298,926	351,082	403,164	455,198	507,198	559,174	611,131
⑩ Unit mining cost (a)	(US$/t)	(⑤+⑥+⑦)/③*2		47.9	33.3			28.3	24.4	21.8	17.6	14.9	13.7	13.0	12.5	12.2	12.0	11.8	11.6	11.5
Water Drainage Cost																				
⑪ No. of drilling hole	Number	Span is av.50mx2holes	69	89	102			114	119	121	129	141	153	166	178	190	203	215	227	240
⑫ Drilling cost	(1,000 US$)	150US$/m x 200m	2,070	2,670	3,060			3,420	3,570	3,630	3,870	4,230	4,590	4,980	5,340	5,700	6,090	6,450	6,810	7,200
⑬ Piping & other cost	(1,000 US$)	⑫*0.2	414	534	612			684	714	726	774	846	918	996	1,068	1,140	1,218	1,290	1,362	1,440
⑭ Electricity cost	(1,000 US$)	100kw x 0.05US$/kwh	3,022	3,898	4,468			4,993	5,212	5,300	5,650	6,176	6,701	7,271	7,796	8,322	8,891	9,417	9,943	10,512
⑮ Total drilling & others cost	(1,000 US$)	⑫+⑬+⑭	5,506	7,102	8,140			9,097	9,496	9,656	10,294	11,252	12,209	13,247	14,204	15,162	16,199	17,157	18,115	19,152
⑯ Ratio of drilling cost		⑮/(⑨+⑮)	0.21	0.13	0.11			0.10	0.09	0.08	0.07	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03
Total Mining Cost A (US$/t)		(⑨+⑮)/③		55.0	37.3			31.3	26.7	23.7	18.9	15.8	14.4	13.6	13.0	12.7	12.4	12.2	12.0	11.9
Reclamation Cost																				

Item	Unit	Formula	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
⑰ Transporting fee	(1,000 US$)	(①+②)x1.3t/m3x0.14US$ /tx10km		27,404	37,017			46,442	52,673	57,472	71,963	95,228	118,350	141,337	164,250	187,117	209,955	232,772	255,574	278,366
⑱ Reclamation cost	(1,000 US$)	(①+②)x1.3t/m^3x1.5US$/t		39,672	54,562			69,192	79,411	87,558	112,275	152,139	191,853	231,377	270,799	310,157	349,474	388,763	428,031	467,284
⑲ Total Reclamation Cost	(1,000 US$)	⑰+⑱		67,076	91,579			115,635	132,084	145,029	184,238	247,367	310,203	372,714	435,048	497,274	559,429	621,535	683,605	745,649
⑳ Total Mining Cost B (US$/t)		(⑨+⑮+⑲)/③		122.0	83.1			69.8	59.5	52.7	41.9	34.8	31.6	29.8	28.6	27.7	27.1	26.6	26.2	25.9
Balance of each year																				
Over Barden of each year	(1,000m3)		184,041	10,351	6,866			6,733	4,450	3,428	10,351	16,618	16,516	16,419	16,366	16,334	16,313	16,298	16,287	16,280
Coal production of each year	(1,000 m3)			770	770			770	790	750	2,325	3,825	3,850	3,850	3,850	3,850	3,850	3,850	3,850	3,850
Coal production of each year	(1,000 t)			1,001	1,001			1,001	1,027	975	3,023	4,973	5,005	5,005	5,005	5,005	5,005	5,005	5,005	5,005
Ratio of Volume (OB:Coal)				10.3	6.9			6.7	4.3	3.5	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3

calculated value

Volume of frustum of pyramid (m3)= $\frac{3}{d}\left(S1+S2+\sqrt{(S1\times Sw)}\right)$

S1: Bottom area (m3) =D x W

S2: Top area (m3) =(214 + W + 214) x (214 + D +214)

d: depth

Example of Y 2014

D=100m S1= 100*154

W=154m = 15,400 m3

d=150m S2= (214+154+214)*(214+100+214)

= 307,296 m3

$$V=\frac{150}{3}\left(15.400+307.296+\sqrt{(15.400\times 307.296)}\right)$$

= 19,574,407 m3

Source: PSMP Study Team

4.4 APPENDIX-4 Import coal price scenario

4.4.1 FOB price of import coal

(1) Pricing structure of FOB

Coal prices differ depending on where the coal was produced and other specifications. However, in general, the trend towards Indonesian Coal is cheaper than for Australian Coal when the coal specifications are the same. During price negotiations, the direct cost for coal production of each mine must be taken into consideration. For example, the direct cost of a mining contractor for the O/C coal mine in East Kalimantan Indonesia in 2008 was as follows. This cost escalated to about 2 times the cost in 2007 because of the steep rise in fort fuel and other prices.

- Stripping Cost : 2.3 US$／$m^3$
- Coal Extraction Cost : 1.5 US$／ton
- Coal Truck Costs：0.14 US$／ton・km
- Crushing and Loading to Barge：3.5 US$／ton
- Barge Transport to a Big Ship about 150km and loading to it：8 US$／ton

For example, when the stripping ratio is 8 and the road distance between the pit and loading point is 50 km、the direct cost of this mine is shown at the next calculation.

Direct cost = Extraction Cost [(2.3×8)＋1.5]＋Truck cost (0.14×50)＋Handling cost 3.5＋Barg cost 8 = (18.4+ 1.5) + ＋7＋3.5＋8＝34.9 US$/ton

The FOB is the above figure plus Management cost and profit. This price is the minimum index for FOB. But the exporter‘s desire is influenced by the international market.

The direct cost has no relation with coal specifications. From this point of view, high price mine development and high quality coal are possible in remote areas. However, in the event of low prices and low quality coal, it is desirable for mine development that the coal seam is thick, the stripping ratio is low and the pit location is nearby the river or sea port because of low transport costs.

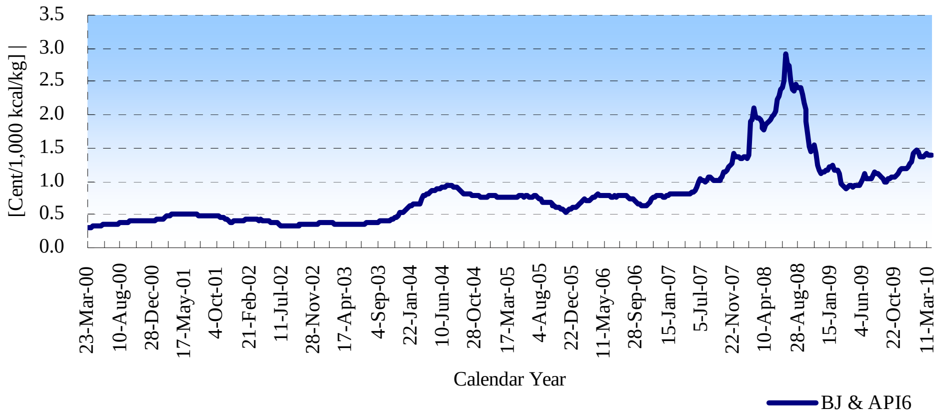
Regarding land transportation, FOB is the same structure of sea transportation. Land transport will be utilized for Indian coal. At present coals are imported from the neighboring Megalaya in India for brick factories and most of the coals are transported by truck.

For power plant handling, the volume of coal is large. It is practical to have the coal directly transported to the power plant by rail because the rail is appropriate for mass transport. Its cost is cheaper than trucks but higher than barges.

(2) Varying prices of FOB

APFig. 4-7 depicts the EIA world coal consumption trend. Based on this, coal consumption has been escalating since 2002. When coal consumption was stable, coal prices were also stable. Recently, coal prices rose because of a supply shortage due to a rapid increase of coal consumption in NON OECD countries. On the other hand, coal resources which were in the past falsely assumed to be un-minable are now being mined resulting in a coal supply increase. Therefore, the coal price will increase until the balance of supply and demand becomes stable.

As a reference, APFig. 4-7 shows a spot price fluctuation of USA Cent/1,000 Kcal/kg for FOB price of 6,700Kcal/kg steaming coal at New Castle for the 10 year period between March 2000 and March 2010. From this graph, it reveals that before September 2003, the coal price was about 0.5 cents, after that the price rapidly rose and peaked in July 2008. There is no graph in this figure, the price also stabilized at about 0.5 cents for the period between 1995 and March 2003. Though understandable, it becomes difficult to estimate future coal prices given recent price fluctuation.



Source： BJ spot price (up to 15th November 2002), Data from A/M API6 (After 15th November 2002)

APFig. 4-7 FOB fluctuation at New Castle Port

(3) Forecast of the FOB price

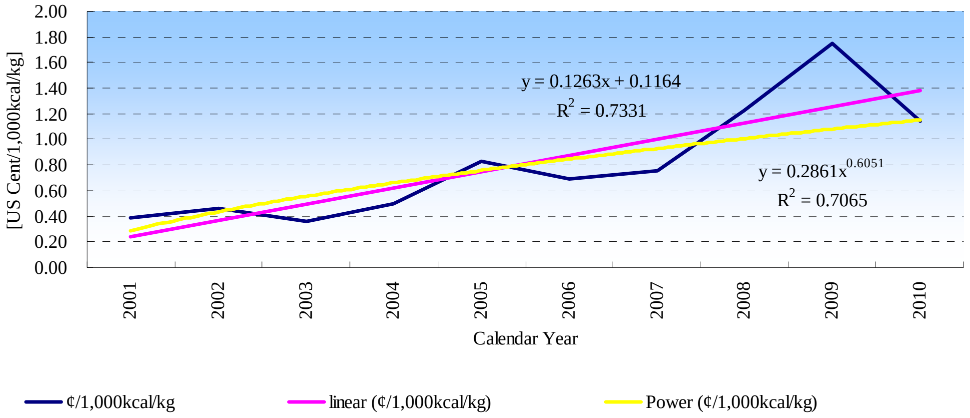
Using data from APFig. 4-7, the FOB spot price to 2030 is an estimate. Regarding the method, every year's average is shown on APTable 4-11 and the graphs are shown at APFig. 4-8. Approximations are calculated using a linear formula and a power approximation formula and the results are shown at APTable 4-12. On this Table, every average reveals a simple average calculated by a linear formula and a power approximation formula. For reference, coal prices were calculated at the case of HVV (High Heating Value) = 6,100kcal/kg.

In addition, the spot price per this 1,000kcal/kg is handled for uniformity regardless of coal quality. Generally when coal quality falls, spot price per 1,000kcal/kg and the long-term contract price tend to fall down, but treat it for uniformity to treat it to take the price risk be a safe side.

APTable 4-11 Average unit price of FOB at New Castle Port 2000－2010

Year	¢/1,000kcal/kg
2001	0.39
2002	0.462
2003	0.361
2004	0.493
2005	0.825
2006	0.694
2007	0.756
2008	1.227
2009	1.754
2010	1.146

Source： BJ spot price (up to 15th November 2002), Data from A/M API6 (After 15th November 2001)



Source: PSMP Study Team based on APTable 4-11

APFig. 4-8 Year's average FOB and approximate functions

APTable 4-12 Estimated unit price of FOB at New Castle Port by 2030

Year	US ¢ /1,000kcal/kg	US ¢ /1,000kcal/kg			US$/6,100kcal/kg		
		Reference	High	Base	Reference	High	Base
		Linear	Average	Power	Linear	Average	Power
		Y=0.1263 X+0.1164		Y=0.2861 X^0.6051	Y=0.1263 X+0.1164		Y=0.2861 X^0.6051
2001	0.390439	0.24	0.26	0.29	14.8	16.1	17.5
2002	0.461799	0.37	0.40	0.44	22.5	24.5	26.5
2003	0.360992	0.50	0.53	0.56	30.2	32.1	33.9
2004	0.493253	0.62	0.64	0.66	37.9	39.1	40.4
2005	0.824985	0.75	0.75	0.76	45.6	45.9	46.2
2006	0.694432	0.87	0.86	0.85	53.3	52.5	51.6
2007	0.755725	1.00	0.96	0.93	61.0	58.8	56.7
2008	1.226690	1.13	1.07	1.01	68.7	65.1	61.4
2009	1.754448	1.25	1.17	1.08	76.4	71.2	66.0
2010	1.146202	1.38	1.27	1.15	84.1	77.2	70.3
2011		1.51	1.36	1.22	91.8	83.2	74.5
2012		1.63	1.46	1.29	99.6	89.0	78.5
2013		1.76	1.55	1.35	107.3	94.8	82.4
2014		1.88	1.65	1.41	115.0	100.6	86.2
2015		2.01	1.74	1.47	122.7	106.3	89.8
2016		2.14	1.83	1.53	130.4	111.9	93.4
2017		2.26	1.93	1.59	138.1	117.5	96.9
2018		2.39	2.02	1.64	145.8	123.1	100.3
2019		2.52	2.11	1.70	153.5	128.6	103.7
2020		2.64	2.20	1.75	161.2	134.1	106.9
2021		2.77	2.29	1.81	168.9	139.5	110.1
2022		2.90	2.38	1.86	176.6	144.9	113.3
2023		3.02	2.46	1.91	184.3	150.3	116.4
2024		3.15	2.55	1.96	192.0	155.7	119.4
2025		3.27	2.64	2.01	199.7	161.0	122.4
2026		3.40	2.73	2.05	207.4	166.4	125.3
2027		3.53	2.81	2.10	215.1	171.7	128.2

Year	US¢ /1,000kcal/kg	US¢/1,000kcal/kg			US$/6,100kcal/kg		
		Reference	High	Base	Reference	High	Base
		Linear	Average	Power	Linear	Average	Power
		Y=0.1263 X+0.1164		Y=0.2861 X^0.6051	Y=0.1263 X+0.1164		Y=0.2861 X^0.6051
2028		3.65	2.90	2.15	222.8	176.9	131.1
2029		3.78	2.99	2.19	230.5	182.2	133.9
2030		3.91	3.07	2.24	238.2	187.4	136.7

Source： PSMP Study Team

4.4.2 Price of CIF

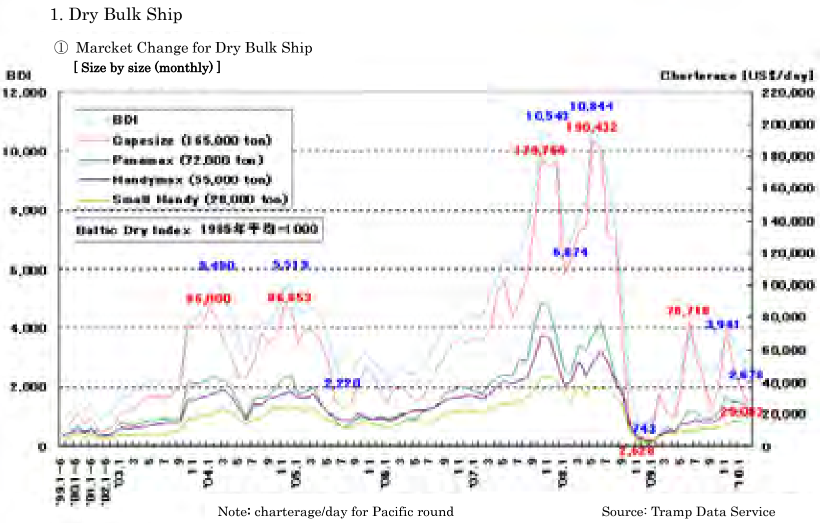
(1) Content and variation of CIF price

In general, the CIF price includes FOB and sea transport costs (freight, insurance and others). The bulk freight market is very volatile, and it fluctuates, along with the type of cargo, the size of the ship and the route traveled all affect the final price.

The cost to move the cape size ship of coal from South America to Europe was around US$15 to US$25 per ton in 2005. According to the Energy White Paper 2008, it has been reported that the Australian steaming coal price for FOB was US$ 55.50 per ton higher than the previous year‘s agreement. On the other hand, according to the Coal Yearbook, the 2009 coal price for CIF was US$70.56 per ton. From these points, the freight between Australia and Japan was estimated at US$15 per ton.
According to CoalinQ.com on April 1st 2010, the steaming coal price for FOB at New Castle was US$ 93.65 /ton and CIF in Japan was US$117.15/ton so that the freight was US$26.5/ton.

Some shippers choose to charter a ship, paying a daily rate instead of a set price per ton. In 2005, the average daily rate for a Handymax ship varied between US$18,000 – US$30,000. A Panamax ship could be chartered for $20,000 – $50,000 per day, and a Cape size for $40,000 – $70,000 per day
There is the Baltic Dry Index (BDI) which shows a bulk carrier price fluctuation. APFig. 4-9 reveals the change of charterage of every size of bulk carrier per day on the web Mitsui O.S.K. Lines, Ltd.

For example, when a Small Handy (28,000 tons) shown at Fig 5-40 is chartered at the charge of US$ 15,000/day, the annual charge is US$5,475,000. If a ship sails from the port of South East Kalimantan (South latitude 4°east longitude 115°) to the port of Bangladesh (North latitude 22°east longitude 92°), the distance is 2,100 sea miles by plane and the sailing distance will be 2,500 sea miles increasing by 20%. When cruising speed is 14 knots/hour, one way sailing becomes 176 hours =7.3 days. The estimated handling time for loading 2 days and unloading 2 days, the total sailing time is about 19 days. The number of times of sailing per year is 19 times in 365 days per year. But thinking about climate and other possible sailing times will be 80%, 15 times per year and coal tonnage per year by ship is 15×28,000＝420,000. Therefore, the charterage /ton is US$ 5,475,000/year ÷420,000 tons/year = US$ 13 /ton. Sea transport costs are charterage plus fuel, insurance and other costs which become about US$ 15 /ton. So in this case, the CIF is an estimated US$ (FOB＋15）per ton.



Charterage (US$/day). Upper Sells: average of calendar year. Lower Sells: average of fiscal year

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Capesize	21,445	12,988	11,433	40,370	66,075	47,278	44,469	112,097	101,106	3,995
	21,437	10,676	14,834	53,524	64,506	38,095	53,428	124,617	76,841	42,182
Panamax	12,008	9,214	8,114	21,645	34,751	21,955	25,143	55,138	43,167	17,065
	12,291	7,764	9,690	28,627	32,976	17,865	29,336	59,356	32,008	22,078
Handymax	10,414	8,474	7,263	17,046	29,070	21,843	23,927	44,839	35,818	13,575
	10,566	7,425	8,451	22,575	28,336	18,592	27,235	47,975	26,605	17,306
small Handy	7,152	6,088	5,552	10,438	20,483	16,601	16,991	30,389	26,014	9,554
	7,261	5,670	6,046	13,958	20,914	14,078	19,225	33,166	19,216	11,978
BDI	1,606	1,215	1,144	2,634	4,521	3,404	3,188	7,091	6,347	2,613
	1,620	1,083	1,332	3,517	4,346	2,870	3,745	7,768	4,895	2,978

Charterage (US$/day). Upper Sells: average of calendar year. Lower Sells: average of fiscal year

	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Capesize	12,839	31,562	20,579	17,898	37,660	78,718	54,941	42,004	24,618	34,885	73,372	50,258
	36,876	25,053	29,899	28,140	41,796							
Panamax	2,232	7,719	11,655	10,060	15,445	22,772	21,137	17,404	16,673	21,239	31,264	27,175
	27,536	23,716	30,520	30,644	32,318							
Handymax	3,549	6,474	9,406	9,595	13,415	14,289	16,645	14,481	14,107	16,681	22,277	22,077
	20,635	17,461	26,105	22,904	25,955							
small Handy	3,840	5,460	8,310	7,083	8,569	10,089	9,914	10,956	10,892	11,259	12,742	15,539
	15,293	14,228	17,177	18,442								
BDI	905	1,816	1,958	1,659	2,540	3,823	3,362	2,685	2,351	2,746	3,941	3,572
	3,168	2,678	3,207	3,043	3,838							

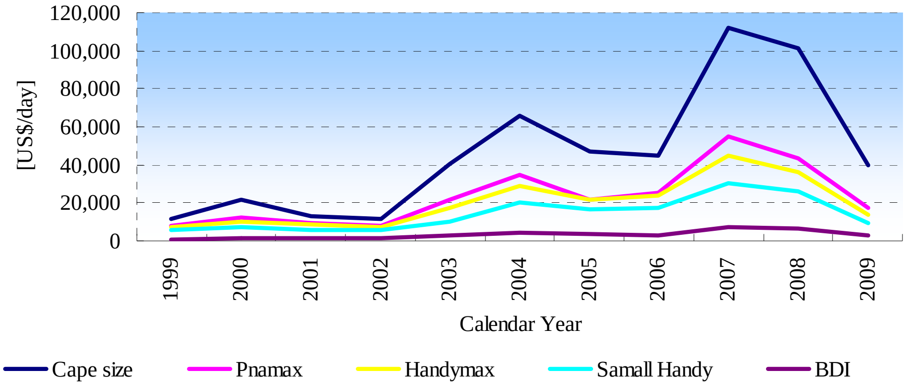
Source: Shosen Mitsui WEB site

APFig. 4-9 Change of charterage for dry bulk carrier in Marcc

(2) Estimation of freight and insurance (F & I)

As mentioned above, the international charterage wildly fluctuates making future forecasting very difficult. It shows the fluctuation of the monthly average chartage per day. Here for example based on APFig. 4-9, sea transport costs (Freight & Insurance) for Small Handy has been estimated until 2030 calculating the increasing ratio and is proportional to US$15 included charterage, fuel and insurance in 2010

APFig. 4-10 shows the charterage of a Small Handy in dry bulk carriers. Further, APFig. 4-11 shows the approximation formulas to estimate the chart rages of Small Handy.



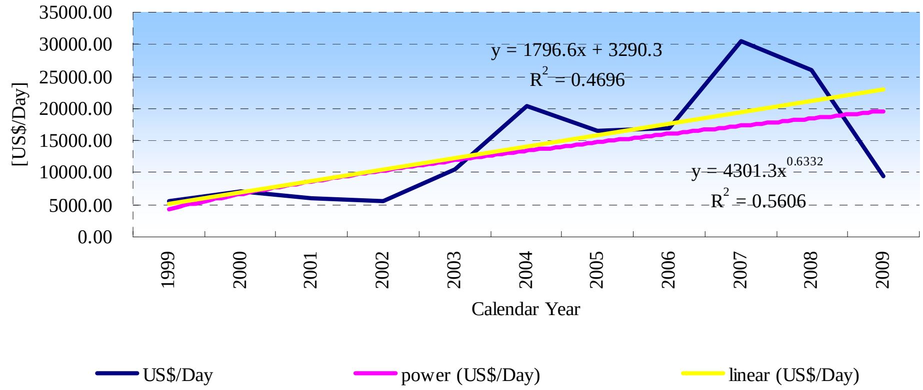
Source: PSMP Study Team based on APFig. 4-9

APFig. 4-10 Charterage of dry bulk carriers

APTable 4-13 Charterage of small handy

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
US$/Day	5,507	7,152	6,088	5,552	10,438	20,483	16,601	16,991	30,389	26,014	9,554

Source: PSMP Study Team based on Fig. APFig. 4-9



Source: PSMP Study Team based on APFig. 4-9.

APFig. 4-11 Approximation formulas to estimate charterage of small handy

APTable 4-14 shows the estimated total value (Freight and Insurance) between 2010 and 2030 in the High Case and Base Case in APFig. 4-11. The High Case shows the intermediate value from the value of Reference Case calculated via a linear approximation Formula and from values calculated via a power approximation formula while the Base case shows the value from a power approximation formula.

APTable 4-14　Freight & insurance estimation

Year	Reference Case		High Case	Base case	
	Approximation Formula of Linearization		Intermediate value	Approximation Formula of Power	
	Y=1796.6X+0.6332			Y=4301.3X^0.6332	
	Increasing Rate	US$/t of F & I	US$/t of F & I	Increasing Rate	US$/t of F & I
2010	1.00	15.0	15.0	1.00	15.0
2011	1.07	16.1	15.9	1.05	15.8
2012	1.14	17.2	16.9	1.10	16.5
2013	1.22	18.3	17.8	1.15	17.3
2014	1.29	19.3	18.7	1.20	18.0
2015	1.36	20.4	19.6	1.25	18.7
2016	1.43	21.5	20.4	1.29	19.4
2017	1.51	22.6	21.3	1.34	20.1
2018	1.58	23.7	22.2	1.38	20.7
2019	1.65	24.8	23.1	1.43	21.4
2020	1.72	25.8	23.9	1.47	22.0
2021	1.80	26.9	24.8	1.51	22.6
2022	1.87	28.0	25.6	1.55	23.3
2023	1.94	29.1	26.5	1.59	23.9
2024	2.01	30.2	27.3	1.63	24.5
2025	2.08	31.3	28.2	1.67	25.1
2026	2.16	32.4	29.0	1.71	25.7
2027	2.23	33.4	29.8	1.75	26.2
2028	2.30	34.5	30.7	1.79	26.8
2029	2.37	35.6	31.5	1.82	27.4
2030	2.45	36.7	32.3	1.86	27.9

Source:　PSMP Study Team

4.4.3　Cost of handling imported coal

The handling costs of imported coal includes the cost for loading coal to barges, coal transport costs by barges to the power plants at riverside and handling costs at the coal center after arriving from overseas. In the event that a power plant is located at riverside and barge cost is the same as that with Indonesia, about US$ 0.04/ton*km, the Handling cost of import coal will estimated as follows:

When the barge distance is 200km. Expenses (import taxes and others) will be US$ 2/t, the handling costs of loading & unloading at the stock yard is US$ 2/t, a total of 200×0.04+2+2＝US$12/tons.

Utilizing the 6% inflation ratio in Bangladesh between 2003 and 2009, the handling cost of imported coal has been estimated and is shown on APTable 4-15 when the inflation ratio is 6% every year and US$12 in 2010 is the base value.

When the power plant has exclusive berth and coal yard, handling cost of imported coal becomes the cheapest. When the power plant obtains coal from the coal center, it increases.

APTable 4-15 Domestic handling cost estimation in Bangladesh (Barging and other)

Year	Inflation Rate	Handling
	(%)	Cost (US$/t)
2010	6	12.0
2011	6	12.7
2012	6	13.5
2013	6	14.3
2014	6	15.1
2015	6	16.1
2016	6	17.0
2017	6	18.0
2018	6	19.1
2019	6	20.3
2020	6	21.5
2021	6	22.8
2022	6	24.1
2023	6	25.6
2024	6	27.1
2025	6	28.8
2026	6	30.5
2027	6	32.3
2028	6	34.3
2029	6	36.3
2030	6	38.5

Source: PSMP Study Team

4.5 APPENDIX – 5 Coal center

4.5.1 Outline of coal center

Following shows an example of coal center. Following is the overview of Onahama Coal Center which is owned by TEPCO. Coal center consists of three parts, those are “Loading Facility” which receives import coal, “Coal Storage Facility” which is from receives to delivery, and “Unloading Facility” which deliver coal to domestic vessel which transport to the power plant.

TEPCO Onahama Coal Center is located in Iwaki city, Fukushima Pref., its purpose is to relay coal which is used at Hirono thermal power station #5 unit (coal-fired 600MW USC) which is located in Hirono Town, Fukushima Pref., its area is 220,000 m^2, (including 62,000 m^2 of coal stock yard), maximum storage of coal is 165,000 t, annual coal treatment amount is 1.2 million t, annual number of import vessel is 18, annual number of domestic vessel is 100. The scale is a little smaller than that this MP is proposing, however the contents is not so different. Following table shows the scale and capacity of major coal centers in Japan.

Source: Tokyo Electric Power Company Inc.

APFig. 4-12 TEPCO Onahama Coal Center

Unloading (Import vessel)

Import vessel (example): 65,500t
Length 225m, Width 32m

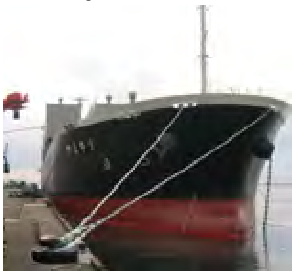
Unloader
1,400t/h, Height 43m

Belt conveyer (receive)
1,550t/h, Length 1.3km

Stacker
2,000t/h
Max piling height 9m

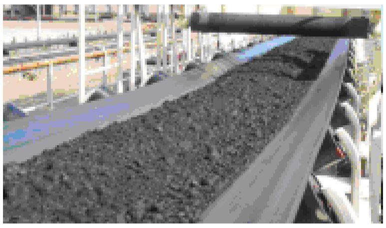
Coal stock yard
Max capacity 165,000t
461m x 37m, 2pile

Loading (domestic vessel)



Domestic coal vessel "YAMAYURI":
12,000t, Length 140m, Width 26m, Self unloading type

Reclaimer
1,000 t/h x 2



Belt conveyer (deliver)
2,400t/h, Length 900m

Ship loader
2,400t/h, Height 23.5m

Source: Tokyo Electric Power Company Inc.

APFig. 4-13 Main equipments of Onahama Coal Center

APTable 4-16 Major Coal Center in Japan

	Ube Kosan Coal Center	Tomato Coal Center	Chubu Coal Center	Shimomatsu Coal Relay Base	Idemitsu Bulk Terminal
Location	Yamaguchi Pref.	Hokkaido	Mie Pref.	Yamaguchi Pref.	Chiba Pref.
Owner/ Shareholder	Japan Trustee Service Bank, etc.	Hokkaido EPCO, Japan Coal Development Co. Oji Paper etc.	Sumitomo Corp., Japan Transcity Corporation, Etc.	JX Nippon Oil & Energy	Idemitsu Kosan
Main User	Power, Cloths etc.	Hokkaido EPCO etc.	Cement, Chemical, Cloths, Power, etc.	Chugoku EPCO	Idemitsu Kosan, Cement, neighbor factories
Coal Stock Capacity	2.5 million t	660,000 t	1 million t	300,000t	350,000t
Annual Treatment Amount	6.25 million t	4 million t	4.million t	2.7 million t	1.5 million t

Source: “Coal Note” 2008 edition

Chapter 5　　Natural Gas Sector APPENDIX

APTable 5-1　Natural Gas Property of Bangladesh

		Water Content	Chemical Composition of Natural Gas (Volume Percent)								Specific Gravity	Gross Calorific Value (Btu/cft)	Hydrogen Sulphaide
SI No.	Gas Field	(lb/MMSCF)	Methane	Ethane	Propane	Iso-Butane	N-Butane	High Comp.	Nitrogen	Carbon di-oxide			
1	Sylhet	1.20	96.63	2.00	0.05	0.14	0.01	0.17	1.06	0.36	0.57	1,020.00	Nil
2	Chattack	n/a	97.90	1.80	0.20	-	-	-	-	-	-	1,005.71	Nil
3	Rashidpur	1.20	98.00	0.21	0.24	-	-	0.17	0.40	0.18	0.57	1,024.00	Nil
4	Kailastila	0.70	95.57	2.70	0.94	0.21	0.20	0.14	0.00	0.14	0.59	1,030.00	Nil
5	Titas	4.60	96.76	1.80	0.39	0.10	0.07	0.06	0.04	0.42	0.58	1,029.00	Nil
6	Habiganj	4.10	97.81	1.48	-	-	-	-	0.71	0.00	0.57	1,016.00	Nil
7	Bakhrabad	4.00	94.01	3.69	0.81	0.25	0.09	0.06	0.47	0.49	0.59	1,050.00	Nil
8	Semutang	n/a	96.94	1.70	0.14	-	0.01	-	0.86	0.35	-	-	-
9	Begumganj	n/a	95.46	3.19	0.64	0.17	0.04	-	-	0.30	0.58	1,045.61	Nil
10	Kutubdia	n/a	95.72	2.87	0.67	-	0.31	-	0.36	0.07	0.59	1,041.66	Nil
11	Beanibazar	4.40	93.68	3.43	1.10	0.29	1.23	0.17	0.99	0.12	0.60	1,061.95	Nil
12	Feni	n/a	95.71	3.29	0.65	0.15	0.05	-	-	0.15	0.58	1,049.84	Nil
13	Kamta	n/a	95.36	3.57	0.47	0.09	-	-	-	0.51	0.57	1,043.13	Nil
14	Fenchuganj	n/a	98.10	1.00	0.09	0.03	0.02	-	0.14	0.35	0.56	1,014.58	Nil
15	Jalalabad	n/a	96.02	2.45	0.56	0.30	0.07	0.30	0.26	0.05	0.59	1,054.01	Nil
16	Narsingdi	3.20	95.66	2.46	0.55	0.15	0.10	0.08	0.45	0.55	0.59	1,035.00	Nil
17	Meghna	4.40	95.16	3.06	0.65	0.17	0.10	0.04	0.39	0.43	0.59	1,043.00	Nil
18	Shahbazpur	n/a	93.68	3.94	0.71	0.20	0.07	0.04	0.46	0.90	0.58	1,046.21	Nil
19	Sangu	n/a	94.51	3.17	0.61	0.19	0.07	0.41	0.44	0.60	0.59	1,058.00	Nil
20	Saldanadi	n/a	95.12	2.20	0.91	0.29	0.18	-	0.14	0.43	0.59	1,057.48	Nil
21	Bibiyana	n/a	95.72	2.37	0.87	0.22	0.18	0.32	0.19	0.13	0.59	1,059.00	Nil
22	Bangura	2.11	95.48	2.56	0.66	0.15	0.15	0.19	0.31	0.66	0.59	1,049.20	Nil
23	Moulavibzar	n/a	97.82	1.29	0.24	0.09	0.05	0.14	0.29	0.08	0.57	1,028.74	Nil
	average		95.95	2.44	0.55	0.18	0.16	0.16	0.42	0.33	0.58	1,039.19	Nil

Source：　Petrobangra Annual Report 2008）

APTable 5-2 Long Term Gas Production Forecast（Government Target Case）2009/10～2029/30

	Company	Sl.No.	Name of Gas Fields	Recoverable Reserve P1+P2+P3	P1	P2	P3	Cummulitive Production June2009	Remaining P1+P2+P3 Reserve	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
				Bcf						mmcfd																					
National	BGFCL	1	Titas Gas Field	8,299	7,441	140	718	2,996	5,303	395	408	453	578	578	578	578	678	678	650	650	600	600	600	600	600	600	600	600	550	500	485
		2	Bakhrabad Gas Field	1,587	1,106	217	264	692	895	33	36	36	56	56	56	56	56	100	100	150	150	150	150	150	100	100	90	90	10	0	0
		3	Habiganj Gas Field	3,221	2,416	372	433	1,617	1,604	236	240	260	265	270	270	275	275	275	275	250	200	100	0	0	0	0	0	0	0	0	0
		4	Narshingdi Gas Field	292	214	3	75	99	193	33	33	33	33	33	33	33	33	20	20	10	0	0	0	0	0	0	0	0	0	0	0
		5	Meghna Gas Field	101	49	0	52	36	65	0	0	15	10	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	Begumganj Gas Field	109	10	23	76	0	109	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	0	0	0	0	0	0
		7	Kamta Gas Field	50	19	31	0	21	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10
	SGFL	8	Sylhet Gas Field	466	301	71	94	189	277	2	7	15	15	15	15	25	25	25	25	25	25	25	40	70	70	39	0	0	0	0	0
		9	Kailashtila Gas Field	3,011	2,126	527	358	466	2,545	91	97	97	97	97	97	97	127	202	277	320	370	390	480	500	500	500	450	499	297	242	27
		10	Rashidpur Gas Field	4,010	2,465	685	860	448	3,562	50	49	49	84	84	84	84	124	220	270	330	342	470	518	600	600	600	584	550	550	550	550
		11	Beanibazar Gas Field	170	118	20	32	57	113	15	16	16	16	16	16	16	16	16	16	16	16	14	10	5	0	0	0	0	0	0	0
	BAPEX	12	Salda Gas Field	390	151	115	124	59	331	10	8	38	38	38	38	38	38	38	38	38	38	38	38	38	38	10	5	0	0	0	0
		13	Fenchuganj gas field	406	170	111	125	60	346	27	25	45	65	65	65	65	65	65	30	30	30	20	0	0	0	0	0	0	0	0	0
		14	Shahbajpur gas Field	318	224	39	55	0	318	0	8	8	8	8	8	8	8	60	80	80	80	80	80	80	80	20	0	0	0	0	0
		15	Semutang Gas Field	369	110	208	51	0	369	0	0	15	15	15	15	15	15	15	15	15	25	25	25	25	25	50	50	50	75	75	75
		16	From New Discovery							0	0	45	60	60	60	60	60	60	60	60	80	80	80	80	80	80	80	80	80	80	80
		17	Chattak(East)							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				22,799	**16,920**	**2,562**	**3,317**	**6,741**	**16,058**	**892**	**927**	**1,125**	**1,340**	**1,340**	**1,340**	**1,350**	**1,520**	**1,784**	**1,866**	**1,984**	**1,966**	**2,002**	**2,031**	**2,158**	**2,103**	**2,009**	**1,869**	**1,879**	**1,572**	**1,457**	**1,227**
IOC	Chevron	18	Jalalabad gas Field	1,727	996	249	482	509	1,218	158	130	130	230	230	280	380	380	95	0	0	0	0	0	0	0	0	0	0	0	0	0
		19	Maulavibazar gas field	1,233	625	264	344	140	1,093	74	60	90	160	160	210	310	360	360	250	10	0	0	0	0	0	0	0	0	0	0	0
		20	Bibiyana gas Field	5,971	4,426	771	774	361	5,610	527	716	716	816	916	1,016	1,116	1,166	1,166	1,156	1,132	845	799	560	400	76	50	50	10	5	0	0
	Cairn	21	Sangu gas Field	801	514	182	105	458	343	50	40	40	40	40	40	40	40	30	30	30	30	20	20	20	20	20	20	20	20	20	20
		22	Sangu gas (South) Field							0	0	30	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0	0	0	0	0
	Tullow	23	Bangura gas Field	708	544	70	94	79	629	87	120	120	120	120	120	120	120	90	90	90	90	90	60	15	10	0	0	0	0	0	0
	Niko	24	Feni gas Field	202	27	103	72	62	140	3	2	2	2	2	2	2	2	2	2	2	2	2	2	10	20	20	20	20	20	20	20
		25	Chattak Gas Field (West)	727	265	209	253	26	701	0	0	0	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50
	B: Total IOC-1			**11,369**	**7,397**	**1,848**	**2,124**	**1,635**	**9,734**	**899**	**1,068**	**1,128**	**1,398**	**1,498**	**1,698**	**1,998**	**2,098**	**1,773**	**1,558**	**1,344**	**1,047**	**961**	**692**	**495**	**176**	**140**	**140**	**100**	**95**	**90**	**90**
		26	From New Discovery(Blocks- 7)							0	0	0	0	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		27	Block-16 (Magnama/Hatia/Manpura)							0	0	0	0	0	0	0	0	50	50	50	100	100	100	100	100	100	100	100	100	100	100
		28	Block-17 & 18							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		29	Offshore Bidding-2008 (IOC-3) 1							0	0	0	0	0	0	0	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
		30	From New Discovery (Netrokona, Block 11)																100	100	100	100 100	100 100	100 100	100 100	100 100	100 200	100 200	100 200	100 200	100 200
	C: Total IOC-2									**0**	**0**	**0**	**0**	**0**	**0**	**0**	**200**	**350**	**450**	**450**	**500**	**600**	**600**	**600**	**600**	**600**	**700**	**700**	**700**	**700**	**700**
	Total IOCs (B+C)									**899**	**1,068**	**1,128**	**1,398**	**1,498**	**1,698**	**1,998**	**2,298**	**2,123**	**2,008**	**1,794**	**1,547**	**1,561**	**1,292**	**1,095**	**776**	**740**	**840**	**800**	**795**	**790**	**790**
			Petrobangla + IOC							**1,791**	**1,995**	**2,253**	**2,738**	**2,838**	**3,038**	**3,348**	**3,818**	**3,907**	**3,874**	**3,778**	**3,513**	**3,563**	**3,323**	**3,253**	**2,879**	**2,749**	**2,709**	**2,679**	**2,367**	**2,247**	**2,017**
			LNG (Import)							0	0	0	0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	D: Total LNG									**0**	**0**	**0**	**0**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**	**500**
	E: Total IOCs (B+C+D) + LNG									**899**	**1,068**	**1,128**	**1,398**	**1,998**	**2,198**	**2,498**	**2,798**	**2,623**	**2,508**	**2,294**	**2,047**	**2,061**	**1,792**	**1,595**	**1,276**	**1,240**	**1,340**	**1,300**	**1,295**	**1,290**	**1,290**
Total	**F: Petrobangla+IOC-1+IOC-2 (A+B+E)**			**34,168**	**24,317**	**4,410**	**5,441**	**8,376**	**25,792**	**1,791**	**1,995**	**2,253**	**2,738**	**3,338**	**3,538**	**3,848**	**4,318**	**4,407**	**4,374**	**4,278**	**4,013**	**4,063**	**3,823**	**3,753**	**3,379**	**3,249**	**3,209**	**3,179**	**2,867**	**2,747**	**2,517**

Source: PSMP Study Team

APTable 5-3 Long Term Gas Production Forecast（PSMP Study Case 1）2009/10～2029/30

	Company	Sl. No.	Name of Gas Fields	Recoverable Reserve P1+P2	P1	P2	P3	Cummulitive Production June2009	Remaining P1+P2 Reserve	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
				Bcf						mmcfd																					
National	BGFCL	1	Titas Gas Field	7,581	7,441	140	718	2,996	4,585	395	408	453	560	565	578	578	678	678	650	650	600	600	600	600	600	600	600	600	550	500	485
		2	Bakhrabad Gas Field	1,323	1,106	217	264	692	631	33	36	36	46	46	51	51	56	56	56	56	56	56	56	56	56	56	56	56	10	10	0
		3	Habiganj Gas Field	2,788	2,416	372	433	1,617	1,171	236	240	260	260	260	260	260	260	260	260	250	200	100	50	31	17						
		4	Narshingdi Gas Field	217	214	3	75	99	118	33	35	35	30	30	30	25	25	20	20	10	0	0	0	0	0	0	0	0	0	0	0
		5	Meghna Gas Field	49	49	0	52	36	13	0	0	10	10	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		6	Begumganj Gas Field	33	10	23	76	0	33	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	0	0	0	0	0	0
		7	Kamta Gas Field	50	19	31	0	21	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10
	SGFL	8	Sylhet Gas Field	372	301	71	94	189	183	2	7	25	25	25	25	25	25	25	25	25	25	25	40	40	35	35	0	0	0	0	0
		9	Kailashtila Gas Field	2,653	2,126	527	358	466	2,187	91	97	97	97	97	97	97	127	140	156	274	274	274	274	274	274	274	252	250	200	200	200
		10	Rashidpur Gas Field	3,150	2,465	685	860	448	2,702	50	49	49	84	84	84	84	124	174	270	350	350	430	430	530	530	587	584	556	490	520	455
		11	Beanibazar Gas Field	138	118	20	32	57	81	15	15	15	15	15	15	15	15	15	16	16	16	16	16	0	0	0	0	0	0	0	0
	BAPEX	12	Salda Gas Field	266	151	115	124	59	207	10	8	23	35	8	8	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		13	Fenchuganj gas field	281	170	111	125	60	221	27	24	44	64	64	65	65	65	65	30	30	30	30	0	0	0	0	0	0	0	0	0
		14	Shahbajpur gas Field	263	224	39	55	0	263	0	8	10	10	10	10	10	60	60	80	80	80	80	80	80	30	30	0	0	0	0	0
		15	Semutang Gas Field	318	110	208	51	0	318	0	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	25	25	25	25	25	25
		16	From New Discovery	0				0	0	0	0	45	60	60	60	60	60	60	60	60	60	60	60	60	60	80	80	80	80	80	80
		17	Chattak(East)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	A: Total Petrobangla			**19,482**	**16,92**	**2,562**	**3,317**	**6,741**	**12,741**	**892**	**927**	**1,117**	**1,311**	**1,284**	**1,303**	**1,298**	**1,515**	**1,578**	**1,648**	**1,826**	**1,716**	**1,696**	**1,631**	**1,696**	**1,627**	**1,697**	**1,607**	**1,577**	**1,365**	**1,345**	**1,255**
IOC	Chevron	18	Jalalabad gas Field	1,245	996	249	482	509	736	158	130	130	230	230	250	250	265	230	138	0	0	0	0	0	0	0	0	0	0	0	0
		19	Maulavibazar gas field	889	625	264	344	140	749	74	60	90	160	160	160	130	130	150	150	150	150	150	130	130	50	20	0	0	0	0	0
		20	Bibiyana gas Field	5,197	4,426	771	774	361	4,836	527	716	716	800	800	900	900	900	900	800	800	600	600	500	500	500	430	400	400	300	200	60
	Cairn	21	Sangu gas Field	696	514	182	105	458	238	50	40	20	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		22	Sangu gas Field (South)	0					0		0	30	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0	0	0	0	0
	Tullow	23	Bangura gas Field	614	544	70	94	79	535	87	120	120	120	120	120	120	120	90	90	90	90	90	60	25	0	0	0	0	0	0	0
	Niko	24	Feni gas Field	130	27	103	72	62	68	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		25	Chattak Gas Field (West)	474	265	209	253	26	448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B: Sub Total IOC-1			**9,245**	**7,397**	**1,848**	**2,124**	**1,635**	**7,610**	**899**	**1,068**	**1,108**	**1,362**	**1,352**	**1,462**	**1,432**	**1,447**	**1,402**	**1,210**	**1,072**	**872**	**842**	**692**	**657**	**552**	**452**	**402**	**402**	**302**	**202**	**62**
		26	From New							0	0	0	0	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		27	Block-16							0	0	0	0	0	0	0	0	50	50	50	100	100	100	100	100	100	100	100	100	100	100
		28	Block-17 & 18							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C: Sub Total IOC-2									**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**	**200**
		29	**Offshore Bidding-2008**							0	0	0	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	D: Sub Total IOC-3									**0**	**0**	**0**	**0**	**0**	**0**	**0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
	D: Total IOCs (B+C+D)									**899**	**1,068**	**1,108**	**1,362**	**1,352**	**1,462**	**1,432**	**1,547**	**1,652**	**1,460**	**1,322**	**1,172**	**1,142**	**992**	**957**	**852**	**752**	**702**	**702**	**602**	**502**	**362**
			Petrobangla + IOC							**1,791**	**1,995**	**2,225**	**2,673**	**2,636**	**2,765**	**2,730**	**3,062**	**3,230**	**3,108**	**3,148**	**2,888**	**2,838**	**2,623**	**2,653**	**2,479**	**2,449**	**2,309**	**2,279**	**1,967**	**1,847**	**1,617**
			LNG Import											200	400	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Total	**E: Petrobangla+IOCs(D)**			**28,727**	**24,31**	**4,410**	**5,441**	**8,376**	**20,351**	**1,791**	**1,995**	**2,225**	**2,673**	**2,836**	**3,165**	**3,230**	**3,562**	**3,730**	**3,608**	**3,648**	**3,388**	**3,338**	**3,123**	**3,153**	**2,979**	**2,949**	**2,809**	**2,779**	**2,467**	**2,347**	**2,117**

Source: PSMP Study Team

APTable 5-4 Long Term Gas Production forecast（PSMP Study Case 2）2009/10～2029/30

Company	Sl. No.	Name of Gas Fields	Recoverable Reserve P1+P2	P1	P2	P3	Cummulitive Production June2009	Remaining P1+P2 Reserve	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
			Bcf						mmcfd																					
BGFCL	1	Titas Gas Field	7,581	7,441	140	718	2,996	4,585	395	408	453	560	560	560	450	450	400	400	350	350	300	300	300	200	200	200	200	200	200	200
	2	Bakhrabad Gas Field	1,323	1,106	217	264	692	631	33	36	36	36	46	51	51	56	56	56	56	56	56	56	56	56	56	56	56	10	10	0
	3	Habiganj Gas Field	2,788	2,416	372	433	1,617	1,171	236	240	260	260	260	260	260	260	260	260	250	200	100	50	50	17	0	0	0	0	0	0
	4	Narshingdi Gas Field	217	214	3	75	99	118	33	35	35	30	30	30	25	25	20	20	10	0	0	0	0	0	0	0	0	0	0	0
	5	Meghna Gas Field	49	49	0	52	36	13	0	0	10	10	10	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	Begumganj Gas Field	33	10	23	76	0	33	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	10	0	0	0	0	0	0
	7	Kamta Gas Field	50	19	31	0	21	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10
SGFL	8	Sylhet Gas Field	372	301	71	94	189	183	2	7	25	25	25	25	25	25	25	25	25	25	25	40	40	35	35	0	0	0	0	0
	9	Kailashtila Gas Field	2,653	2,126	527	358	466	2,187	91	97	97	97	97	97	97	127	140	156	174	224	254	254	274	274	274	250	250	250	200	200
	10	Rashidpur Gas Field	3,150	2,465	685	860	448	2,702	50	49	67	85	85	85	85	124	134	238	250	300	350	350	430	530	547	560	556	490	520	400
	11	Beanibazar Gas Field	138	118	20	32	57	81	15	15	15	15	15	15	15	15	15	16	16	16	16	16	16	0	0	0	0	0	0	0
BAPEX	12	Salda Gas Field	266	151	115	124	59	207	10	8	23	35	8	8	8	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	Fenchuganj gas field	281	170	111	125	60	221	27	24	44	64	64	60	60	60	60	30	30	30	30	0	0	0	0	0	0	0	0	0
	14	Shahbajpur gas Field	263	224	39	55	0	263	0	8	10	10	10	10	10	10	60	80	80	80	80	80	80	80	80	0	0	0	0	0
	15	Semutang Gas Field	318	110	208	51	0	318	0	0	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15	25	25	25	25	25
	16	From New Discovery	0				0	0	0	0	45	60	60	60	60	60	60	60	60	60	60	60	60	60	80	80	80	80	80	80
	17	Chattak(East)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A: Total Petrobangla			**19,482**	**16,92**	**2,562**	**3,317**	**6,741**	**12,741**	**892**	**927**	**1,120**	**1,287**	**1,270**	**1,281**	**1,166**	**1,232**	**1,255**	**1,366**	**1,326**	**1,366**	**1,296**	**1,231**	**1,331**	**1,277**	**1,297**	**1,181**	**1,177**	**1,065**	**1,045**	**915**
Chevron	18	Jalalabad gas Field	1,245	996	249	482	509	736	158	130	130	200	200	200	200	180	180	150	150	100	100	80	0	0	0	0	0	0	0	0
	19	Maulavibazar gas field	889	625	264	344	140	749	74	60	70	70	80	80	80	90	100	120	120	100	90	80	65	50	0	0	0	0	0	0
	20	Bibiyana gas Field	5,197	4,426	771	774	361	4,836	527	716	716	750	800	850	900	900	840	790	750	650	600	600	600	500	500	476	450	300	200	100
Cairn	21	Sangu gas Field	696	514	182	105	458	238	50	40	20	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	22	Sangu gas Field (South)						0		0	30	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0	0	0	0	0
Tullow	23	Bangura gas Field	614	544	70	94	79	535	87	120	120	120	120	120	120	120	90	90	90	90	90	60	25	0	0	0	0	0	0	0
Niko	24	Feni gas Field	130	27	103	72	62	68	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	25	Chattak Gas Field (West)	474	265	209	253	26	448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B: Total IOC-1			**9,245**	**7,397**	**1,848**	**2,124**	**1,635**	**7,610**	**899**	**1,068**	**1,088**	**1,192**	**1,242**	**1,282**	**1,332**	**1,322**	**1,242**	**1,182**	**1,142**	**972**	**882**	**822**	**692**	**552**	**502**	**478**	**452**	**302**	**202**	**102**
	26	From New Discovery(Kajula,							0	0	0	0	0	0	0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	27	Block-16							0	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	28	Block-17 & 18							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C: Total IOC-2									**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**	**150**
		Offshore Bidding-2008							0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D: Total IOC-3									**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
E: Total IOCs (B+C+D)									**899**	**1,068**	**1,088**	**1,192**	**1,242**	**1,282**	**1,332**	**1,322**	**1,392**	**1,332**	**1,292**	**1,122**	**1,032**	**972**	**842**	**702**	**652**	**628**	**602**	**452**	**352**	**252**
		Petrobangla + IOC							**1,791**	**1,995**	**2,208**	**2,479**	**2,512**	**2,563**	**2,498**	**2,554**	**2,647**	**2,698**	**2,618**	**2,488**	**2,328**	**2,203**	**2,173**	**1,979**	**1,949**	**1,809**	**1,779**	**1,517**	**1,397**	**1,167**
		LNG import												200	300	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
F: Petrobangla+IOCs(E)			**28,727**	**24,31**	**4,410**	**5,441**	**8,376**	**20,351**	**1,791**	**1,995**	**2,208**	**2,479**	**2,512**	**2,763**	**2,798**	**3,054**	**3,147**	**3,198**	**3,118**	**2,988**	**2,828**	**2,703**	**2,673**	**2,479**	**2,449**	**2,309**	**2,279**	**2,017**	**1,897**	**1,667**

Source: PSMP Study Team

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APTable 5-5　Power Station Mid Long Term Tlan

Unit:mmcfd

	node		Power Station Site	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TGTDCL	18	Ex.	Ashuganj 150 MW Steam Turbine #3	25	22	23	22	23	21	20	19	18	19	19	19	19	19	19	0	0	0	0	0	0	0
	18	Ex.	Ashuganj 150 MW Steam Turbine #4	25	22	23	22	23	21	20	19	18	19	19	19	19	19	19	0	0	0	0	0	0	0
	18	Ex.	Ashuganj 150 MW Steam Turbine #5	25	22	23	22	23	21	20	19	18	19	19	19	19	19	19	0	0	0	0	0	0	0
	18	Ex.	Ashuganj 2x64 MW Steam Turbine	26	23	23	22	23	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	Ex.	Ashuganj Combined Cycle	8	8	7	7	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	Ex.	Ashuganj GT 1	8	8	7	7	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	Ex.	Ashuganj GT 2	8	8	7	7	7	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18		Ashuganji CCPP #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	50	51	51
	18		Ashuganji CCPP #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	50	51	51
	18		Ashuganji CCPP #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51
	56	Ex.	Ghorasal 210 MW S/T #5	36	35	36	34	35	31	30	29	27	28	28	29	27	28	29	30	31	31	33	32	25	0
	56	Ex.	Ghorasal 210 MW S/T #6	36	35	36	34	35	31	30	29	27	28	28	29	27	28	29	30	31	31	33	32	25	0
	56	Ex.	Ghorasal 210 MW Steam Turbine #3	36	35	36	34	35	31	30	29	27	28	28	29	27	28	29	30	31	31	33	32	25	0
	56	Ex.	Ghorasal 210 MW Steam Turbine #4	36	35	36	34	35	31	30	29	27	28	28	29	27	28	29	30	31	31	33	32	25	0
	56	Ex.	Ghorasal 55 MW Steam Turbine #1	10	9	9	8	9	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	56	Ex.	Ghorasal 55 MW Steam Turbine #2	10	9	9	8	9	8	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	47	Ex.	Haripur 3x33 MW Gas Turbine	27	28	24	25	25	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	48	Ex.	Siddhirganj 210 MW Steam Turbine	36	35	36	34	35	31	30	29	27	28	28	29	27	28	29	30	31	31	33	32	25	35
	59	Ex.	Tongi 100 MW Gas Turbine	19	16	22	20	23	17	14	13	10	11	13	14	13	14	16	21	21	21	22	22	23	24

	node		Power Station Site	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	45	Ex.	CDC, Haripur	53	53	53	53	53	53	53	52	51	51	51	51	50	50	50	50	50	50	0	0	0	0
	43	Ex.	CDC, Meghnaghat	64	64	64	64	64	64	64	64	63	63	63	63	62	62	62	62	62	62	0	0	0	0
	43		Meghnaghat 360MW CCPP #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	51	50	51	51
	43		Meghnaghat 360MW CCPP #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	50	51	51
	47	Ex.	NEPC (Haripur, BMPP)	17	17	17	17	17	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	58	Ex.	RPCL (Mymensingh)	25	25	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24	0	0	0	0	0
	60	Ex.	Tangail SIPP (22 MW)	4	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	51	New	Kaliakair, Gazipur	0	0	0	20	21	20	19	19	18	18	18	18	18	17	19	13	19	18	12	0	0	0
	59	New	Savar, Dhaka	0	0	0	20	21	20	19	19	18	18	18	18	18	17	19	13	19	18	12	19	19	20
	56	New	Ghorasal	0	0	0	38	38	35	33	32	30	30	30	31	30	31	31	33	33	34	35	35	36	36
	18	New	Ashuganj – 3 yrs	0	13	13	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	57	New	Mouna, Gazipur SIPP(REB)	6	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	50	New	Narsindi SIPP(REB)	4	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	50		Mahdabdi, Narsindi Summit SIPP, REB	7	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	54	New	Rupganj , Narayanganj	6	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
BGSL	41	Ex.	Chittagong (Shkalbaha) 1x60 MW Steam Turbine	9	8	8	8	8	8	7	7	6	7	7	0	0	0	0	0	0	0	0	0	0	0
	41	Ex.	Chittagong (Shkalbaha) 2x28 MW Barge Mounted GT	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	41	Ex.	Rauzan (Chittagong) 210 MW S¥T (1st)	41	36	37	36	37	34	33	32	29	30	31	31	29	30	31	31	32	31	0	0	0	0
	41	Ex.	Rauzan (Chittagong) 210	41	36	37	36	37	34	33	32	29	30	31	31	29	30	31	31	32	31	2	30	0	0

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	node		Power Station Site	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
			MW S¥T (2nd)																						
	40	Ex.	Barabkundu	4	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	37	Ex.	Feni SIPP (22 MW)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0	0
	33	Ex.	Jangalia , Comilla	6	7	8	8	8	7	7	7	5	5	6	7	6	7	6	7	0	0	0	0	0	0
	33	Ex.	Summit Power (REB)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	33		Ashulia, Dhaka Summit SIPP, REB	9	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	33		Chandina, Comillaj Summit SIPP, REB	5	4	5	5	5	5	5	5	3	4	4	5	4	4	4	5	0	0	0	0	0	0
	34	New	Chandpur 150 MW CC (BPDB)	0	0	0	24	24	30	24	23	20	20	22	22	21	22	22	22	22	21	21	22	22	17
	41	New	Sikalbaha 150 MW Peaking Plant (BPDB)	0	31	35	34	35	32	26	24	17	18	20	24	20	24	25	30	29	30	31	31	33	33
	72	New	Haripur 360 MW CCPP (EGCB)	0	0	0	0	0	53	53	52	51	51	51	51	50	50	50	50	50	50	51	50	51	51
	73	New	Siddhirganj 2X120 MW Peaking Plant (EGCB)	0	49	55	54	56	51	41	39	28	29	31	38	32	38	40	48	47	49	50	50	53	52
	71	New	Meghnaghat Combined Cycle Power Plant (2nd unit) Duel Fuel	0	0	0	0	0	0	0	0	52	54	55	56	54	55	54	55	54	54	55	53	55	55
	73	New	Siddirganj 2x150 GT (EGCB)	0	0	0	0	69	64	51	49	35	36	39	48	40	47	49	60	59	61	62	62	66	65
	37	New	Feni SIPP(REB)	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0
JGTDSL	6	Ex.	Fenchuganj C.C. (Unit #1)	15	15	15	15	15	15	15	15	14	14	14	14	13	14	0	0	0	0	0	0	0	0
	15	Ex.	Shahjibazar 60 MW Gas Turbine	18	18	16	15	16	11	15	10	14	14	15	15	9	9	10	0	0	0	0	0	0	0
	15	Ex.	Shahjibazar Gas Turbine(7 units)	14	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	Ex.	Sylhet 1x20 MW Gas Turbine	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	Ex.	Kumargao 10 MW (15 Years)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0

	node		Power Station Site	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	2	Ex.	Kumargoan (3 Years)	9	10	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	Ex.	Sahzibazar RPP (3 Years)	10	10	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	Ex.	Sahzibazar RPP (15 Years)	17	17	20	21	21	19	19	19	14	14	15	18	15	17	17	19	0	0	0	0	0	0
	6	New	Fenchuganj 90 MW CCPP (BPDB)	0	14	14	14	14	18	14	14	12	12	13	13	13	13	13	13	13	13	13	13	13	10
	6		Mahdabdi, Narsindi Summit SIPP, REB	0	10	4	4	4	4	4	4	3	3	3	4	3	4	3	4	0	0	0	0	0	0
	2	New	Sylhet 150 MW CCPP (BPDB)	0	0	0	24	24	30	24	23	20	20	22	22	21	22	22	22	22	21	21	22	22	17
	13	New	Bibiyana Combined Cycle Power Plant (2nd Unit)	0	0	0	0	0	0	64	63	58	61	62	63	61	62	61	62	61	61	61	60	61	61
	13	New	Bibiana 450 MW CCPP (Power Cell)	0	0	0	0	0	65	64	63	58	61	62	63	61	62	61	62	61	61	61	60	61	61
	13		Bibiana 360MW CCPP #3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	51	50	51	51
	13		Bibiana 360MW CCPP #4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	51	50	51	51
	6	New	Fenchuganj – 3 Yrs rental	0	10	12	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	New	Hobiganj SIPP(REB)	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0
PGCL	67	Ex.	Baghabari 100 MW Gas Turbine	18	16	22	20	22	17	14	13	10	12	12	13	12	14	0	0	0	0	0	0	0	0
	67	Ex.	Baghabari 71 MW Gas Turbine	17	17	17	17	17	17	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	67	Ex.	WEST MONT (Baghabari)	14	15	14	15	14	14	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	69	Ex.	Bogra Rental (15 Years)	4	4	4	4	4	4	4	4	3	3	3	4	3	4	0	0	0	0	0	0	0	0
	1*	New	Bhola Combined Cycle Power Plant (2nd unit)	0	0	0	0	0	0	24	23	20	20	22	22	21	22	22	22	22	21	21	22	22	17
	63	New	Sirajganj 150 MW GT (NWPGC)	0	0	0	0	0	32	26	24	17	18	20	24	20	24	25	30	29	30	31	31	33	33
	63	New	Serajganj 450 MW CCPP/ 500 MW Coal (Power Cell)	0	0	0	0	0	0	64	63	58	61	62	63	61	62	61	62	61	61	61	60	61	61

	node		Power Station Site	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	63		Sirajganj 360MW CCPP #2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51
	69	New	Bogra –3 yrs rental	0	4	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	67	New	Ullapara SIPP (REB)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
S/SW	1*	New	Bhola 150 MW CCPP (BPDB)	0	0	0	0	0	30	24	23	20	20	22	22	21	22	22	22	22	21	21	22	22	17
	1*		Bhola (3 Years)	0	7	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	77	New	Bheramara 360 MW CCPP (NWPGC)	0	0	0	0	0	0	53	52	51	51	51	51	50	50	50	50	50	50	51	50	51	51
	83	New	Khulna 150 MW GT (NWPGC)	0	0	0	0	0	32	26	24	17	18	20	24	20	24	25	30	29	30	31	31	33	33
Total				826	919	941	1027	1112	1223	1276	1218	1107	1135	1170	1219	1135	1186	1169	1151	1225	1209	1193	1207	1168	1154

Source: PSMP Study Team

APTable 5-6 TGTDCL Gas Demand Forecast (Base Case)

Unit : mmcfd

F. year	Power	Captive P.	Fertilizer	Industry	Commercial	Domestic	CNG	Tea Estate	Total
2009	537	219	97	234	13	142	58	0	1,301
2010	541	214	155	235	13	169	63	0	1,389
2011	553	231	155	262	13	191	74	0	1,479
2012	620	250	155	291	14	215	85	0	1,630
2013	631	290	155	323	15	243	96	0	1,754
2014	568	291	155	360	16	274	107	0	1,772
2015	490	314	155	400	17	310	118	0	1,804
2016	466	340	155	444	18	350	129	0	1,903
2017	422	110	155	494	20	395	140	0	1,736
2018	428	110	155	549	21	446	152	0	1,860
2019	434	110	155	611	22	504	163	0	1,998
2020	446	110	155	679	24	569	174	0	2,155
2021	425	99	155	744	25	631	185	0	2,264
2022	435	88	155	815	26	701	196	0	2,416
2023	445	77	155	892	28	778	207	0	2,582
2024	391	66	155	978	29	864	218	0	2,701
2025	431	55	155	1,071	31	960	229	0	2,932
2026	410	44	155	1,164	33	1,056	240	0	3,103
2027	447	33	155	1,266	34	1,163	251	0	3,350
2028	438	22	155	1,377	36	1,280	263	0	3,571
2029	408	11	155	1,497	38	1,409	274	0	3,792
2030	368	0	155	1,628	40	1,552	285	0	4,028

Source: PSMP Study Team

APTable 5-7 BGSL Gas Demand Forecast (Base Case)

Unit : mmcfd

F. year	Power	Captive P.	Fertilizer	Industry	Commercial	Domestic	CNG	Tea Estate	Total
2009	42	32	92	37	6	48	21	0	278
2010	191	32	120	37	5	57	23	0	465
2011	205	35	120	41	6	64	27	0	498
2012	224	37	120	45	6	73	31	0	537
2013	301	40	120	50	7	82	35	0	635
2014	336	44	120	56	7	93	39	0	695
2015	298	47	120	62	7	105	43	0	683
2016	290	51	120	69	8	118	47	0	703
2017	291	16	120	77	8	134	51	0	698
2018	300	16	120	86	9	151	56	0	737
2019	312	16	120	95	10	170	60	0	784
2020	332	16	120	106	10	192	64	0	840
2021	301	15	120	116	11	214	68	0	844
2022	324	13	120	127	11	237	72	0	904
2023	328	12	120	139	12	263	76	0	950
2024	356	10	120	152	13	292	80	0	1,023
2025	324	8	120	167	13	325	84	0	1,042
2026	328	7	120	182	14	357	88	0	1,096
2027	271	5	120	197	15	393	92	0	1,094
2028	298	3	120	215	16	433	96	0	1,181
2029	279	2	120	233	16	477	100	0	1,227
2030	273	0	120	254	17	525	104	0	1,293

Source: PSMP Study Team

APTable 5-8 JGTDSL Gas Demand Forecast (Base Case)

Unit : mmcfd

F. year	Power	Captive P.	Fertilizer	Industry	Commercial	Domestic	CNG	Tea Estate	Total
2009	62	7	15	14	1	12	1	2	115
2010	124	6	15	14	1	14	2	2	178
2011	113	7	15	16	1	16	2	2	172
2012	114	7	15	17	1	18	2	2	177
2013	117	7	15	19	2	21	2	2	184
2014	171	7	45	22	2	23	3	2	275
2015	224	7	45	24	2	26	3	2	333
2016	216	8	45	27	2	30	3	2	332
2017	196	8	45	30	2	34	4	2	319
2018	203	8	45	33	2	38	4	2	335
2019	211	8	45	37	2	43	4	2	352
2020	217	9	45	41	2	49	4	2	368
2021	199	8	45	45	3	54	5	2	359
2022	206	7	45	49	3	60	5	2	376
2023	191	6	45	53	3	67	5	2	372
2024	186	5	45	59	3	74	6	2	379
2025	257	4	45	64	3	82	6	2	463
2026	256	3	45	70	3	90	6	2	476
2027	258	3	45	76	3	99	6	2	492
2028	255	2	45	83	4	109	7	2	506
2029	259	1	45	90	4	121	7	2	528
2030	251	0	45	98	4	133	7	2	539

Source: PSMP Study Team

APTable 5-9 PGCL Gas Demand Forecast (Base Case)

Unit : mmcfd

F. year	Power	Captive P.	Fertilizer	Industry	Commercial	Domestic	CNG	Tea Estate	Total
2009	62	2	0	2	0	5	5	0	76
2010	56	5	0	2	0	6	5	0	74
2011	63	6	0	2	1	6	6	0	84
2012	62	7	0	2	1	7	7	0	85
2013	64	8	0	2	1	8	8	0	91
2014	85	10	0	3	1	9	9	0	116
2015	163	12	0	3	1	10	10	0	198
2016	146	14	50	3	1	12	11	0	236
2017	110	17	50	4	1	13	11	0	206
2018	115	21	50	4	1	15	12	0	218
2019	120	25	50	4	1	17	13	0	230
2020	127	30	50	5	1	19	14	0	246
2021	118	27	50	5	1	21	15	0	238
2022	126	24	50	6	1	23	16	0	246
2023	108	21	50	6	1	26	17	0	230
2024	115	18	50	7	1	29	18	0	238
2025	112	15	50	8	1	32	19	0	236
2026	112	12	50	8	1	35	20	0	239
2027	114	9	50	9	1	39	20	0	242
2028	113	6	50	10	1	43	21	0	244
2029	116	3	50	11	1	47	22	0	251
2030	162	0	50	12	1	52	23	0	300

Source: PSMP Study Team

APTable 5-10 SGCL Gas Demand Forecast (Base Case)

Unit : mmcfd

F. year	Power	Captive P.	Fertilizer	Industry	Commercial	Domestic	CNG	Tea Estate	Total
2009	0	0	0	0	0	0	0	0	0
2010	7	0	0	0	0	0	0	0	7
2011	7	0	0	0	0	11	0	0	18
2012	7	0	0	0	0	12	0	0	19
2013	0	0	0	0	0	13	0	0	13
2014	62	0	0	0	0	14	0	0	76
2015	102	0	0	0	0	15	0	0	117
2016	100	0	0	0	0	17	0	0	117
2017	89	0	0	0	0	18	0	0	106
2018	89	0	0	0	0	19	0	0	108
2019	93	0	0	0	0	21	0	0	114
2020	98	0	0	0	0	22	0	0	120
2021	91	0	0	0	0	23	0	0	115
2022	96	0	0	0	0	24	0	0	120
2023	96	0	0	0	0	26	0	0	122
2024	103	0	0	0	0	27	0	0	130
2025	101	0	0	0	0	28	0	0	129
2026	102	0	0	0	0	29	0	0	131
2027	103	0	0	0	0	31	0	0	133
2028	103	0	0	0	0	32	0	0	135
2029	106	0	0	0	0	33	0	0	139
2030	100	0	0	0	0	34	0	0	135

Source: PSMP Study Team

5.1.1 Assessment of current status for existing gas fields

The production status of existing gas fields was investigated through the site survey for the purpose of forecasting scenarios of the future gas development program in the Bangladesh. The summary of investigating results for each gas fields are shown as following paragraphs.

(1) Titas gas field (Block 12) (BGFCL)

Titas gas field lies at the foundation of village in Brahmanbaria area approximately 100km away from northeast of the capital Dhaka in Bangladesh. Pakistan Shell Oil Company carried out the rudimentary seismic survey and found this gas field in 1962. The structure of the gas field is asymmetry anticline structure extending north and south long of approximately 19km x 10km2, which is the large gas field with the vertical closure of 500m. The production was started in 1968 and the accumulated production volume by June 30, 2009 reached 2,996Bcf (billion cubic feet). It is equivalent to 58 % of recoverable reserves (P1+P2) 5,128 Bcf officially announced by Petrobangla, so the residual recoverable reserves are 2,131 Bcf, however, the reserves are reviewed at the current moment and the wide upward revision is expected. Until now, sixteen production wells have been excavated and 395mmcfd (million cubic feet per day) gas is produced from fifteen wells. Seven vertical wells and nine inclined wells are excavated at six locations approximately 8 km away each other. The excavation of seventeenth and eighteenth wells are planned in future. Currently, it keeps the second highest production volume in Bangladesh after Cheveron gas field of IOC. The gas field has five Glycol dehumidifying facilities with processing capacity of 60 mmcfd per facility and six low-temperature separation type gas processing facilities and the gas is supplied to the pipeline of Titas Gas Transmission & Distribution Co. Ltd (TGTDCL) and Gas Transmission Co. Ltd. (GTCL). For Titas 14th well, the production was discontinued in November 2006 because of flooding, however, the renovation was terminated in September 2009 and the production was restarted. For the third well of Titas, which has kept leaking of gas because of the blast since 2003, the leakage was stopped by an American expert in January 2008 and it was reclaimed with cement. Consequently, the gas does not leak from the windz, however, the leakage from the crack in the windz seems to be continued.

(2) Bakhrabad gas field (block 9)

Bakhrabad gas field lies at Muradnagar upazila in Comilla area approximately 40km away from east of the capital Dhaka. It was discovered by Pakistan Shell Oil Co.Ltd (PSCO) in 1969 in a same way as Titas and Habiganj gas fields. Concerning the structure, the first well was excavated up to 2,838m based on the magnetic measurement carried out by Pakistan Petroleum Ltd. (PPL) in 1953 and the result of 1-polymerization seismic experiment carried out by Shell in 1968 and a lot of gas layers were confirmed. The anticline structure has long and thin symmetric shape facing NNW-SSE direction and the scale is approximately 69 km (L) and 10 km (W). The production was started in 1984 and the accumulated gas production by the end of June 2009 is 692 Bcf. It is equivalent to 66% of recoverable reserves (1,049 Bcf) officially announced by HCU. Consequently, it is reported that the residual recoverable reserves is 357 Bcf. Total eight production wells were excavated at two locations, however, the production of four wells are discontinued because of flooding. It is planned to stop the flooding by the renovation. The gas production that reached 120 mmcfd once decreased to 33 mmcfd from four wells at the current moment. One well is a vertical well, however, other wells are inclined wells. It has four silica gel type gas processing plants and after the processing, the gas is supplied to Transmission pipeline of BGSL.

(3) Habiganj gas field (block 12) (BGFCL)

Habiganj gas field lies in Habiganj area approximately 100 km away from northeast of the capital Dhaka. The structure of this gas field exists at the north end of Tripuran Baramura anticline structure in India and there are a main gas layer and upper gas sandstone bed in south of Sadr. In 1962, PSOC carried out 1-polymerization seismic survey here and in 1963, carried out the exploratory excavation to find the gas-containing sandstone bed configured with two layers. Concerning the scale of the structure, the height of 12km x 5km square km closure is 300m. The production was started in 1968 and the accumulated gas production volume by the end of June 2009 is 1,617 Bcf and 42 % of recoverable reserves (3,852 Bcf) are produced. It is reported that the residual reserves are 2,235 Bcf. Currently, 238mmcfd gas is produced from nine production wells in eleven wells. The produced gas is processed by six Glycol type dehumidifying plants and supplied to Transmission line of Titas Gas Transmission Co. Ltd. (TGTDCL), Jalalabad Transmission Co.Ltd. (JDTDSL), and Gas Transmission Co. Ltd (GTCL). Nine wells are vertical wells and two remaining wells are inclined wells. Nine wells are dispersed at places approximately 14km away from each other. The eighth well and the ninth well have problems of flooding and sand generation at the current moment and the production is discontinued.

(4) Narsingdi gas field (block 9)

Narsingdi gas field lies in Narsingdi area in Shibpur upazila approximately 45 km away from the capital Dhaka. This area exists at the north peak of large Bakhrabad anticline area and it was named A 2 peak by Shell in the beginning of 1960s. Shell decided that it was a prospect with high risk. In 1984-86, Petrobangla carried out 12-polymerization seismic experiment for this area and reevaluated the prospect, and decided that it had the potential of 2,474 Bcf 50% of the time. In 1990, the exploratory excavation was carried out with a name of Bakhrabad ninth well and the gas-containing sandstone bed configured with two layers (upper and lower) was confirmed and the test was carried out for the lower layer. The production was started in 1996 and the accumulated production volume by the end of June 2009 is 99Bcf. It is equivalent to approximately 46% of recoverable reserves (215 Bcf). The residual reserves are 116Bcf. The production of 34mmcfd is kept in two production wells as of middle of November 2009. The produced gas is dehumidified by the gas processing plant and supplied to TGTDCL.

(5) Meghna gas field (block 9)

Meghna gas field lies in Brahmanbaria area. This area is typified by a lot of side streams of Meghna river. Concerning the gas field structure, the gravity anomaly was confirmed in 1953 and it was certified as a prospect by 1-polymerization seismic survey carried out by Shell. After that, Petrobangla carried out 24-polymerization seismic survey in 1984-86. In 1990, a test well was excavated and the gas-containing sandstone bed configured with six layers was confirmed in the depth between 2,850m and 3,020m. The production was started in 1997 and 36Bcf gas, which equivalent to 30% of recoverable reserves (120 Bcf) was produced until the production was stopped in 2007. The current residual recoverable reserves are 84Bcf. The production is not carried out currently.

(6) Sylhet (Haripur) gas field (block 13)

Sylhet gas field lies in the neighborhood of Sylhet city in Sylhet area 225km away from northeast of the capital Dhaka. The rock of Dupi Tila period is exposed on the land surface. The first well was excavated based on the geological and physical exploration data in 1955 and three gas layers were confirmed in the depth of 2,377m. However, the cement filled in 10-7/8" casing pipe was not sufficient, so the gas blew out from the abnormal overpressured zone and a fire was generated, and it disappeared under the ground with drilling rig and its auxiliary equipment. Then, the fire was extinguished naturally, however, a crack was generated on the geological layer and the gas reached the peripheral hill and it keeps bursting. In the next year, the second well was excavated, however, the blast of the gas due to the abnormal overpressured zone was generated in the depth of 2,818m. In order to control the blast, the windz was reclaimed and abolished. In 1957, the third well was excavated and the excavation was stopped in the depth of 1,800m and the gas-containing sandstone bed at upper part and lower part was finished as two layers. In 1969, the production was stopped at the lower layer because the formation water increased. The production at the upper layer was continued by 1988, however, the gas production was discontinued in the same year because of the increase of the formation water. In this period, accumulated total of 89 Bcf gas was produced. In

1962, the fourth well was excavated, however, the abnormal overpressured zone was found when the excavation reached 338m, so this well was abolished from the viewpoint of safety. In 1969, the fifth well was excavated next to the fourth well, however, it was abolished because of a technical reason. In 1964, the sixth well was excavated up to 1,515m and the upper and lower Bokabil sandstone beds were finished in two layers. In 1993, the production at the lower layer was discontinued because of the ingress of formation water. However, the production at the upper layer was continued currently, however, the production volume as of June 2009 is very small; 2mmcfd. The production from this well will be discontinued in the immediate future. The accumulated production volume by June 2009 is approximately 189 Bcf.

The seventh well was excavated by BAPEX, however, the petroleum was discovered between the depth of 2009-2033m and it was finished as a production well of petroleum. It is the first discovery of petroleum in Bangladesh. For this well, the petroleum was produced 350 barrels per day at first, however, the production volume of formation water increased gradually and the production was stopped in July 1994. The accumulated production volume of crude was 560,869 bbls. Then, this well was renovated in March 2005 and changed to the gas production well. At first, 15 mmcfd gas was produced, however, the production is currently discontinued and the re-renovation is planned. The product is processed by the silica gel type gas processing plant with the processing capacity of 30 mmcfd in Haripur.

(7) Kailastilla gas field (block 13)

Kailastilla gas field lies at Gurapganj in Sylhet area approximately 300km away from northeast of the capital Dhaka. Shell estimated Kailastilla structure based on the analog seismic experiment data of one polymerization carried out in 1960. Shell says that the anticline structure is 4-way inclination closure. In 1961, the first well was excavated and it was excavated up to 4,138m to confirm the gas-containing sandstone bed configured with four layers. Then, the second well and the third well were excavated in 1988 and the production was started in 1992. In 1955, the fourth well was excavated and the production volume reached 65mmcfd. From 2006 to 2007, the fifth well and the sixth well were added. The windz group is laid off at two points 6km away each other. The accumulated production volume by the end of June 2009 is 466 Bcf and it is equivalent to 24% of recoverable reserves. The residual recoverable reserves are 1,439Bcf. For the fifth well, the production volume decreases because of the ingress of water currently and the production was discontinued more recently. Currently, the gas production of whole gas field is 91mmcfd as of June 2009. For the fifth well, a new layer that did not exist in other well was found at the lowest layer at the time of completion work, so the main layer at the upper part was saved and the new layer was finished in order to avoid the residual resource of the new layer. It is planned to carry out the production from the upper sandstone bed by carrying out the renovation at some future date. Since 1983, the silica gel type gas processing plant with the capability of 30mmcfd has been operated. Additionally, the Molecular Sieve Turbo Expander plant with the capability of 90mmcfd has been operated since 1995. Currently, the preparation for the excavation of the seventh and eighth wells is promoted in order to increase the production from this gas field.

Kailashtila gas field
(2009/10/31)

Kailashtila gas field
(2009/10/31)

(8) Rashidpur gas field (block 12)

Rashidpur gas field lies at the place approximately 100 km away from northeast of the capital Dhaka. Rashidpur structure was drawn based on the seismic experiment record of one polymerization carried out by Shell from 1959 to 1960, which is the anticline structure extending long in north and south. The first well was excavated in 1960 and the gas-containing sandstone bed configured with two layers (upper and lower) was confirmed. In 1961, the second well was excavated up to 4,593m. After the research result of gas under the lower layer, it was water. Then, up to the seventh well was excavated and the production was started in 1993. The accumulated production volume by the end of June 2009 is 448 Bcf and it is equivalent to approximately 32 % of recoverable reserves(1,402 Bcf). It is reported that the residual recoverable reserves are 954 Bcf . Currently, the production of the second and fifth wells is discontinued because of the ingress of formation water. The gas production volume from five wells as of June 2009 is approximately 50mmcfd. For the fifth and second wells for which the production is discontinued, the renovation is planned. The excavation of the eighth well is newly planned. Four gas processing plants are operated and one plant is the Glycol type with processing capacity of 60 mmcfd, one plant is the silica gel type with the processing capacity of 70 mmcfd, and two plants are the silica gel type with the processing capacity of 45mmcfd.

(9) Beanbazar gas field (block 14)

Beanbazar gas field lies at a place 15km away from east of Kailashtilla gas field. The structure of the gas field was identified by PSOC in the beginning of the 1960s for the first time, however, Oil And Gas Development Corporation (OGDC) carried out the geological research later. In 1971, Plakla Seosmos carried out 12-polymerization seismic survey in this area. After the data was analyzed, the first well was excavated from 1980 to 1981 and the gas-containing sand stone configured with two layers (upper and lower) was confirmed. The scale of the structure is 12 km (north and south) and 7 km (east and west) and the height of the closure is 425m. The second well was excavated from 1988 to 1989 and the production was started in 1999, and the accumulated production volume by June 2009 is 57 Bcf and it is equivalent to 34% of recoverable reserves(170 Bcf). It is reported that the residual reserves are 113 Bcf. The production volume as of June 2009 is 15mmcfd from two wells. The silica gel type gas processing plant was transferred from Feni gas field and laid at the location 1 of this gas field. The test operation was carried out in May 1999 and the operation was started in July officially.

(10) Saldanadi gas field (block 9)

Saldanadi gas field lies in Brahmanbarai near the border of India 75km away from east of the capital Dhaka. Saldah anticline is a part of the large Rukhia structure, which extends north and south. BAPEX identified this structure based on the data of past seismic survey and excavated the first well in 1996. The gas-containing sandstone bed with two layers was confirmed and this gas field was discovered. The production was started in 1998 and the second well was excavated in 1999, however, the continuousness of the sandstone bed was not confirmed. Then, the production of the gas from two production well has been continued and 59Bcf gas has been produced by the end of June 2009. It is equivalent to approximately 51% of recoverable reserves (116 Bcf). The residual recoverable reserves are 57 Bcf. The gas production volume in June 2009 is 10 mmcfd.

(11) Fenchuganj gas field (block 14)

Fenchuganj gas field lies approximately 200km from northeast of the capital Dhaka and it is surrounded by Beanni Bazaar gas field in northeast, Bibiyana gas field in west, Molvi Bazar gas field in southeast, and Kailastila gas field in north. The existence of Fenchuganj anticline structure can be clearly confirmed in air photo and satellite photo etc. For the subsurface structure, the contour was identified by PPL as a result of analog seismic experiment in 1957. The test well was excavated in 1960, however, the gas was not discovered. Petrobangla got Prakla Seismos to take multi-polymerization digital seismic experiment record under the technical support of Germany and rewire the anticline structure drawing based on this record. As a result, it came out that the first well existed in southwest from the central part of the structure. Petrobangla excavated the second well from 1985 to 1986 and the depth reached 4,975m. As a result, the carbon hydride-containing sandstone bed with five layers was confirmed by the well logging analysis. The open hole test was conducted in five times and the production of the gas was confirmed. An existence of petroleum was also confirmed slightly in the lower layer. Then, the third well was excavated and the production was started in 2004. It is reported that the accumulated production volume by the end of June 2009 was 60Bcf. It is equivalent to approximately 21% of recoverable reserves (283 Bcf). The residual recoverable reserves are 223 Bcf. The production volume as of June 2009 is 27mmcfd.

(12) Shahbazpur gas field (block 10)

Shahbazpur gas field lies in Bhola area approximately 140km away from south of the capital Dhaka and the nearest gas field is Begumganj in a place 80km northwest of it. The unproduced gas field over the ocean and Kutubdia gas field lie approximately 100km away from south of this gas field. In this area, the seismic survey was carried out for the first time in the 1950s. To Atlantic Rich Field Co. (ARCO), the marine mine site of one zone including Bhola island was given and this company carried out the shallow-water seismic survey around the island and exploratory excavation, and then returned the mine site. Petrobangla carried out the seismic survey in this area from 1986 to 1987 and selected the excavation position. This company excavated the first well from 1993 to 1994, however, this company found an abnormal overpressured zone in the depth of 3,631m, so the excavation organization was held. The excavation organization was released using the coil tubing unit (CTU). The depth between 3,201m and 3,210m was tested using the CTU and the flow of the dry gas was confirmed. Continuously, the side track well in horizontal displacement of 250m from the same position of the first well was excavated the well up to 3,342m in 1995 and the existence of the gas sand was confirmed by well logging. The additional seismological measurement was carried out from 1995 to 1996. As a result, it came out that a raise of a structure existed in north. BAPEX reanalyzed the data of these seismic surveys with Unocal Corporation to evaluate the structure again. In 2001, the evaluation and the development project of this gas field were accepted by ECNEC. The main consumer of this gas field is Bhola, which is PDB that promotes the power station of 150MW. As the construction of the power station by PDB is not promoted, the production of the gas from this gas field was held up. However, the rental power station of 30MW that was laid in Bhola changed this situation. With the operation of this power station, the consumption of 10mmcfd is expected and it sees the light of the production, so the LTX gas processing plant of Meghna gas field was transferred to this gas field. Additionally, the excavation, the test and the completion of the second well were completed and the production was started. The gas production volume in November 2009 is 7mmcfd. The accumulated production volume by June 2009 is 0.1Bcf and the residual recoverable reserves are forecasted to be approximately 466 Bcf. Considering reserve amount, 70 mmcfd could be produced in near future.

(13) Jalalabad gas field (block 13) (IOC: Chevron)

Jalalabad gas field lies at the place approximately 200 km away from northeast of the capital Dhaka. Jalalabad structure was identified by Petrobangla under the technical support of Germany. This structure was selected as an excavation candidate for the multiple windz excavation project under the support of Germany, however, it was not realized. It was left without excavation for a long time. In 1987, PSC of this area including Jalalabad was given to Scimitar Oil and this company excavated the first well in 1989 to discover the gas. As a test result, the gas-containing sandstone bed of three layers was confirmed. The structure shows the anticline structure in SW-NE direction. The PSC of block 13 in Scimitar that fell due in 1995 was given to Occidental. Occidental excavated four additional wells by 1998, however, 3 wells in 4 wells were gas wells. Occidental started the production in February 1999. In this year, Unocal obtained the right of Occidental to become an operator. This company also laid 15km pipeline to gas processing plant and existing north and south Transmission lines. The accumulated production volume by June 2009 is 509 Bcf and it is equivalent to 61 % of recoverable reserves (837 Bcf). It is forecasted that the residual recoverable reserves are 328 Bcf. The production volume of this gas field as of June 2009 is 158 mmcfd. If current production continues, the reserve would be depleted within 3 to 4 years, however, Chevron is optimistic regarding future production based on their 3D seismic survey.

(14) Moulavi Bazar gas field (block 14) (IOC: Chevron)

MoulaviBazar gas field lies Kalapur, Srimangal, Moulavi Bazar area approximately 170km away from northeast of Dhaka. For this area, a lot of geological engineers have drawn geological survey maps according to each era. The southern part of the structure lay on India side, so the closure was not drawn within the territory of Bangladesh. As a result, it seemed that this area was not so attractive as a target of exploration. The digital multi-polymerization seismic survey was carried out under the technical support of Germany and a new structural drawing was shown. After the result of detailed inspection, it was decided that this structure had a value of exploration and it was selected as an exploration target of multiple windz excavation project funded by German government. However, this project was not realized. From 1990 to 1991, BAPEX carried out the additional seismic survey for covering this structure. In 1995, the mine sites of blocks 12, 13, and 14 were given to Occidental. In 1997, Occidental started excavating the first well, however, the gas sand of think layer was found in the depth of 840m and it blew out, so the work was discontinued. Unocal that took over the project from Occidental excavated the second well up to 3,510m in 1999 and confirmed the gas-containing sandstone bed of a few layers. The third well was also excavated in order to research the scale of the gas field. Then, Chevron that took over Unocal concluded the Purchase and Sales Agreement (GPSA) with Petrobangla in 2003 and added three production wells to start the production in 2005. This company also constructed the gas processing plant with the processing capacity of 150 mmcfd and laid 24km pipeline newly. The accumulated gas production volume by the end of June 2009 is 140 Bcf. It is equivalent to approximately 39% of recoverable reserves(360 Bcf). It is reported that the residual reserves are 220 Bcf. The gas production volume in June 2009 is 74mmcfd.

Cheveron Bibiyana gas plant
(2009/10/31)

Bibiyana gas plant south area
(2009/10/31)

(15) Bibiyana gas field (block 12) (IOC: Chereron)

Biniyana gas field lies in Habiganj area approximately 220km away from northeast of the capital Dhaka. The gas field shows the long anticline structure in north and south and the scale of the closure is 14km (L) and 4km (W). From 1997 to 1998, Occidental in US identified Bibiyana as a gas structure for the first time and excavated the first well in the next year, 1999. This company excavated the well up to 4,014m, however, the fallen object remained in the depth of 3,618m, so total six tests were conducted for the remaining of the upper part. The second well was also excavated by Occidental up to 4,276m and the test for the gas-containing sandstone bed at the lowest part was conducted. In the excavation of first two wells, the gas-containing sandstone bed of nine layers was confirmed. From 1998 to 1999, 3D seismic survey for Bibiyana structure was carried out. In 1999, Unocal obtained the right of mine sites of blocks 12, 13 and 14 from Occidental to become an operator.

Then, Chevron that took over the project from Unocal constructed five wells in south area, seven wells in north area, total twelve production wells and 600 mmcfd gas processing plant and laid 42km pipeline from gas processing plant to Muchai, and started the production in March 2007. The accumulated gas production volume by the end of June 2009 is 361 equivalent to approximately 15 % of recoverable reserves (2,401 Bcf). It is reported that the residual reserves are 2040 Bcf. The gas production volume as of June 2009 is 527 mmcfd, so it is the largest gas field in Bangladesh. However, the reserves are currently evaluated again and it may be upwardly revised widely.

(16) Sangu gas field (block 16) (IOC: Cairn)

UK-based Cairn Energy Plc. has been involved in petroleum / gas exploration development project in Bangladesh since 1994. After 2D seismic survey was carried out in the mine site of block 16 obtained by PSC, the first marine gas field was discovered in Bangladesh in 1996. The gas field lies on ocean approximately 45km away from southwest of the second city of Bangladesh, Chittagon. The platform for excavation was constructed on ocean with water depth of approximately 10m and total nine production wells were excavated. The production was started in 1998 by constructing the gas processing facility with the gas processing capacity of 520mmcfd at Chillimpur terminal in Chittagon and linking the platform and the gas processing facility with 20" pipeline. The mine mouth pressure that was 4,600 psi at first decreased to around 1,000psi currently. As of June 2009, six production wells produce approximately 50 mmcfd gas. The accumulated production volume by the end of June 2009 was 458 Bcf and it is equivalent to 92% of recoverable reserves (500 Bcf). It is forecasted that the residual recoverable reserves are 42 Bcf. The structure of the gas field is the anticline structure facing NW-SE direction, however, the top of the structure is filled with clastics. The reservoir is configured with the gas-containing sandstone bed of ten layers, however, the main component is the sandstone bed called SG.3155, which makes up 50% of structure. It is forecasted that the production from this gas field will be terminated in a few years.

(17) Bangola gas field (block 9) (IOC: Niko)

Bangola gas field lies 100km away from southeast of the capital Dhaka. Tullow Oil Plc has been involved in the petroleum / gas exploration activities in Bangladesh since 1997. In 2001, this company obtained PSC for the mine site of block 9. This company is the operator, however, it is the collaborative development by Tullow (30%), Niko (60%), and BAPEX (10%). The detailed information on the background and the structure of exploration is not obtained. It seems that Lalmi-Bangora large anticline structure has been identified by Tullow. The third well of Lalmi was excavated in May 2004 and a gas layer was discovered as a result of a test. The first well of Bongora was excavated in 40km away from north of the third well of Lalmi and it was excavated the well up to 3,636m and a gas-containing sandstone bed was discovered in the depth between 2,580m and 3,285m. The test result recorded the production capability of 25mmcfd. Then, the excavation of the fifth well was finished by May 2009 and the production was started (a part of production was started in April 2006). As Ashuganj-Bakhrabad pipeline is laid in the neighborhood, the gas is supplied through the gas processing plant with the processing capacity of 120 mmcfd. Currently, the result of production data and 3D seismic survey is generally studied including the relationship with Lalmi structure. The accumulated gas production volume by the end of June 2009 is 79 Bcf and it is equivalent to approximately 26 % of recoverable reserves (309 Bcf). It is reported that the residual recoverable reserves are 230 Bcf. The gas production volume in June 2009 was 87mmcfd.

(18) Feni gas field (block 15) (IOC: Niko)

Feni gas field lies approximately 125km away from the capital Dhaka. After obtaining 1-polymerization seismic experiment data carried out from 1975 to 1976, Taila Sandhani Company named this structure Feni. From 1979 to 1980, 2-polymerization analog seismic experiment was carried out and a new structural drawing was obtained. As a result, it was a long and thin anticline structure. In June 1960, the first well was excavated. The overpressured zone was found in the depth of 3,200m and the digging was stopped at this depth and the upper layer was evaluated. The gas-containing sandstone bed with two layers of upper and lower was confirmed in well logging and test. In 1991, Feni gas field started the production. The second well was excavated in 1994 and the production was started in 1995. However, the production was discontinued in 1998 because of ingress of formation water.

In 2003, Niko Resouces Ltd. signed the joint venture with BAPEX in order to promote the development and the production of Feni gas field and Chhatak gas field. Feni gas field and Chhatak gas field discontinued the production activities in 1996 and 1982, respectively. Niko Resouces Ltd. restarted the production in November 2004 and the production volume was recovered to 20mmcfd. Additionally, in January 2005, the production processing plant was reinforced. However, the activities are stopped after that. As of June 2009, the production volume is 3mmcfd. The accumulated production volume by the end of June 2009 is 62 Bcf equivalent to approximately 47% of recoverable reserves. It is reported that the residual reserves are 67 Bcf.

(19) Kamta gas field (block 9) (suspended)

Kamta gas field lies at Kaliganj in Gazipur area approximately 17km away from north of the capital Dhaka. This gas field was discovered by Petrobangla in 1982. The gas production was started in November 1984, however, the gas production volume that reached 20 mmcfd in the beginning of the production decreased gradually because of the ingress of water and decreased to 3 mmcfd in 1988. Then, the production volume kept decreasing, so the production was discontinued in 1991 until now. The accumulated production volume in this period is 21 Bcf and it is equivalent to approximately 42% of recoverable reserves (50Bcf). However, the residual recoverable reserves are 29 Bcf and the possibility of re-development in future is left.

(20) Chattak gas field (block 12) (suspended)

Chatak gas field lies at the place approximately 2.5 km away from northwest of Sylhet city. The structure of the gas field exists at the north end of Surma basin, which is the anticline structure in ESE-WNW direction. In 1959, PPL carried out the seismic survey of 75km. In 1959, the first well of Chatak was excavated up to 2135m and the gas-containing sandstone bed of nine layers was found in the depth between 1090m-1975m. In 1960, the gas production was started in Bangladesh for the first time. However, the gas production was discontinued since 1986 because of the ingress of formation water. It is reported that the accumulated production volume is 26 Bcf. The reserves have been reviewed by various organizations very frequently and the latest information reports that the residual recoverable reserves are 447 Bcf, so it seems that the considerable amount of gas is not recovered and the unrecovered gas may be recovered in future.

In 2000, Niko Resouces of Canada (Nico) focused on Chatak gas field and carried out the collective research for reserves with BAPEX. The legal issues outstanding between BAPEX and Nico regarding the Joint Venture Agreement (JVA) is going to be settled soon as the Govoerment has taken all out initiatives effort over the matter. Hence it is expected that the development program for Chhatak East can be initiated. The 3D seismic survey has already carried out in this field which has positive indications.

(21) Block 17 and 18

Exploration and development under PSC in Block # 17 and 18 is being uncertain because Total E & P left Bangladesh without any discovery. Recently Okland of USA has showed interest to carry out some study in these blocks. A new offshore bidding round needed to be invited by Petrobangla. If so, there might be some gas discovery which may lead to production form Block # 17 and 18.

5.1.2 Risk assessment and recommendation for stable supply to gas power plants

(1) Risk for Generation of Formation Water

Spring of formation water is a serious problem to collect natural gas under the ground. Collecting gas is suspended in many gas fields in Bangladesh due to increased formation water. High flowing bottom hole pressure is required to push excessive formation water flown into a well out to the ground by gas. It is often the case that, even a producing well currently in natural flow of gas should be closed due to a certain reason. It is, however, often that such producing well can no longer produce natural flow of gas due to deteriorated gas layers. In a gas layer, formation water slipped into it can block a path of gas to the well. Action of formation water imposes a great impact on gas production. Due to this, production control of gas wells in gas fields is very important. In order to systematically produce gas, gas wells must be controlled appropriately. For this sake, condition of gas production from a well must be understood correctly. In addition to daily monitoring and measurement (i.e. choke size, wellhead pressure, temperature, volume of gas, volume of liquid including water and condensates, etc.), bottom hole pressure should be measured regularly (normally once in 6 months) and fluid analysis should be made as well as production capacity tests should be implemented as required. By understanding gas production conditions, it is necessary to maintain gas production volume at an appropriate level and to control generation of formation water as much as possible. Unfortunately, in Bangladesh, the demand to gas is high and measuring bottom hole pressure by temporary suspending gas production is not made at many gas fields. Generally speaking, bottom hole pressure is monitored by drilling an observation well around a gas fields. Any gas field in the world isn't exempt from inflow of formation water after certain volume of gas has been produced. To delay the inflow as much as possible, it is essential to take measures from the onset of developing a gas well to finish a gas layer horizontally, rather than vertically. "Insertion"

Inflow of formation water could generate a plug of sand in sandstone beds to block a path of gas and thus, it is necessary to take a measure by using a special pipe filled with sand to prevent sands from flowing into a well. In addition, there is a way to minimize movement of formation water by injecting chemicals into a well. It is essential to examine how inflow of formation water should be blocked from various ways to keep a risk of suspension of gas production to a minimum.

(2) Risk for generation of sand

Generation of sand and clogging of gas production path arising from it as well as erosion of facilities used for collecting gas can progress in a rapid speed and can be a serious problem leading to suspension of gas production. Generation of sand is depending on the degree of density of sand layers, gas production paths and gas layer pressure. It is often triggered by generation of formation water. Erosion can occur frequently to safety valves in wells, wellhead facilities, chokes, bending part of flow lines where smooth flow is significantly hindered. Erosion caused by generation of sands decreases strength of facilities in a well and can be a cause of gas leakage.

For a gas layer consisting of sandstone layers, once sand starts flowing, it is difficult to stop it. In order to prevent it, sand flow prevention measures should be implemented in an assured manner when the layer is finished. In order to do so, it is extremely essential to learn the property of sand beforehand. Grain size analysis is one of them. Layer completion must be made in the most appropriate way judging from the sand data obtained beforehand.

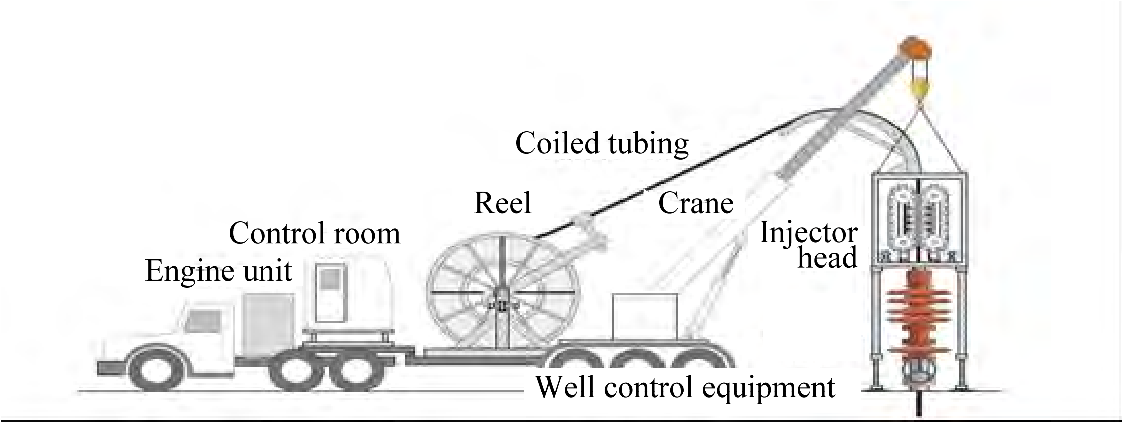
There are several ways in general to stop sand flow including mechanical method, chemical method and combination of the two. Mechanical method refers to make a bridge over loose sand stones to stop flowing out of sand. Use of gravel packs is the representative method of it. Chemical method refers to injecting epoxy or furane resins in a layer to artificially consolidate loose sandstones, which are otherwise referred to as plastic consolidation.

(3) Risk for generation of scales

Formation water generated along with collection of natural gas contains salts of calcium carbonate, calcium sulfate and barium sulfate. These salts can become scales in gas pipes and/or flow lines due to decrease in pressure and in temperature. The scales become deposits on inner surface of pipes narrow and block up the pipes completely, which impede gas production. These deposits have low solubility and removal of them is almost impossible.

In order to prevent this, periodical measurement of inner diameter of gas pipes and removal of scales are required. For this purpose, a hot acid is generally used. A magnesium bar is suspended in a well to pour hydrochloride acid with addictives. Part of the hydrochloride acid reacts with magnesium to generate heat. Remaining hydrochloride acid is warmed up and reacts with hydrate rapidly to dissolve it. However, barium sulfate that doesn’t react against hydrochloride acid should be removed mechanically. In this case, there is no way but removing hydrates using a coil tubing unit. When inhibitors that prevent generation of scales appropriately can be identified by such methods as water quality analysis, the inhibitors must be injected in the well periodically. Anyway, it is important to prevent deposit of scales by periodically measuring inner diameter of gas pipes.

APFig. 5-1 is an example of a trailer-mount type coil tubing device. Its performance is highly remarkable, because it is not only capable of removing scales but also used for other applications as well. To this sense, early introduction of it is wanted.



Source: Sekiyu Kaihatsu Jiho No.157 (08/05)

APFig. 5-1 Trailer-Mount Type Coil Tubing Device

(4) Risk of clogging due to clay minerals

Flowing of filtrated water of mud water and cement slurry into oil and gas layers containing clay minerals makes the clay minerals inflated and dispersed and cavities in the layers are clogged. If this happens, the rate of penetration of the layers downs. The inflation and dispersion are caused by attachment of water onto the surface and edges of clay minerals and between layers. Freshwater has a strong tendency to this, but seawater and oil barely cause the phenomenon. Once the rate of penetration is decreased, it is hard to recover it. Hence, it is necessary to carefully make a plan for drilling and completion. There are several ways to prevent this: (1) to curtail time for drilling and completion to reduce generation of filtrated water, (2) to reduce the specific gravity of mud water to narrow the gap between oil and gas layer pressure to reduce generation of filtrated water, (3) to form thin but strong mud walls to reduce generation of filtrated water, (4) to use mud water containing either salt or oil for layers that are easy to inflate or to disperse .

(5) Risk of clogging by solid substances

Solid substances contained in mud water (such as bentonite, baryte and slime) form a mud wall onto the well wall as mud water penetrates through oil and gas layers. If this happens, the solid substances clog cavities in oil and gas layers to reduce the rate of penetration of the layers. The depth of the affected areas will depend on difference between mud water column pressure and oil/gas layer pressure, etc. Typically it is said to be 2 to 30 cm. As the affected area will be perforated through and making deep holes in the layers, such impediment should normally be accepted. Measures to prevent this include decreasing the specific gravity of mud water t reduce pressure difference with oil/gas layer pressures and to mechanically separate solid substances from mud water at the same time.

(6) Risk for cementing failure

Cementing is an important process that could significantly impact on productivity of a well. Failure to do this could trigger various impediments. Failure to shield production layers from upper and lower layers can cause unnecessary generation of formation water, which leads to a decrease in productivity and in the ratio of collecting gas. To prevent occurrence of this, it is necessary to make and implement a well-established cementing plan.

(7) Risk of clogging of perforated holes

Perforated holes may sometimes be clogged causing a well unable to demonstrate its due production capacity. The cause of this include (i) clogging by iron scrap, cement, fine particles contained in mud water and rocks caused by drilling operation, (2) scales generated due to decreased temperature and pressure, (3) clogging by paraffin and asphalt contents. Measures against this include perforation using a perforator of large bore size and having strong drilling performance leaving no residual matters or to inject perforation fluid in the well in lieu of conventional one and to use through tubing perforator to drill a hole using pressure lower than that of oil/gas layers.

(8) Risk of freezing

Natural gas generated from gas layers are saturated with water. The temperature of gas at the well mouth is, generally, lower than that in gas layers. Thus, water in natural flow of fluids is condensed near the well mouth. The water in this state enters into a flow line. When there is a large decrease of pressure at the well mouth, gas will inflate causing its temperature further down. This generates water and/or gas hydrates in the flow line. This hinders flow of gas in the flow line. In the worst case of scenario, the line is totally clogged by it. Naturally, small bore pipes cause the pipe freezing phenomenon more serious than large bore pipes. When a pipe is partially narrowed by deposits of sands and gravels, the narrowing phenomenon increases and the pipe is finally totally clogged. In order to prevent clogging by freezing, there are no alternatives but removing water content in gas. Separation of water contents in gas starts when fluids pass through layers into the well and is accelerated as it goes through gas collection pipes, flow lines and above-ground facilities. On the above-ground, a 3-phase separator is used to separate oil/condensate, gas and water. The gas so separated will be subject to total removal of water contents using a dehumidification system before it is delivered to the market through flow lines. As gas in the pipeline from the well mouth to the separator hasn't been dehumidified, it is necessary to take anti-freezing measures. Typical measures include heating and injection of agents that prevents generation of hydrates (methanol and glycol, etc.) as well as decreasing gas pressure in pipes.

Chapter 6 Other Primary Energy APPENDIX

6.1 Renewable Energy Sector

6.1.1 Potentiality of Renewable Energy

Past investigations revealed that potential renewable energies available for use in the country include solar power, wind power, biomass and small-scale hydraulic power. Among them, solar power and biomass (incl. rice husk, baggasse and jute) are potentially and comparatively high as future power generation sources.

(1) Solar Power Generation

Located at 20.30° to 26.38° north, Bangladesh receives 4.0 to 6.5 kWh/m^2/day of average solar radiation. The solar radiation volume reaches its peak in March and April and its bottom in December and January. Bangladesh is a region suitable for solar power generation. However, the present cost for solar power generation is extremely expensive at 30 cents/kWh or higher and is uncompetitive with other power sources in terms of grid connection. The country is blessed with a solar power source, but the cost of power generation is basically high and has little chance to compete with other power sources in the case of connecting to power distribution systems. Due to this, it is necessary to receive subsidies to introduce solar power generation in the country. Actually, GEF, UNDP, WB, GTZ and KfW provide financial support for rural areas minus a grid connection.

(2) Wind Power Generation

Nationwide surveys are conducted to explore wind conditions. According to existing surveys, the average wind velocity at an altitude of around 25m above ground is low i.e. approx. 3.0 m/s to 4.5 m/s even during the monsoon period. Bangladesh has little places where wind condition is good for power generation. A separate survey, however, found several places along the coastal side that has a wind velocity of 6 m/s or above, which is suitable for wind power generation. Thus, although the past surveys are inaccurate, there seem to be potential sites with an average wind speed of 6 m/s or more which is a generally accepted as an economically viable point for wind-power generation. BPDB installed an experimental test plant to Muhuri Dam (Feni), one of such sites in September 2005. The plant consists of four 225 kW power generators, the total output power of 900 kW. GoB plans to invite a bid of 400 MW wind power generation plant but due to the low purchasing price (approx. 6 cents/kWh) it is estimated that only a small number of organizations would submit their bidding documents.

(3) Biomass Power Generation

Bangladesh is a producer of agricultural products namely rice, sugar cane and jute. Their residues are evaluated to be used as promising biomass resources for power generation. Even now, residues of agricultural products are effectively applied to multiple purposes including fuel, fertilizers and animal feeds. The residues are barely disposed as wastes.

(4) Hydropower Generation

Candidate places for small-scale hydropower generation plant having an output power of several hundred kilowatt that can be connected to electricity distribution systems have just been found and are located in the country's south-east areas (especially the hillside of Chittagong). An existing preliminary survey, however, indicates that hydropower generation requires a hefty amount of cost and hence it is not feasible to develop it as a project for profit.

Thus, there are a few places suitable for hydraulic power generation in Bangladesh. However, there exist suitable places for hydraulic power generation with mountain ranges of 1000 - 2000 m in height located in the East and North of Bangladesh as shown below.

Source: GRAND NEW WORLD ATLAS

APFig. 6-1 Map of Bangladesh (Northern, Eastern)

According to the Central Electricity Authority (CEA) of India, the hydraulic power potential in northeast India is considerably large (more than 60000 MW). The hydraulic power potential in regions surrounding Bangladesh has been reported as follows.

APTable 6-1 Hydraulic Power Potentials in Regions Surrounding Bangladesh (March 2008)

(Unit: MW)

State	Potential	Developed/ Under construction	Not developed	Under 50000MW initiative
Meghalaya	2,394	309	2,085	931
Manipur	1,784	105	1,679	362
Mizoram	2,196	0	2,196	1,500
Total	6,374	414	5,960	2,793

Source: Central Electricity Authority (CEA) of India

Undeveloped hydraulic power potentials of about 6000 MW exist in the regions surrounding Bangladesh. CEA has already prepared a Preliminary Feasibility Report for 2800 MW of the above undeveloped hydraulic power potential as part of the 50,000 MW initiative.

If hydropower generation is developed on a relatively large scale (100 MW or more) in such regions, the generated electric power will not be completely consumed in the northeastern provinces in the rainy season. Thus, the electric power will need to be transmitted to major power-consuming areas such as Kolkata. In considering this point, it is likely to be more economical to connect to the grid on the Bangladesh system to transmit electricity to Bangladesh in the rainy season.

Another issue is that most of those potentials exist in the basin of the River Barak (Bangladeshi name: River Kushiyara/Meghna) on the Bangladeshi side of the mountain ranges. Given that the rainwater that falls on the Bangladeshi side of the mountain areas is flowing into the sea via

Bangladesh, hydropower development on a relatively large scale will cause no little impact to Bangladesh.

In light of these points, it is recommended that the Bangladesh side requests the India side to set up a forum for discussion on hydropower development on a relatively large scale and encourage India to participate in the joint development by having both countries fully take advantage of such an opportunity.

The most effective means of joint development is to connect a part of the developed units directly to the Bangladeshi system by changing the number of connected units according to the supply-demand situation of the two countries. The hydraulic generator responds more promptly to load changes than the thermal generator. The hydraulic generator is therefore more responsive than the thermal generator to frequency changes associated with load changes under normal conditions and is more resistant to the system disturbance that occurred in facility failures. Accordingly, connecting the hydraulic generator directly to the system will strengthen the system and contribute to the improvement of electric power quality.

(5) Waste Power Generation

In Bangladesh, the per capita generation of waste is around 0.4 kg/day to 0.5 kg/day in city areas, and around 0.15 kg/day in rural areas. As there is an abundant amount of waste generated in city areas, this waste can be a very good energy source in city areas. If the per capita waste generation is 0.24 kg/day (0.01 kg/hour), the total population is 140 million, and the waste calorie is 1500 kcal/kg, the electric power generated by inputting all waste into power generation is estimated to be approximately 700 MW per hour by simple arithmetic. Thus, much cannot be expected from waste power generation. In addition, the generation of waste usable for power generation is predicted to further decrease with the progress in waste segregation and recycling.

Proposals to establish power plants (output power: 100 MW each) using wastes in such large cities as Dhaka, Chittagong, Khulna and Rajshahi are submitted to GoB, but there has been no progress seen since then.

6.1.2 Assistance from International and ODA Agencies

Donors extend loans and/or provide technical assistance mainly to the off-grid solar power development for the rural electrification in Bangladesh. Projects of each donor are as follows:

(1) UNDP

UNDP provided financial assistance for the “Sustainable Rural Energy Project” executed between 1998 and 2006. The objective of the project, implemented by the Local Government Engineering Department, was the development of a community-based rural electrification model by renewable energy. To achieve that, there were three components of activities under the project:

- Demonstration of renewable energy technologies (RETs)
- Capacity building through training on RETs
- Development of a renewable energy information network

As a result, 40.5kW solar energy, 10kW wind-solar hybrid energy, 15.5kW biomass energy and 10kW microhydro energy were developed and the web site for wide dissemination of renewable energy technologies, named Renewable Energy Information Network (REIN), opened[1].

(2) World Bank, GEF

The World Bank has supported “Rural Electrification and Renewable Energy Development Project” and the “Grameen Shakti Solar Home Systems Project”.

The Rural Electrification Board (REB) and the state-owned Infrastructure Development. Co. Ltd. (IDCOL) are the implementing agencies of “Rural Electrification and Renewable Energy Development Project” and aims to achieve rural electrification via the grid extension and

[1] http://www.lged-rein.org/

dissemination of the Solar Home System (SHS). There are two program schemes for installation of SHS, one is the public program by REB and the other is IDCOL's program with its microfinance, implemented through 23 registered private partner organizations. "Grameen Shakti Solar Home Systems Project" supports the activities by Grameen Shakti, one of the partner organizations.

World Bank approved to provide financial assistance with $190.98 million in 2002 and, given the successful implementation of the IDCOL program, additional assistance with $130 million with grant aid by GEF in 2009. Following the same project design, KfW and GTZ also started to support the project by providing grant funds for technical assistance. The latest IDCOL target is to finance 1 million SHSs by the end of year 2012 and a total of 645,033 SHSs have already been installed under the program by August 2010. Under this assistance, World Bank signed an Emissions Reduction Purchase Agreement with IDCOL and Grameen Shakti.

(3) KfW, GTZ

KfW and GTZ supports SHS program on the basis of successful support by IDCOL.

(4) ADB

In 2008, ADB and GoB signed a loan agreement of $165 million for the Public-Private Infrastructure Development Facility and $33 million of that was for the promotion of renewable energy through IDCOL's renewable energy program.

(5) USAID

In 2000, USAID gave Grameen Shakti a grant equivalent to $4.0 million and 38,500 SHSs were installed in various parts of Bangladesh successfully by the time the project ended in August 2005. USAID continues the support for Grameen Shakti program with $2.0 million in funding to focus on rural women economical empowerment by training to install and maintain a Solar Home System.

Chapter 9 Power System Analysis APPENDEX

APTable 9-1 Result of each substation demand forecast (MW)

East or West	Region	Name of Grid Substation	2015	2020	2025	2030
East	Southern	Chandraghona	33.7	70.9	112.8	160.9
East	Southern	Hathazari	55.3	93.8	132.3	174.5
East	Southern	Baroirhat, Ctg	63.3	112.1	162.3	218.2
East	Southern	Madunaghat	89.2	147.9	205.3	267.8
East	Southern	Sikalbaha	64.7	113.9	164.4	220.6
East	Southern	Dohazari	51.7	87.6	123.5	162.9
East	Southern	Cox’s bazar	63.9	101.0	135.4	172.1
East	Southern	Halishahar	54.4	81.8	105.5	129.9
East	Southern	Agrabad	60.1	94.5	126.3	160.1
East	Southern	Kulsi	65.4	106.1	145.1	187.3
East	Southern	Abul Khair Steel Mills	38.3	69.2	101.4	137.4
East	Southern	Baraulia	60.6	104.6	149.2	198.4
East	Southern	Bakulia	74.9	129.0	183.6	243.8
East	Southern	Julda	29.3	46.9	63.5	81.3
East	Southern	Shahmirpur	19.4	52.6	92.5	139.3
East	Southern	Rangamati	34.4	72.9	116.4	166.3
East	Southern	Feni	58.0	98.6	139.1	183.6
East	Southern	Chowmuhani	48.6	68.5	83.6	98.0
East	Southern	Khagrachari	60.7	108.5	158.1	213.4
East	Southern	Ramganj	66.0	115.7	166.6	223.0
East	Southern	Chouddagram	50.3	81.3	110.8	142.6
East	Southern	Comilla (N)	75.6	151.6	235.7	331.4
East	Southern	Comilla (S)	56.9	99.1	142.1	189.7
East	Southern	Chandpur	59.6	105.5	152.9	205.6
East	Southern	Daudkandi	58.7	105.8	154.9	209.8
East	Southern	Kaptai	12.3	24.4	37.6	52.6
East	Southern	Bakulia	74.9	129.0	183.6	243.8
East	Southern	Chandpur	59.6	105.5	152.9	205.6
East	Southern	Chouddagram	50.3	81.3	110.8	142.6
East	Southern	Feni	58.0	98.6	139.1	183.6
East	Southern	Kulsi	65.4	106.1	145.1	187.3
East	Southern	Agrabad	60.1	94.5	126.3	160.1
East	Southern	Halishahar	54.4	81.8	105.5	129.9
East	Southern	Dohazari	51.7	87.6	123.5	162.9
East	Southern	Comilla (S)-2	56.9	99.1	142.1	189.7
East	Dhaka	Haripur	66.6	129.9	198.9	277.3
East	Dhaka	Siddhirganj	69.8	97.1	117.0	135.6
East	Dhaka	Moghbazar	56.8	90.0	121.0	154.1
East	Dhaka	Maniknagar	63.5	102.2	139.0	178.5
East	Dhaka	Ullon	80.7	135.5	189.8	249.3
East	Dhaka	Dhanmondi	82.9	138.5	193.4	253.3
East	Dhaka	Narinda	69.6	107.4	141.5	177.2

East or West	Region	Name of Grid Substation	2015	2020	2025	2030
East	Dhaka	Matuail	54.9	112.7	177.2	251.0
East	Dhaka	BangaBhaban	95.3	155.4	213.1	275.6
East	Dhaka	Shyampur	84.9	128.2	165.8	204.7
East	Dhaka	Madanganj	70.9	122.3	174.3	231.7
East	Dhaka	Hasnabad	92.9	151.5	207.9	269.0
East	Dhaka	Sitalakhya	98.1	181.6	270.2	369.8
East	Dhaka	Meghnaghat	56.7	103.1	151.7	206.2
East	Dhaka	Gulshan	79.6	144.0	211.5	286.9
East	Dhaka	Munshiganj	76.2	129.5	182.8	241.3
East	Dhaka	Kamrangirchar	96.6	195.4	304.8	429.8
East	Dhaka	Hasnabad	92.9	151.5	207.9	269.0
East	Dhaka	Mirpur	81.1	137.2	193.0	254.2
East	Dhaka	NewTongi	90.6	140.7	186.2	234.3
East	Dhaka	Kalyanpur	56.6	106.4	159.8	219.9
East	Dhaka	Uttara	97.2	175.8	258.0	349.9
East	Dhaka	Basundhara	71.5	123.9	177.1	235.9
East	Dhaka	Tongi	56.6	99.2	142.8	191.3
East	Dhaka	Kabirpur	64.3	129.9	202.6	285.7
East	Dhaka	Manikganj	61.3	107.3	154.5	206.8
East	Dhaka	Tangail	82.6	146.1	211.6	284.5
East	Dhaka	Ghorasal	87.2	142.5	195.8	253.4
East	Dhaka	Narsingdi	77.5	131.3	184.9	243.7
East	Dhaka	Joydebpur	50.9	91.1	132.8	179.3
East	Dhaka	Bhulta	55.0	85.4	112.9	141.8
East	Dhaka	Savar	57.9	91.5	122.8	156.1
East	Dhaka	Purbachal	19.4	52.6	92.5	139.3
East	Dhaka	Madartek	75.8	128.9	182.1	240.5
East	Dhaka	Nabinagar(Md.pur)	64.5	100.5	133.4	168.1
East	Dhaka	DhakaUniversity	82.9	138.5	193.4	253.3
East	Dhaka	Cantonment	80.3	135.1	189.3	248.7
East	Dhaka	OldAirport	67.8	105.0	138.7	174.0
East	Dhaka	Sreepur	86.6	143.6	199.4	260.0
East	Dhaka	Savar	57.9	91.5	122.8	156.1
East	Dhaka	Matuail	54.9	112.7	177.2	251.0
East	Dhaka	Kamrangirchar	96.6	195.4	304.8	429.8
East	Dhaka	OldAirport	67.8	105.0	138.7	174.0
East	Dhaka	Nabinagar(Md.pur)	64.5	100.5	133.4	168.1
East	Dhaka	Joydebpur	50.9	91.1	132.8	179.3
East	Dhaka	Tangail	82.6	146.1	211.6	284.5
East	Dhaka	Manikganj	61.3	107.3	154.5	206.8
East	Dhaka	Kabirpur	64.3	129.9	202.6	285.7
East	Dhaka	Tongi	56.6	99.2	142.8	191.3
East	Dhaka	Kalyanpur	56.6	106.4	159.8	219.9
East	Dhaka	Shyampur	84.9	128.2	165.8	204.7
East	Dhaka	Moghbazar	56.8	90.0	121.0	154.1

East or West	Region	Name of Grid Substation	2015	2020	2025	2030
East	Dhaka	Siddhirganj	69.8	97.1	117.0	135.6
East	Dhaka	Uttara-2	97.2	175.8	258.0	349.9
East	Dhaka	Gulshan-2	79.6	144.0	211.5	286.9
East	Dhaka	Basundhara-2	71.5	123.9	177.1	235.9
East	Dhaka	Basundhara-3	71.5	123.9	177.1	235.9
East	Dhaka	Narinda-2	69.6	107.4	141.5	177.2
East	Central	Ashuganj	48.0	82.1	116.5	154.3
East	Central	Kishoreganj	79.4	130.4	179.7	233.3
East	Central	Mymensingh	65.2	103.5	139.2	177.4
East	Central	Jamalpur	98.8	197.4	306.1	430.0
East	Central	Netrokona	55.9	92.0	127.1	165.1
East	Central	Bhaluka	73.3	125.6	178.2	236.1
East	Central	Sherpur	71.3	122.9	175.0	232.5
East	Central	Brahmanbaria	54.7	100.4	148.6	202.7
East	Central	Shahjibazar	76.9	125.2	171.7	222.0
East	Central	Sreemangal	55.4	85.0	111.6	139.3
East	Central	Fenchuganj	55.7	89.7	121.8	156.4
East	Central	Sylhet	66.8	123.8	184.2	252.1
East	Central	Chhatak	55.7	91.5	126.1	163.6
East	Central	Sylhet-2	52.0	83.5	113.4	145.6
East	Central	Sylhet-2	52.0	83.5	113.4	145.6
East	Central	Sylhet	66.8	123.8	184.2	252.1
West	Western	Goalpara	21.4	49.1	81.1	118.1
West	Western	Khulna(C)	67.3	101.2	130.5	160.7
West	Western	Chuadanga	62.7	105.0	146.7	192.2
West	Western	Noapara	61.9	104.6	147.0	193.5
West	Western	Jessore	71.3	101.3	124.3	146.5
West	Western	Jhenaidah	55.0	84.0	109.7	136.6
West	Western	Kustia(Bottail)	59.7	96.9	132.4	170.8
West	Western	Magura	62.7	105.0	146.7	192.2
West	Western	Bheramara&GKProject	49.0	77.7	104.3	132.7
West	Western	Faridpur	95.2	152.2	205.8	263.3
West	Western	Gopalganj	45.9	85.5	127.6	175.0
West	Western	Madaripur	50.8	85.3	119.5	156.8
West	Western	Barisal	56.5	93.2	128.9	167.6
West	Western	Bhandaria	58.0	101.3	145.4	194.3
West	Western	Bagerhat	63.3	104.1	143.5	186.4
West	Western	Barisal (N)	59.1	100.0	140.8	185.6
West	Western	Mongla	35.6	63.5	92.5	124.8
West	Western	Gallamari	62.7	105.0	146.7	192.2
West	Western	Patuakhali	84.9	153.3	224.9	304.8
West	Western	Satkhira	65.5	111.5	157.6	208.2
West	Western	Madaripur	50.8	85.3	119.5	156.8
West	Western	Jessore	71.3	101.3	124.3	146.5
West	Western	Khulna(C)	67.3	101.2	130.5	160.7

East or West	Region	Name of Grid Substation	2015	2020	2025	2030
West	Northern	Ishurdi	49.5	86.6	124.4	166.4
West	Northern	Natore	51.9	88.4	124.9	165.0
West	Northern	Niamatpur	73.0	125.1	177.6	235.5
West	Northern	Rajshahi	73.0	144.5	223.2	312.7
West	Northern	Ch. Nowabganj	87.2	148.2	209.3	276.4
West	Northern	Rajshahi New	71.7	123.4	175.5	233.1
West	Northern	Pabna	72.1	112.4	149.0	187.8
West	Northern	Shahjadpur	75.8	131.4	187.8	250.2
West	Northern	Sirajganj	65.1	113.7	163.3	218.3
West	Northern	Bogra	68.5	117.5	166.9	221.4
West	Northern	Joypurhat	76.2	129.5	182.8	241.3
West	Northern	Noagaon	99.2	192.1	293.1	407.6
West	Northern	Palashbari	61.8	115.8	173.5	238.5
West	Northern	Rangpur	56.8	97.6	138.8	184.2
West	Northern	Lalmonirhat	82.9	143.5	205.0	272.9
West	Northern	Saidpur	81.6	112.9	135.1	155.7
West	Northern	Purbasadipur	95.2	162.3	229.5	303.5
West	Northern	Panchaghar	60.7	108.5	158.1	213.4
West	Northern	Thakurgaon	82.1	166.5	260.1	367.1
West	Northern	Barapukuria	74.0	126.5	179.3	237.3
West	Northern	Rangpur	56.8	97.6	138.8	184.2
West	Northern	Bogra	68.5	117.5	166.9	221.4
West	Northern	Bogra	68.5	117.5	166.9	221.4
West	Northern	Sirajganj	65.1	113.7	163.3	218.3
West	Northern	Natore	51.9	88.4	124.9	165.0
Total			10282.95	17599.58	24955.58	33056.969

Source: PSMP Study Team

APTable 9-2 The list of generators for system analys

Station Name	2015 Heavy Load	2015 Light Load	2020 Heavy Load	2025 Heavy Load	2030 Heavy Load	2030 Light Load	Bus Number
Barapukuria 2x125 MW ST	200	200	200	200	200	200	2042
Barapukuria 250MW (3rd unit)	250	0	250	250	250	0	2042
B-K-D-P 1 600MW #1	0	0	600	600	600	0	4507
B-K-D-P 1 600MW #2	0	0	600	600	600	0	4507
B-K-D-P 1 600MW #3	0	0	600	600	600	0	4507
B-K-D-P 2 600MW #1	0	0	0	600	600	0	4507
B-K-D-P 2 600MW #2	0	0	0	600	600	0	4507
B-K-D-P 2 600MW #3	0	0	0	0	600	0	4507
B-K-D-P 3 1000 MW #1	0	0	0	0	1000	0	4507
B-K-D-P 3 1000 MW #2	0	0	0	0	1000	0	4507
B-K-D-P 4 1000 MW #1	0	0	0	0	1000	0	4507
B-K-D-P 4 1000 MW #2	0	0	0	0	1000	0	4507
B-K-D-P 5 1000 MW #1	0	0	0	0	1000	0	4507
B-K-D-P 5 1000 MW #2	0	0	0	0	1000	1000	4507
Khulna South 600 MW ST #1	0	0	600	600	600	0	4051
Khulna South 600 MW ST #2	0	0	600	600	600	0	4051
Chittagong 600 MW ST #1	0	0	600	600	600	0	4026
Chittagong 600 MW ST #2	0	0	600	600	600	0	4026
Chittagong South 600MW #1	0	0	600	600	600	0	4026
Matarbari 600MW #1	0	0	0	600	600	0	4509
Matarbari 600MW #2	0	0	0	600	600	0	4509
Matarbari 600MW #3	0	0	0	0	600	0	4509
Matarbari 600MW #4	0	0	0	0	600	600	4509
Megnagatt 600MW #1	0	0	0	0	600	0	2014
Mawa 600MW #1	0	0	0	0	600	0	4505
Zajira 600MW #1	0	0	0	0	600	0	4506
Siddhirgonj 210 MW ST #1	177	0	177	177	177	0	2004
Ghorasal 4x210 ST #6	178	0	178	178	0	0	2010
Ghorasal 4x210 ST #5	178	0	178	178	0	0	2010
Ghorasal 4x210 ST #4	178	0	178	0	0	0	2010
Ghorasal 4x210 ST #3	178	0	178	0	0	0	2010
Ashuganj 3x150 MW ST #5	120	0	120	0	0	0	2008
Ashuganj 3x150 MW ST #4	120	0	120	0	0	0	2008
Ashuganj 3x150 MW ST #3	120	0	120	0	0	0	2008
Raozan 2X210 ST#2	175	0	175	175	0	0	2001
Raozan 2X210 ST#1	175	0	175	175	0	0	2001
Ghorasal 2x55 ST #1	50	0	0	0	0	0	1130
Ghorasal 2x55 ST #2	30	0	0	0	0	0	1130
Ashuganj 2x64 MW ST #2	0	0	0	0	0	0	1201
Ashuganj 2x64 MW ST #1	0	0	0	0	0	0	1201
Chittagon (Sikalbaha) 60 MW ST	0	0	0	0	0	0	1006
NEPC, Haripur BMPP	110	0	0	0	0	0	1101
Jangalia, comilla SIPP	0	0	0	0	0	0	1031
Tangail SIPP (22 MW)	0	0	0	0	0	0	1128
Feni SIPP	0	0	0	0	0	0	1020

Station Name	2015 Heavy Load	2015 Light Load	2020 Heavy Load	2025 Heavy Load	2030 Heavy Load	2030 Light Load	Bus Number
Barobkundo SIPP	0	0	0	0	0	0	1006
Kumargao 10 MW (15 Years)	0	0	0	0	0	0	1215
Hobiganj,Feni, Rupganj, Mouna, Narsindi, Ullapara, SIPP, REB	0	0	0	0	0	0	
Chandina,Mahdabdi,AshuliaSummit , REB	0	0	0	0	0	0	
Kumargoan 48MW (3 Years)	0	0	0	0	0	0	1215
West Mount Baghabari BMPP	70	0	0	0	0	0	1412
Sahzibazar RPP (3 Years)	0	0	0	0	0	0	1211
Sahzibazar RPP (15 Years)	86	0	86	0	0	0	1211
Tongi 100 MW GT	100	0	100	100	0	0	1125
Baghabari 100 MW CT	99	0	99	0	0	0	1412
Baghabari 100 MW CT (Repowering)	0	0	0	165	0	0	1412
Baghabari 71 MW CT	70	0	0	0	0	0	1412
Shahjibazar GT 7 units	0	0	0	0	0	0	1211
Shahjibazar2x35 MW CT #2	0	0	0	0	0	0	1211
Shahjibazar2x35 MW CT #1	0	0	0	0	0	0	1211
Chittagon (Sikalbaha) BMGT	0	0	0	0	0	0	1006
Haripur 3x33 CT #3	0	0	0	0	0	0	1101
Haripur 3x33 CT #2	0	0	0	0	0	0	1101
Haripur 3x33 CT #1	0	0	0	0	0	0	1101
Sylhet 20 MW CT	0	0	0	0	0	0	1215
Ashuganj CT 56 MW	0	0	0	0	0	0	1201
CDC, Haripur	360	360	360	360	0	0	2015
CDC, Meghnaghat	450	0	450	450	0	0	2014
Mymenshing (RPC) 210 MW CC	175	175	175	175	175	175	1208
Fenchuganj CC	88	0	88	0	0	0	1214
Ashuganj 90 MW CC	0	0	0	0	0	0	1201
Ghorasal, Dual Fuel, Peaking Plant	290	0	290	290	290	290	2010
Kaliakair, Dual Fuel, Peaking Plant	100	0	100	100	0	0	1147
Savar, Dual Fuel, Peaking Plant	100	0	100	100	0	0	1135
Ashuganj – 3 yrs Rental, commissioned	0	0	0	0	0	0	1201
Fenchuganj (15 Years), commissioned	51	0	51	51	0	0	1214
Ashuganj 50	52	0	52	52	52	52	1201
Comilla Peaking, Dual Fuel, Peaking Plant	50	0	50	50	0	0	1030
Fenchuganj – 3 Yrs rental, U/C	0	0	0	0	0	0	1214
Bhola (3 Years), Commissioned	0	0	0	0	0	0	1328
Bogra –3 yrs rental, U/C	0	0	0	0	0	0	1415
Siddhirgonj 2X150 MW CT	450	0	450	450	450	0	2004
Ashuganj 150 MW	150	0	150	150	150	0	1201
Khulna 150MW , Dual Fuel, Peaking Plant	150	0	150	150	150	0	1303
Sikalbaha 150MW Peaking Plant, U/C	149	0	149	149	149	0	1006
Sirajganj 150MW , Dual Fuel, Peaking Plant	150	0	150	150	150	0	2036
Siddhirgonj 2X120 MW Peaking Plant (U/C)	208	0	208	208	208	0	1102
Keraniganj, 750 MW, CC	0	0	750	750	750	750	2504
Meghnaghat Large #1, 750 MW, CC	0	0	750	750	750	750	2014
Meghnaghat Large #2, 750 MW, CC	0	0	750	750	750	750	2014
Ashuganj 450 MW CCPP	0	0	450	450	450	450	2008
Bibiana 450 MW CCPP(Ist Unit)	450	450	450	450	450	450	4054
Bibiana 450 MW CCPP(2nd Unit)	450	450	450	450	450	450	4054

Station Name	2015 Heavy Load	2015 Light Load	2020 Heavy Load	2025 Heavy Load	2030 Heavy Load	2030 Light Load	Bus Number
Meghnaghat CCPP (2nd unit) Dual Fuel	450	450	450	450	450	450	2014
North Dhaka 450MW CCPP	0	0	450	450	450	450	4047
Serajganj 450 MW CCPP	450	450	450	450	450	450	2036
Bheramara 360 MW CCPP (NWPGC)	360	360	360	360	360	360	2044
Haripur 360 MW CCPP (EGCB)	360	360	360	360	360	360	1101
Bhola 150MW CCPP(Ist unit), BPDB	150	0	150	150	150	150	2055
Chandpur 150 MW CCPP (BPDB), U/C	150	150	150	150	150	150	1032
Sylhet 150 MW CCPP (BPDB), U/C	150	150	150	150	150	150	1215
Fenchuganj CC(2nd Phase), U/C	108	108	108	108	108	108	1214
Bhola CCPP(2nd unit)	225	225	225	225	225	225	2055
Madanganj,Keraniganj CCPP Dual Fuel	225	225	225	225	225	225	1112
Sikalbaha 225 MW Dual Fuel, CC	225	225	225	225	225	225	2009
Khulna 60 MW ST	33	0	0	0	0	0	1301
khulna 110 MW ST	54	54	0	0	0	0	1301
Syedpur Peaking Plant	100	0	100	100	0	0	1425
Jamalpur Peaking Plant	100	0	100	100	0	0	1204
Chapai Nababgonj Peaking Plant	100	0	100	100	0	0	1406
Khulna Peaking Plant	100	0	100	100	0	0	1332
Dohazari Peaking Plant	100	0	100	100	100	0	1008
Hathazari Peaking Plant	100	0	100	100	100	0	1003
FaridpurPeaking Plant	50	0	50	50	50	0	1313
Baghabari Peaking Plant	50	0	50	50	50	0	1412
Katakhali Peaking Plant	50	0	50	50	50	0	1405
Santahar Peaking Plant	50	0	50	50	50	0	1417
BPDB & RPCL, 150MW	150	0	150	150	150	0	1208
Khulna(quick rental)	115	0	0	0	0	0	1301
Modanganj(quick rental)	102	0	0	0	0	0	1112
Gopalgonj Peaking Plant	100	0	100	100	100	0	1314
Julda(quick rental)	100	0	0	0	0	0	1017
Kadda, Meghna(quick rental)	100	0	0	0	0	0	1115
Kadda, Sidhirganj(quick rental)	100	100	0	0	0	0	1102
Keranigong(quick rental)	100	0	0	0	0	0	1119
Meghnagat(quick rental)	100	0	0	0	0	0	1115
Noapara, Jessore, Rental, U/C	100	0	0	0	0	0	1306
Bera, Pabna, Peaking Plant	70	0	70	70	70	0	1410
Shikalbaha – 3 yrs rental, commissioned	0	0	0	0	0	0	1006
Barisal, Rental,U/C	50	0	0	0	0	0	1320
Chapai Nawabgonj(quick rental)	50	0	0	0	0	0	1406
Doudkandi	50	0	50	50	50	0	1033
Gazipur 50 MW	50	0	50	50	50	0	1132
Katakhali(quick rental)	50	0	0	0	0	0	1405
Katakhali, Rajshahi, Peaking Plant	50	0	50	50	0	0	1405
Noapara(quick rental)	0	0	0	0	0	0	1305
Raujan 20 MW	0	0	0	0	0	0	
Tangail 20 MW	0	0	0	0	0	0	1128
Chandpur 15 MW	0	0	0	0	0	0	1032
Narayanganj 30MW	0	0	0	0	0	0	1032
Keraniganj Peaking	0	0	0	0	200	0	1119

Station Name	2015		2020	2025	2030		Bus
	Heavy Load	Light Load	Heavy Load	Heavy Load	Heavy Load	Light Load	Number
Bogra Peaking	0	0	0	100	100	0	1415
Comilla Peaking	0	0	100	100	100	0	1031
Daudkandi Peaking	0	0	0	0	100	0	1106
Jessore Peaking	0	0	100	100	100	0	1306
Jhenaidah Peaking	0	0	0	100	100	0	1307
Halishahar Peaking	0	0	0	100	100	0	1011
Khulna Center Peaking	0	0	0	100	100	0	1302
Ashuganj Peaking	0	0	200	200	200	0	2008
Mymensingh Peaking	0	0	0	0	100	0	1203
Rajshahi Peaking	0	0	0	0	100	0	1405
Rangpur Peaking	0	0	0	0	100	0	1420
Khulna Rental (3 Years)	0	0	0	0	0	0	1301
KPCL, Khulna BMPP	106	0	0	0	0	0	1301
Rangpur 20MW CT	19	0	0	0	0	0	1420
Saidpur 20MW CT	19	0	0	0	0	0	1425
Barisal 2x20MW CT #1	0	0	0	0	0	0	1320
Barisal 2x20MW CT #2	0	0	0	0	0	0	1320
Bheramara 3x20 MW CT #1	0	0	0	0	0	0	1310
Bheramara 3x20 MW CT #2	0	0	0	0	0	0	1310
Bheramara 3x20 MW CT #3	0	0	0	0	0	0	1310
Barisal Diesel (9 units)	0	0	0	0	0	0	1320
Bhola Diesel	0	0	0	0	0	0	1328
Bhola Diesel (New)	0	0	0	0	0	0	1328
Ghorashal (quick rental)	0	0	0	0	0	0	2010
Bheramara, Rental , U/C	0	0	0	0	0	0	1310
Siddirganj(quick rental)	0	0	0	0	0	0	1102
Khulna(quick rental)	0	0	0	0	0	0	1301
Pagla, Narayaganj(quick rental)	0	0	0	0	0	0	
Thakurgao, Rental, U/C	0	0	0	0	0	0	1432
Karnafuli hydro power plant #1	40	40	40	40	40	40	1001
Karnafuli hydro power plant #2	40	40	40	40	40	40	1001
Karnafuli hydro power plant #3	50	50	50	50	50	50	1001
Karnafuli hydro power plant #4	50	50	50	50	50	50	1001
Karnafuli hydro power plant #5	50	50	50	50	50	50	1001
Karnafuli Hydro (#6&7, 2x50 MW)	0	0	0	100	100	100	1001
Sarishabari, Jamalpur	0	0	0	0	0	0	1204
Rajabarihat Goat Development Firm	0	0	0	0	0	0	1405
Kaptai Power Plant	0	0	0	0	0	0	1001
Patenga Offshore, Chittagong	100	100	100	100	100	100	1011
Rooppur Nuclear # 1, 1000 MW	0	0	1000	1000	1000	1000	4508
Rooppur Nuclear # 2, 1000 MW	0	0	1000	1000	1000	1000	4508
Rooppur Nuclear # 3, 1000 MW	0	0	0	1000	1000	1000	4508
Rooppur Nuclear # 4, 1000 MW	0	0	0	0	1000	0	4508
PALLATANA to COMILLA	0	0	0	250	250	0	2005
SILCHAR to FENCHUGANJ 1	0	0	0	750	750	750	2065
BAHARAMPUR to BHERAMARA Phase-1	500	0	500	500	500	500	2044
BAHARAMPUR to BHERAMARA Phase-2	0	0	0	500	500	0	2044
Hydro from Nepal (Kishanganj (PURNIA) to Bogra)	0	0	0	500	500	500	2040

Station Name	2015 Heavy Load	2015 Light Load	2020 Heavy Load	2025 Heavy Load	2030 Heavy Load	2030 Light Load	Bus Number
Hydro from Bhutan (Alipurduar to Bogra)	0	0	0	500	500	500	2040
Meghalaya to Mymengsing	0	0	0	0	0	0	
Myanmmer to Bangladesh (should refer from PGCB PP)	0	0	500	500	500	500	2603
Total	12688	4822	22010	27586	36254	15400	

Source :PSMP Study Team

APTable 9-3 Standard parameters of the newly installed transmission line 100MVA Base

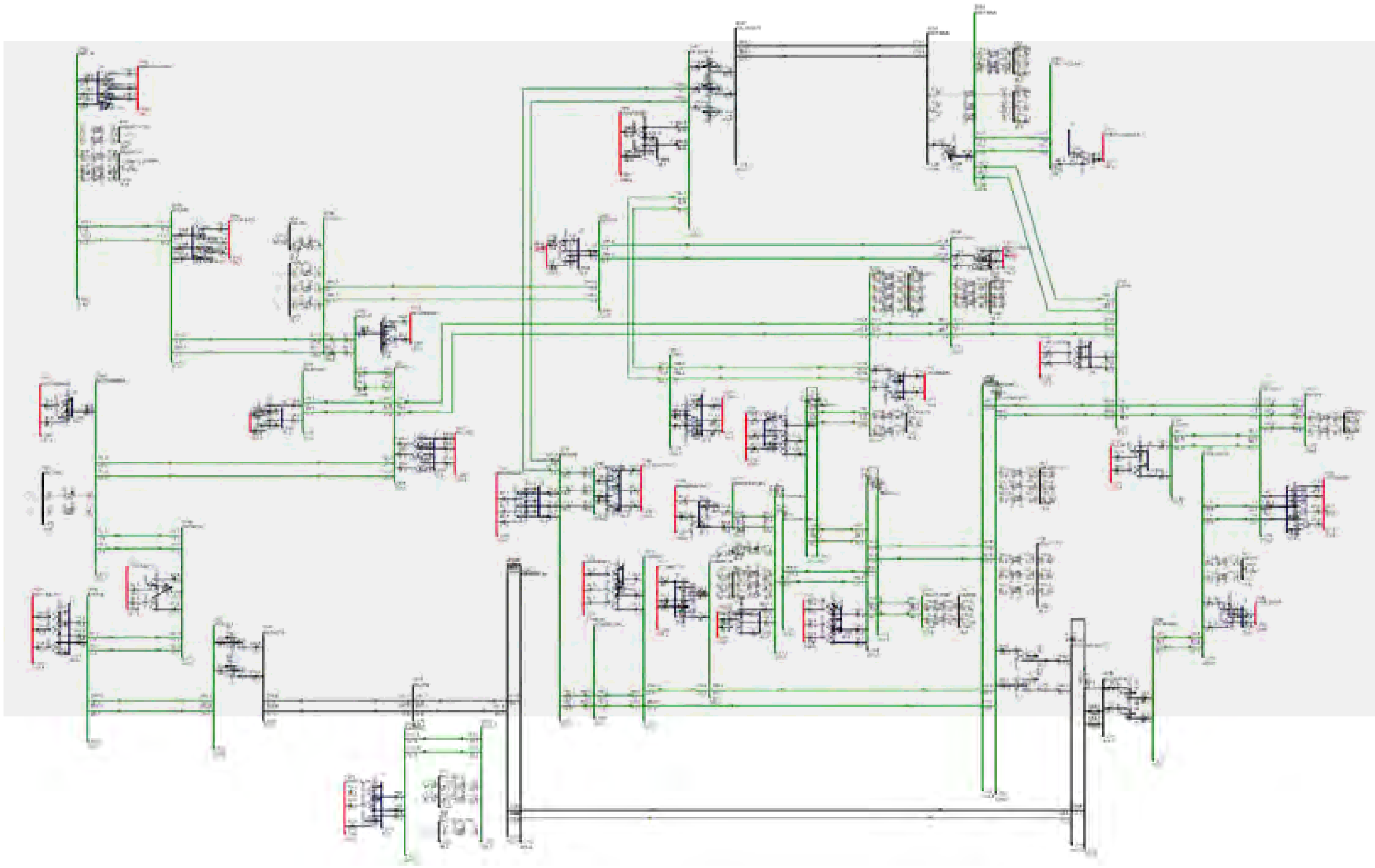
	R_1 [pu/km]	X_1 [pu/km]	B_1 [pu/km]	R_0 [pu/km]	X_0 [pu/km]	Allowable Current [MVA]
400kV	1.9×10^{-5}	1.71×10^{-4}	7.0×10^{-3}	9.7×10^{-5}	4.98×10^{-4}	2347.2
230kV	8.0×10^{-5}	5.5×10^{-4}	2.1×10^{-3}	6.0×10^{-4}	2.0×10^{-3}	597.6
132kV	5.8×10^{-4}	2.2×10^{-3}	5.2×10^{-4}	1.8×10^{-3}	7.7×10^{-3}	150.9

Source :PSMP Study Team

APTable 9-4 Standard parameters of 400kV/230kV transformer

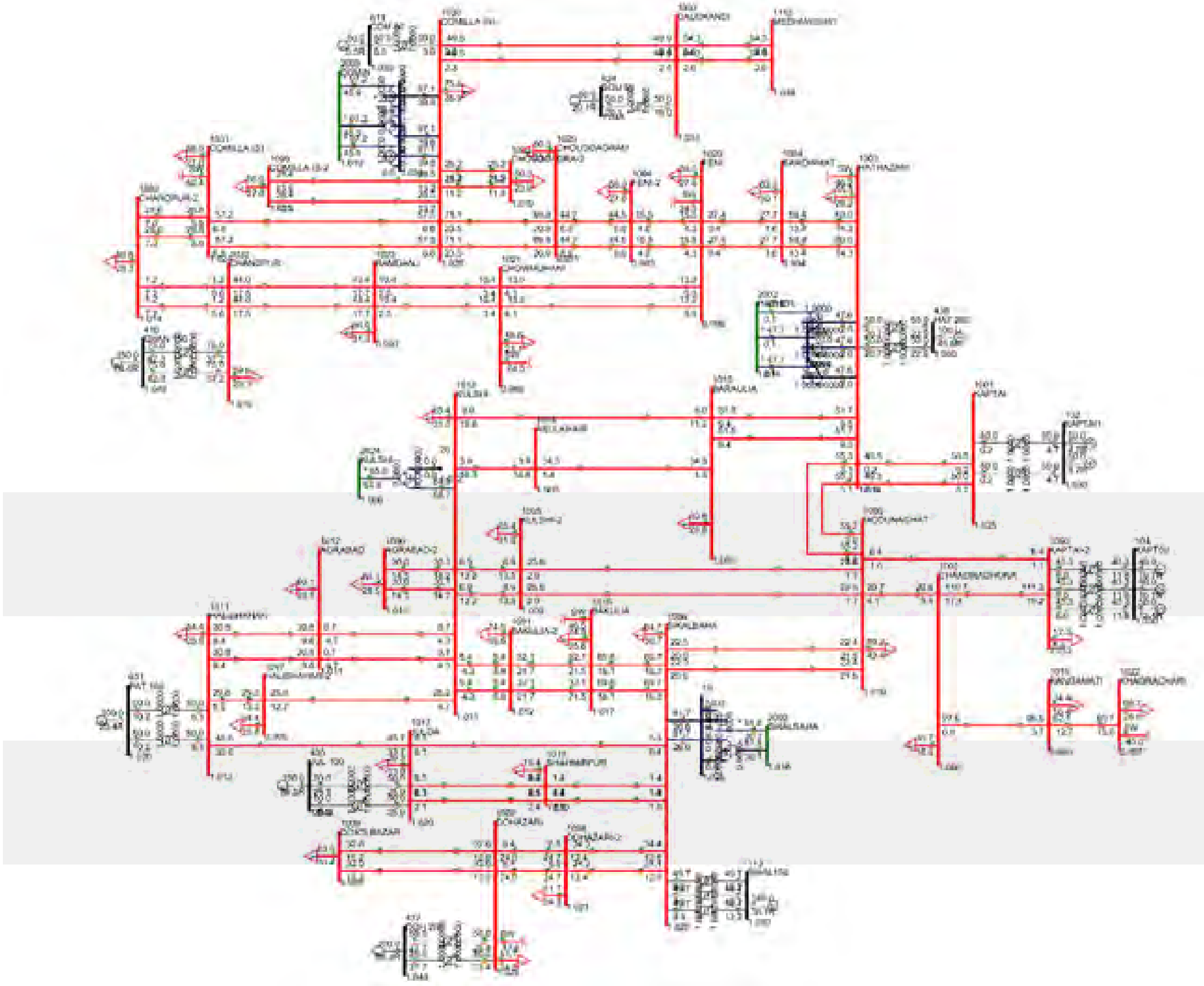
400kV/230kV			Allowable Current [MVA]		500
Positive Sequence Impedance [pu]					
P-S		S-T		P-T	
R_1	X_1	R_1	X_1	R_1	X_1
3.1×10^{-3}	1.3×10^{-1}	2.8×10^{-3}	1.1×10^{-1}	4.5×10^{-4}	1.9×10^{-2}
Zero Sequence Impedance [pu]					
P		S		T	
R_0	X_0	R_0	X_0	R_0	X_0
3.1×10^{-3}	1.3×10^{-1}	2.8×10^{-3}	1.1×10^{-1}	4.5×10^{-4}	1.9×10^{-2}

Source :PSMP Study Team



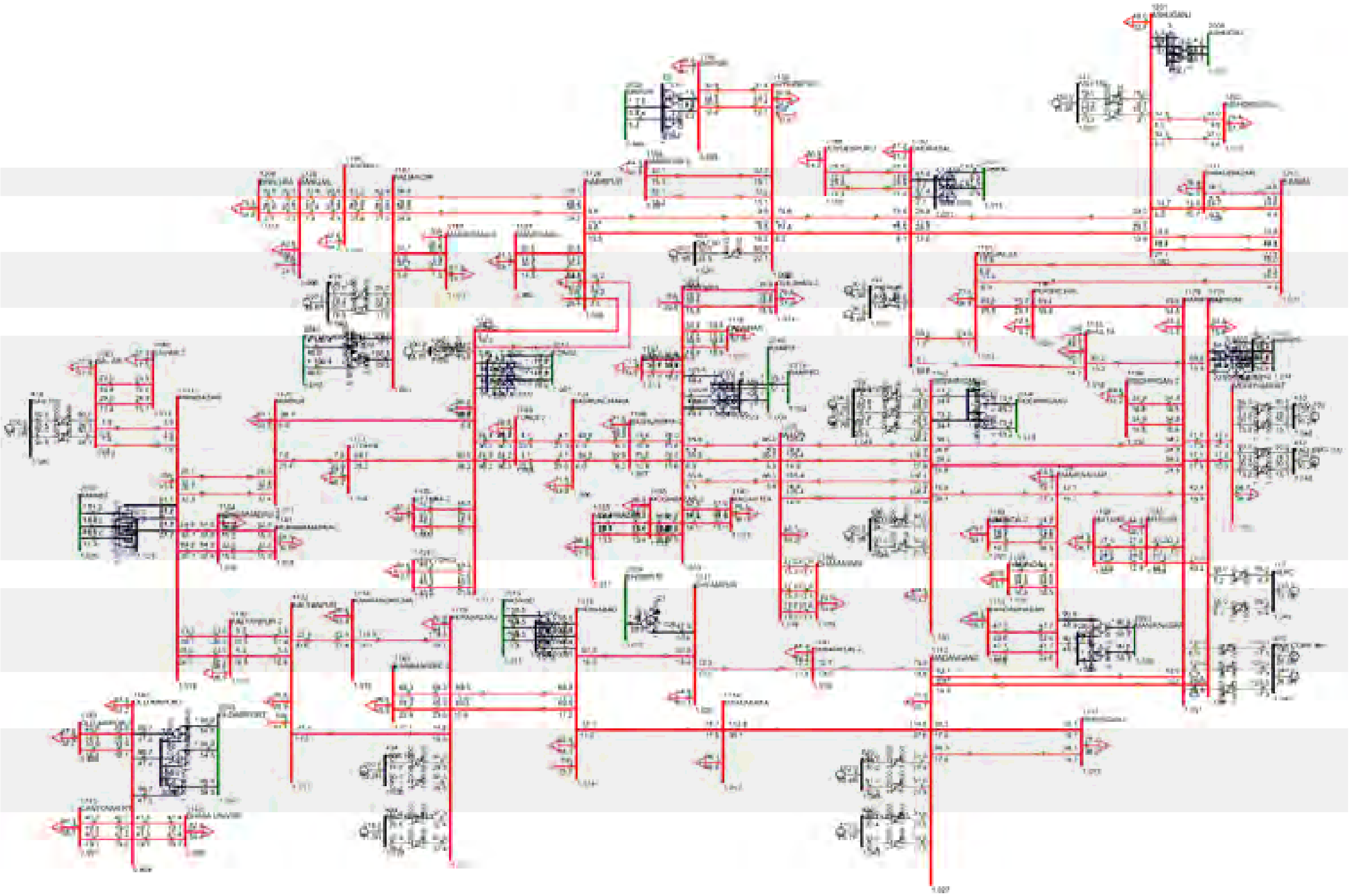
Source: PSMP Study Team

APFig. 9-1 230kV・400kV power flow (2015, pattern east)



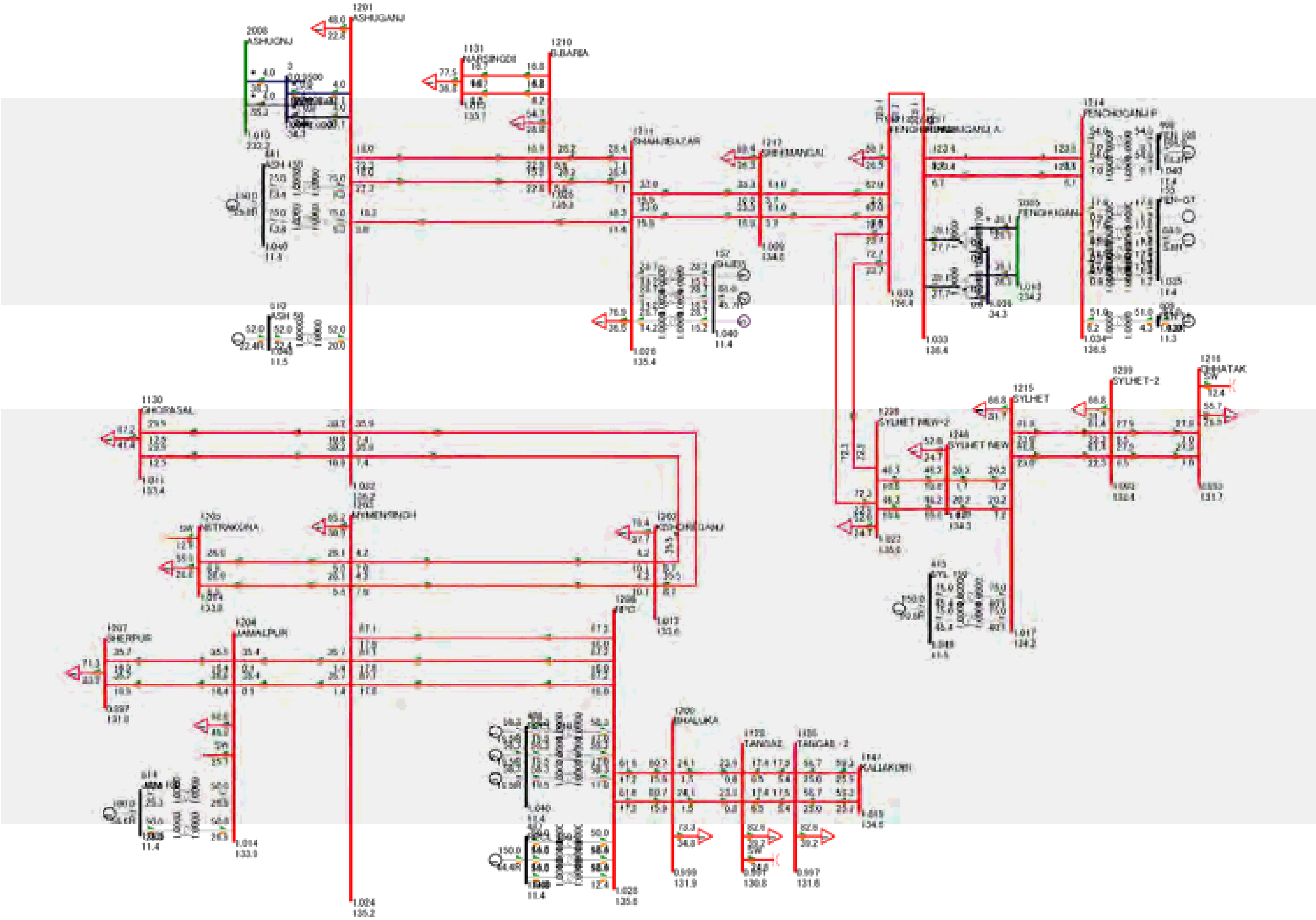
Source: PSMP Study Team

APFig. 9-2 132kVSouthern power flow (2015, pattern east)



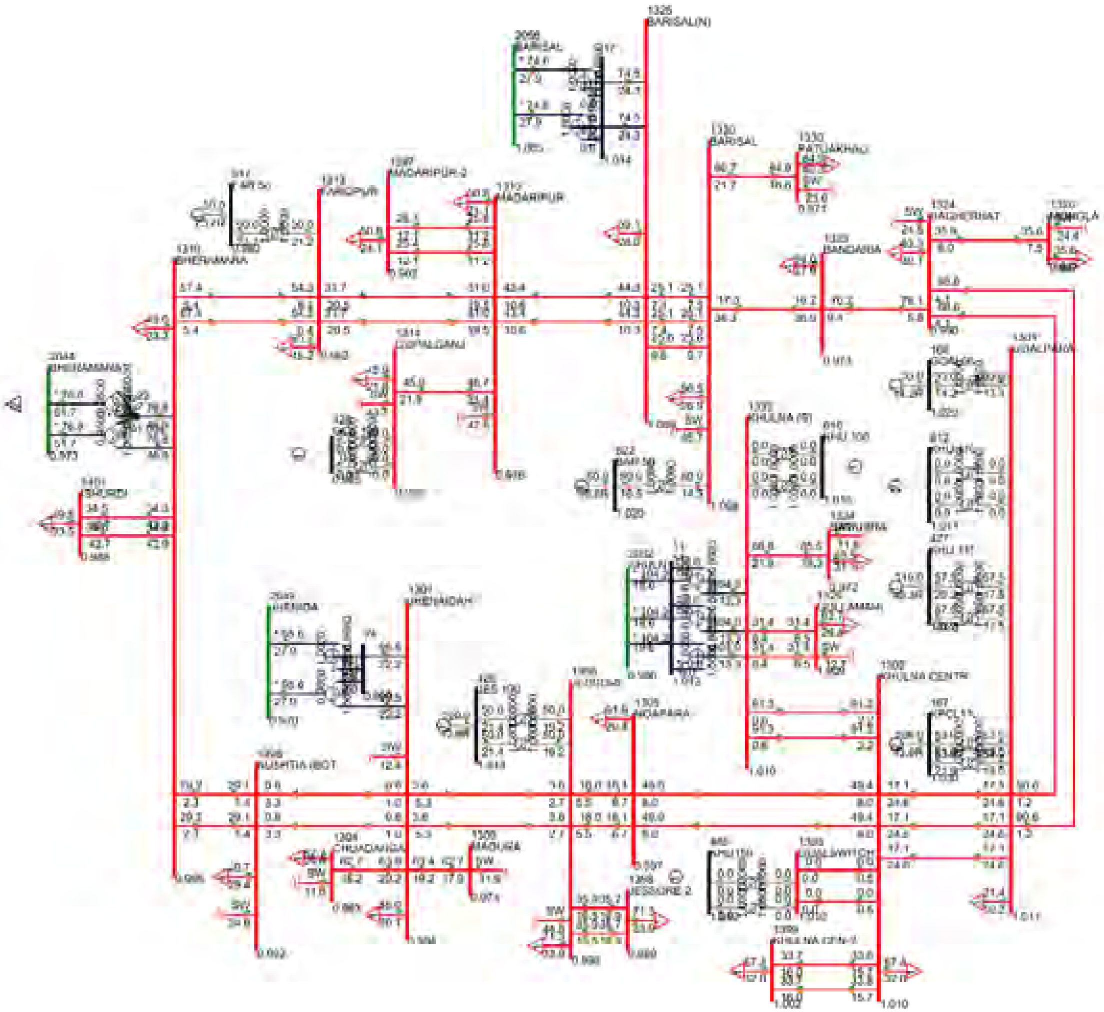
Source: PSMP Study Team

APFig. 9-3 132kVDhaka power flow (2015, pattern east)



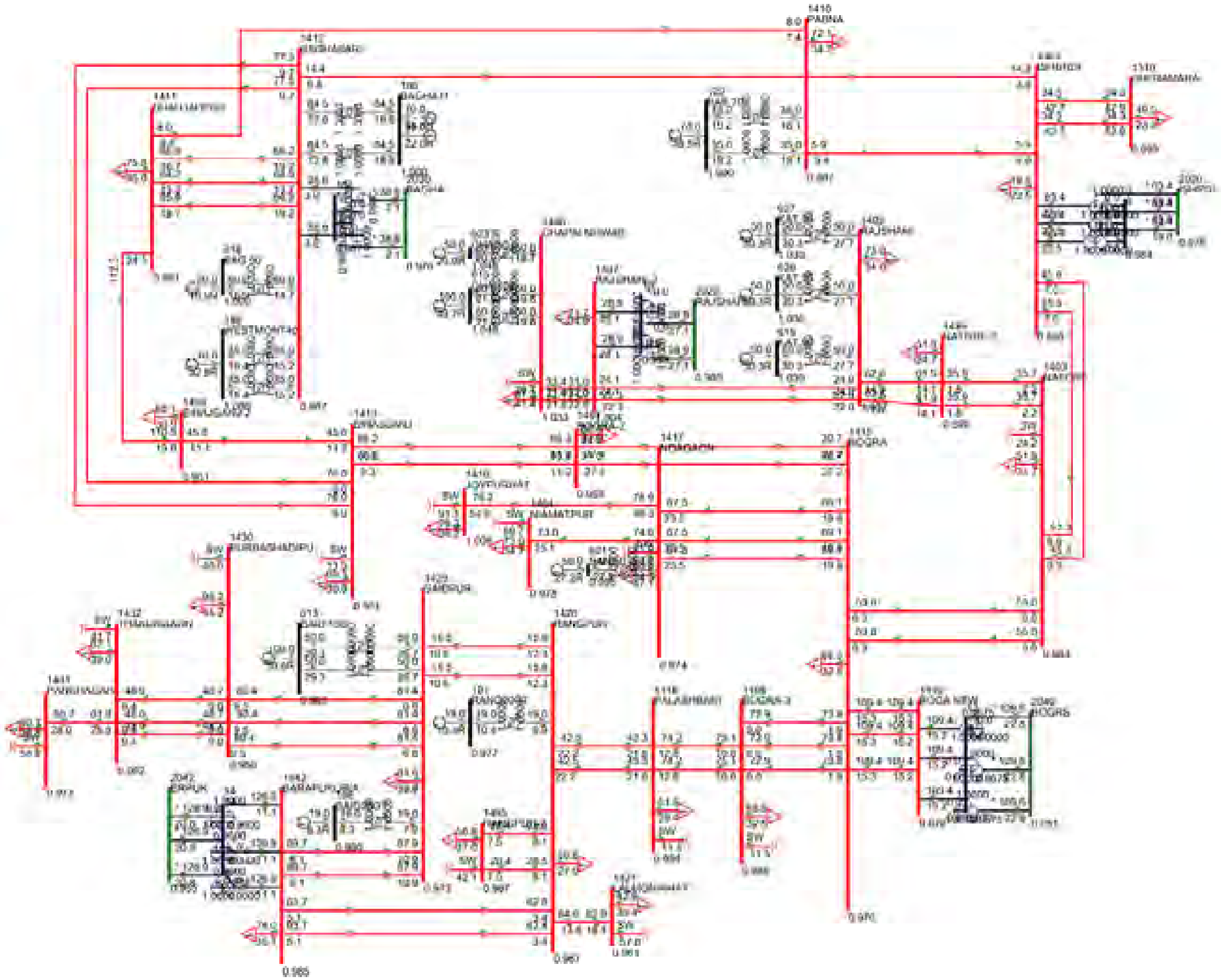
Source: PSMP Study Team

APFig. 9-4 132kVCentral power flow (2015, pattern east)



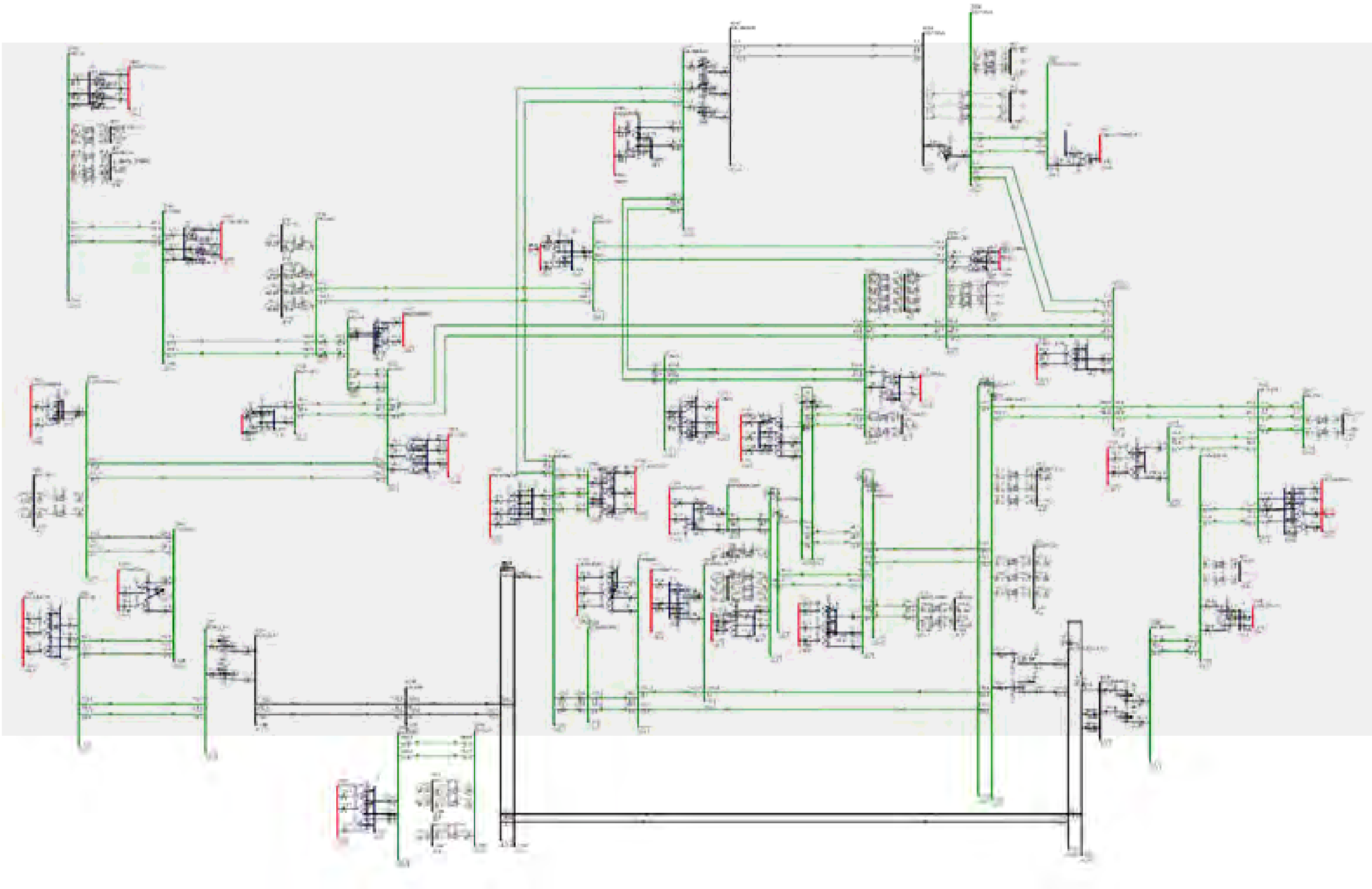
Source: PSMP Study Team

APFig. 9-5 132kVWestern power flow (2015, pattern east)



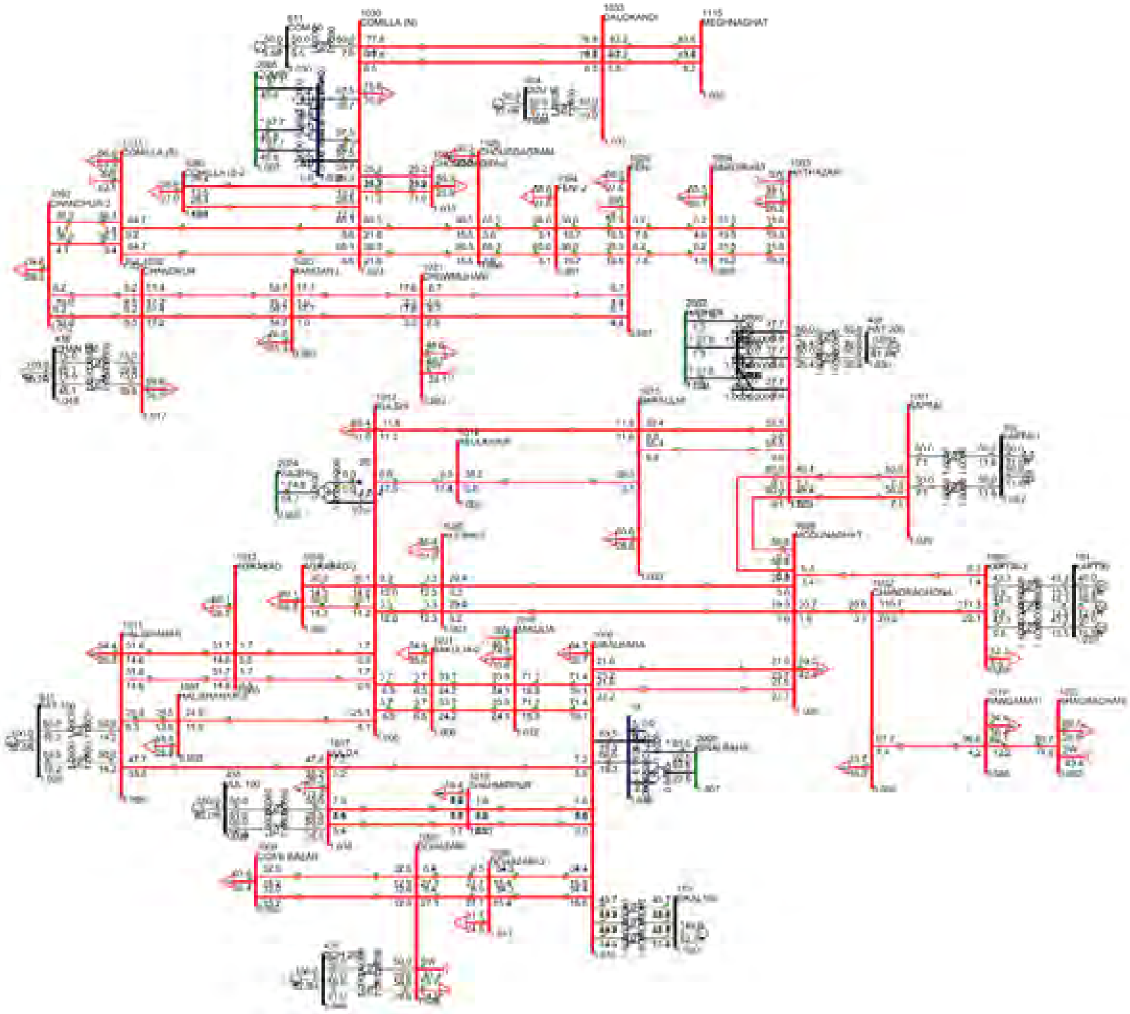
Source: PSMP Study Team

APFig. 9-6 132kVNorthern power flow (2015, pattern east)



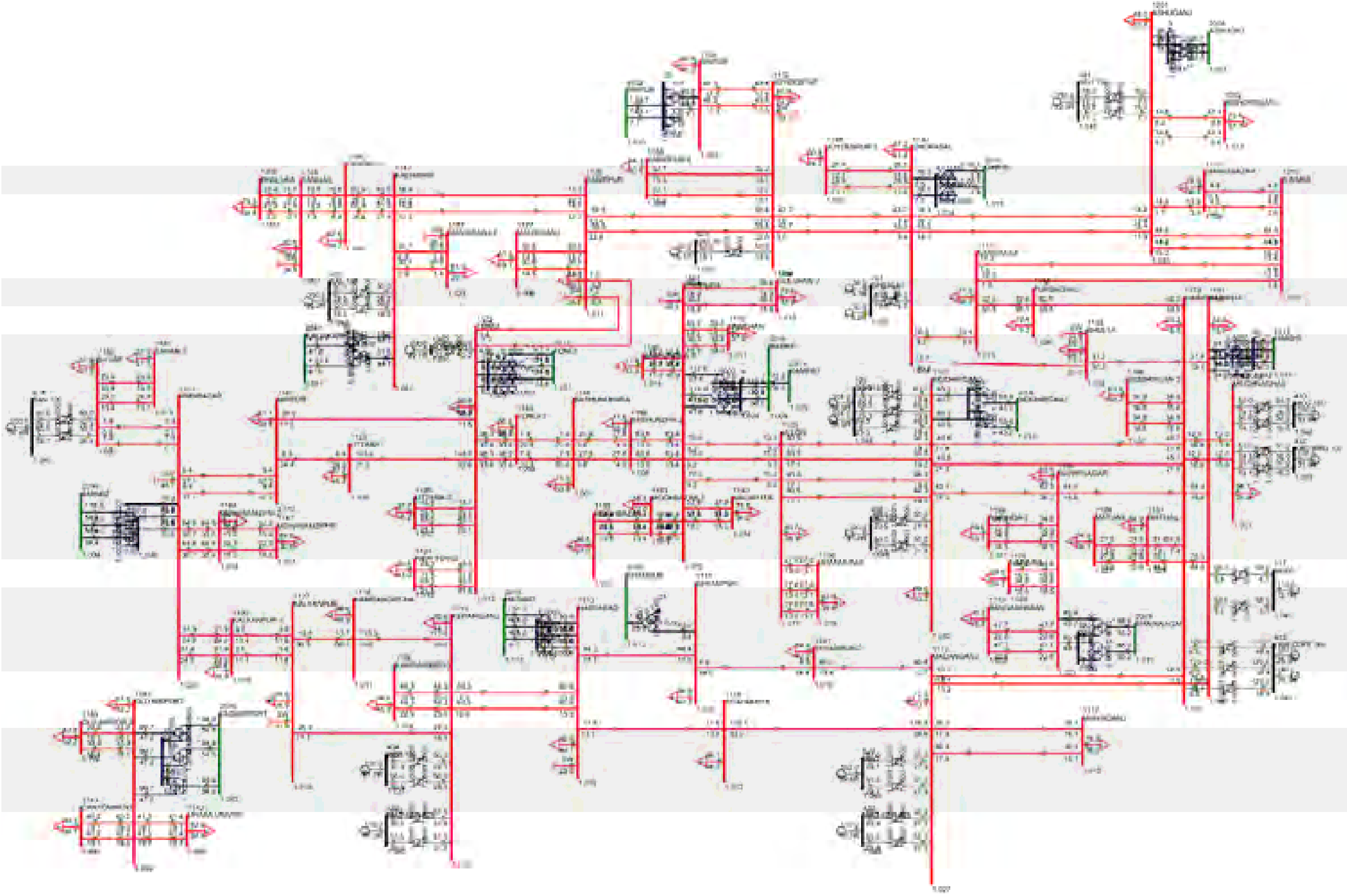
Source: PSMP Study Team

APFig. 9-7 400kV, 230kV power flow (2015, pattern west)



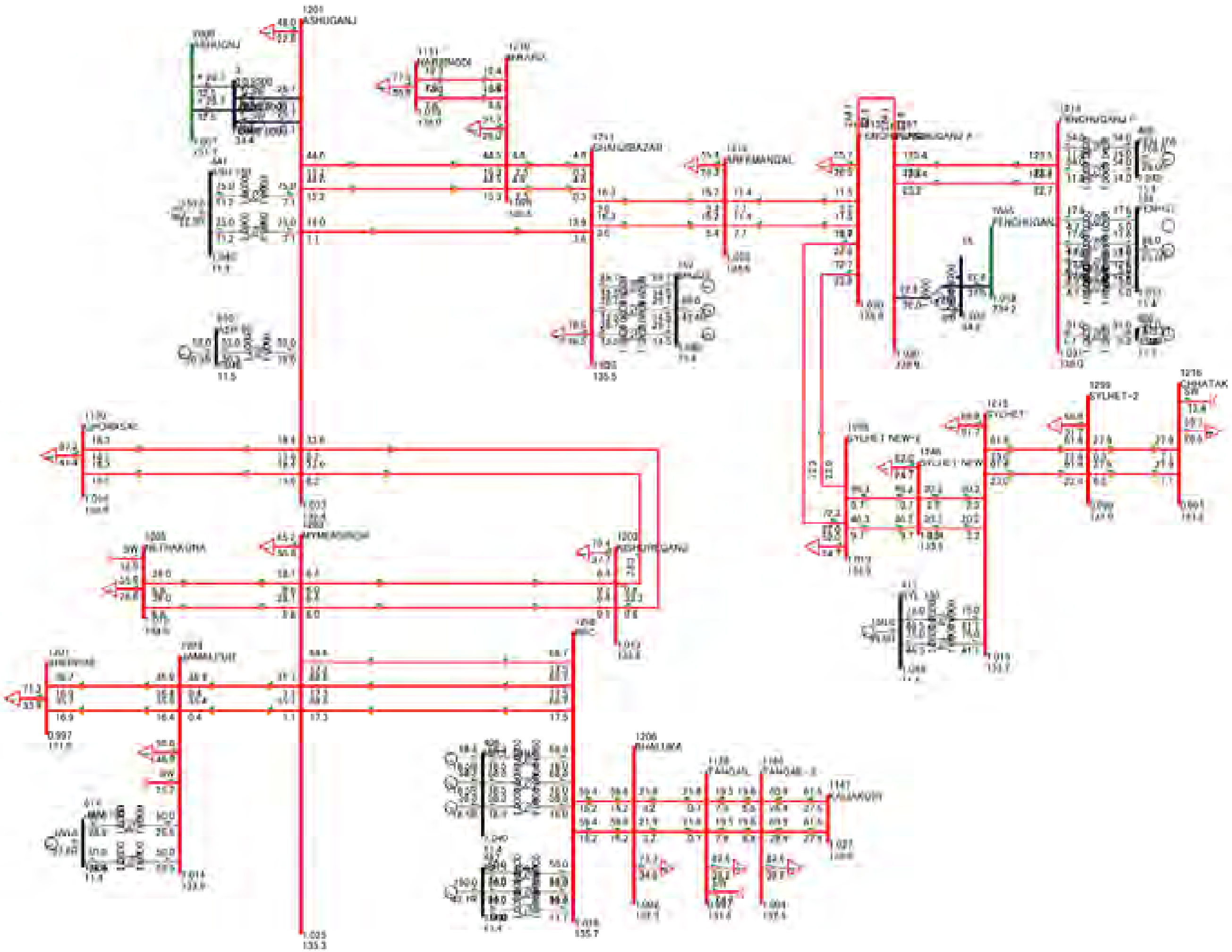
Source: PSMP Study Team

APFig. 9-8 132kV Southern power flow (2015, pattern west)



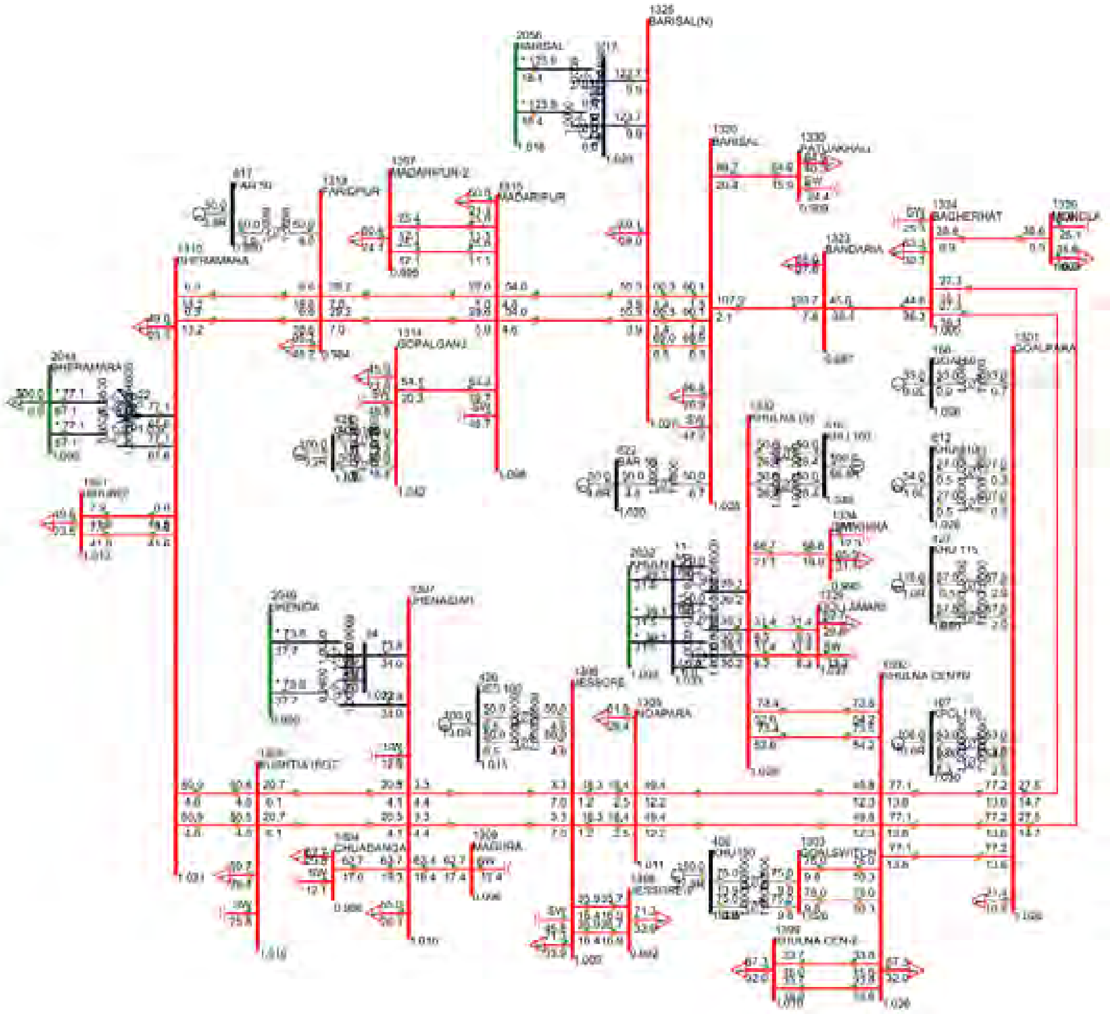
Source: PSMP Study Team

APFig. 9-9 132kV Dhaka power flow (2015, pattern west)



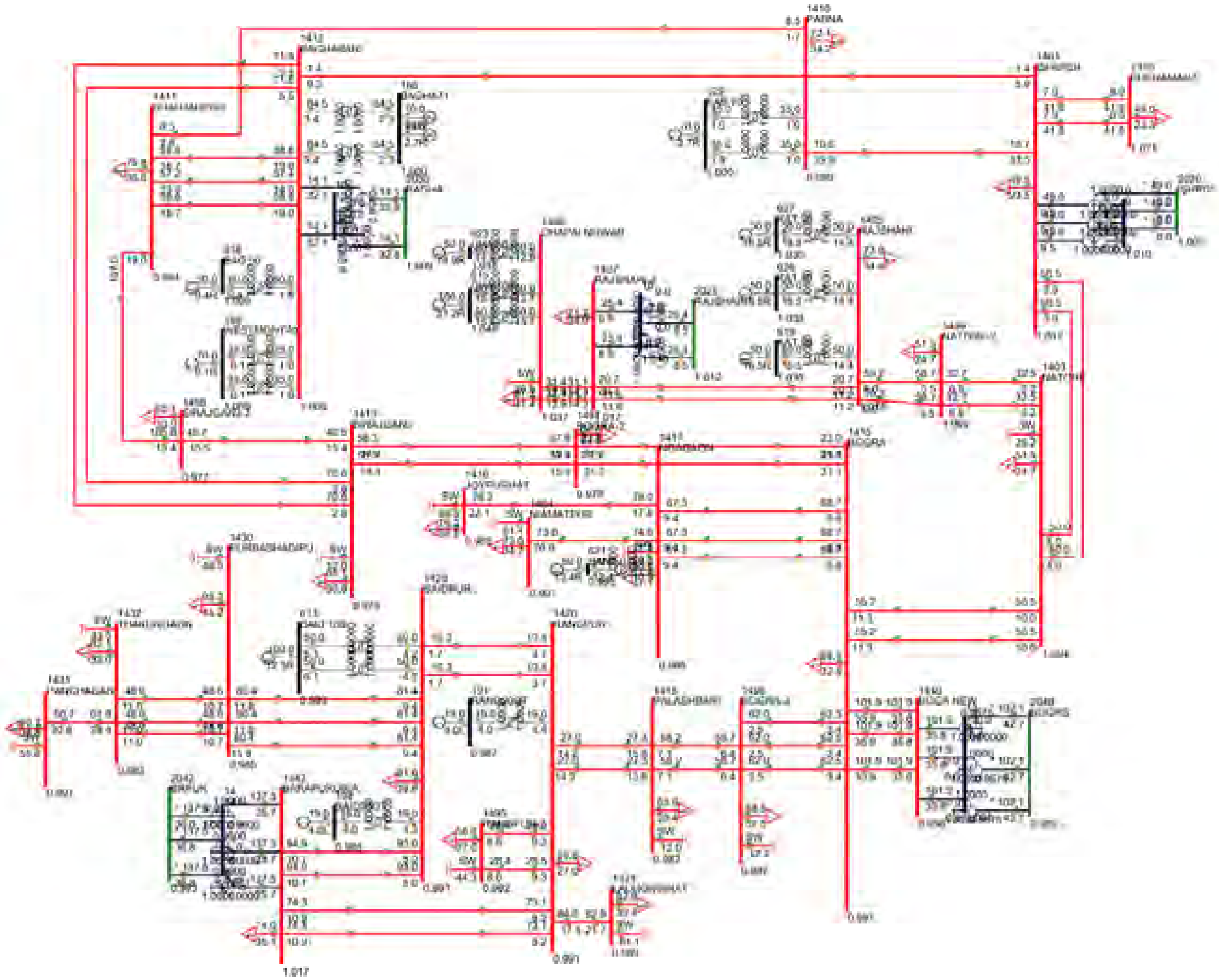
Source: PSMP Study Team

APFig. 9-10 132kV Central power flow (2015, pattern west)



Source: PSMP Study Team

APFig. 9-11 132kV Western power flow (2015, pattern west)



Source: PSMP Study Team

APFig. 9-12 132kV Northern power flow (2015, pattern west)

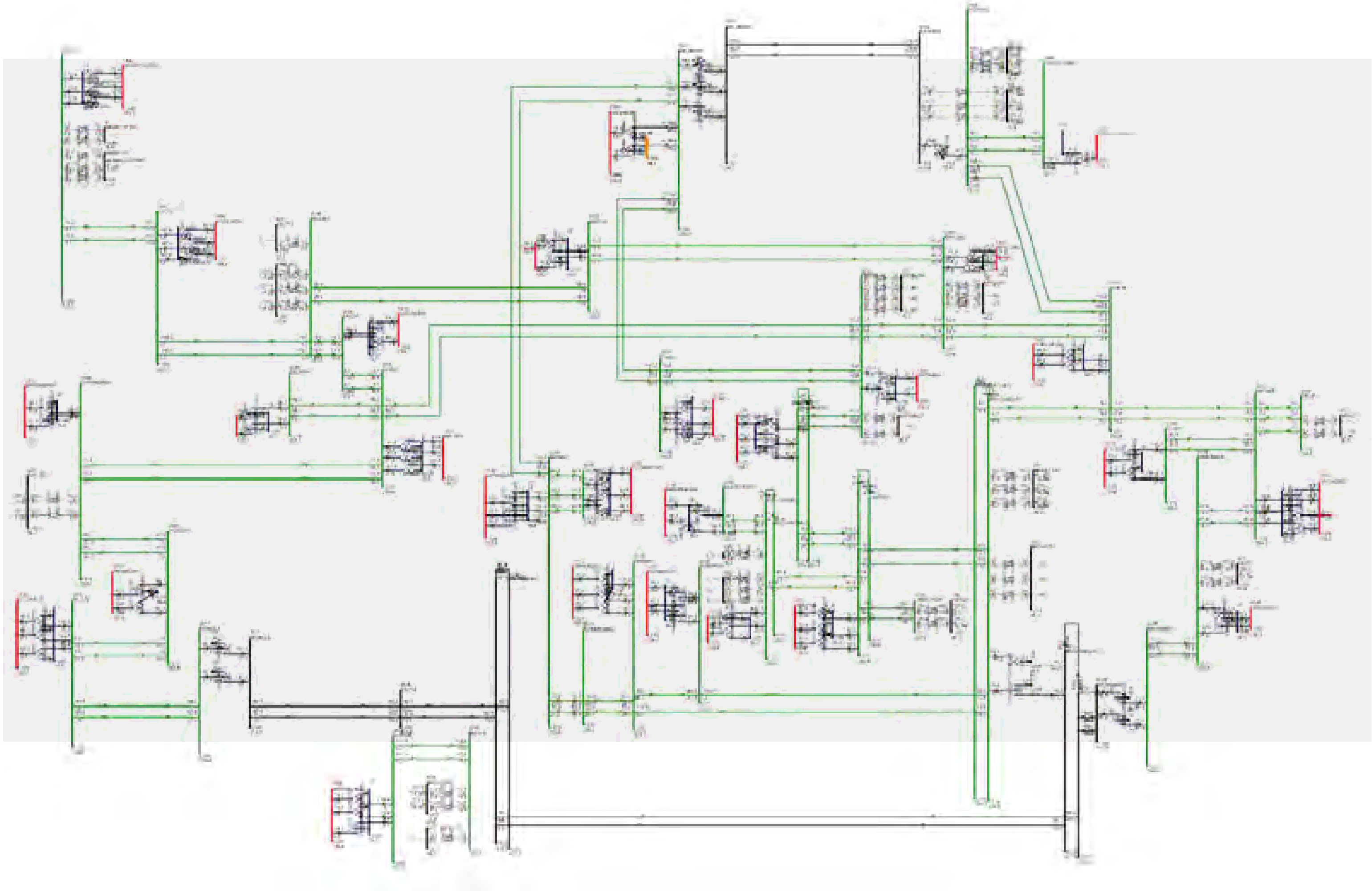
APTable 9-5 Results of short-circuit and ground-fault current analysis (2015) (kA)

Substation		I"k		Asym Ib		Substation		I"k		Asym Ib	
Name	Voltage	3PH	LG	3PH	LG	Name	Voltage	3PH	LG	3PH	LG
KAPTAI	132kV	9.2	6.7	9.1	6.9	FENCHUGANJ	132kV	16.6	14.4	16.9	15.7
CHANDRAGHONA	132kV	9.2	6.4	9.2	6.4	FENCHUGANJ P	132kV	16.4	14.2	16.7	16.0
HATHAZARI	132kV	27.7	27.1	27.6	28.1	SYLHET	132kV	9.7	7.7	9.4	8.4
BAROIRHAT	132kV	12.5	7.9	12.5	7.9	CHHATAK	132kV	5.6	3.7	5.5	3.7
MODUNAGHAT	132kV	26.1	23.0	25.3	23.0	SYLHET NEW	132kV	10.8	8.3	10.2	8.4
SIKALBAHA	132kV	27.8	25.9	27.6	27.2	FENCHUGANJ A	132kV	16.6	14.4	16.9	15.7
DOHAZARI	132kV	10.9	8.0	10.6	8.3	SYLHET NEW-2	132kV	12.8	10.0	12.1	10.0
COX'S BAZAR	132kV	3.4	2.0	3.4	2.0	SYLHET-2	132kV	7.1	5.0	6.9	5.0
HALISHAHAR	132kV	21.2	17.4	20.5	17.5	GOALPARA	132kV	23.7	22.1	24.1	23.9
AGRABAD	132kV	22.0	18.1	21.5	18.1	KHULNA CENTR	132kV	24.3	23.1	24.9	24.7
KULSHI	132kV	26.7	24.8	25.8	25.0	GOALSWITCH	132kV	23.7	22.0	23.9	23.1
ABULKHAIR	132kV	19.3	14.9	19.2	14.9	CHUADANGA	132kV	4.0	2.4	4.0	2.4
BARAULIA	132kV	22.1	18.1	21.8	18.1	NOAPARA	132kV	13.1	9.1	13.0	9.1
BAKULIA	132kV	24.4	20.8	23.5	20.8	JESSORE	132kV	12.1	9.0	11.8	9.2
JULDA	132kV	23.8	20.2	22.8	20.3	JHENAIDAH	132kV	15.7	13.3	15.7	13.4
SHAHMIRPUR	132kV	23.1	19.2	22.2	19.2	KUSHTIA (BOT	132kV	13.3	9.0	13.3	9.0
RANGAMATI	132kV	4.9	3.0	4.9	3.0	MAGURA	132kV	5.4	3.3	5.4	3.3
FENI	132kV	11.0	6.7	11.0	6.7	BHERAMARA	132kV	23.7	20.5	24.1	20.8
CHOWMUHANI	132kV	8.1	4.9	8.1	4.9	FARIDPUR	132kV	6.7	4.7	6.6	4.9
KHAGRACHARI	132kV	2.1	1.2	2.1	1.2	GOPALGANJ	132kV	4.7	3.9	5.3	5.0
RAMGANJ	132kV	7.6	4.8	7.5	4.8	MADARIPUR	132kV	7.4	5.4	7.2	5.4
CHOUDDAGRAM	132kV	11.4	7.0	11.4	7.0	BARISAL	132kV	9.2	9.7	9.3	9.9
COMILLA (N)	132kV	26.4	21.8	26.3	22.1	BANDARIA	132kV	5.6	3.5	5.6	3.5
COMILLA (S)	132kV	15.1	10.3	15.0	10.3	BAGHERHAT	132kV	8.6	5.4	8.6	5.4
CHANDPUR	132kV	9.6	7.3	9.5	8.2	BARISAL(N)	132kV	9.4	10.4	9.6	11.0
DAUDKANDI	132kV	21.0	14.5	20.8	14.5	MONGLA	132kV	3.9	2.3	3.9	2.3
KAPTAI-2	132kV	9.5	7.2	9.5	7.5	GOLLAMARI	132kV	19.5	16.4	18.7	16.4
BAKULIA-2	132kV	22.8	18.8	22.3	18.8	PATUAKHALI	132kV	3.4	2.2	3.4	2.2
CHANDPUR-2	132kV	10.1	6.7	9.9	6.7	KHULNA (S)	132kV	24.1	23.2	24.0	24.7
CHOUDDAGRA-2	132kV	11.8	7.6	11.8	7.6	SATKHIRA	132kV	3.9	2.3	3.9	2.3
FENI-2	132kV	10.9	6.7	10.9	6.7	MADARIPUR-2	132kV	4.8	3.2	4.8	3.2
KULSHI-2	132kV	24.0	20.3	23.4	20.3	JESSORE-2	132kV	6.5	4.1	6.5	4.1
AGRABAD-2	132kV	21.9	18.1	21.6	18.1	KHULNA CEN-2	132kV	13.5	9.7	13.5	9.7
HALISHAHAR-2	132kV	6.7	5.9	6.7	5.9	ISHURDI	132kV	26.8	24.2	26.9	24.5
DOHAZARI-2	132kV	15.1	11.1	14.8	11.1	NATORE	132kV	15.3	10.3	15.3	10.3
COMILLA (S-2	132kV	17.7	12.5	17.7	12.5	NIAMATPUR	132kV	3.0	1.8	3.0	1.8
HARIPUR	132kV	42.7	34.0	43.5	35.2	RAJSHAHI	132kV	15.4	13.0	15.2	13.2
SIDDHIRGANJ	132kV	57.0	48.5	57.0	50.2	CHAPAI NOWAB	132kV	8.8	7.2	9.1	8.3
MOGHBAZAR	132kV	28.4	19.8	28.4	19.8	RAJSHAHI-2	132kV	16.0	14.5	15.7	14.6
MANIKNAGAR	132kV	28.9	21.6	29.1	21.9	PABNA	132kV	13.2	9.3	12.9	9.4
ULLON	132kV	40.9	31.1	40.9	31.1	SHAHJADPUR	132kV	19.2	15.0	18.9	15.1
DHANMONDI	132kV	33.8	26.2	33.8	26.2	BAGHABARI	132kV	22.6	19.8	23.4	21.8
RAMPURA	132kV	40.5	32.0	40.6	32.2	SIRAJGANJ	132kV	12.9	8.6	12.9	8.6
NARINDA	132kV	25.8	19.5	25.8	19.6	BOGRA	132kV	19.3	17.6	19.3	17.7
MATUAIL	132kV	25.4	16.4	25.4	16.4	JOYPURHAT	132kV	3.0	1.8	3.0	1.8
BANGABHABAN	132kV	25.4	19.7	25.5	19.8	NOAGAON	132kV	8.4	6.0	8.3	6.0
SHYAMPUR	132kV	28.0	22.8	28.1	23.1	PALASHBARI	132kV	9.7	6.5	9.7	6.5
MADANGANJ	132kV	34.8	25.6	33.9	25.8	RANGPUR	132kV	10.7	8.1	10.6	8.1

HASNABAD	132kV	34.1	28.0	34.0	28.3	LALMONIRHAT	132kV	3.7	2.3	3.7	2.3
SITALAKHYA	132kV	21.5	13.9	21.5	13.9	SAIDPUR	132kV	10.4	8.6	10.3	9.0
MEGHNAGHAT	132kV	25.4	18.4	24.7	19.0	PURBASHADIPU	132kV	7.4	5.3	7.3	5.3
GULSHAN	132kV	24.3	19.8	24.3	19.8	PANCHAGAR	132kV	2.4	1.4	2.4	1.4
MUNSIGANJ	132kV	13.2	8.0	13.2	8.0	THAKURGAON	132kV	4.9	3.2	4.9	3.2
KAMRANGIRCHA	132kV	22.5	15.7	22.3	15.7	BOGA NEW	132kV	19.3	17.6	19.3	17.8
KERANIGANJ	132kV	28.0	21.5	27.2	21.8	BARAPUKURIA	132kV	13.7	13.6	15.4	15.2
MIRPUR	132kV	27.8	19.7	27.7	19.7	RANGPUR-2	132kV	7.1	4.8	7.1	4.8
NEW TONGI	132kV	35.0	27.3	34.9	27.3	BOGRA-3	132kV	12.7	9.2	12.7	9.2
KALYANPUR	132kV	29.4	22.2	29.1	22.2	BOGRA-2	132kV	11.9	7.9	11.9	7.9
UTTARA	132kV	22.2	14.7	22.2	14.7	SIRAJGANJ-2	132kV	11.0	7.1	11.0	7.1
BASHUNDHARA	132kV	29.6	20.5	29.6	20.5	NATORE-2	132kV	13.3	9.3	13.3	9.3
TONGI	132kV	38.2	30.9	38.1	31.3	RAOZN	230kV	17.0	14.6	15.9	15.2
KABIRPUR	132kV	27.3	18.5	27.2	18.5	HATHZR	230kV	20.6	20.3	19.5	20.8
MANIKGANJ	132kV	9.0	5.3	9.0	5.3	MANIKNAGAR	230kV	32.6	25.3	32.4	25.4
TANGAIL	132kV	9.2	5.5	9.2	5.5	SIDDHIRGANJ	230kV	45.1	39.6	44.7	41.1
GHORASAL	132kV	32.2	22.5	32.7	23.1	COMIN	230kV	28.3	22.8	28.2	22.9
NARSINGDI	132kV	22.6	15.7	22.6	15.7	ASHUGNJ	230kV	26.7	21.3	26.3	21.4
JOYDEBPUR	132kV	25.4	17.2	25.3	17.2	SIKALBAHA	230kV	19.7	17.8	18.9	18.3
BHULTA	132kV	15.4	9.2	15.4	9.2	GHRSL	230kV	40.9	33.4	38.8	35.4
AMINBAZAR	132kV	33.3	27.3	33.3	27.8	TONGI	230kV	31.2	24.6	31.1	24.7
SAVAR	132kV	18.1	12.9	17.7	13.0	HARIPR	230kV	47.1	42.0	46.6	43.4
PURBACHAL	132kV	31.0	21.1	31.0	21.1	HASNBD	230kV	31.9	26.8	31.7	26.9
MADARTEK	132kV	34.0	25.1	34.0	25.1	MEGHNAGHAT	230kV	46.7	40.1	45.4	41.0
MOHAMMADPUR	132kV	23.9	17.2	23.9	17.2	HARIPUR360	230kV	41.7	36.3	40.6	36.9
DHAKA UNIVER	132kV	13.7	12.0	13.8	12.0	RAMPR	230kV	33.1	25.3	33.2	25.4
CANTONMENT	132kV	13.9	12.1	13.9	12.1	ISHRDI	230kV	22.4	21.1	22.1	21.2
OLD AIRPORT	132kV	15.7	13.7	15.8	14.0	KULSHI	230kV	16.2	14.2	15.8	14.3
KALIAKOIR	132kV	24.7	19.3	24.8	20.0	ANOWARA	230kV	17.0	14.0	16.6	14.1
SRIPUR	132kV	17.8	14.0	17.9	14.2	RAJSHAHI	230kV	11.1	9.1	11.1	9.2
HARIPUR-2	132kV	57.1	47.4	55.6	48.0	SHAMPUR	230kV	29.8	24.5	29.7	24.6
SAVAR-2	132kV	12.7	8.3	12.6	8.3	BAGHA	230kV	20.3	16.0	20.3	16.1
MATUAIL-2	132kV	36.3	25.4	36.2	25.4	KHULN	230kV	15.4	14.3	15.4	14.6
KAMRANGIRC-2	132kV	24.7	18.1	24.2	18.2	AMINBZ	230kV	31.7	29.0	31.8	29.2
OLD AIRPOR-2	132kV	14.7	12.8	14.7	12.9	SRJGNJ	230kV	22.9	17.8	22.7	18.8
MOHAMMADPU-2	132kV	27.9	21.1	27.7	21.1	BOGRS	230kV	14.7	13.0	14.6	13.0
JOYDEBPUR-2	132kV	15.1	9.2	15.1	9.2	BRPUK	230kV	11.6	11.7	11.6	13.2
TANGAIL-2	132kV	12.3	7.7	12.3	7.7	BHERAMARA	230kV	21.4	20.3	21.0	20.6
MANIKGANJ-2	132kV	12.9	8.4	12.9	8.4	OLDAIRPORT	230kV	24.4	22.0	24.4	22.0
KABIRPUR-2	132kV	17.3	10.9	17.3	10.9	KALIAKAIR	230kV	29.5	25.3	29.5	25.5
TONGI-2	132kV	32.5	23.8	32.5	23.8	JHENIDA	230kV	14.5	14.1	14.5	14.1
KALYANPUR-2	132kV	31.0	24.3	30.8	24.3	MONGLA	230kV	13.8	11.2	13.9	11.3
SHYAMPUR-2	132kV	21.9	14.6	21.9	14.6	SRIPUR	230kV	18.4	13.7	18.4	13.8
MOGHBAZAR-2	132kV	33.4	24.4	33.4	24.4	BIBIYANA	230kV	17.3	12.7	18.2	14.2
SIDDHIRGAN-2	132kV	50.4	39.4	49.3	39.5	BHOLA	230kV	6.0	5.8	8.1	7.7
UTTARA-2	132kV	29.0	21.1	29.0	21.1	BARISAL	230kV	5.6	6.2	5.6	6.5
GULSHAN-2	132kV	37.0	29.5	37.1	29.5	FENCHUGANJ	230kV	12.8	9.0	13.0	9.1
BASHUNDHA-3	132kV	30.8	24.8	30.8	24.8	KERANIGANJ	230kV	29.0	22.9	29.0	22.9
BASHUNDHA-2	132kV	28.8	19.4	28.8	19.4	MEGHNAGHAT2	230kV	46.7	40.1	45.4	41.0
NARINDA-2	132kV	27.2	20.5	27.3	20.7	HARIPR2	230kV	47.1	42.0	46.6	43.4
ASHUGANJ	132kV	27.1	22.2	26.8	23.1	SIDDHIRGANJ2	230kV	45.1	39.6	44.7	41.1
KISHOREGANJ	132kV	10.3	6.4	10.3	6.4	RAMPR2	230kV	33.1	25.3	33.2	25.4
MYMENSINGH	132kV	13.6	11.2	13.5	11.8	MEGHNAGHAT	400kV	16.4	10.7	17.4	11.2

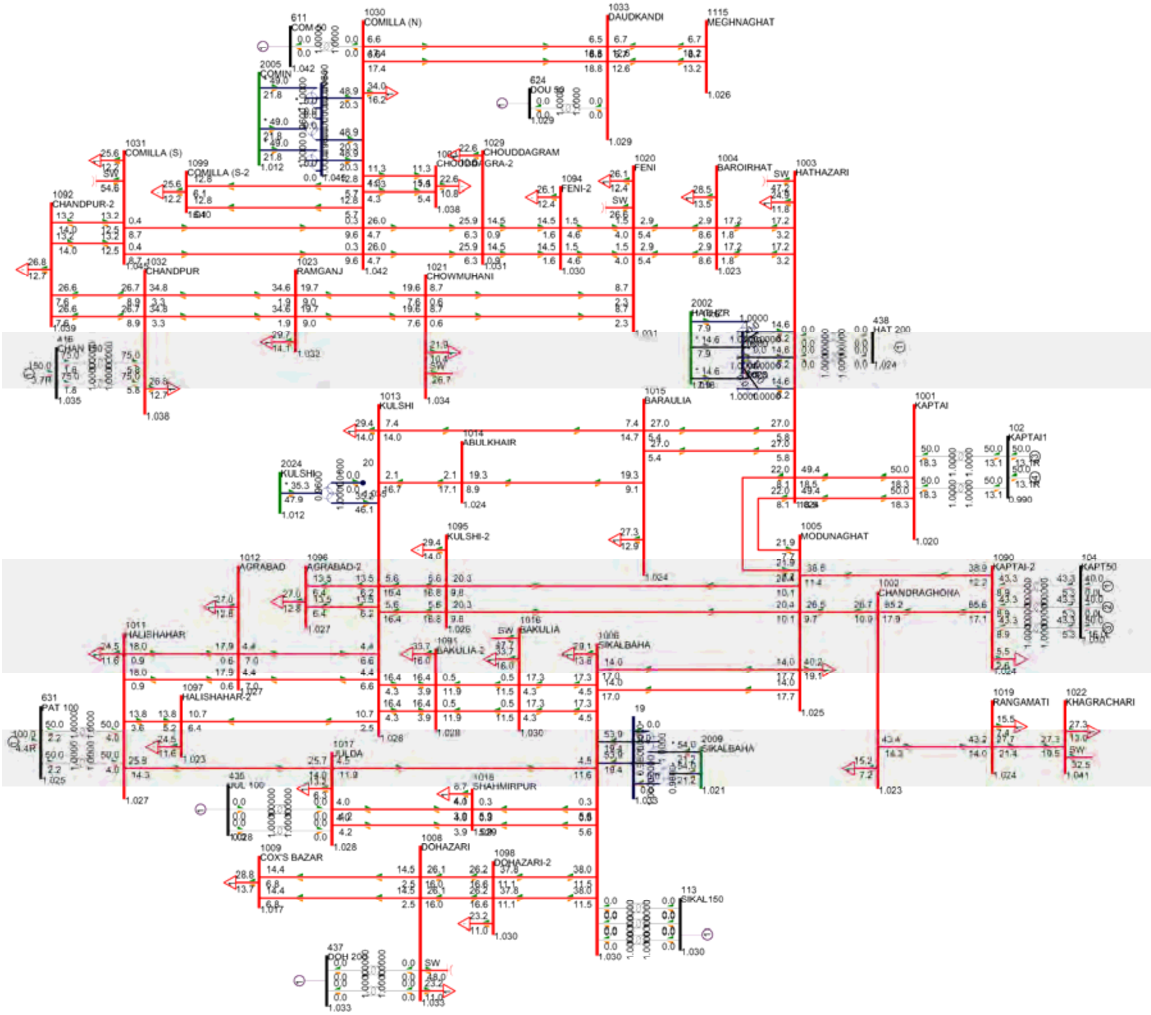
JAMALPUR	132kV	6.8	5.3	6.8	6.0	ANOWARA	400kV	8.8	6.1	9.0	6.4
NETRAKONA	132kV	6.5	4.2	6.5	4.2	AMINBAZAR	400kV	15.7	10.5	16.4	10.9
BHALUKA	132kV	8.8	5.6	8.8	5.6	KALIAKAIR	400kV	11.9	8.4	12.3	8.9
SHERPUR	132kV	4.6	3.2	4.5	3.2	MONGLA	400kV	8.7	6.4	8.7	6.5
RPC	132kV	14.0	11.9	15.6	15.1	BIBIYANA	400kV	10.3	8.0	10.9	9.2
B.BARIA	132kV	20.9	14.5	20.7	14.5	ZAJIRA	400kV	12.0	8.1	12.2	8.2
SHAHJIBAZAR	132kV	14.1	9.8	13.7	9.9	AMINBAZAR2	400kV	15.7	10.5	16.4	10.9
SREEMANGAL	132kV	10.7	6.8	10.7	6.8	MEGHNAGHAT2	400kV	16.4	10.7	17.4	11.2

Source: PSMP Study Team



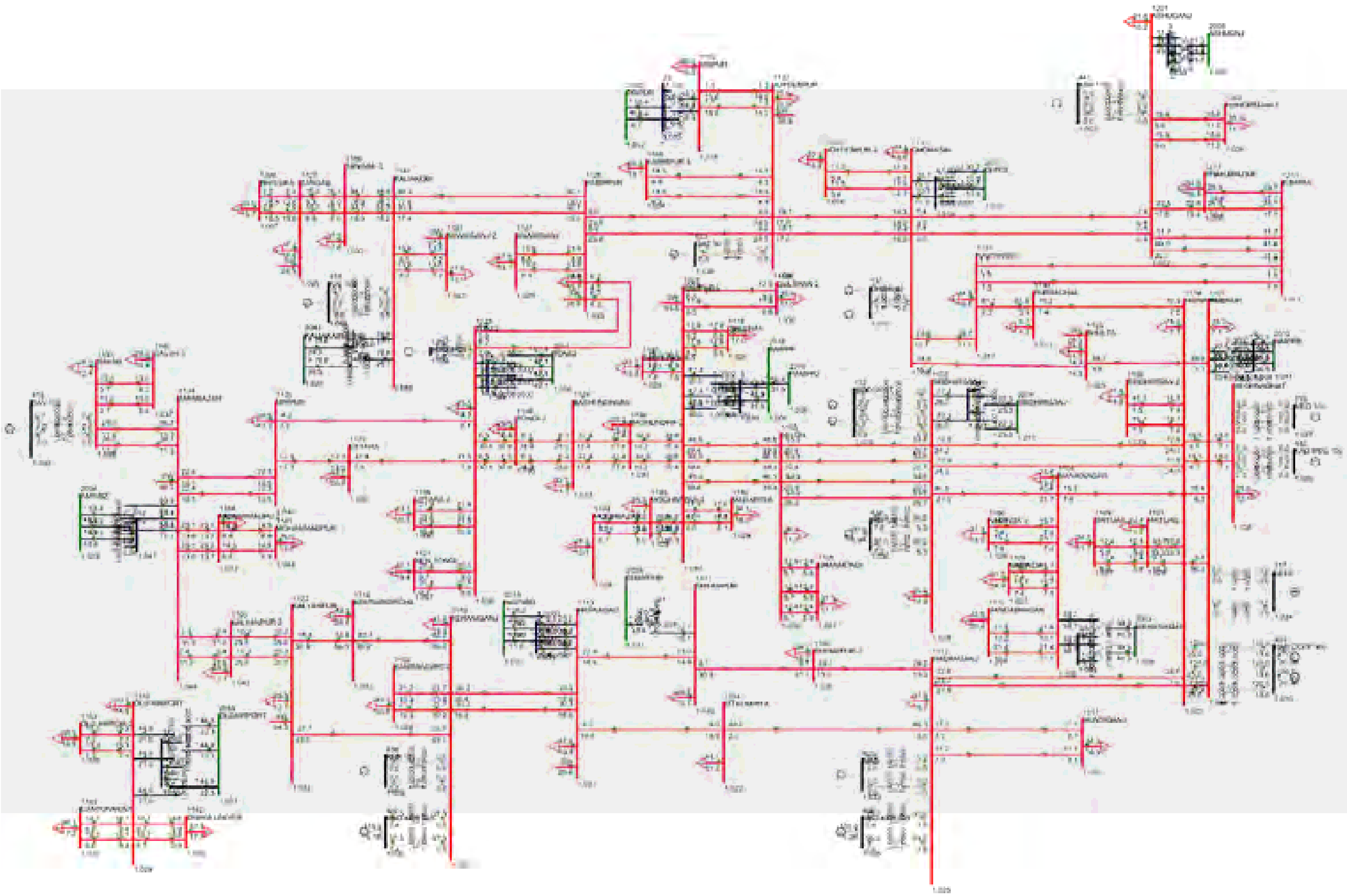
Source: PSMP Study Team

APFig. 9-13 400kV, 230kV power flow (2015, light load)



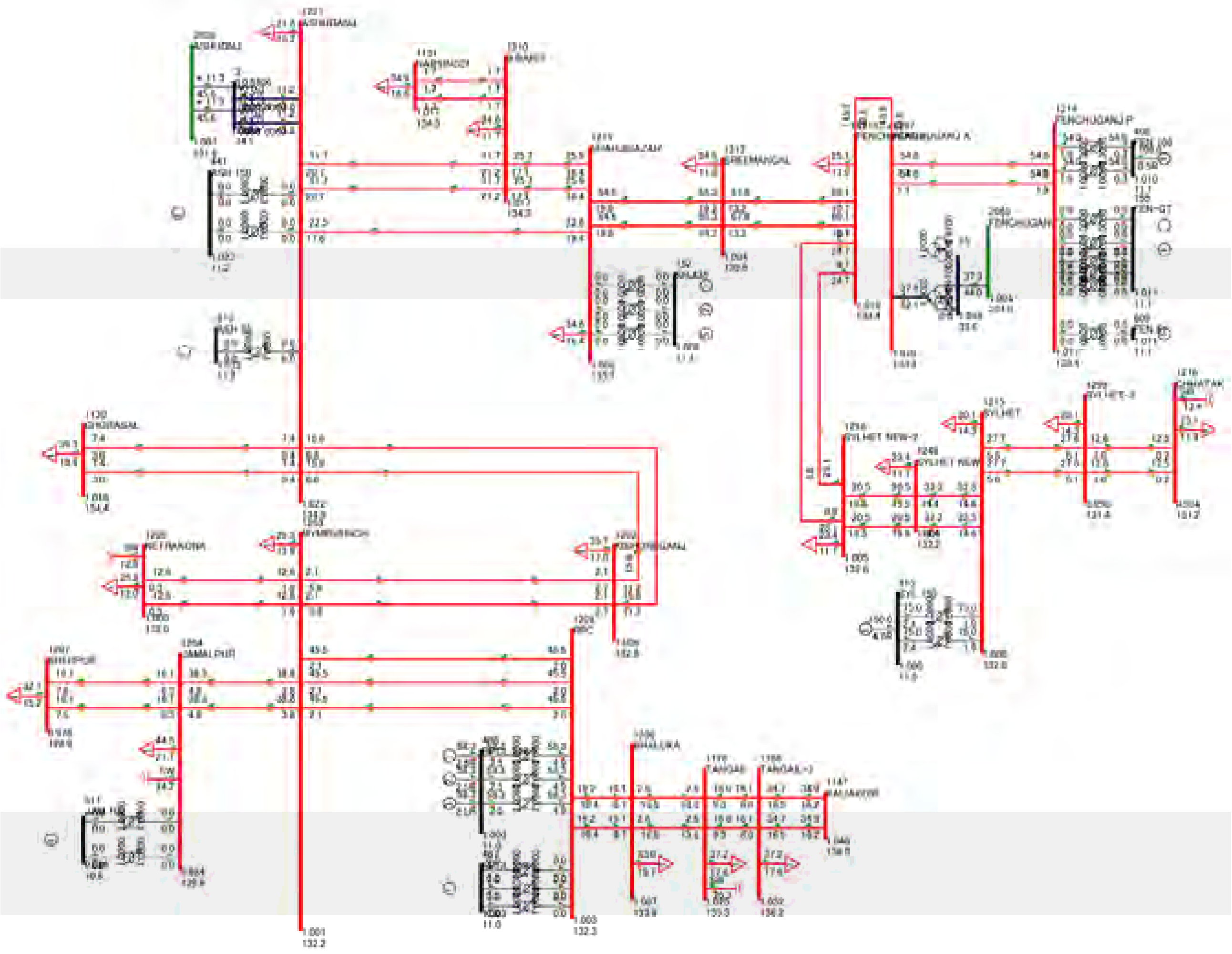
Source: PSMP Study Team

APFig. 9-14 132kV Southern power flow (2015, light load)



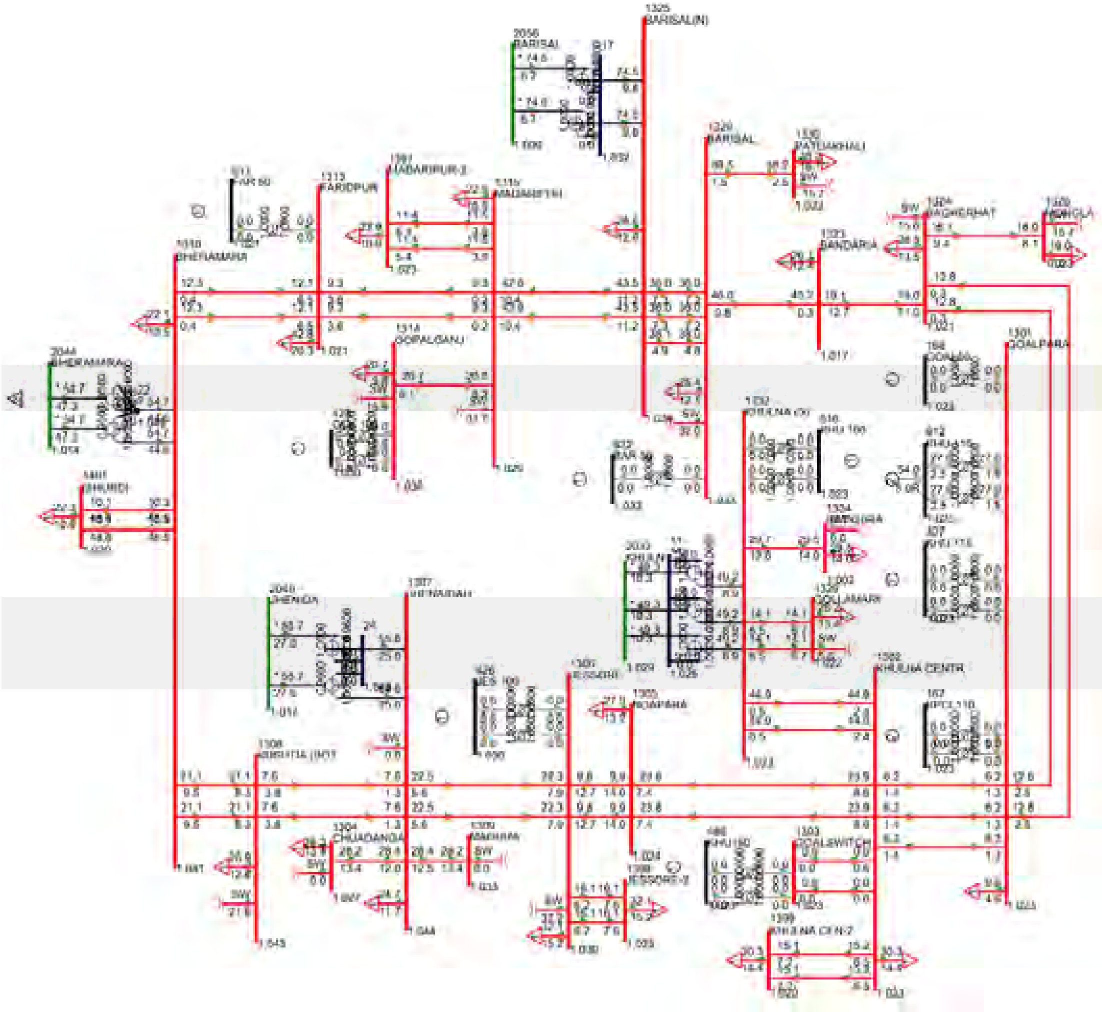
Source: PSMP Study Team

APFig. 9-15 132kV Dhaka power flow (2015, light load)



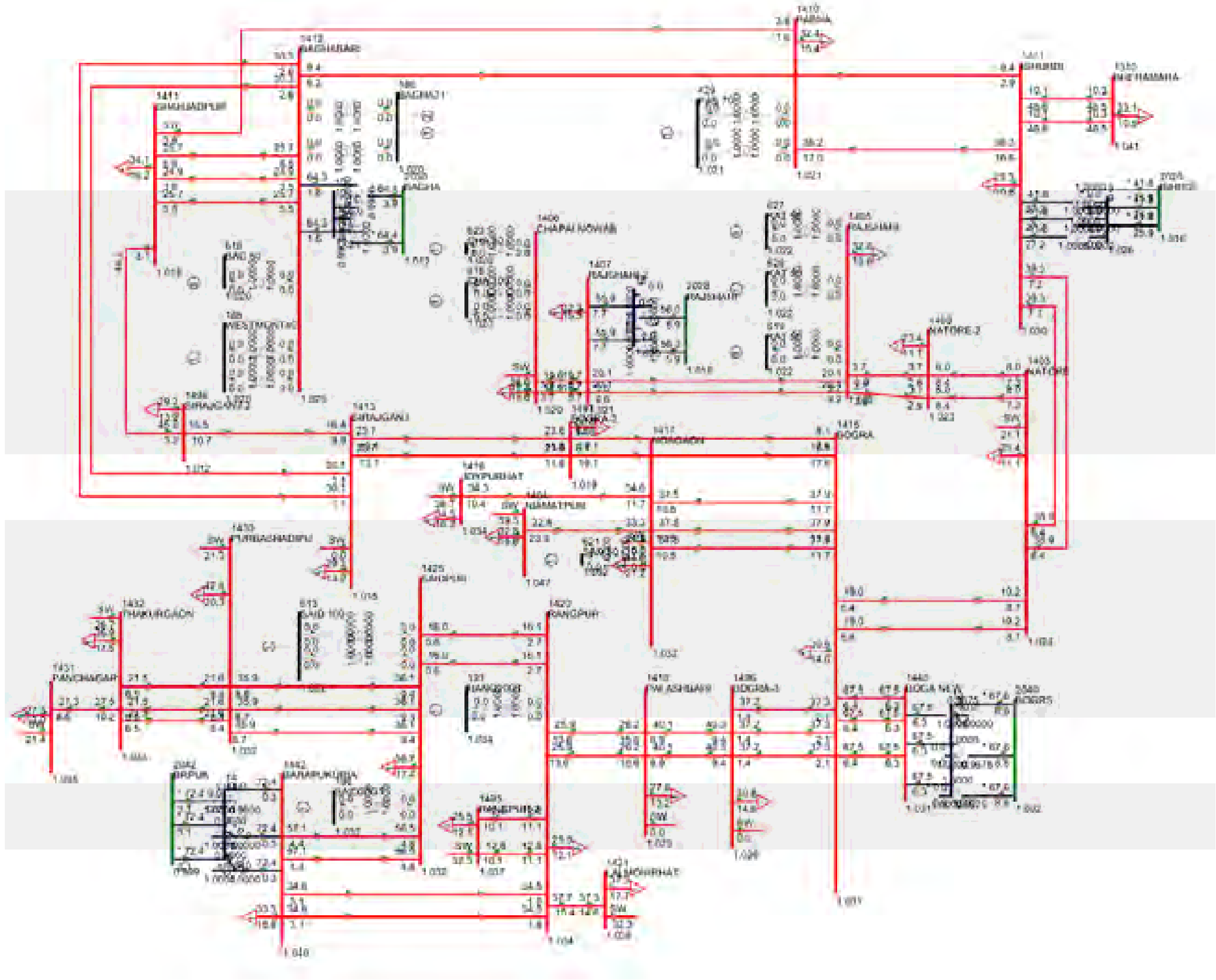
Source: PSMP Study Team

APFig. 9-16 132kV Central power flow (2015, light load)



Source: PSMP Study Team

APFig. 9-17 132kV Western power flow (2015, light load)



Source: PSMP Study Team

APFig. 9-18 132kV Northern power flow (2015, light load)

APTable 9-6 The transmission line for which construction is necessary by 2015

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	ABULKHAIR	BARAULIA			1	4
132kV	AGRABAD	KULSHI			2	14
132kV	AMINBAZAR	KALYANPUR-2			2	4
132kV	AGRABAD	MOHAMMADPU-2			2	5
132kV	AMINBAZAR	SAVAR			2	26
132kV	ASHUGANJ	B.BARIA			2	24
132kV	AMINBAZAR	KISHOREGANJ	2	104	2	104
132kV	ASHUGANJ	SHAHJIBAZAR	3	156	1	52
132kV	B.BARIA	SHAHJIBAZAR			2	80
132kV	BAGHABARI	SIRAJGANJ	2	84	2	84
132kV	BAGHERHAT	MONGLA	1	28	1	28
132kV	BAKULIA	BAKULIA-2			2	15.5
132kV	BANDARIA	BAGHERHAT	1	39	1	39
132kV	BARISAL	BANDARIA	1	50	1	50
132kV	BANDARIA	BARISAL(N)			3	12
132kV	BARISAL	PATUAKHALI	1	40	1	40
132kV	BAROIRHAT	FENI			2	118
132kV	BASHUNDHARA	BASHUNDHA-2			2	22
132kV	BAROIRHAT	TONGI	2	16		
132kV	BASHUNDHARA	TONGI-2			2	8
132kV	BHALUKA	RPC			2	80
132kV	BHERAMARA	FARIDPUR	2	240	2	240
132kV	BHALUKA	ISHURDI	2	20	2	20
132kV	BOGRA	BOGA NEW	2	2	3	3
132kV	BHALUKA	BOGRA-2			2	66
132kV	BOGRA	BOGRA-3			3	75
132kV	BHALUKA	NOAGAON	2	104	3	156
132kV	BOGRA	PALASHBARI	2	100		
132kV	CANTONMENT	OLD AIRPORT			2	12
132kV	CHANDPUR	CHANDPUR-2			2	61
132kV	CHANDRAGHONA	KAPTAI-2			1	8
132kV	CHANDPUR	MODUNAGHAT	1	31	1	31
132kV	CHANDRAGHONA	RANGAMATI			1	20
132kV	CHAPAI NOWAB	RAJSHAHI-2			2	88
132kV	CHHATAK	SYLHET-2			2	32.5
132kV	CHOUDDAGRAM	COMILLA (N)			2	80
132kV	CHHATAK	FENI-2			2	23.5
132kV	CHOWMUHANI	CHANDPUR	2	272		
132kV	CHHATAK	RAMGANJ			2	60
132kV	CHUADANGA	JHENAIDAH	1	39	1	39
132kV	COMILLA (N)	CHANDPUR	1	77		

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	CHUADANGA	CHOUDDAGRA-2			2	40
132kV	COMILLA (N)	COMILLA (S)	1	16	2	32
132kV	CHUADANGA	COMILLA (S-2			2	16
132kV	COMILLA (N)	DAUDKANDI			2	60
132kV	CHUADANGA	HARIPUR	2	138		
132kV	COMILLA (S)	CHANDPUR	1	61		
132kV	CHUADANGA	CHANDPUR-2			2	61
132kV	DAUDKANDI	MEGHNAGHAT			2	24
132kV	DHAKA UNIVER	OLD AIRPORT			2	13
132kV	DOHAZARI	COX'S BAZAR	2	174	2	175
132kV	DHAKA UNIVER	DOHAZARI-2			2	32
132kV	FARIDPUR	MADARIPUR	2	132	2	132
132kV	FARIDPUR	FENCHUGANJ P	2	8		
132kV	FENCHUGANJ	SYLHET NEW-2			2	23
132kV	FENCHUGANJ P	FENCHUGANJ A			2	8
132kV	FENCHUGANJ	SYLHET	2	58		
132kV	FENI	CHOWMUHANI	2	64	2	64
132kV	FENCHUGANJ	COMILLA (N)	2	128		
132kV	FENI	FENI-2			2	23.5
132kV	GHORASAL	ASHUGANJ	2	100	2	100
132kV	FENI	BHULTA	1	14	1	14
132kV	GHORASAL	JOYDEBPUR	2	52	2	59
132kV	FENI	JOYDEBPUR-2			2	30
132kV	GHORASAL	NARSINGDI	1	14	1	14
132kV	GOALPARA	BAGHERHAT	1	43	2	86
132kV	GHORASAL	KHULNA CENTR	2	4	3	6
132kV	GOLLAMARI	KHULNA (S)	2	8.4	2	8.4
132kV	GOPALGANJ	MADARIPUR	1	46	1	46
132kV	HALISHAHAR	AGRABAD			2	13
132kV	GOPALGANJ	HALISHAHAR-2			1	7
132kV	HALISHAHAR	JULDA	1	7	1	7
132kV	GOPALGANJ	KULSHI	3	42		
132kV	HARIPUR	BHULTA	1	30	1	30
132kV	GOPALGANJ	MADANGANJ	1	13	1	13
132kV	HARIPUR	MANIKNAGAR	2	53.2	1	26
132kV	GOPALGANJ	MATUAIL	1	10		
132kV	HARIPUR	MATUAIL-2			1	5
132kV	GOPALGANJ	NARSINGDI	1	32		
132kV	HARIPUR	SHYAMPUR	1	32		
132kV	GOPALGANJ	SIDDHIRGANJ	2	4		
132kV	HARIPUR-2	MATUAIL-2			1	5
132kV	GOPALGANJ	SIDDHIRGAN-2			2	2
132kV	HASNABAD	KALYANPUR	1	21		
132kV	GOPALGANJ	KAMRANGIRCHA	1	11		
132kV	HASNABAD	KERANIGANJ			2	26

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	GOPALGANJ	SITALAKHYA	1	12	1	12
132kV	HATHAZARI	BARAULIA	2	20	2	20
132kV	GOPALGANJ	BAROIRHAT			2	60
132kV	HATHAZARI	FENI	2	178		
132kV	GOPALGANJ	MODUNAGHAT	2	18	2	18
132kV	ISHURDI	BAGHABARI			1	63
132kV	GOPALGANJ	NATORE	2	80	2	80
132kV	ISHURDI	PABNA	1	16	1	16
132kV	JAMALPUR	SHERPUR			2	60
132kV	JESSORE	JESSORE-2			2	60
132kV	JAMALPUR	JHENAIDAH	2	100	2	100
132kV	JHENAIDAH	KUSHTIA (BOT	2	90	2	90
132kV	JAMALPUR	MAGURA	1	26	1	26
132kV	JOYDEBPUR	KABIRPUR-2			2	15.5
132kV	JAMALPUR	SRIPUR			2	64
132kV	JOYPURHAT	NOAGAON	1	46	1	46
132kV	JULDA	SHAHMIRPUR	2	12	2	12
132kV	KABIRPUR	JOYDEBPUR	2	30	2	31
132kV	JULDA	KALIAKOIR			2	40
132kV	KABIRPUR	MANIKGANJ	2	63	2	63
132kV	JULDA	TANGAIL	2	99		
132kV	KALIAKOIR	MANIKGANJ-2			2	31.5
132kV	JULDA	TANGAIL-2			2	50
132kV	KALYANPUR	AMINBAZAR	2	8		
132kV	JULDA	KALYANPUR-2			2	4
132kV	KAMRANGIRCHA	KALYANPUR	1	12	1	12
132kV	JULDA	KERANIGANJ			1	4
132kV	KAPTAI	CHANDRAGHONA	1	8		
132kV	JULDA	HATHAZARI	2	78	2	78
132kV	KAPTAI	MODUNAGHAT	1	39		
132kV	KERANIGANJ	KALYANPUR			1	17
132kV	KAPTAI	KAMRANGIRC-2			2	4
132kV	KHULNA (S)	SATKHIRA	1	46	1	46
132kV	KHULNA CENTR	GOALSWITCH			2	5
132kV	KHULNA (S)	KHULNA (S)	2	18	2	18
132kV	KHULNA CENTR	KHULNA CEN-2			2	28
132kV	KHULNA (S)	NOAPARA	2	56	2	56
132kV	KISHOREGANJ	MYMENSINGH	2	118	2	117.8
132kV	KULSHI	ABULKHAIR			1	8.9
132kV	KISHOREGANJ	AGRABAD-2			2	7
132kV	KULSHI	BAKULIA	2	31		
132kV	KISHOREGANJ	BAKULIA-2			2	15.5
132kV	KULSHI	BARAULIA	2	26	1	13
132kV	KISHOREGANJ	HALISHAHAR-2			1	7
132kV	KULSHI	KULSHI-2			2	13

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	KUSHTIA (BOT	BHERAMARA	2	54	2	54
132kV	MADANGANJ	HARIPUR-2			1	13
132kV	KUSHTIA (BOT	MUNSIGANJ			2	40
132kV	MADANGANJ	SHYAMPUR-2			1	9.5
132kV	KUSHTIA (BOT	SITALAKHYA	1	10	1	10
132kV	MADARIPUR	BARISAL	2	124		
132kV	KUSHTIA (BOT	BARISAL(N)			2	116
132kV	MADARIPUR	MADARIPUR-2			2	58
132kV	MANIKNAGAR	BANGABHABAN	2	10	2	4
132kV	MADARIPUR	MATUAIL	1	24		
132kV	MANIKNAGAR	NARINDA	2	6	2	6
132kV	MADARIPUR	NARINDA-2			2	3
132kV	MATUAIL	MATUAIL-2			2	10
132kV	MEGHNAGHAT	HARIPUR-2			2	42
132kV	MIRPUR	AMINBAZAR	2	20	2	19
132kV	MEGHNAGHAT	TONGI	1	15	1	14.5
132kV	MIRPUR	UTTARA	1	13	1	13
132kV	MODUNAGHAT	KAPTAI-2			1	39
132kV	MIRPUR	KULSHI	2	26		
132kV	MODUNAGHAT	KULSHI-2			2	13
132kV	MIRPUR	SIKALBAHA	2	32	2	32
132kV	MOGHBAZAR	MOGHBAZAR-2			2	4.5
132kV	MIRPUR	RAMPURA	1	4.5		
132kV	MOGHBAZAR	ULLON	1	6		
132kV	MOHAMMADPUR	MOHAMMADPU-2			2	5
132kV	MYMENSINGH	JAMALPUR	2	110	2	109.8
132kV	MOHAMMADPUR	NETRAKONA	2	68	2	68
132kV	MYMENSINGH	RPC			3	12
132kV	NARSINGDI	B.BARIA			2	110
132kV	MYMENSINGH	PURBACHAL			1	1
132kV	NATORE	BOGRA	2	140	2	140
132kV	MYMENSINGH	NATORE-2			2	42
132kV	NATORE	RAJSHAHI	2	84		
132kV	NEW TONGI	TONGI	2	2	2	2
132kV	NIAMATPUR	NOAGAON	1	46	1	46
132kV	NOAPARA	JESSORE	2	56	2	56
132kV	OLD AIRPORT	OLD AIRPOR-2			2	6.5
132kV	PABNA	SHAHJADPUR	1	42	1	42
132kV	PALASHBARI	BOGRA-3			2	50
132kV	PABNA	RANGPUR	2	106	2	106
132kV	PANCHAGAR	THAKURGAON			1	45
132kV	PURBACHAL	HARIPUR-2			1	4.5
132kV	PURBASHADIPU	THAKURGAON	2	88	3	132
132kV	RAJSHAHI	CHAPAI NOWAB	2	108		
132kV	PURBASHADIPU	NATORE-2			2	42

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	RAJSHAHI	RAJSHAHI-2			2	20
132kV	RAMGANJ	CHANDPUR			2	90
132kV	RAMPURA	BASHUNDHA-2			2	22
132kV	RAMGANJ	BASHUNDHA-3			2	11
132kV	RAMPURA	BASHUNDHARA	2	22		
132kV	RAMGANJ	GULSHAN	2	6.6	2	6.6
132kV	RAMPURA	GULSHAN-2			2	3.3
132kV	RAMGANJ	MADARTEK			2	4
132kV	RAMPURA	MOGHBAZAR-2			2	4.5
132kV	RANGAMATI	KHAGRACHARI			1	60
132kV	RANGPUR	BARAPUKURIA	2	80	2	80
132kV	RANGAMATI	LALMONIRHAT	1	37	1	37
132kV	RANGPUR	RANGPUR-2			2	40
132kV	RANGAMATI	SAIDPUR	2	82	2	82
132kV	SAIDPUR	BARAPUKURIA	2	72	2	72
132kV	RANGAMATI	PURBASHADIPU	2	50	3	75
132kV	SAVAR	SAVAR-2			2	20
132kV	SHAHJADPUR	BAGHABARI	2	16	3	24
132kV	SAVAR	SIRAJGANJ	1	34		
132kV	SHAHJADPUR	SIRAJGANJ-2			1	17
132kV	SHAHJIBAZAR	SREEMANGAL	2	72	2	73
132kV	SHYAMPUR	HASNABAD	1	15	1	15
132kV	SHAHJIBAZAR	SHYAMPUR-2			1	9.5
132kV	SIDDHIRGANJ	HARIPUR-2			2	4
132kV	SHAHJIBAZAR	MANIKNAGAR			1	10
132kV	SIDDHIRGANJ	ULLON	2	32	4	64
132kV	SIKALBAHA	BAKULIA	2	8	2	8
132kV	SIDDHIRGANJ	DOHAZARI	2	64		
132kV	SIKALBAHA	DOHAZARI-2			2	32
132kV	SIDDHIRGANJ	JULDA	1	5	1	5
132kV	SIKALBAHA	SHAHMIRPUR	2	12	2	12
132kV	SIRAJGANJ	BOGRA	2	132		
132kV	SIKALBAHA	BOGRA-2			2	66
132kV	SIRAJGANJ	SIRAJGANJ-2			1	17
132kV	SREEMANGAL	FENCHUGANJ	2	98	2	98
132kV	SYLHET	CHHATAK	2	64		
132kV	SREEMANGAL	SYLHET NEW			2	20
132kV	SYLHET	SYLHET-2			2	32.5
132kV	SYLHET NEW	SYLHET NEW-2			2	23
132kV	TANGAIL	BHALUKA			2	120
132kV	SYLHET NEW	TANGAIL-2			2	50
132kV	TONGI	KABIRPUR	2	46	2	49
132kV	SYLHET NEW	TONGI-2			2	8
132kV	TONGI	UTTARA-2			2	7
132kV	ULLON	DHANMONDI	2	12	3	16.5

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
132kV	TONGI	RAMPURA	2	8	3	12
132kV	UTTARA	TONGI	1	7	1	7
132kV Total				6116.7		7384.8
230kV	AMINBZ	KALIAKAIR			2	76
230kV	AMINBZ	OLDAIRPORT			3	30
230kV	ASHUGNJ	GHRSL	2	88	2	88
230kV	ASHUGNJ	SRIPUR			2	140
230kV	ASHUGNJ	SRJGNJ	2	286		
230kV	BAGHA	SRJGNJ	2	76	2	76
230kV	BHERAMARA	JHENIDA			2	150
230kV	BHOLA	BARISAL			2	120
230kV	BIBIYANA	FENCHUGANJ			2	64
230kV	BOGRS	BRPUK	2	212	2	212
230kV	COMIN	ASHUGNJ	2	158	2	158
230kV	COMIN	BIBIYANA			2	320
230kV	COMIN	MEGH	2	116		
230kV	COMIN	MEGHNAGHAT			2	116
230kV	GHRSL	ISHRDI	2	356	2	356
230kV	GHRSL	RAMPR	2	100	2	100
230kV	GHRSL	TONGI	2	54	2	54
230kV	HARIPR	HARIPUR360	2	4.8	2	4.8
230kV	HARIPR	MEGH	2	24		
230kV	HARIPR	MEGHNAGHAT			2	24
230kV	HARIPR	RAMPR	2	56	2	56
230kV	HARIPR	SIDDHIRGANJ			1	2
230kV	HASNBD	AMINBZ	2	42	2	42
230kV	HASNBD	MEGH	2	52		
230kV	HASNBD	MEGHNAGHAT			1	26
230kV	HASNBD	SHAMPUR			1	10
230kV	HATHZR	COMIN	2	300	2	300
230kV	HATHZR	KULSHI			2	40
230kV	HATHZR	SIKALBAHA			2	50
230kV	ISHRDI	BAGHA	2	110	2	110
230kV	ISHRDI	BHERAMARA			2	20
230kV	ISHRDI	KHULN	2	370		
230kV	ISHRDI	RAJSHAHI			2	140
230kV	KHULN	JHENIDA			2	200
230kV	KHULN	MONGLA			2	80
230kV	MANIKNAGAR	SIDDHIRGANJ			2	20
230kV	MEGHNAGHAT	SHAMPUR			1	16
230kV	RAOZN	HATHZR	2	45	3	67.5
230kV	SIDDHIRGANJ	HARIPR			1	2
230kV	SIKALBAHA	ANOWARA			2	40
230kV	SRJGNJ	BOGRS	2	144	2	144
230kV	SRJGNJ	SRIPUR			2	146

Voltage	From Substation	To Substation	2010		2015	
			cct.	Length (km)	cct.	Length (km)
230kV	TONGI	AMINBZ	2	51		
230kV	TONGI	KALIAKAIR			2	76
230kV Total				2644.8		3676.3
400kV	AMINBAZAR	MEGHNAGHAT			1	50
400kV	AMINBAZAR	ZAJIRA			1	56.25
400kV	KALIAKAIR	BIBIYANA			2	336
400kV	MEGHNAGHAT	AMINBAZAR			1	50
400kV	MEGHNAGHAT	ANOWARA			2	520
400kV	MONGLA	ZAJIRA			2	272
400kV	ZAJIRA	AMINBAZAR			1	56.25
400kV Total						1340.5

Source: PSMP Study Team

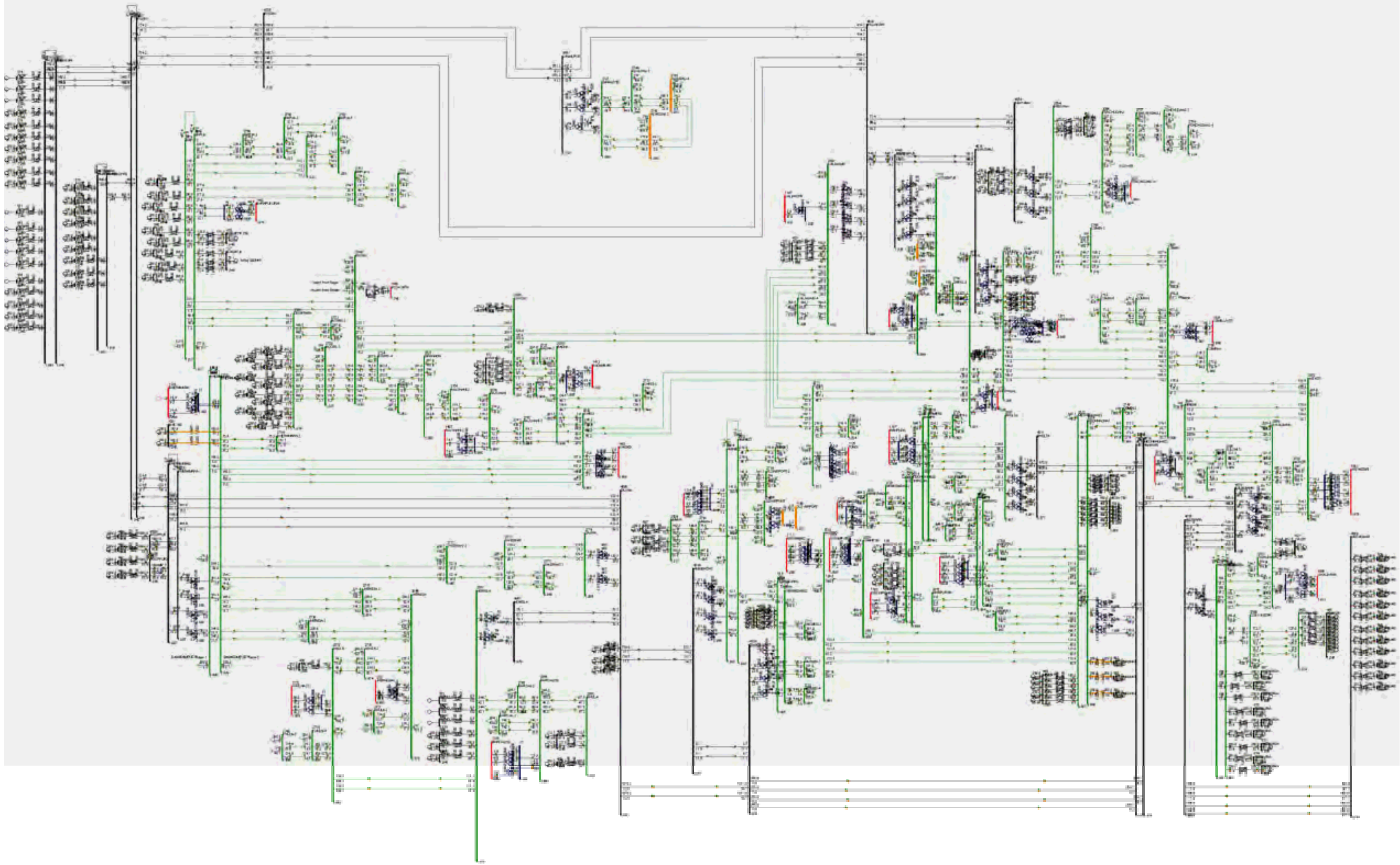
APTable 9-7 The substation for which construction is necessary by 2015

Voltage	East or West	Region	Name	Type
132/33kV	East	Southern	Dohazari	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Halishahar	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Agrabad	132/33kV(2x100MW, GIS)
132/33kV	East	Southern	Agrabad	132/33kV(2x100MW, GIS)
132/33kV	East	Southern	Kulsi	132/33kV(2x100MW, GIS)
132/33kV	East	Southern	Baroirhat, Ctg	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Feni	132/33kV(2x100MW, GIS)
132/33kV	East	Southern	Ramganj	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Comilla (S)-2	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Chouddagram	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Chouddagram	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Chandpur	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Rangamati	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Khagrachari	132/33kV(2x100MW, AIS)
132/33kV	East	Southern	Bakulia	132/33kV(2x100MW, GIS)
132/33kV	East	Southern	Daudkandi	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Siddhirganj	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Moghbazar	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Narinda	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Shyampur	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Hasnabad	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Kalyanpur	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Basundhara-2	132/33kV(2x100MW, GIS)

Voltage	East or West	Region	Name	Type
132/33kV	East	Dhaka	Basundhara-3	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Tongi	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Kabirpur	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Manikganj	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Tangail	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Joydebpur	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Uttara-2	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Cantonment	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Nabinagar(Md.pur)	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Nabinagar(Md.pur)	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	OldAirport	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	OldAirport	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	DhakaUniversity	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Kamrangirchar	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Madartek	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Gulshan-2	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Matuail	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Meghnaghat	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Savar	132/33kV(2x100MW, GIS)
132/33kV	East	Dhaka	Purbachal	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Munshiganj	132/33kV(2x100MW, AIS)
132/33kV	East	Dhaka	Sreepur	132/33kV(2x100MW, AIS)
132/33kV	West	Western	Khulna(C)	132/33kV(2x100MW, AIS)
132/33kV	East	Central	Bhaluka	132/33kV(2x100MW, AIS)
132/33kV	East	Central	Sherpur	132/33kV(2x100MW, AIS)
132/33kV	East	Central	Sylhet	132/33kV(2x100MW, AIS)
132/33kV	East	Central	Sylhet New	132/33kV(2x100MW, AIS)
132/33kV	East	Central	Sylhet New	132/33kV(2x100MW, GIS)
132/33kV	East	Central	Brahmanbaria	132/33kV(2x100MW, GIS)
132/33kV	West	Western	Jessore	132/33kV(2x100MW, AIS)
132/33kV	West	Western	Magura	132/33kV(2x100MW, AIS)
132/33kV	West	Western	Chuadanga	132/33kV(2x100MW, AIS)
132/33kV	West	Western	Madaripur	132/33kV(2x100MW, AIS)
132/33kV	West	Western	Barisal (N)	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Natore	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Rajshahi New	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Sirajganj	132/33kV(2x100MW, AIS)

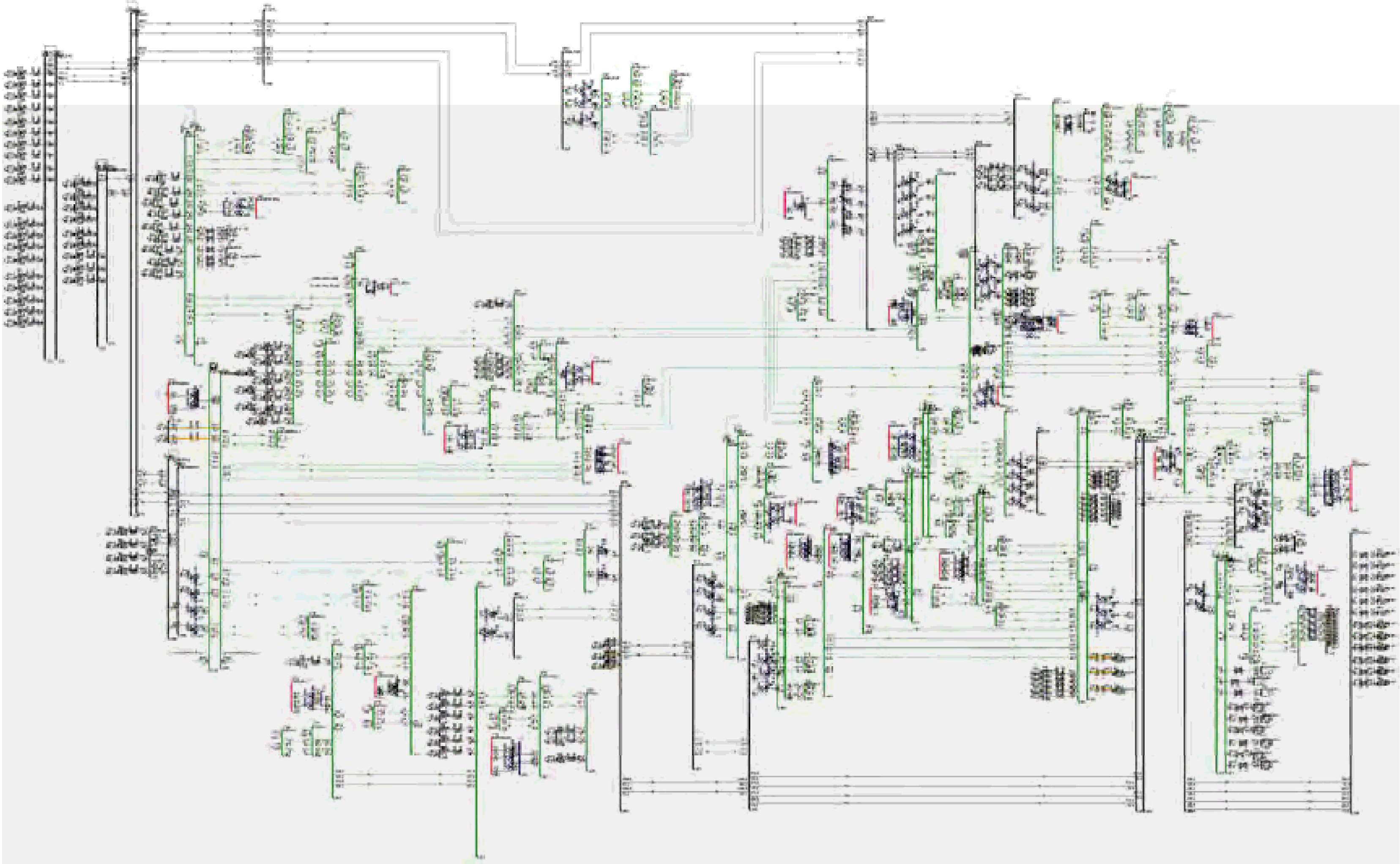
Voltage	East or West	Region	Name	Type
132/33kV	West	Northern	Bogra	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Bogra	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Rangpur	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Panchaghar	132/33kV(2x100MW, AIS)
132/33kV	West	Northern	Joypurhat	132/33kV(2x100MW, AIS)
230/132kV	East	Southern	KULSHI	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	SIKALBAHA	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	KALIAKAIR	230/132kV(2x300MW, AIS)
230/132kV	East	Dhaka	OLDAIRPORT	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	SHAMPUR	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	SIDDHIRGANJ	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	SRIPUR	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BARISAL	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BHERAMARA	230/132kV(2x300MW, AIS)
230/132kV	West	Western	JHENIDA	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	RAJSHAHI	230/132kV(2x300MW, AIS)
400/230kV	East	Southern	ANOWARA	400/230kV(2x500MVA, AIS)
400/230kV	East	Dhaka	AMINBAZAR	400/230kV(3x500MVA, AIS)
400/230kV	East	Dhaka	KALIAKAIR	400/230kV(3x500MVA, AIS)
400/230kV	East	Dhaka	MEGHNAGHAT	400/230kV(3x500MVA, AIS)
400/230kV	East	Central	BIBIYANA	400/230kV(1x500MVA, AIS)
400/230kV	West	Western	MONGLA	400/230kV(3x500MVA, AIS)

Source: PSMP Study Team



Source: PSMP Study Team

APFig. 9-19 400kV, 230kV power flow (2030, pattern east)



Source: PSMP Study Team

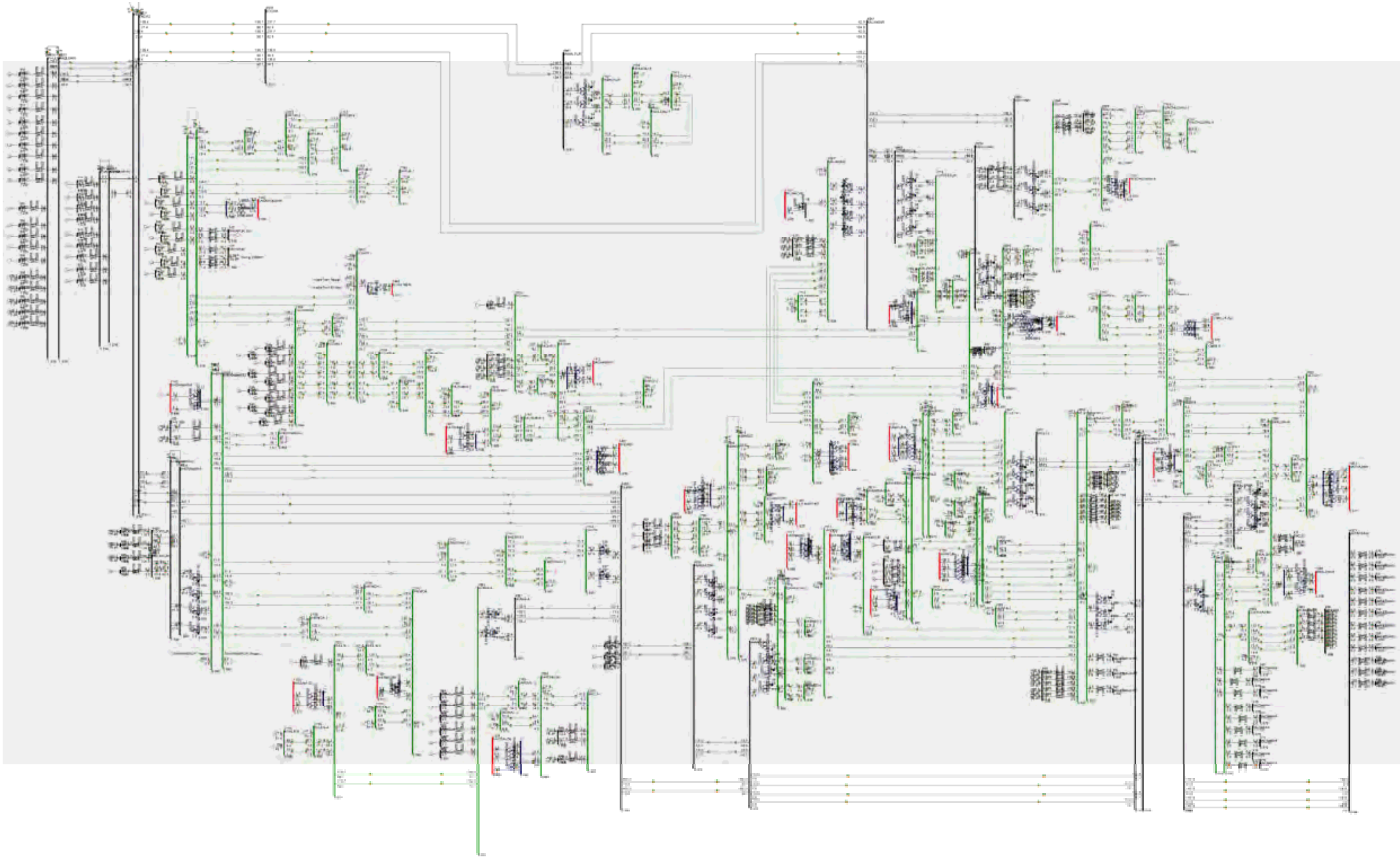
APFig. 9-20 400kV, 230kV power flow (2030, pattern west)

APTable 9-8 Results of short-circuit and ground-fault current analysis (2030) (kA)

Substation		I"k		Asym Ib		Substation		I"k		Asym Ib	
Name	Voltage	3PH	LG	3PH	LG	Name	Voltage	3PH	LG	3PH	LG
HATHZR	230kV	34.6	28.9	34.4	29.0	RAMPR-3	230kV	21.4	17.3	21.5	17.4
MANIKNAGAR	230kV	34.1	26.5	34.1	26.5	RAMPR-4	230kV	31.4	20.9	31.4	20.9
SIDDHIRGANJ	230kV	51.9	45.0	52.1	46.1	RAMPR-5	230kV	31.4	20.9	31.4	20.9
COMIN	230kV	36.5	26.4	36.4	26.4	ISHRDI-2	230kV	16.2	9.8	16.2	9.8
ASHUGNJ	230kV	44.0	38.4	43.4	39.8	BHERAMARA-2	230kV	41.9	30.0	42.0	30.0
SIKALBAHA	230kV	48.5	43.5	48.7	45.2	JHENIDA-2	230kV	24.4	20.8	24.4	20.8
GHRSL	230kV	34.5	28.7	33.2	28.9	JHENIDA-3	230kV	24.4	20.8	24.4	20.8
TONGI	230kV	27.9	23.7	27.7	23.8	KHULN-2	230kV	11.3	9.9	11.3	9.9
HARIPR	230kV	56.1	49.5	57.1	50.7	KHULN-3	230kV	18.5	15.9	18.5	16.0
HASNBD	230kV	33.7	27.5	33.6	27.6	KHULN-4	230kV	16.9	12.3	16.8	12.3
MEGHNAGHAT	230kV	54.3	43.2	55.3	46.0	KHULN-5	230kV	13.8	9.3	13.8	9.3
HARIPUR360	230kV	47.3	40.7	47.1	40.8	ASHUGNJ-2	230kV	13.3	7.8	13.3	7.8
RAMPR	230kV	21.5	18.0	21.6	18.4	ASHUGNJ-3	230kV	8.7	4.9	8.7	4.9
ISHRDI	230kV	48.0	37.9	48.1	38.1	ASHUGNJ-4	230kV	8.7	4.9	8.7	4.9
KULSHI	230kV	42.5	36.3	41.9	36.4	ASHUGNJ-5	230kV	9.9	5.6	9.9	5.6
ANOWARA	230kV	48.7	40.4	51.9	46.4	JAMALPUR	230kV	16.9	10.7	17.1	11.1
RAJSHAHI	230kV	19.3	13.9	19.1	14.0	COMIN-2	230kV	34.9	22.0	34.9	22.0
SHAMPUR	230kV	28.9	23.8	28.9	23.9	COMIN-3	230kV	15.8	9.3	15.8	9.3
BAGHA	230kV	29.3	21.0	29.1	21.1	COMIN-4	230kV	14.9	8.6	14.9	8.6
KHULN	230kV	21.8	18.3	21.5	18.4	COMIN-5	230kV	23.7	14.9	23.7	14.9
AMINBZ	230kV	37.1	33.1	37.0	33.8	COMIN-6	230kV	13.4	7.6	13.4	7.6
SRJGNJ	230kV	34.3	24.4	33.6	24.9	GHRSL-2	230kV	29.2	21.6	28.9	21.7
BOGRS	230kV	37.3	25.0	37.3	25.0	RAJSHAHI-2	230kV	18.6	11.6	18.6	11.6
BRPUK	230kV	40.0	33.2	43.8	42.5	RAJSHAHI-3	230kV	23.4	15.1	23.3	15.1
BHERAMARA	230kV	53.1	42.4	54.4	43.9	MAWA-2	230kV	25.1	18.3	24.2	18.4
OLDAIRPORT	230kV	27.5	23.5	27.4	23.5	BRPUK-2	230kV	14.6	8.6	14.6	8.6
KALIAKAIR	230kV	31.7	26.3	32.1	27.6	BRPUK-3	230kV	12.7	7.3	12.7	7.3
JHENIDA	230kV	24.7	22.0	24.6	22.0	BRPUK-4	230kV	18.2	11.2	18.2	11.2
MONGLA	230kV	30.0	24.4	30.4	28.0	BRPUK-5	230kV	13.7	8.0	13.7	8.0
SRIPUR	230kV	19.4	14.5	19.4	14.5	BRPUK-6	230kV	15.3	9.1	15.4	9.1
BIBIYANA	230kV	22.1	18.1	22.7	19.6	BRPUK-7	230kV	9.8	5.5	9.8	5.5
BHOLA	230kV	8.5	7.2	8.9	8.4	BARISAL-2	230kV	13.2	9.5	13.1	9.5
BARISAL(N)	230kV	9.6	9.4	9.4	9.5	BARISAL-3	230kV	6.1	4.5	6.1	4.5
FENCHUGANJ	230kV	14.3	11.4	14.2	11.5	FENCHUGANJ-2	230kV	12.3	9.2	12.3	9.2
COXS BAZAR	230kV	11.7	7.0	11.6	7.0	FENCHUGANJ-3	230kV	9.7	6.6	9.7	6.6
NOAGAON	230kV	23.4	14.2	23.4	14.2	FENCHUGANJ-4	230kV	8.0	5.1	8.0	5.1
KERANIGANJ	230kV	37.1	29.8	38.4	32.6	TAKERHAT	230kV	15.2	7.9	15.2	7.9
BHULTA	230kV	22.4	18.5	22.6	19.1	TAKERHAT-2	230kV	13.5	7.2	13.5	7.2
DIGHIPARA	230kV	42.1	31.8	43.3	39.2	TAKERHAT-3	230kV	11.7	6.1	11.7	6.1
MAWA	230kV	22.3	16.1	21.4	17.2	ZAJIRA	230kV	19.9	10.4	20.5	10.9
AMINBZ2	230kV	37.1	33.1	37.0	33.8	KERANIGANJ2	230kV	37.1	29.8	38.4	32.6

Substation		I"k		Asym Ib		Substation		I"k		Asym Ib	
Name	Voltage	3PH	LG	3PH	LG	Name	Voltage	3PH	LG	3PH	LG
MEGHNAGHAT2	230kV	55.0	47.4	56.9	50.3	ANOWARA2	230kV	48.7	40.4	51.9	46.4
HARIPR2	230kV	56.1	49.5	57.1	50.7	BHERAMARA2	230kV	53.1	42.4	54.4	43.9
SIDDHIRGANJ2	230kV	51.9	45.0	52.1	46.1	BRPUK2	230kV	40.0	33.2	43.8	42.5
RAMPR2	230kV	21.5	18.0	21.6	18.4	MEGHNAGHAT	400kV	36.7	29.0	38.8	29.9
MYANMMER	230kV	9.1	7.1	10.3	9.0	ANOWARA	400kV	28.1	23.1	32.0	25.1
TONGI-2	230kV	20.3	14.5	20.3	14.5	AMINBAZAR	400kV	31.3	24.7	32.1	25.2
TONGI-3	230kV	24.7	17.6	24.7	17.6	KALIAKAIR	400kV	26.4	22.7	26.9	23.3
HATHZR-2	230kV	30.2	21.0	30.1	21.0	MONGLA	400kV	16.4	10.6	17.0	10.8
SIKALBAHA-2	230kV	32.7	22.5	32.3	22.5	BIBIYANA	400kV	14.4	12.0	14.8	13.0
KULSHI-2	230kV	40.6	32.4	40.1	32.5	ZAJIRA	400kV	38.9	30.8	40.0	31.7
KULSHI-3	230kV	43.2	36.4	42.5	36.5	PKDP	400kV	46.6	42.1	52.5	47.8
HARIPR-2	230kV	40.9	28.6	40.8	28.6	ROOPPUR	400kV	47.8	29.4	42.6	31.2
HARIPR-3	230kV	41.3	30.4	41.1	30.4	MATARBARI	400kV	26.4	23.5	30.8	29.5
HASNBD-2	230kV	29.9	21.6	29.9	21.6	SIKALBAHA	400kV	28.0	22.4	31.1	23.8
HASNBD-3	230kV	29.9	21.6	29.9	21.6	BHULTA	400kV	24.6	19.8	25.0	20.1
HASNBD-4	230kV	29.9	21.6	29.9	21.6	MEGHNAGHAT2	400kV	36.7	29.0	38.8	29.9
OLDAIRPORT-2	230kV	31.6	26.3	31.3	26.3	PKDP2	400kV	46.6	42.1	52.5	47.8
JOYDEBPUR	230kV	29.0	21.4	29.3	21.9	ROOPPUR2	400kV	47.8	29.4	42.6	31.2
KALIAKAIR-2	230kV	15.9	9.8	15.9	9.8	KHARASPIR	400kV	40.5	35.5	44.2	39.1
KALIAKAIR-3	230kV	15.9	9.8	15.9	9.8	PHULBARI	400kV	45.6	42.0	52.5	51.9
KALIAKAIR-4	230kV	19.8	13.3	19.8	13.3	PHULBARI2	400kV	45.6	42.0	52.5	51.9
BOGRS-3	230kV	35.4	23.4	34.9	23.4	BHERAMARA	400kV	49.6	31.6	45.7	33.3
BOGRS-5	230kV	23.7	14.3	23.7	14.3	BOGRA	400kV	27.6	21.4	28.0	21.5
BOGRS-2	230kV	17.3	10.2	17.3	10.2	DHAKA WEST	400kV	37.7	30.4	39.4	31.4
BOGRS-4	230kV	23.7	14.3	23.7	14.3	ASHUGANJ	400kV	21.0	16.3	21.6	16.7
BAGHA-2	230kV	21.4	13.4	21.4	13.4	JOYDEBPUR	400kV	23.7	20.0	24.2	20.6
BAGHA-3	230kV	21.4	13.4	21.4	13.4	JAMALPUR	400kV	20.2	16.7	20.4	16.9
MANIKNAGAR-2	230kV	41.2	31.2	41.0	31.2	BHERAMARA2	400kV	49.6	31.6	45.7	33.3
RAMPR-2	230kV	14.0	9.6	13.9	9.6	KHARASPIR2	400kV	40.5	35.5	44.2	39.1

Source :PSMP Study Team



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APFig. 9-21　400kV, 230kV power flow (2030, light load)

APTable 9-9 The transmission line for which construction is necessary by 2030

Voltage	From Substation	To Substation	2010		2030	
			cct.	Length (km)	cct.	Length (km)
230kV	AMINBZ	KERANIGANJ			2	42
230kV	AMINBZ	MAWA-2			2	40
230kV	AMINBZ	OLDAIRPORT			1	10
230kV	AMINBZ	OLDAIRPORT-2			3	15
230kV	AMINBZ	TONGI-3			2	27
230kV	ANOWARA	COXS BAZAR			1	95
230kV	ANOWARA	SIKALBAHA-2			2	20
230kV	ASHUGNJ	ASHUGNJ-2			2	104
230kV	ASHUGNJ	GHRSL	2	88	2	88
230kV	ASHUGNJ	SRIPUR			2	140
230kV	ASHUGNJ	SRJGNJ	2	286		
230kV	ASHUGNJ-3	ASHUGNJ-4			2	109.8
230kV	ASHUGNJ-3	JAMALPUR			2	177.8
230kV	ASHUGNJ-4	ASHUGNJ-5			2	68
230kV	ASHUGNJ-5	JAMALPUR			2	109.8
230kV	BAGHA	BAGHA-2			1	19
230kV	BAGHA	BAGHA-3			1	19
230kV	BAGHA	ISHRDI-2			2	55
230kV	BAGHA	SRJGNJ	2	76	2	76
230kV	BARISAL(N)	BARISAL-2			2	117
230kV	BARISAL(N)	BARISAL-3			2	117
230kV	BHERAMARA	JHENIDA-3			2	75
230kV	BHERAMARA	TAKERHAT-2			1	120
230kV	BHERAMARA-2	BHERAMARA			2	10
230kV	BHOLA	BARISAL(N)			2	120
230kV	BHULTA	RAMPR-3			2	4
230kV	BIBIYANA	COMIN-3			2	160
230kV	BIBIYANA	FENCHUGANJ			2	64
230kV	BOGRS	BOGRS-3			4	135
230kV	BOGRS	BOGRS-4			2	52
230kV	BOGRS	BOGRS-5			2	52
230kV	BOGRS	BRPUK	2	212	2	212
230kV	BRPUK	BRPUK-2			2	122
230kV	BRPUK	BRPUK-6			2	80

Voltage	From Substation	To Substation	2010		2030	
			cct.	Length (km)	cct.	Length (km)
230kV	BRPUK-2	BRPUK-3			2	88
230kV	BRPUK-3	BRPUK-5			2	72
230kV	BRPUK-4	BRPUK			2	72
230kV	BRPUK-4	BRPUK-5			2	72
230kV	BRPUK-6	BRPUK-7			2	74
230kV	COMIN	ASHUGNJ	2	158	4	316
230kV	COMIN	COMIN-2			2	58
230kV	COMIN	COMIN-3			2	160
230kV	COMIN	COMIN-4			2	79
230kV	COMIN	COMIN-5			2	32
230kV	COMIN	COMIN-6			2	240
230kV	COMIN	MEGH	2	116		
230kV	COMIN-5	COMIN-6			2	122
230kV	COXS BAZAR	ANOWARA			1	95
230kV	COXS BAZAR	MYANMMER			4	760
230kV	DIGHIPARA	BOGRS-2			2	67.5
230kV	DIGHIPARA	BOGRS-3			4	135
230kV	DIGHIPARA	BRPUK			2	101.25
230kV	FENCHUGANJ	FENCHUGANJ-2			4	87.332
230kV	FENCHUGANJ-2	FENCHUGANJ-3			2	43.666
230kV	FENCHUGANJ-3	FENCHUGANJ-4			2	43.666
230kV	GHRSL	GHRSL-2			2	29.5
230kV	GHRSL	ISHRDI	2	356	2	356
230kV	GHRSL	RAMPR	2	100		
230kV	GHRSL	TONGI	2	54	2	54
230kV	HARIPR	HARIPUR360	2	4.8	2	4.8
230kV	HARIPR	MEGH	2	24		
230kV	HARIPR	MEGHNAGHAT			3	36
230kV	HARIPR	RAMPR	2	56		
230kV	HARIPR	RAMPR-4			2	28
230kV	HARIPR	RAMPR-5			2	28
230kV	HARIPR	SIDDHIRGANJ			1	2
230kV	HASNBD	AMINBZ	2	42		
230kV	HASNBD	MEGH	2	52		
230kV	HASNBD	MEGHNAGHAT			3	78
230kV	HASNBD	SHAMPUR			1	10

Voltage	From Substation	To Substation	2010		2030	
			cct.	Length (km)	cct.	Length (km)
230kV	HASNBD-4	KERANIGANJ			2	13
230kV	HATHZR	COMIN	2	300	2	300
230kV	HATHZR	KULSHI			2	40
230kV	HATHZR	SIKALBAHA			2	50
230kV	ISHRDI	BAGHA	2	110	2	110
230kV	ISHRDI	BHERAMARA			4	40
230kV	ISHRDI	KHULN	2	370		
230kV	ISHRDI	RAJSHAHI-3			2	70
230kV	JHENIDA	JHENIDA-2			2	75
230kV	JHENIDA	JHENIDA-3			2	75
230kV	JHENIDA	KHULN-2			2	95
230kV	JHENIDA	KHULN-3			2	95
230kV	JHENIDA-2	BHERAMARA			2	75
230kV	JOYDEBPUR	GHRSL-2			2	29.5
230kV	JOYDEBPUR	KALIAKAIR-2			2	56.25
230kV	JOYDEBPUR	KALIAKAIR-3			2	56.25
230kV	KALIAKAIR	KALIAKAIR-4			2	38
230kV	KERANIGANJ	HASNBD-2			2	13
230kV	KERANIGANJ	HASNBD-3			2	13
230kV	KHULN	KHULN-3			2	95
230kV	KHULN	KHULN-4			2	26.666
230kV	KHULN	MONGLA			2	80
230kV	KHULN-4	KHULN-5			2	26.666
230kV	KULSHI	KULSHI-3			2	8
230kV	MANIKNAGAR	SIDDHIRGANJ			2	20
230kV	MAWA	MAWA-2			4	80
230kV	MEGHNAGHAT	COMIN-2			2	58
230kV	MEGHNAGHAT	HARIPR			3	36
230kV	MEGHNAGHAT	HARIPR-2			2	12
230kV	MEGHNAGHAT	HARIPR-3			2	12
230kV	MONGLA	BARISAL-2			2	117
230kV	NOAGAON	BOGRS-4			2	52
230kV	NOAGAON	BOGRS-5			2	52
230kV	NOAGAON	RAJSHAHI-2			2	70.876
230kV	OLDAIRPORT	AMINBZ			2	20
230kV	RAJSHAHI	RAJSHAHI-2			2	70.876

Voltage	From Substation	To Substation	2010		2030	
			cct.	Length (km)	cct.	Length (km)
230kV	RAJSHAHI	RAJSHAHI-3			2	70
230kV	RAMPR	BHULTA			4	16
230kV	RAMPR	RAMPR-2			2	50
230kV	RAOZN	HATHZR	2	45		
230kV	SHAMPUR	MEGHNAGHAT			1	16
230kV	SIDDHIRGANJ	HARIPR			1	2
230kV	SIDDHIRGANJ	MANIKNAGAR-2			2	10
230kV	SIKALBAHA	ANOWARA			4	80
230kV	SIKALBAHA	HATHZR-2			2	25
230kV	SIKALBAHA	KULSHI			2	16
230kV	SIKALBAHA	KULSHI-2			2	8
230kV	SIKALBAHA	KULSHI-3			2	8
230kV	SRJGNJ	BAGHA-2			1	19
230kV	SRJGNJ	BAGHA-3			1	19
230kV	SRJGNJ	BOGRS	2	144	4	288
230kV	SRJGNJ	SRIPUR			2	146
230kV	TAKERHAT	TAKERHAT-2			2	101.25
230kV	TAKERHAT	TAKERHAT-3			2	38.25
230kV	TAKERHAT	ZAJIRA			2	67.5
230kV	TAKERHAT-2	BHERAMARA			1	120
230kV	TONGI	AMINBZ	2	51		
230kV	TONGI	KALIAKAIR			4	152
230kV	TONGI	TONGI-2			2	27
230kV Total				2644.8		9360.198
400kV	AMINBAZAR	DHAKA WEST			2	67.5
400kV	AMINBAZAR	ZAJIRA			2	112.5
400kV	ANOWARA	MATARBARI			4	180
400kV	ANOWARA	SIKALBAHA			4	80
400kV	ASHUGANJ	JOYDEBPUR			2	56.25
400kV	BHULTA	MEGHNAGHAT			1	25.875
400kV	BOGRA	JAMALPUR			2	130.5
400kV	KALIAKAIR	BIBIYANA			2	336
400kV	KALIAKAIR	BOGRA			2	270
400kV	KALIAKAIR	JAMALPUR			2	162
400kV	KALIAKAIR	JOYDEBPUR			2	56.25
400kV	MEGHNAGHAT	BHULTA			1	25.875

Voltage	From Substation	To Substation	2010		2030	
			cct.	Length (km)	cct.	Length (km)
400kV	MEGHNAGHAT	DHAKA WEST			4	99
400kV	MEGHNAGHAT	SIKALBAHA			1	240
400kV	MONGLA	ZAJIRA			2	272
400kV	PKDP	BHERAMARA			4	810
400kV	PKDP	BOGRA			4	450
400kV	PKDP	KHARASPIR			2	20
400kV	PKDP	PHULBARI			4	40
400kV	ROOPPUR	BHERAMARA			4	49.5
400kV	SIKALBAHA	MEGHNAGHAT			1	240
400kV	ZAJIRA	BHERAMARA			4	675
400kV	ZAJIRA	DHAKA WEST			2	81
400kV Total						4479.25

Source :PSMP Study Team

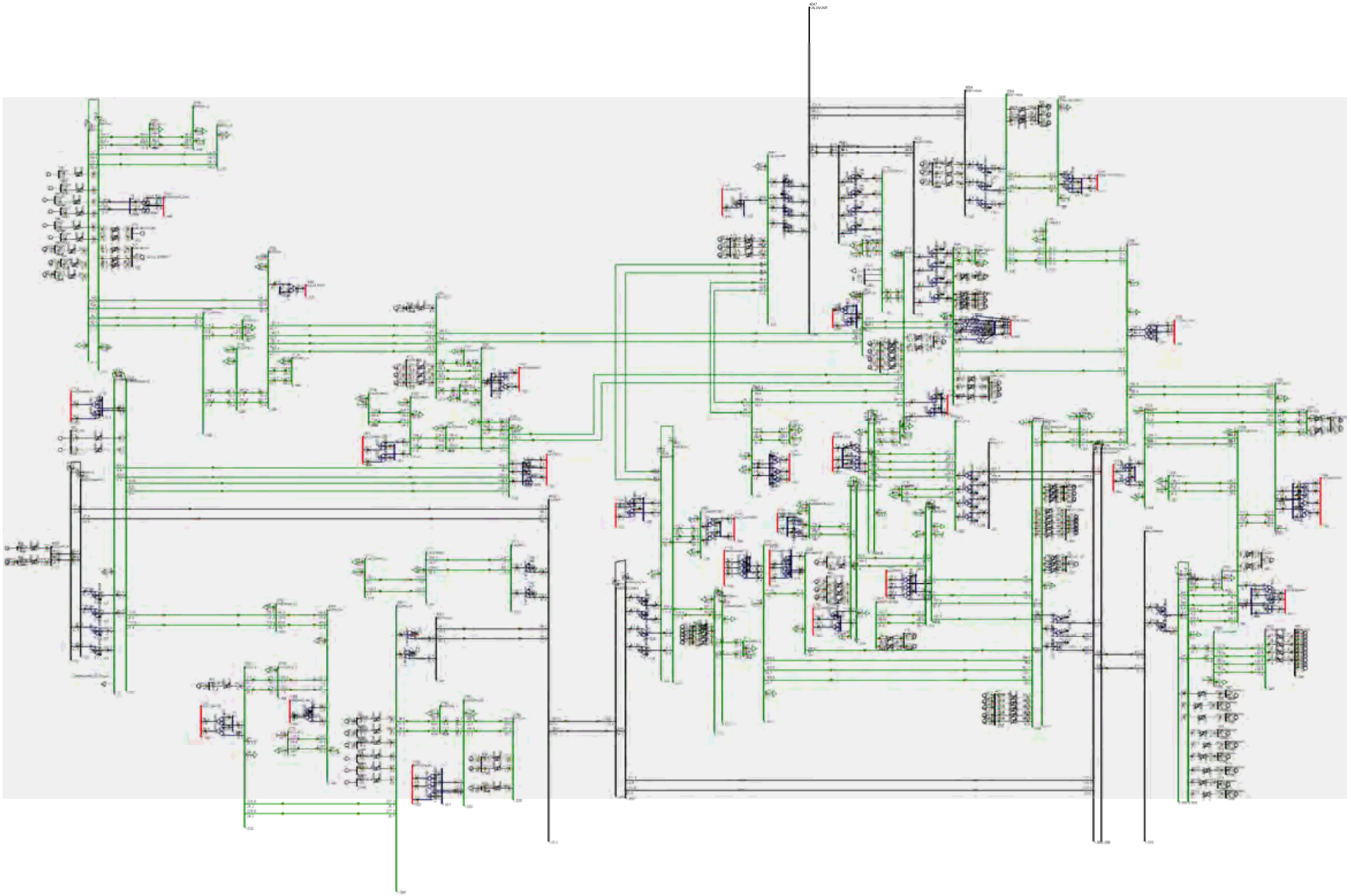
APTable 9-10 The substation for which construction is necessary by 2030

Voltage	East or West	Area	New Substation	Type
230/132kV	East	Southern	HATHZR-2	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	COMIN-2	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-3	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-4	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-5	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-6	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-7	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	COMIN-8	230/132kV(2x300MW, AIS)
230/132kV	East	Southern	SIKALBAHA	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	ANOWARA	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	Cox's bazar	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	KULSHI	230/132kV(2x500MW, GIS)
230/132kV	East	Southern	KULSHI-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	MANIKNAGAR	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	MANIKNAGAR-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	GHRSL-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	TONGI-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	TONGI-3	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	HARIPR-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	HARIPR-3	230/132kV(2x500MW, GIS)

Voltage	East or West	Area	New Substation	Type
230/132kV	East	Dhaka	HARIPR-4	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	HASNBD-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	HASNBD-4	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	RAMPR-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	RAMPR-3	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	RAMPR-4	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	RAMPR-5	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	SHAMPUR	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	AMINBZ-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	AMINBZ-3	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	OLDAIRPORT	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	OLDAIRPORT-2	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	KALIAKAIR	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	KALIAKAIR-3	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	KALIAKAIR-4	230/132kV(2x500MW, GIS)
230/132kV	East	Dhaka	SRIPUR	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-2	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-3	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-4	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-5	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-6	230/132kV(2x300MW, AIS)
230/132kV	East	Central	ASHUGNJ-7	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ-2	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ-3	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ-4	230/132kV(2x300MW, AIS)
230/132kV	East	Central	FENCHUGANJ-5	230/132kV(2x300MW, AIS)
230/132kV	West	Western	KHULN-2	230/132kV(2x300MW, AIS)
230/132kV	West	Western	KHULN-3	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BHERAMARA	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BHERAMARA-2	230/132kV(2x300MW, AIS)
230/132kV	West	Western	JHENIDA	230/132kV(2x300MW, AIS)
230/132kV	West	Western	JHENIDA-2	230/132kV(2x300MW, AIS)
230/132kV	West	Western	JHENIDA-3	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BARISAL	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BARISAL-2	230/132kV(2x300MW, AIS)
230/132kV	West	Western	BARISAL-3	230/132kV(2x300MW, AIS)

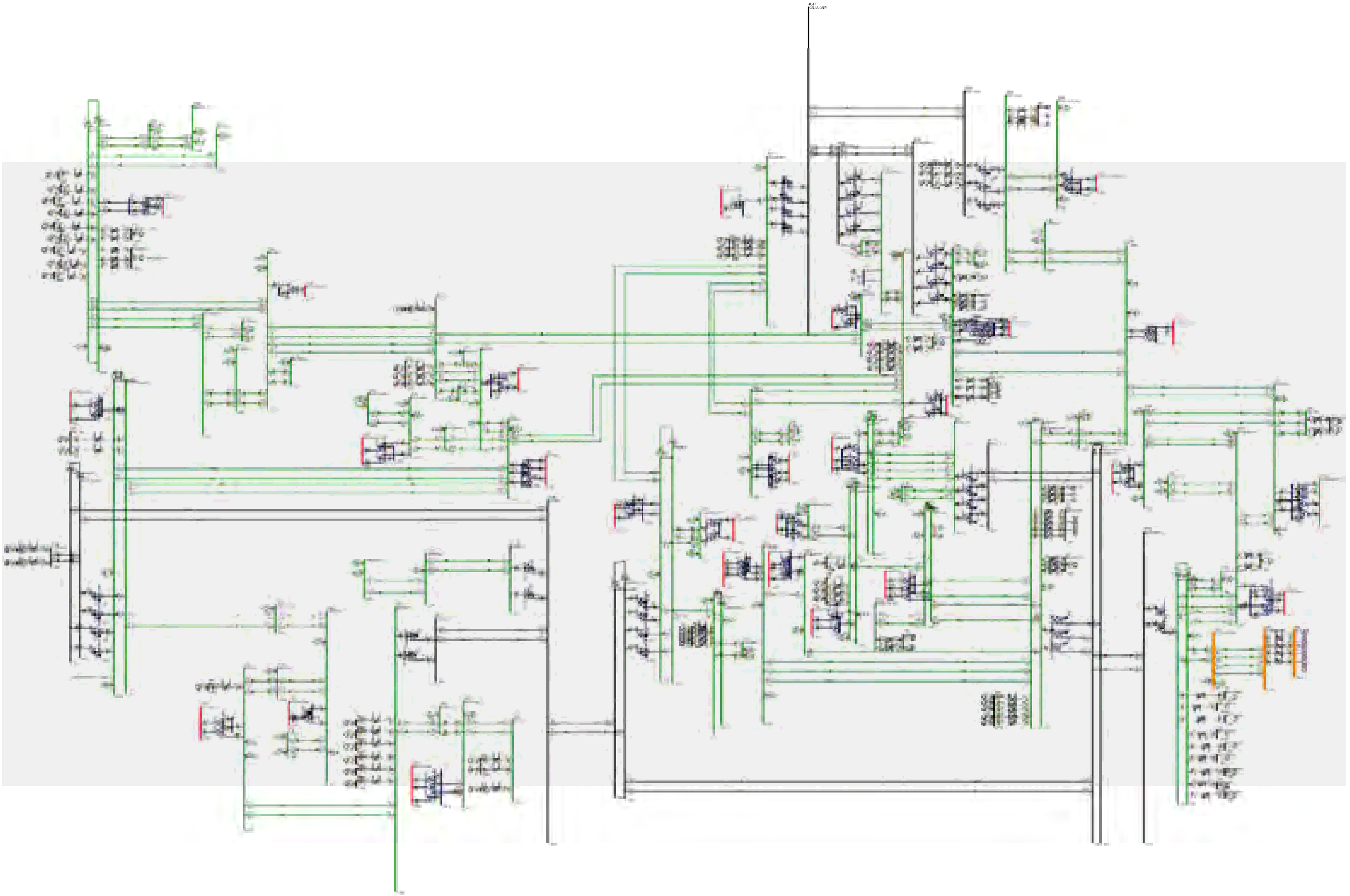
Voltage	East or West	Area	New Substation	Type
230/132kV	West	Western	ZAJIRA	230/132kV(2x300MW, AIS)
230/132kV	West	Western	ZAJIRA-2	230/132kV(2x300MW, AIS)
230/132kV	West	Western	ZAJIRA-3	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	ISHRDI-2	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	RAJSHAHI	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	RAJSHAHI-2	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	RAJSHAHI-3	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BAGHA-2	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BAGHA-3	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-2	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-3	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-4	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-5	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-6	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS-7	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BOGRS(NOAGAON)	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BRPUK-2	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BRPUK-3	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BRPUK-5	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BRPUK-6	230/132kV(2x300MW, AIS)
230/132kV	West	Northern	BRPUK-7	230/132kV(2x300MW, AIS)
400/230kV	East	Southern	ANOWARA	400/230kV(2x500MW, AIS)
400/230kV	East	Southern	SIKALBAHA	400/230kV(4x500MW, AIS)
400/230kV	East	Dhaka	AMINBAZAR	400/230kV(4x500MW, AIS)
400/230kV	East	Dhaka	DHAKA WEST	400/230kV(3x500MW, AIS)
400/230kV	East	Dhaka	MEGHNAGHAT2	400/230kV(3x500MW, AIS)
400/230kV	East	Dhaka	BHULTA	400/230kV(4x500MW, AIS)
400/230kV	East	Dhaka	KALIAKAIR	400/230kV(4x500MW, AIS)
400/230kV	East	Dhaka	JOYDEBPUR	400/230kV(4x500MW, AIS)
400/230kV	East	Central	JAMALPUR	400/230kV(3x500MW, AIS)
400/230kV	East	Central	BIBIYANA	400/230kV(3x500MW, AIS)
400/230kV	East	Central	ASHUGANJ	400/230kV(3x500MW, AIS)
400/230kV	West	Western	ZAJIRA	400/230kV(2x500MW, AIS)
400/230kV	West	Western	MONGLA	400/230kV(2x500MW, AIS)
400/230kV	West	Western	BHERAMARA	400/230kV(4x500MW, AIS)

Source: PSMP Study Team



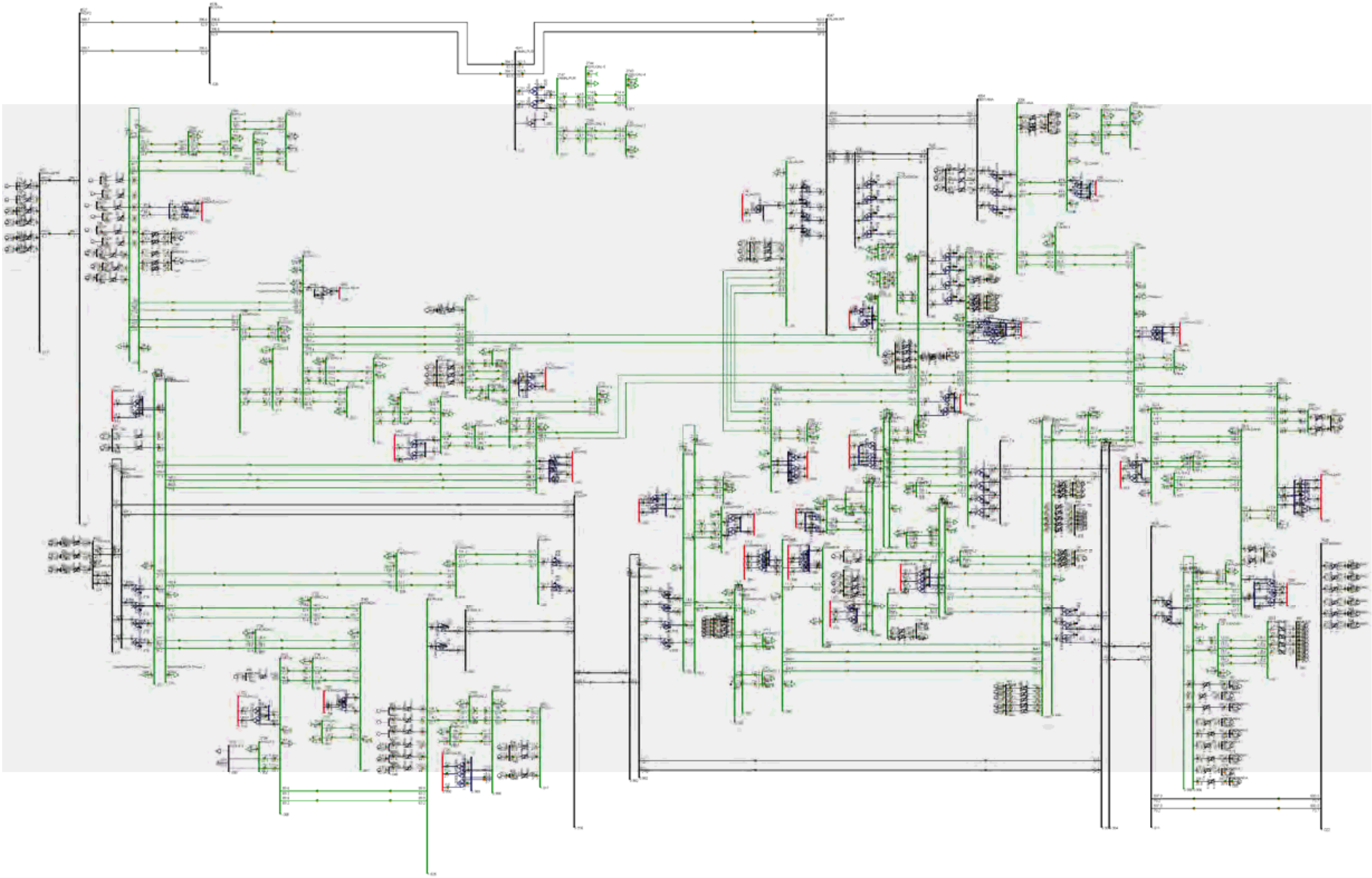
Source: PSMP Study Team

APFig. 9-22 400kV, 230kV power flow (2020, pattern east)



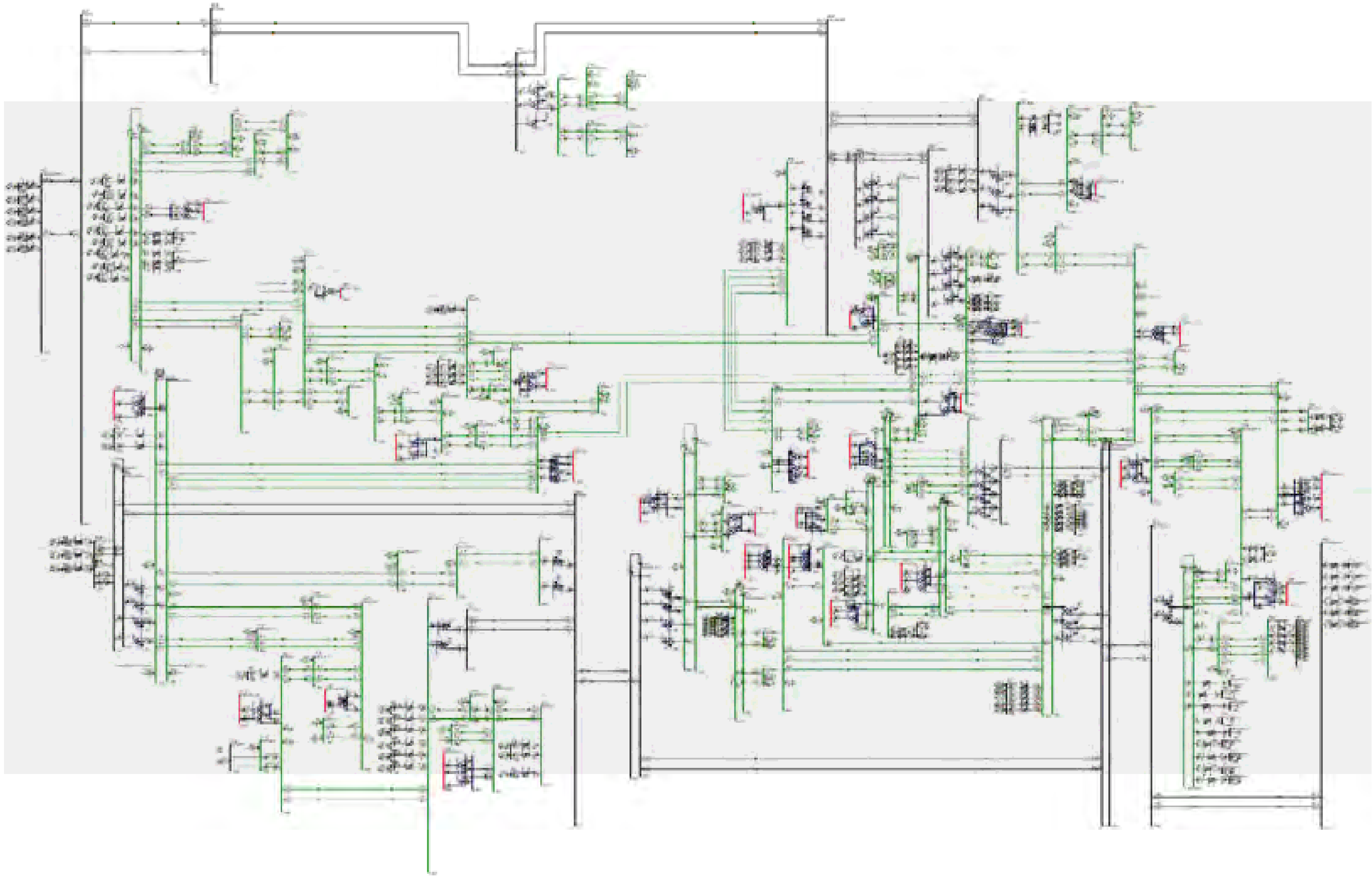
Source: PSMP Study Team

APFig. 9-23 400kV, 230kV power flow (2020, pattern west)



Source: PSMP Study Team

APFig. 9-24 400kV, 230kV power flow (2025, pattern east)



Source: PSMP Study Team

APFig. 9-25 400kV, 230kV power flow (2025, pattern west)