PROSPECT OF LPG IN BANGLADESH
AND
ITS CONTRIBUTION TO NATIONAL ENERGY

By

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RECOMMENDATION OF THE BOARD OF EXAMINERS

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Abstract

Total number of gas fields in Bangladesh since the discovery of the first one in 1955, now stands at 22. Chatak gas field was the first field in Bangladesh to come on production. It came on commercial production in 1960 to supply gas to the cement factory and the pulp and paper mill. Out of 22 gas fields, 12 fields are now in production. Natural gas contains methane (93.50% to 98%), ethane (0.21% to 3.65%), propane (0.05%to 1.1%), butane (0.01% to 1.52%),etc. LPG is a mixture of propane and butane or its individuals. Most of the LPG in the natural gas now is not separated but left behind. Only 5000 MT of LPG per annum is being produced from natural gas of Kailashtilla gas field by Kailashtilla LPG Plant, which has come into production in 1998.

Gas production data of different producing fields, gas reserve, gas composition, present gas consumption trend, gas demand and production forecast have been discussed. Existing gas processing systems and LPG development have been evaluated. LPG reserve has been estimated and future gas processing system has been suggested for augmenting its production.

Properties and different type of use of LPG have been discussed. Since government has given priorities to use LPG in domestic sector, only domestic sector has been considered in order to estimate LPG demand. Its use in domestic sector can help reduce the dependence on imported kerosene and deforestation. Market analysis shows that LPG has excellent economic benefits over fuel wood and kerosene. Finally, various effects relating to the extraction of LPG from natural gas have been discussed.

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CHAPTER 1

Introduction

1.1 Background

LPG is acronym for liquefied petroleum gas. It is also known as LP-gas/cylinder gas. It is one of the cleanest fuels available to domestic, commercial and industrial users. Domestic sector is the largest consumer of LPG in all over the world. In Asia (excluding Middle-East) more than 50% of total consumed LPG is used in the domestic sector and industrial sector is the second largest consumer.

Bangladesh has to spend 25% of the hard earned foreign currency to import crude oil and refined petroleum products. After refining the crude oil component, the country has surplus of naphtha and shortage of kerosene and diesel that is made up with refined product imports. Considerable amount of kerosene is now being used in domestic sector for cooking in the country.

All rural households and a large number of urban households use biomass fuels for cooking. To meet this cooking fuel demand, tree cutting increases day by day and causes deforestation.

Natural gas of discovered gas fields in Bangladesh contain LPG. Till today, a little has been done to extract those LPG from natural gas. LPG may replace the use of fuel wood as well as imported kerosene used in domestic sector for cooking.

Being an indigenous resource, having economic and environmental benefits, LPG has a tremendous market potential in domestic sector. This study provides information regarding LPG extraction potentiality and its demand in domestic sector.

1.2 Definition

The term LPG is used by the oil industry for a mixture of petroleum hydrocarbons consisting mainly of propane and butane, and also for its individual components.

The term "Liquefied Petroleum Gases" shall mean and include any material having a vapor pressure not exceeding that allowed for commercial propane, that is composed predominantly of any of the following hydrocarbons, or mixtures of them: propane, propylene, butanes (normal butane or iso- butane) and butylenes (NFPA59, 1992).

LPG under normal temperature and pressure remains gaseous state. It has the special property of becoming liquid at atmospheric temperature if moderately compressed and reverting to gases when the pressure is sufficiently reduced. For this property it is advantageous to transport and store LPG in the liquid state when it is about 250 times as dense as it is in gaseous state.

Being a very light hydrocarbon, LPG is quite easily purified and separated from both heavier and lighter hydrocarbons and from adventitious impurities.

LPG is readily flammable when mixed with air in the right proportion. This is the property that makes it suitable as a fuel. This also causes fire and explosion hazards but when handled correctly it is perfectly safe.

1.3 Sources of LPG

The two principal sources of LPG are:

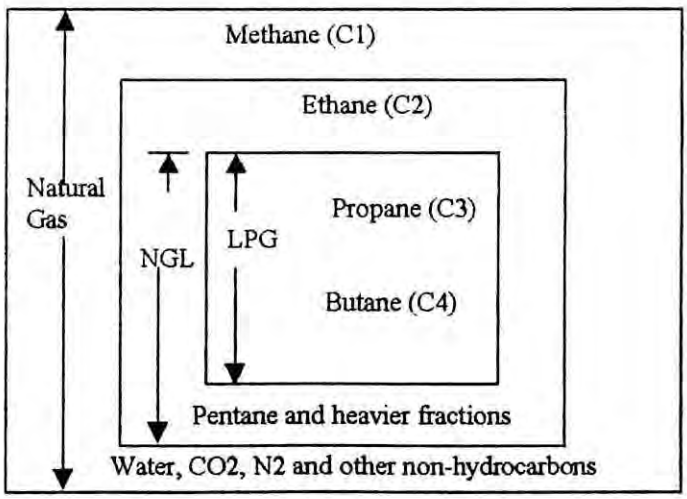
(1) Natural gas and oil reservoirs

(2) Petroleum refineries

Gas Reservoirs

Natural gas is rarely produced from the reservoir in a completely dry condition, i.e., containing practically no hydrocarbons heavier than ethane. In most fields, substantial quantities of heavier hydrocarbons are associated with the gas and have to be separated before the gas can be sent to the pipeline.

Figure 1.1: Constituents of Natural Gas



Two important terms relating to LPG from natural gas are defined herein:

Natural gas liquids (NGL) are those hydrocarbons liquefied at the surface in field facilities or in gas processing plants. Natural gas liquids include propane, butanes and natural gasoline (GPSA, 1987). Where condensate is defined as " the liquid formed by the condensation of a vapor or gas: specially, the hydrocarbon liquid separated from natural gas because of changes in temperature and pressure when the gas from the reservoir was delivered to the surface separators" (GPSA, 1987). In this report, condensate is defined as the recovered liquids from natural gas production, comprised of the pentane and heavier components (i.e. C_{5+}). NGL is defined herein as the recovered liquids from natural gas production, comprised of the propane, butane and heavier components (i. e. C_{3+}).

Oil Reservoirs

Crude oil produced from reservoirs contains substantial quantities of lighter hydrocarbon (i.e. gas) associated with oil. The gas (including excess propane and some butane) has to be removed from the oil before the oil is stocked in tank or shipped in tankers as crude oil. This removal of the gas has to be done with a view to maintaining its vapor pressure at a certain level that can be contained by storage tank or ship's tank.

Petroleum Refinery

LPG is recovered from crude oil primarily by distillation in the refinery. The output of LPG from the crude oil fractionation is supplemented by conversion processes which are usually aimed at increasing the output or quality of the gasoline and which produce LP gases only as by-product. Refinery conversion processes are as follows: (1) catalytic

reforming, (2) catalytic cracking, (3) steam cracking, (4) polymerization/ alkylation, (5) thermal cracking and coking/vis-breaking. Most oil refineries operate only one or two of those processes.

1.4 Types of LPG

LPG as marketed in most countries rarely consists of pure propane or butane. It is mostly a mixture of liquefiable saturated and unsaturated hydrocarbons in the C_3 - C_4 boiling range. The actual gas mixture varies depending on whether it is produced from refinery gases or associated gas, i.e., gas produced with crude oil or coming from a gas field. However, LPG is sold commercially to domestic and industrial customers in four grades:

- LPG- butane/commercial butane: It consists mainly of n-butane, iso-butane and/or the butylenes. As per British Standard (BS4250) "Commercial butane shall be a hydrocarbon mixture consisting predominantly of butanes and or butylenes. It shall not contain harmful quantities of nauseating substances and shall be free from mechanically entrained water"(B.N.Bradley, 1994).
- LPG- propane/commercial propane: It consists mainly of propane and/or propylene. In colder countries such as Norway and Sweden, the LPG market is confined mainly to propane.
- LPG mixture: It consists of a variable amount of all C_3/ C_4 hydrocarbons.
- High purity propane containing about 95% of this single hydrocarbons.

It may be mentioned here that LPG mixture/commercial butane is suitable for Bangladesh. The LPG presently being marketed in Bangladesh is a by-product of Eastern Refinery Ltd,

Chittagong and product of Kailashtilla LPG plant, Sylhet. The specification of the LPG produced from ERL is:

- Butane: 50 % to 80 % (Vol.)
- Propane: 20 % to 50% (Vol.)

The specification of LPG produced form Kailashtilla LPG plant Sylhet is:

- Butane: 50 % to 60% (Vol.)
- Propane: 40 % to 50% (Vol.)

1.5 Properties of LPG

LPG is a colorless, odorless and invisible gas. It is non-toxic but if inhaled in considerable quantities over prolonged period can have an anaesthetic effect. It floats on water. Physical properties of LPG depend on its ingredients. Moreover, its existence is in two phases - liquid and gaseous.

From the distribution and supply point of view, one requires to know the properties of the liquid phases. On the other hand, from burner or furnace feed stock angle, properties of gaseous phase are important. However, the user of domestic or camping gas (which is sold as bottled/ cylinder LPG) may wish to know about some properties of both phases, e.g., specific gravity of the liquid, yield of gas from the liquid, heating value of the gas, etc. Some important physical properties of LPG are discussed below:

(a) Calorific Value: The calorific value or heat of combustion is defined as the amount of heat released when a unit quantity of fuel is burned under given conditions. Butane and propane have very high calorific values in comparison with other forms of fuel.

Comparative heating values of LPG and other fuels (B. N. Bradley, 1994):

	MJ/Kg	Btu/ Ib	MJ/Std m^3	Btu/SCF
Propane	50.24	21,600	93.14	2,500
Butane	49.54	21,300	119.23	3,200
Coal gas			18.63	500
Natural Gas			39.12	1,050

(b) Flammability Limits :

Gaseous fuels will only burn when mixed with air in right proportions that lies between two well defined limits, known as the lower and upper limits of flammability. The lower limit of flammability is the lowest quantity of combustible gas that when mixed with a given quantity of air (or O_2) will support self-propagating flame. Where upper limit of flammability is the highest quantity of combustible gas mixed with a given quantity of air (or O_2) will support self-propagating flame.

Table 1.1: Flammability Limits

(Representative values at 30" Hg and 60° F)

(% gas by volume in air – gas mixture)

Items	Lower Limit	Upper Limit
Propane	2.10	10.10
n- butane	1.85	8.41
Iso–Butane	1.80	8.44
Commercial propane	2.0	10.00
Commercial Butane	1.8	8.50
Natural Gas	5.0	15.00
Coal gas	5.0	40.00

(c) Relative Density (Specific Gravity) :

Propane and butane as liquids are lighter than other petroleum products, relative densities vary between 0.50-0.52 for propane and 0.56-0.59 for butane. It shows that they are much lighter than water and will float on it. Unlike coal gas or natural gas, LPG vapor is heavier than air and will cling to the ground seeking to enter trenches.

(d) Co-efficient of Cubical Expansion:

It is defined as the increase in volume of unit volume of substance when its temperature is raised by one degree. Liquid LPG expands considerably when its temperature increases. The coefficient at 15°C are approximately 0.0016 per °C for propane and 0.0011 per °C for butane, these values being four times as much that of fuel oil, ten times as much that of water and 100 times as much that of steel.

(e) Flash Point:

This is the temperature at which, under controlled test conditions, a fuel will give off sufficient vapor, which in air will ignite when an ignition source is applied. For LPG the flash point is low, being –76°F for normal butane. It is a measure of the fire risk of an oil in bulk and oil with flash points below 73° F are regarded as "dangerous" (highly flammable) for transport and storage purposes. Fuel oils that normally flash above 150° F is regarded as "safe".

(f) Vapor Pressure:

An important characteristic of LPG is the pressure that it can develop in an enclosed container. The higher the temperature the greater the pressure exerted, however, at

sufficiently low temperatures the pressure may fall below atmospheric. Understanding of the vapor pressure of a gas is essential in order to be able to specify the design conditions for the pressurized system. The higher vapor pressure exerted by propane is an advantage in many commercial applications but it requires stronger storage vessels, which are more expensive than those for butane. Due to propane's higher vapor pressure, it must never be stored in a butane vessel.

It is to be noted that the physical properties of a mixture are largely a function of its chemical composition. Reasonably accurate properties of LPG mixture may be obtained by computation, applying weight percentage of each in the mixture to the values of the property it is desired to obtain. Slightly more accurate results for the vapor pressure are obtained by using the volume percentage. Very accurate results can be obtained using data and methods explained in petroleum and chemical engineering data books.

1.6 Application of LPG

Many domestic and commercial applications of LPG are similar to those of natural gas. Moreover, LPG is marketed in portable cylinders and disposable cartridge in different countries. For this its range of applications – especially for recreational and leisure use – is much wider. LPG is used for:

- Cooking
- Lighting
- Space heating
- Hot-water supply

- Refrigeration

Industrial applications are also similar to those of natural gas and including production and manufacture of:

- Gas and chemicals
- Glass
- Ceramics
- Food and beverage
- Vehicles
- Textiles, leather and clothing
- Paper and printing
- Power generation

Because of its portability, LPG can be put to a number of other uses, which are normally outside the scope of natural gas:

On building and civil engineering site

In agriculture – various applications

LPG can be used for large industrial applications in areas beyond pipeline gas distribution networks, e. g., brick fields.

CHAPTER 2

Scope of the Study

2.1 Objective of the Study

The objective of this study is to estimate possible LPG production from the natural gas sector and analyse the market potential of LPG in Bangladesh. This study will also investigate the LPG demand and explore ways to increase the LPG utilization in the country. It will also explore the marketing strategies to supply LPG all over the country.

2.2 Brief Description on the Procedure/ Methodology

The method of the study comprises:

- Review of relevant reports, studies and documents
- Discussion with concerned officials and experts
- Data collection from Petrobangla, Bangladesh Petroleum Corporation (BPC), Eastern Refinery Ltd (ERL), LP-Gas Ltd (LPGL), Rupantarita Prakritik Gas Company Ltd (RPGCL) , Sylhet Gas Fields Ltd (SGFL) and other relevant sources regarding natural gas reserve, gas composition, LPG production etc
- Estimate LPG production potential of the country
- Evaluate present LPG recovery process
- LPG demand in the country
- Explore marketing strategies

CHAPTER 3

Oil and Gas Industry: Organization/Company Profile

3.1 Petrobangla

After independence, the Government of the People's Republic of Bangladesh, on March 1972, promulgated the presidential order to establish the Bangladesh Mineral, Oil and Gas Corporation. In 1974, Bangladesh Oil and Gas Corporation (Petrobangla) was established under a presidential order. Later, in 1985 Petrobangla and Bangladesh Mineral Exploration and Development Corporation were merged to form Bangladesh Oil, Gas and Mineral Corporation, also short named Petrobangla with the following objectives:

(i) Exploration and development of oil , gas and mineral resources

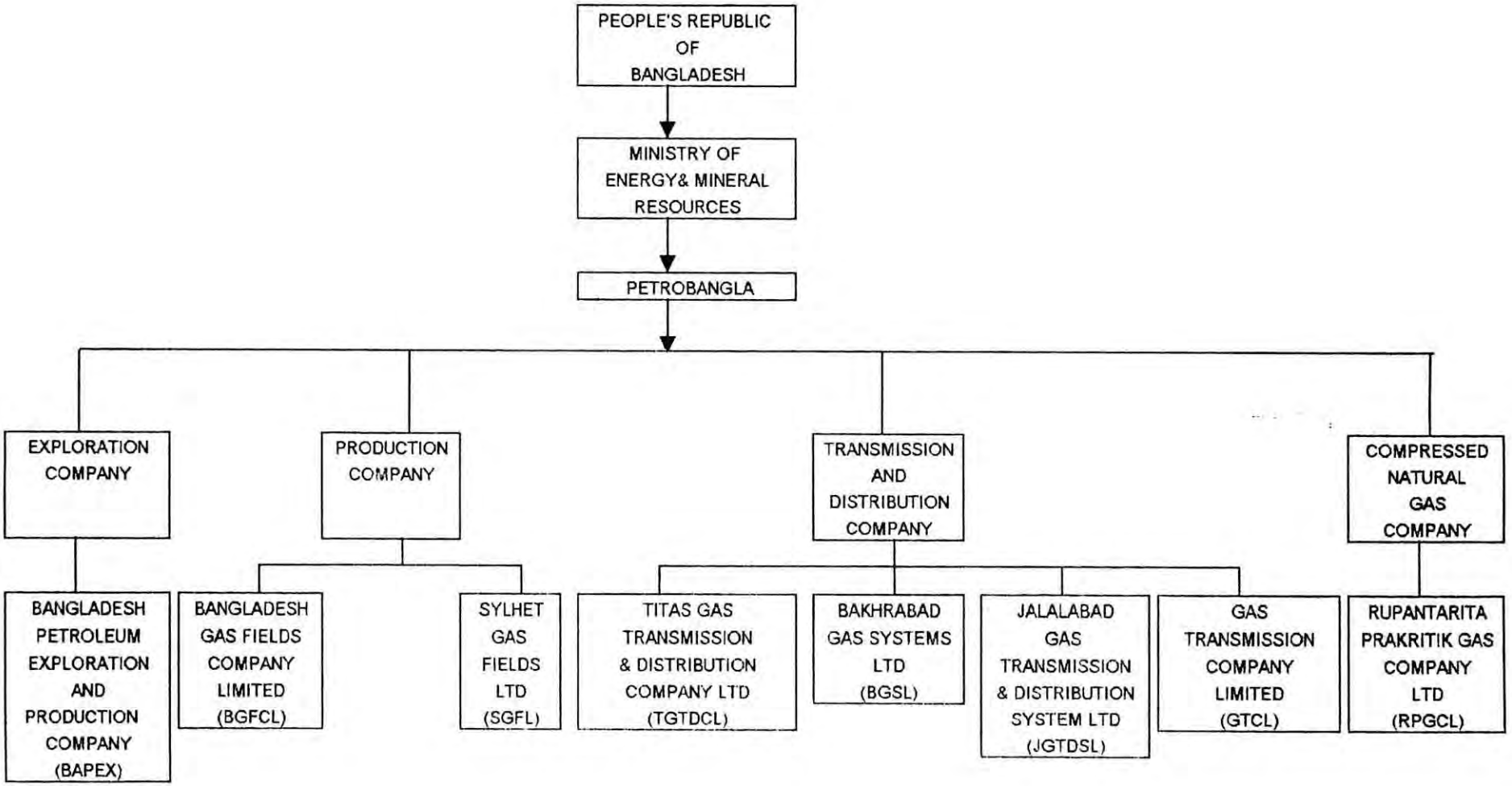
(ii) Production and marketing of indigenous gas, NGL, Condensate , oil and mineral resources

Presently, Petrobangla performs its activities by its eight companies (Figure 3.1).

3.1.1 Bangladesh Petroleum Exploration and Production Company Ltd. (BAPEX)

BAPEX was created in 1989 for carrying out hydrocarbon exploration in the country. They are also capable of providing the following services: (i) Surface geological mapping (ii) Seismic data acquisition and processing (iii) Basin analysis (iv) Exploration and development drilling (v) Cementation and finishing (vi) Mud engineering and logging (vii) Reservoir engineering and production services (viii) Laboratory services (biostratigraphy,

Figure 3.1 : Oganisational Structure of Petrobangla



palenology, petrography, petrophysics, geochemistry) and (ix) Rig building. Recently it has discovered two gas fields: Shahbajpur and Shaldanadi.

3.1.2 Bangladesh Gas Fields Company Ltd. (BGFCL)

Pakistan Shell Oil Company Limited (SOCL) is the predecessor of BGFCL. SOCL discovered the following gas fields: Rashidpur, Kailashtilla, Titas, Habiganj and Bakhrabad. Of these five gas fields SOCL had only Titas and Habiganj gas fields for production and supply of natural gas. After independence, Pakistan Shell Oil Company Limited was renamed as Bangladesh Shell Oil Company Limited. From September 1975, this name has been changed to "Bangladesh Gas Fields Company Limited" by a special resolution on August 1975. Then it was placed under Petrobangla.

At present, BGFCL is operating seven gas fields, i.e., Titas, Habiganj, Kamta, Feni, Bakhrabad, Narsingdi and Meghna; out of which natural gas is being produced from six fields, viz., Titas, Habiganj, Bakhrabad, Narsingdi and Meghna. This company has produced 81% of the total gas consumed in the country during fiscal year 1996-97.

3.1.3 Sylhet Gas Fields Ltd. (SGFL)

SGFL is the pioneer in the discovery and production of natural gas and mineral oil in the country. Though this company was incorporated on 8 May, 1982, its history of production and sale of natural gas dated back to 1960 under the umbrella of its predecessor, erstwhile Pakistan Petroleum Limited (PPL). It is operating three producing fields in the north-eastern part of the country, i.e., Sylhet, Kailashtilla and Rashidpur in the Surma Basin. It also looks after the production of Beanibazar.

3.1.4 Titas Gas Transmission and Distribution Company Ltd. (TGTDCL)

TGTDCL was incorporated as a public limited company on November 20, 1964. At the outset, the authorized and paid up capital of the company was Taka 1.78 crore of which 90% were subscribed by the then Government of Pakistan while the remaining 10% belonged to the Shell Oil Company. It is responsible for transmission and distribution of natural gas in mid eastern region of Bangladesh including Dhaka. Its franchise area comprises Greater Dhaka, Greater Mymensingh and Brahmanbaria. A sizeable gas transmission and distribution network has been developed in Dhaka and its surroundings. The distribution network in Dhaka and other townships in the Titas Gas Franchise area receive gas from an integrated transmission system, which connects five gas fields, i.e., Titas, Habiganj, Rashidpur, Bakhrabad and Narsingdi. It is the country's largest gas distribution company in terms of gas sales and number of customers. It presently (on June 30,1997) supplies gas to 575255 customers (i.e., 8 power plants, 4 fertilizer factories, 1880 industrial units, 151 seasonal consumers, 5793 commercial consumers and 567419 domestic consumers).

3.1.5 Bakhrabad Gas Systems Ltd. (BGSL)

BGSL, a company of Petrobangla is a wholly state-owned entity. It was established on June 7, 1980 with three-fold responsibility of production, transmission and distribution of natural gas to South-East Bangladesh (excluding Brahmanbaria district) through the development of Bakhrabad gas field and construction of Bakhrabad-Chittagong transmission pipeline. In May 1989 Bakhrabad gas field was transferred to BGFCL under a reorganization plan of the companies under Petrobangla, making BGSL confined to

transmission and distribution activities only. Its franchise area comprises greater Comilla (excluding Brahmanbaria), Noakhali, Chittagong and Chittagong Hill Tracts districts. It presently serves (on June 30, 1997) 139913 customers (i.e. 4 power plants, 3 fertilizer factories, 566 industrial units, 2158 commercial units and 137,182 domestic consumers). Its sources of Gas supply are Bakhrabad, Meghna, Shaldanadi, Sangu gas fields and transmitted gas through A-B pipeline.

3.1.6 Jalalabad Gas Transmission and Distribution System Ltd. (JGTDSL)

JGTDSL was constituted as a public limited company on December 1, 1986 by merging Habiganj valley project and Sylhet town gas supply project with an authorized capital of Tk.150 crore under the company's act. It is responsible for gas transmission and distribution in its franchise area. Its franchise area covers the districts of Sylhet, Sunamganj, Habiganj and Moulavibazar.

3.1.7 Gas Transmission Company Ltd. (GTCL)

GTCL was formed on December 14, 1993 under Company's Act 1913 with an authorized capital of Tk.1000 crore. It was formed to establish, operate and maintain the national gas grid network. Currently, it is operating and maintaining the 190 km, 24 inch north - south Pipeline (with a design capacity 330 MMSCFD) and its parallel 6-inch condensate/NGL pipeline (capacity 90,000 Litres/day) from Kailashtilla to Ashuganj via Rashidpur and Fenchuganj. It is also operating the 58 km 30 inch Ashuganj to Bakhrabad gas transmission line. It is engaged to extend the transmission to the Western side of the

Jamuna. The ownership of all the gas transmission lines that are part of national gas grid will be transferred to the company in phases.

3.1.8 Rupantarita Prakritik Gas Company Ltd. (RPGCL)

In 1987, the company was formed to popularize the use of CNG in the transport sector in an effort to reduce dependence on imported petroleum fuel, introduce environmentally and technically acceptable alternate transport fuel. Afterwards in 1991, the company was given the responsibility of production, transmission and sale of LPG from Natural Gas Liquids (NGL) obtained from gas fields. Now it is operating one CNG workshop and 5 CNG refueling stations in Dhaka City and a small NGL fractionation plant at Kailashtilla.

3.2 Bangladesh Petroleum Corporation (BPC)

On the 13th of November 1976, Bangladesh Petroleum Corporation (BPC) was established with the following objectives:

(i) Refining of crude oil and marketing of petroleum products

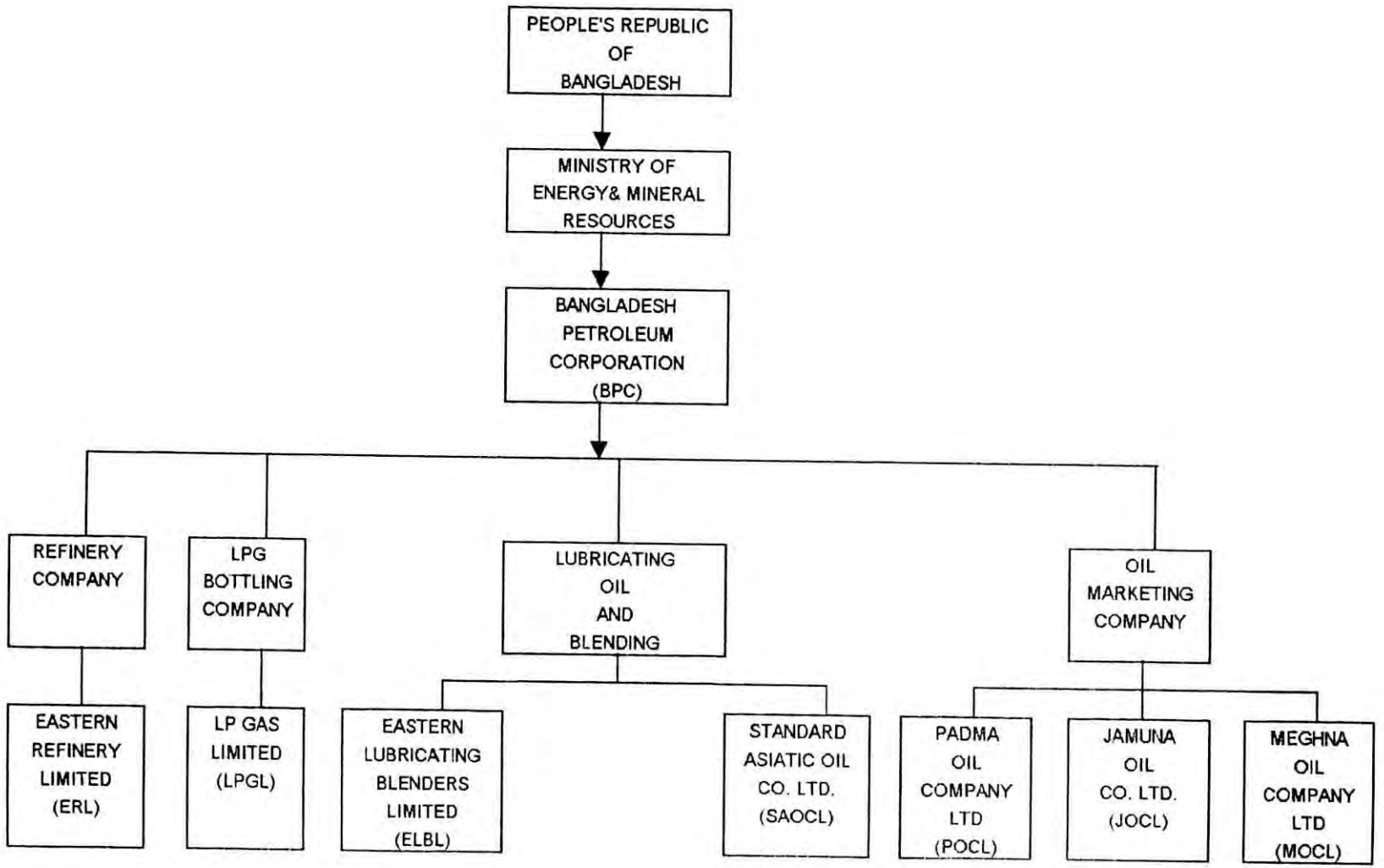
(ii) Import and export of crude oil and petroleum products

Presently, BPC performs its activities by its seven companies (Figure 3.2).

3.2.1 Eastern Refinery Ltd. (ERL)

The ERL has the capacity to process 1.5 million tones of crude oil annually. The crude oil is imported by BPC. ERL has a storage capacity of 314,900 MT. Out of this, 190,000 is designed for storing crude oil and the rest storing different refined products. Refinery products are sold to the marketing companies.

Figure 3.2 : Oganisational Structure of BPC



3.2.2 LP Gas Ltd. (LPGL)

The LPGL bottles LPG received from ERL and Kailashtilla LPG plant and sells them to the marketing companies for marketing. The facility in Chittagong has a capacity to produce 18,000 tones of LPG annually. Present production is 15,000 tones per year. The facility in Kailashtilla has a capacity to bottle 5000 MT of LPG annually. A part of the LPG is purchased by the Bangladesh Oxygen Limited under an agreement with the LPGL for bottling for industrial consumers.

3.2.3 Lubricating Oil and Blending

Eastern Lubricant Blenders Ltd. (ELBL) and Standard Asiatic Oil Company Ltd. (SAOCL) blend lubricating oil from base oil imported by BPC as per formulation provided by oil marketing companies as well as the Lube Oil Association. The finished products are delivered in containers to the customers.

3.2.4 Oil Marketing Companies

Three companies, namely Padma Oil Company Ltd. (POCL), Jamuna Oil Company Ltd. (JOCL) and Meghna Petroleum Ltd. (MPL) are responsible for distribution and marketing of petroleum products in the country. It is mentioned here that LPG marketed in the bottled form (Size 12.5 kg). It is transported by road and water transport. In addition to this BOL markets LPG in bottles having capacities of 24 Kg and 45 Kg.

CHAPTER 4

LPG Development in Bangladesh

4.1 Introduction

The LPG production in the country started in 1978 when LPG recovery unit at ERL was set up. A LPG plant was also set up adjacent to the ERL for bottling the LPG produced from the ERL. Later, a NGL fractionation plant was set up at Kailashtilla to recover LPG from natural gas. This fractionation plant started producing LPG in 1998.

4.2 Status of LPG Production form ERL

LPG is supplied from ERL to the LPG plant where the product is stored in six pressurized bullets and two pressurized spheres. The cylinders are filled in a semi-automatic plant. The plant is designed for filling one size of cylinder (12.5 Kg). A limited number of 40 Kg cylinder sizes can also be filled manually at the plant.

The maximum plant capacity using three shifts is 5400 cylinders per day and this amounts to 24500 MT per year. The plant management projects maximum plant capacity is as 20000 MT.

The Chittagong plant storage facilities consist of the following:

- Six horizontal bullets with a total storage capacity of 290 MT
- Two storage spheres with a total capacity of 1200 MT
- Tank test pressure of 235 psi

- Tank operating pressure of 156 psi

The capacity of the ERL to supply LPG, accordingly to ERL officials, depends upon the refinery throughput and the type of crude being processed. The maximum capacity is 18,000 MT per year. The supply of LPG since the inception of the LPG plant is shown in Figure 4.1.

4.3 LPG Production from Natural Gas Streams

In order to extract NGL and produce LPG, it was decided to install following components under the second gas development project (SGDP):

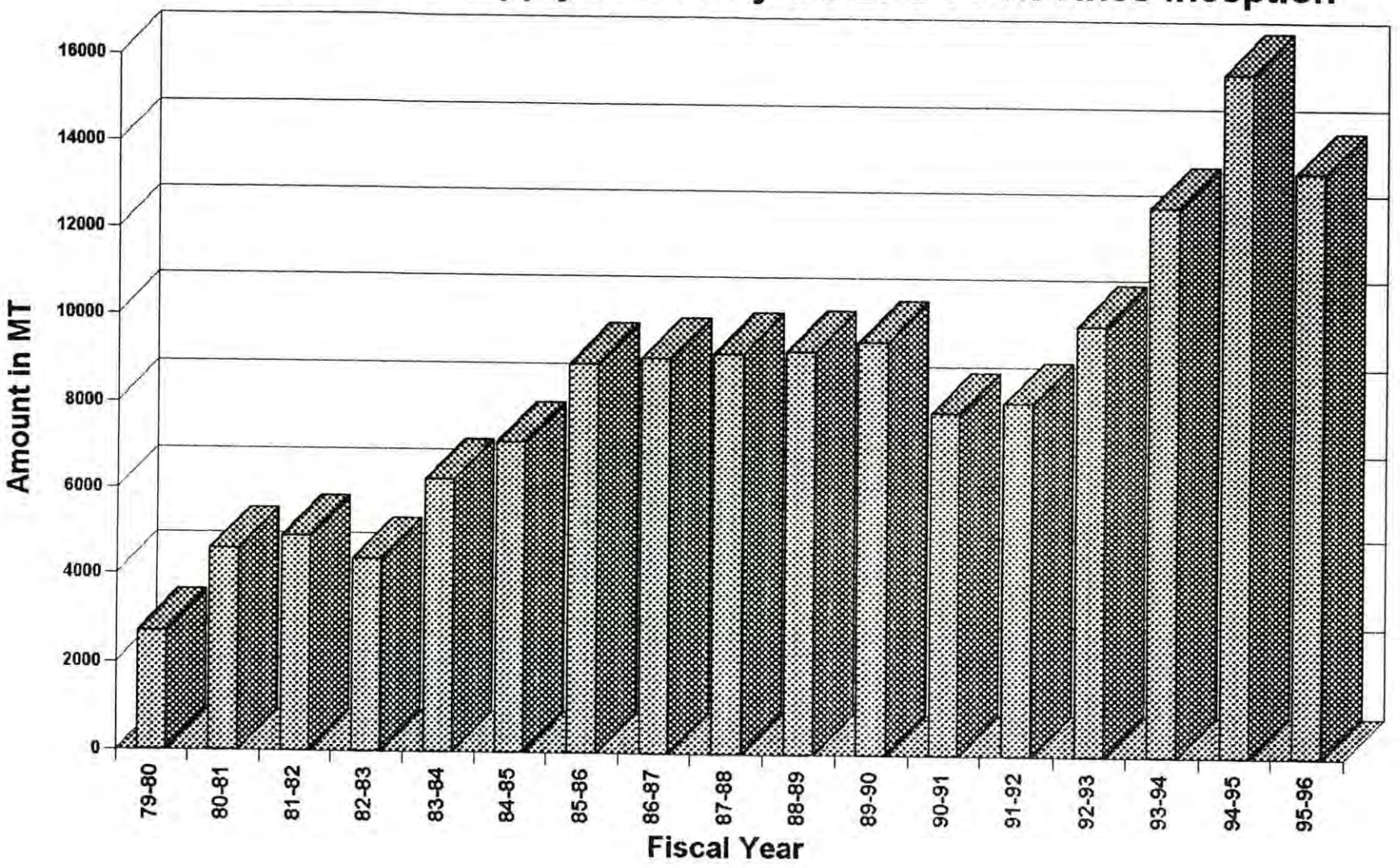
- Molecular sieve turbo-expander (MSTE) plants at Kailashtilla gas field and Beanibazar gas field
- NGL pipeline from Beanibazar to Ashuganj via Kailashtilla, Rashidpur, Habiganj and Titas gas fields
- NGL fractionation plant at Ashuganj.

Out of them, only a MSTE Plant at Kailashtilla gas field and construction of 6-inch NGL pipeline from Kailashtilla to Ashuganj have been completed under the SGDP.

4.3.1 Kailashtilla LPG Plant

This plant is located near well # 1 of Kailashtilla gas field. The design capacity of the plant is to process 65 MT of NGL per day. Required NGL is supplied from the MSTE plant installed at Kailashtilla gas field (Location #2). As per project proforma (PP) the distillates of the fractionated NGL at this plant is as follows:

Figure 4.1: Supply of LPG by the LPG Plant since Inception



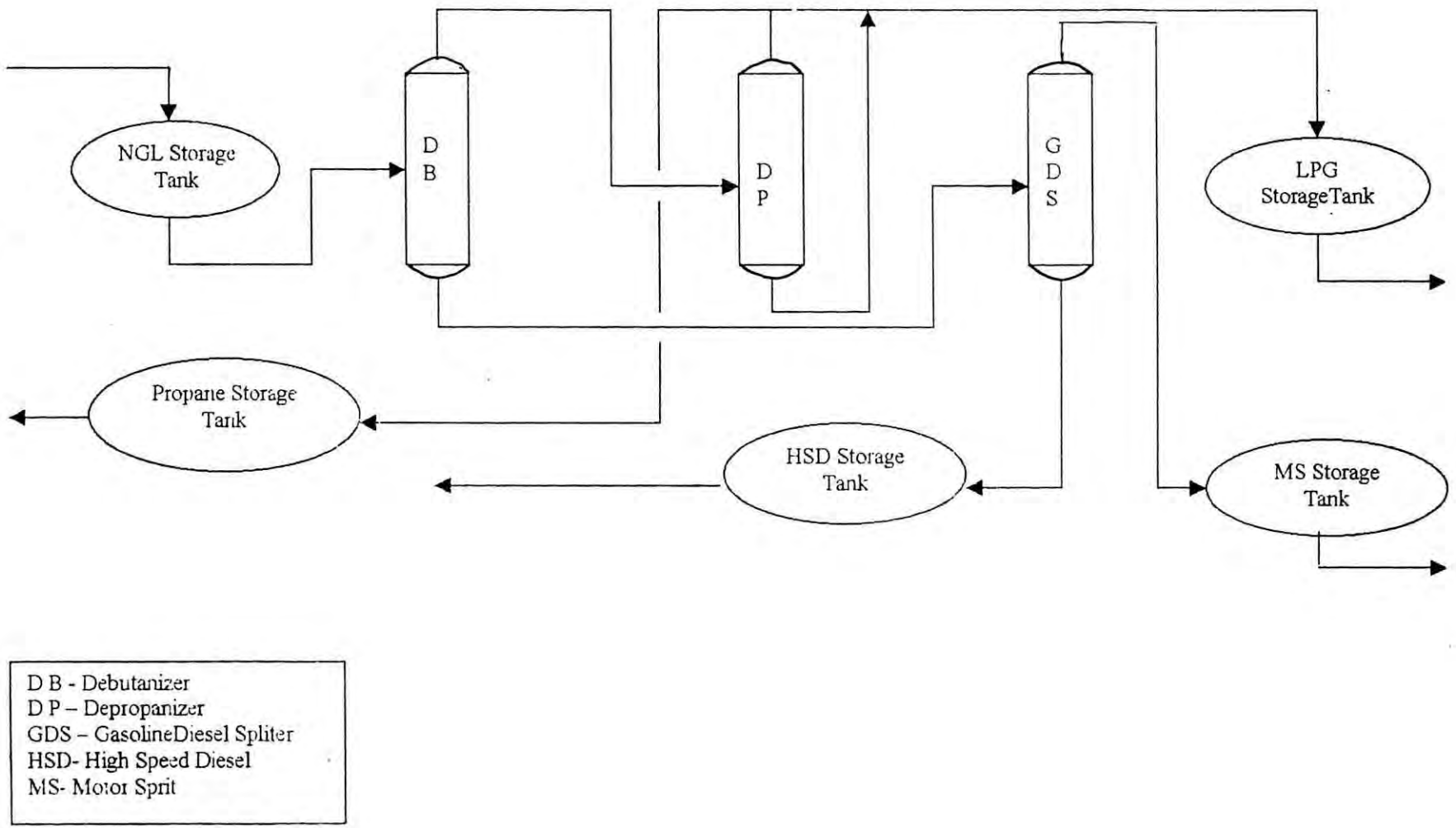
PRODUCTS	CAPACITY (TON/YEAR)	%
LPG	5000	23.80%
MOTOR SPIRIT	7600	36.20%
HIGH SPEED DIESEL	8400	40.00%

The process flow diagram of Kailashtilla LPG plant is shown in Figure 4.2. NGL is received in NGL surge drum. The capacity of the surge drum is equivalent to 8 hours design feed rate. From the surge drum NGL is fed to debutanizer tower. This is a fractionation column whose overhead product is butane, propane and other lighter ends (i.e. C_{3-}) and the bottom product is pentane, hexane and other higher hydrocarbons (C_{6+}). The overhead product of debutanizer flows to another fractionation column called depropanizer where propane and butane are separated and then it is mixed to produce LPG. The combined stream of propane and butane is sent to LPG storage tank that has a capacity of 105 MT, which is equivalent to seven days production of LPG. From this storage tank LPG is pumped to LPG bottling plant. On the other hand, the bottom product of debutanizer flows to another factionation column called gasoline - diesel splitter. Motor spirit and diesel are separated in gasoline- diesel splitter. Presently NGL is supplied from the deethanizer bottom of the MSTE plant which do not contain any diesel component. As such no fractionation is performed in this third column. That means, the debutanizer bottom product is nothing but motor spirit and this product is directly supplied to MS storage tank.

4.3.2 Kailashtilla LPG Bottling Plant

This LPG bottling plant is located adjacent to Kailashtilla LPG plant. This plant has been completed in 1998. The LPG is supplied to the plant from the Kailashtilla LPG plant

Figure 4.2: Process Flow Diagram of Kailashtilla LPG Plant



through LPG pipeline. There are 3 pressurized bullets to store LPG and cylinders are filled in a semi-automatic plant. The plant is designed for filling one size of cylinder (12.5 kg). The bottling capacity of the plant is 5000 MT of LPG per year.

4.3.3 Ashuganj NGL Fractionation Plant (Proposed)

This proposed plant was, in fact, an integrated component of SGDP. It could not be implemented, as scheduled earlier, due to various reasons. In 1991 RPGCL was given the responsibility of production, transmission and sale of LPG from NGL obtained from gas fields. Recently RPGCL has taken a step to install NGL fractionation plant at Ashuganj and has prepared a project that has been subsequently approved by GOB. Summary of the project is given below (PP of ANFP, 1998):

Objective of the project: To install a 110 MT per day capacity NGL fractionation plant with ancillary facilities at Ashuganj.

Feed/NGL availability:

Name of the Gas Field	NGL Availability (MT)	
	Daily	Annually
Kailashtilla Gas Field	110	36300
Total	110	36300

Products:

Name of the product	Amount (MT/ Year)
LPG	8560
Motor Spirit (MS)	13140
High Speed Diesel (HSD)	14600

Investment Cost:

Foreign Exchange:		Tk. 4914.00 Lakh
Local Currency	:	Tk. 4415.00 Lakh
Total	:	Tk. 9329.00 Lakh

Investment worth:

Internal rate of return (IRR): 21.75%

CHAPTER 5

LPG Reserve and Production Forecast in Bangladesh

5.1 Introduction

LPG reserve and its production forecast is closely related to gas composition, gas reserve and gas production. Gas production depends on gas demand. In this chapter these items will be discussed in brief.

5.2 Gas Composition

Natural gas composes of hydrocarbon gases and some impurities. The hydrocarbon gases normally found in natural gas are methane, ethane, propane, butane, pentane and small amounts of hexanes, heptanes, octanes and heavier gases. The amount of those hydrocarbons varies from gas field to gas field. The composition of natural gas of all discovered fields (excluding Bibiyana and Moulavibazar) is given in Table 5.1.

5.3 Gas Reserve and Present Status of Discovered Fields

Bangladesh has proved its hydrocarbon potentiality through discovery of 22 gas fields and one oil field. These gas fields are situated in greater Sylhet, Noakhali, Chittagong, Sylhet and Dhaka districts with recoverable reserve of 16591 BCF. Field wise gas and condensate reserve is furnished in Table 5.2. Out of 22 gas fields, 12 fields now are in production. Gas production from Chatak, Kamta and Feni gas fields has been suspended. Rest of the gas fields is non- producing. Brief descriptions on gas reserve, condensate production rates and production capability of the producing gas fields are provided here.

Table 5.1 : Composition of Natural Gas in Bangladesh

Sl. No.	Gas Fields	Chemical Composition in Mole %								Sp. Gr.	Calorific Value (BTU/CFT)
		Me - thene	Ethene	Pro - pane	Iso - butane	N - butane	C5+	Nitro - gen	CO2		
1	Sylhet	96.63	2.00	0.05	0.14	0.01	0.17	1.06	0.36	0.57	1020.00
2	Rashidpur	98.00	0.21	0.24	-		0.17	0.40	0.18	0.57	1026.00
3	Kailashtilla	95.57	2.70	0.94	0.21	0.20	0.14	0.00	0.14	0.60	1030.00
4	Titas	97.33	1.72	0.35	0.08	0.05	0.06	0.50	0.43	0.58	1040.00
5	Bakhrabad	94.20	3.65	0.72	0.20	0.10	0.24	0.57	0.45	0.59	1051.00
6	Habiganj	97.60	1.31	0.27	0.08	0.04	0.06	0.80	0.00	0.57	1014.00
7	Narsingdi	94.79	2.49	0.60	0.20	0.15	0.13	0.53	0.56	0.60	1042.00
8	Meghna	95.15	2.83	0.60	0.16	0.09	0.07	0.45	0.48	0.59	1049.00
9	Sangu	94.51	3.17	0.61	0.19	0.07	0.41	0.44	0.60	0.59	1058.00
10	Shaldanadi	96.32	2.16	0.45	0.12	0.07	0.05	0.55	0.68	0.58	1031.60
11	Chatak	97.90	1.80	0.20						0.55	1005.71
12	Kamta	95.36	3.57	0.47	0.09				0.51	0.57	1043.13
13	Feni	95.71	3.29	0.65	0.15	0.05			0.15	0.58	1049.84
14	Beanibazar	93.68	3.43	1.10	0.29	1.23	0.17	0.26	0.22	0.60	1061.95
15	Fenchugonj	95.66	2.50	0.63	0.11	0.04			0.06	0.57	1043.33
16	Jalalabad	94.408	3.246	1.257	0.306	0.305	0.201	0.211	0.062	0.60	1073.30
17	Begumgonj	95.46	3.19	0.64	0.17	0.04			0.30	0.58	1045.61
18	Kutubdia	95.72	2.87	0.67		0.31		0.36	0.07	0.59	1041.66
19	Semutang	96.94	1.70	0.14		0.01		0.86	0.35		
20	Shahbazpur	93.68	3.94	0.71	0.20	0.07	0.04	0.46	0.90	0.58	1046.21

Source : Production & Marketing Division, Petrobangla, 2000.

Table 5.2: Reserve of Natural Gas and Condensate in Bangladesh

Sl. No.	Name of Gas Fields	Year of Discovery	Natural Gas				Condensate		
			Total Reserve (BCF)	Recoverable Reserve (BCF)	Cummulative Production (as on June '2000) (BCF)	Remaining Reserve (BCF)	Recoverable Reserve (MMBBL)	Cummulative Production (as on June '2000) (MMBBL)	Remaining Reserve (MMBBL)
1	Sylhet	1955	444	266	166.243	99.757	0.890	0.569	0.321
2	Rashidpur	1960	2242	1309	191.315	1117.685	4.000	0.285	3.715
3	Kailashtilla	1962	3657	2529	230.244	2298.756	27.560	2.938	24.622
4	Titas	1962	4138	2100	1721.177	378.823	3.020	2.321	0.699
5	Bakhrabad	1969	1432	867	580.272	286.728	2.130	0.865	1.265
6	Habiganj	1963	3669	1895	783.670	1111.330	0.100	0.039	0.061
7	Narsingdi	1990	194	126	26.026	99.974	0.310	0.058	0.252
8	Meghna	1990	159	104	20.107	83.893	0.210	0.033	0.177
9	Sangu	1996	1031	848	93.320	754.680	-	0.034	-
10	Shaldanadi	1996	200	140	12.063	127.937	0.420	0.010	0.410
11	Chatak	1959	1900	1140	26.500	1113.500	0.080	0.000	0.080
12	Kamta	1981	325	195	21.100	173.900	0.040	0.004	0.036
13	Feni	1981	132	80	39.510	40.490	0.240	0.092	0.148
14	Beanibazar	1981	243	167	3.355	163.645	1.820	0.103	1.717
15	Fenchugonj	1988	350	210	0.000	210.000	0.520	0.000	0.520
16	Jalalabad	1989	1500	900	49.096	850.904	15.750	0.679	15.071
17	Begumgonj	1977	25	15	0.000	15.000	0.010	0.000	0.010
18	Kutubdia	1977	780	468	0.000	468.000	0.000	0.000	0.000
19	Semutang	1969	164	98	0.000	98.000	0.020	0.000	0.020
20	Shahbazpur	1995	514	333	0.000	333.000	-	-	-
21	Bibiyana	1998	3144.52	2401	0.000	2401.000	-	-	-
22	Moulavibazar	1999	500	400	0.000	400.000	-	-	-
	Total :		**26743.52**	**16591.00**	**3964.00**	**12627.00**	**57.12**	**8.03**	**49.12**

Source : Production and Marketing Division,Petrobangla, 2000.

Note: Source (Reserve): Habitat Study, IKM Reports and Reservoir Study Cell, Petrobangla

5.3.1 Titas Gas Field

In 1962, this field was discovered with a big reserve in the district of Brahmanbaria by the bank of the river Titas. It is one of the older developed areas for the production of natural gas in Bangladesh. There are three distinct well sites at present. The first and primary site is location # 1, which includes well # 1, 3, 4, 5 and 7. This site is equipped with primary gas separation, four glycol dehydration units plus one low temperature extraction (LTX) unit and two fractionation plants. The condensate that is separated from the natural gas is stored in stock tanks and then processed through a fractionation plant which is located at this site to produce motor spirit and high speed diesel.

Titas location # 2 is a single well location, which includes well # 2. At this site, there is gas separation from the free condensate using a low – temperature extraction (LTX) unit. The condensate is transported to location # 1 for storage and further processing.

Location # 3 includes five wells and these are well # 6, 8, 9, 10 and 11. Processing facilities at this site consist of a glycol dehydration unit and two low temperature extraction (LTX) units, which are processing the gas from wells # 6, 8, 9, 10 and 11. Condensate at this location is also piped to location # 1 for storage and processing by the existing fractionation plant.

At present about 302 MMSCFD gas is being produced from 11 wells of this field and being processed through nine process plants. Condensate produces with gas as by-product. On average 1.35 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 1.34 bbl/MMSCF of condensate

is now being produced from this gas field (Production Report, September 13, 2000, Petrobangla).

As per reservoir data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell) total recoverable reserve of gas and condensate of this field are 2100 BCF and 3.02 MMBBL respectively, out of which 1721.177 BCF gas (81.96%) and 2.321 MMBBL condensate (76.85%) have been recovered till June, 2000.

5.3.2 Kailashtilla Gas Field

In 1962, this gas field was discovered in Golapgonj thana under Sylhet district. There are two distinct well sites at present. Kailashtilla Location # 1 has a single well named as KTL# 1. KTL # 1 was brought into production in June 1983. This site is equipped with one silica gel process plant, one fractionation plant and storage facilities for condensate, motor spirit and high speed diesel. The condensate separated from the natural gas is processed through the fractionation plant, which is located at this site to produce motor spirit and high speed diesel.

Location # 2 includes three wells viz. KTL # 2, KTL# 3 and KTL# 4. This site is equipped with primary gas separation and MSTE plant. This MSTE plant is the first of its kind in Bangladesh. The installed processing capacity of MSTE plant is 90 MMCF of gas per day. KTL # 2, KTL # 3 and the MSTE plant have been brought into production on the 25th September 1995. KTL # 4 was brought into production in March 1997.

is now being produced from this gas field (Production Report, September 13, 2000, Petrobangla).

As per reservoir data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell) total recoverable reserve of gas and condensate of this field are 2100 BCF and 3.02 MMBBL respectively, out of which 1721.177 BCF gas (81.96%) and 2.321 MMBBL condensate (76.85%) have been recovered till June, 2000.

5.3.2 Kailashtilla Gas Field

In 1962, this gas field was discovered in Golapgonj thana under Sylhet district. There are two distinct well sites at present. Kailashtilla Location # 1 has a single well named as KTL# 1. KTL # 1 was brought into production in June 1983. This site is equipped with one silica gel process plant, one fractionation plant and storage facilities for condensate, motor spirit and high speed diesel. The condensate separated from the natural gas is processed through the fractionation plant, which is located at this site to produce motor spirit and high speed diesel.

Location # 2 includes three wells viz. KTL # 2, KTL# 3 and KTL# 4. This site is equipped with primary gas separation and MSTE plant. This MSTE plant is the first of its kind in Bangladesh. The installed processing capacity of MSTE plant is 90 MMCF of gas per day. KTL # 2, KTL # 3 and the MSTE plant have been brought into production on the 25th September 1995. KTL # 4 was brought into production in March 1997.

At present about 110 MMSCFD gas is being produced from four wells of this field and being processed through two process plants. On average 11.70 bbl/MMSCF of condensate has been produced from this gas field till June 1998 (P&M Division, Petrobangla). About 15.04 bbl/MMSCF of condensate/NGL is now being produced from this gas field (MIS Report, June 2000, Petrobangla).

Condensate produced with gas of KTL # 1 is being processed through the fractionation plant of location # 1 into motor spirit (petrol) and diesel. Gas of KTL# 2, KTL# 3 and KTL# 4 are processed in the MSTE plant. Condensate and processed gas of the MSTE plant are supplied to Ashuganj through 6 - inch North-South (N-S) condensate pipeline and a 24 -inch N-S gas pipeline, respectively.

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 2529 BCF and 27.56 MMBBL respectively; out of which 230.244 BCF gas (9.10%) and 2.938 MMBBL condensate (10.66%) have been recovered till June 2000.

5.3.3 Bakhrabad Gas Field

In 1969, this field was discovered in the district of Brahmanbaria. There are eight wells in this field. It is equipped with four silica gel process plants and one fractionation plant. Total production capacity of this field is 240 MMCFD. Because of rapid decrease in wellhead pressure, increase in water/gas ratio and sand production, gas is being produced at a limited rate of 35 MMCFD from four wells through aforesaid four process plants. Gas production from the rest four wells was suspended. On average 1.49 bbl/MMSCF of

condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 0.95 bbl/MMSCF of condensate is now being produced from this gas field (Production Report, September 13, 2000, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 867 BCF and 2.13 MMBBL respectively, out of which 580.272 BCF (66.93%) gas and 0.865 MMBBL (40.61%) condensate have been recovered till June 2000.

5.3.4 Narsingdi Gas Field

In 1990, this field was discovered by Project Implementation Unit (PIU), Petrobangla. This site is equipped with a glycol plant. Production commenced from this field in July 1996. Production capacity of this field is 20 MMSCFD. Condensate produces with gas as by- product. On average 2.23 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 2.30 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 126 BCF and 0.31M MBBL respectively; out of which 26.026 BCF (20.66%) gas and 0.058 MMBBL (18.71%) condensate have been recovered till June 2000.

5.3.5 Meghna Gas Field

In 1990, this field was discovered by PIU, Petrobangla. This site is equipped with a LTX plant. Gas production from this field commenced in June 1997. This field is now producing around 17 MMSCF of gas per day and about 1.68 bbl/MMSCF of condensate (MIS Report, June 2000, Petrobangla). On average 1.64 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 104 BCF and 0.21 MMBBL respectively; out of which 20.107 BCF (19.33%) gas and 0.033 MMBBL (15.71%) condensate have been recovered till June 2000.

5.3.6 Habiganj Gas Field

This field was discovered in 1963. There are seven wells equipped with four glycol process plants with total capacity 270 MMCFD in the field. It is planned to drill three additional wells and install two glycol process plants each with a capacity of 75 MMCFD by 2000.

On average 0.05 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 0.05 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla). So far it is the driest gas producing field in the country.

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 1895 BCF and 0.10 MMBBL respectively; out of which 783.67 BCF (41.35%) gas and 0.039 MMBBL (39%) condensate have been recovered till June 2000.

5.3.7 Sylhet (Haripur) Gas Field

Sylhet gas field was discovered by PPL in 1955. This field is equipped with a silica gel plant and a fractionation plant. Present gas production of this field is 6 MMCFD. About 3.41 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla). On average 3.42 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 266 BCF and 0.89 MMBBL respectively; out of which 166.243 BCF (62.57%) gas and 0.569 MMBBL (63.93%) condensate have been recovered till June 2000.

5.3.8 Rashidpur Gas Field

Rashidpur Gas Field was discovered in 1960. This field has been brought into production in 1993. In this field, there are four existing production wells (well # 1,2,3 and 4) where one glycol dehydration plant with a capacity of 60 MMCFD and one silica gel process plant of 70 MMCFD have been functioning for gas processing. The processed gas is supplying to the North – South pipeline (i.e. part of the national gas grid).

On average 1.48 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 1.42 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 1309 BCF and 4 MMBBL respectively; out of which 191.315 BCF (14.62%) gas and 0.285 MMBBL (7.125%) condensate have been recovered till June 2000.

5.3.9 Shaldanadi Gas Field

In 1996, this field was discovered by BAPEX. This field is equipped with a glycol plant, which processes gas produced from well # 1. This field is now producing 15 MMSCF of gas per day and about 0.80 bbl/MMSCF of condensate (MIS Report, June 2000, Petrobangla). On average 0.83 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). Work of drilling and completion of second well (well # 2) is completed recently.

As per data provided by Petrobangla (Reservoir Study cell), total recoverable reserve of gas and condensate of this field are 140 BCF and 0.42 MMBBL respectively; out of which 12.063 BCF (1.16%) gas and 0.10 MMBBL (2.38%) condensate have been recovered till June 2000.

5.3.10 Sangu Gas Field

In 1996, this field was discovered by Cairn Energy PLC. It is the second off shore gas field in the country. This field is equipped with a glycol plant with gas processing capacity 150 MMSCFD. About 0.40 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla).

As per data provided by Petrobangla (Reservoir study cell), total recoverable reserve of this field is 848 BCF.

5.3.11 Beanibazar Gas Field

In 1981, this field was discovered by Petrobangla. There are two wells in this field. This site is equipped with one silica gel process plant. This field has been brought into production in 1999. Production capacity of this field is 35 MMSCFD. On average 14.80 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (MIS Report, June 2000, Petrobangla).

As per data provided by Petrobangla (Habitat study, IKM reports and Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 167 BCF and 1.82 MMBBL respectively.

5.3.12 Jalalabad Gas Field

In 1989, this field was discovered by Scimiter. There are four wells in this field. It is equipped with an IPEXOL gas treatment plant. Gas produced from this field is transported by a 17 Km, 14 inch gas pipeline to the existing North – South (N-S) gas pipeline and

condensate is transported to the existing N-S condensate pipeline through 4 inch liquid pipeline.

Present gas production capacity of this field is 100 MMSCFD. On average13.83 bbl/MMSCF of condensate has been produced from this gas field till June 2000 (P&M Division, Petrobangla). About 15.65 bbl/MMSCF of condensate is now being produced from this gas field (MIS Report, June 2000, Petrobangla).

As per data provided by Petrobangla (Reservoir Study Cell), total recoverable reserve of gas and condensate of this field are 900 BCF and 15.75 MMBBL respectively; out of which 49.096 BCF (5.455%) gas and 0.679 MMBBL (4.31%) condensate have been recovered till June 2000.

5.4 Gas Demand and Supply

To study LPG extraction potential, knowledge about natural gas production is required. Gas production depends on its demand and reserve. Chatak field was the first field in Bangladesh to come into production. It came into commercial production in 1960 to supply gas to the Chatak cement factory and the pulp and paper mill. Since this first gas production, the industry has grown from individual fields and small distribution systems to the present stage with large fields and inter-connected distribution system. In 1960-61, the gas consumption was 911 MMSCF per year, which has increased to 265.27 BCF in 1997-98. Natural gas is transported and distributed by GTCL, TGTDCL, BGSL and JGTDSL through interconnected gas network. Figure 5.1 shows the gas field location and gas transmission network.

Figure 5.1: Gas Fields and Gas Transmission Pipelines

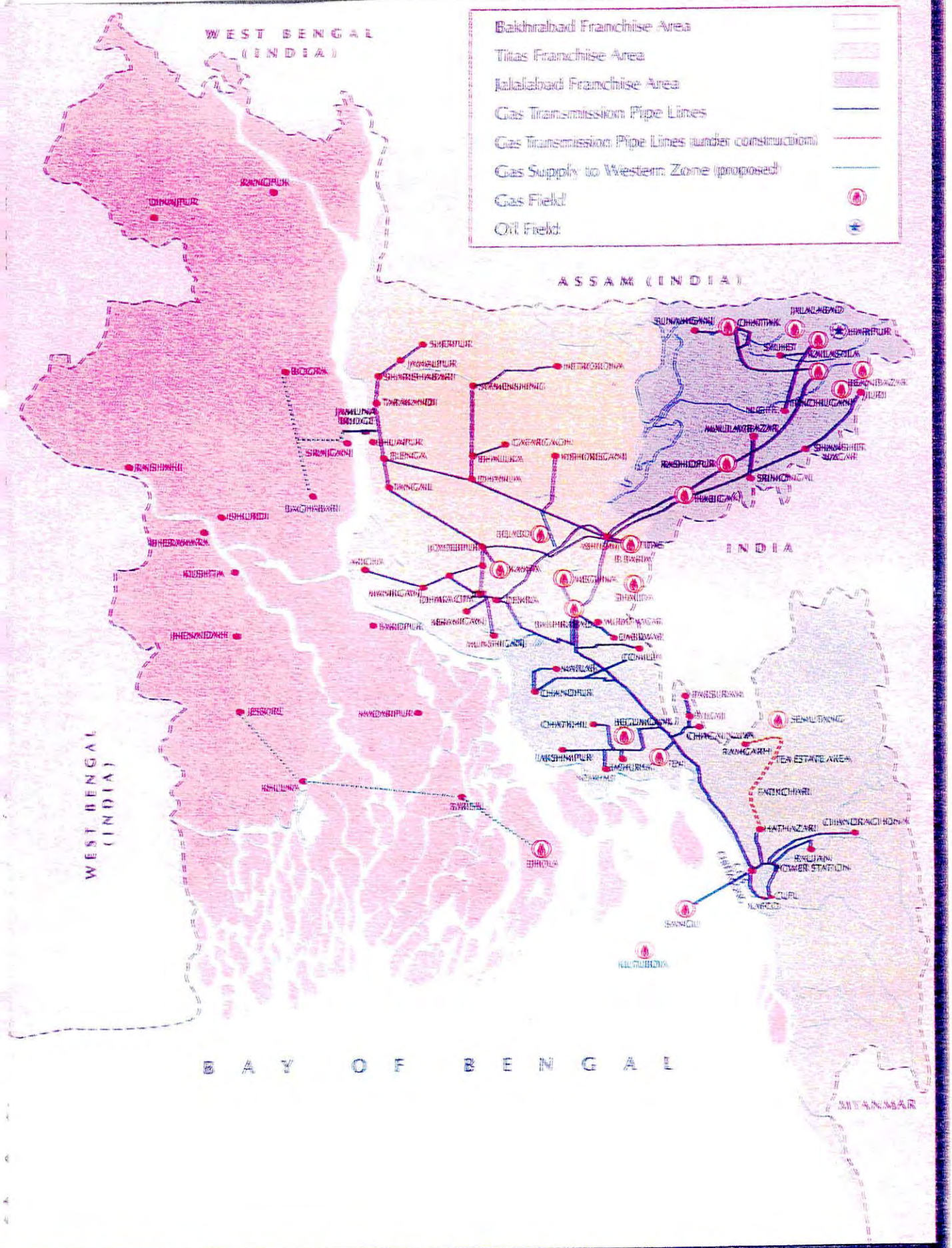


Figure 5.2 shows the sector-wise historical gas demand in Bangladesh and Table 5.3 provides the future gas demand forecast (Petrobangla, 2000).

The power sector and the fertilizer industry are forecasted to account for 70.32% of Bangladesh's total natural gas demand by the end of 2004/05 (Figure 5.3). The power sector is the country's largest consumer of natural gas (Figure 5.4) and gas demand growth in this sector is expected to be dominated by the development of independent power producer (IPP) projects.

The fertilizer industry is Bangladesh's second largest consumer of natural gas. Recent forecasts by BCIC include four new plants planned to be located in Chittagong, Chandpur, Bhola and North Bengal. It is unlikely that these four planned fertilizer units would be implemented before the end of 2004/05.

Average gas demand by industrial users is projected to increase from about 78 MMSCFD in 1996-97 to 225 MMSCFD by 2004-05. According to Petrobangla's April, 2000 forecast, the significant rise in gas consumption is driven by a 60% boost in gas demand by industrial users in the Titas (TGTDCL) franchise area, and the development of a sponge iron plant, an export processing zone (EPZ) in Chittagong and a cement plant in the Jalalabad (JGTDSL) franchise area.

For the non-bulk commercial, domestic and seasonal users, the total projected average gas demand is forecasted by Petrobangla to increase from 80 MMSCFD in 1996-97 to 140 MMSCFD in 2004-05.

Figure 5.2 : Historical Gas Demand in Bangladesh

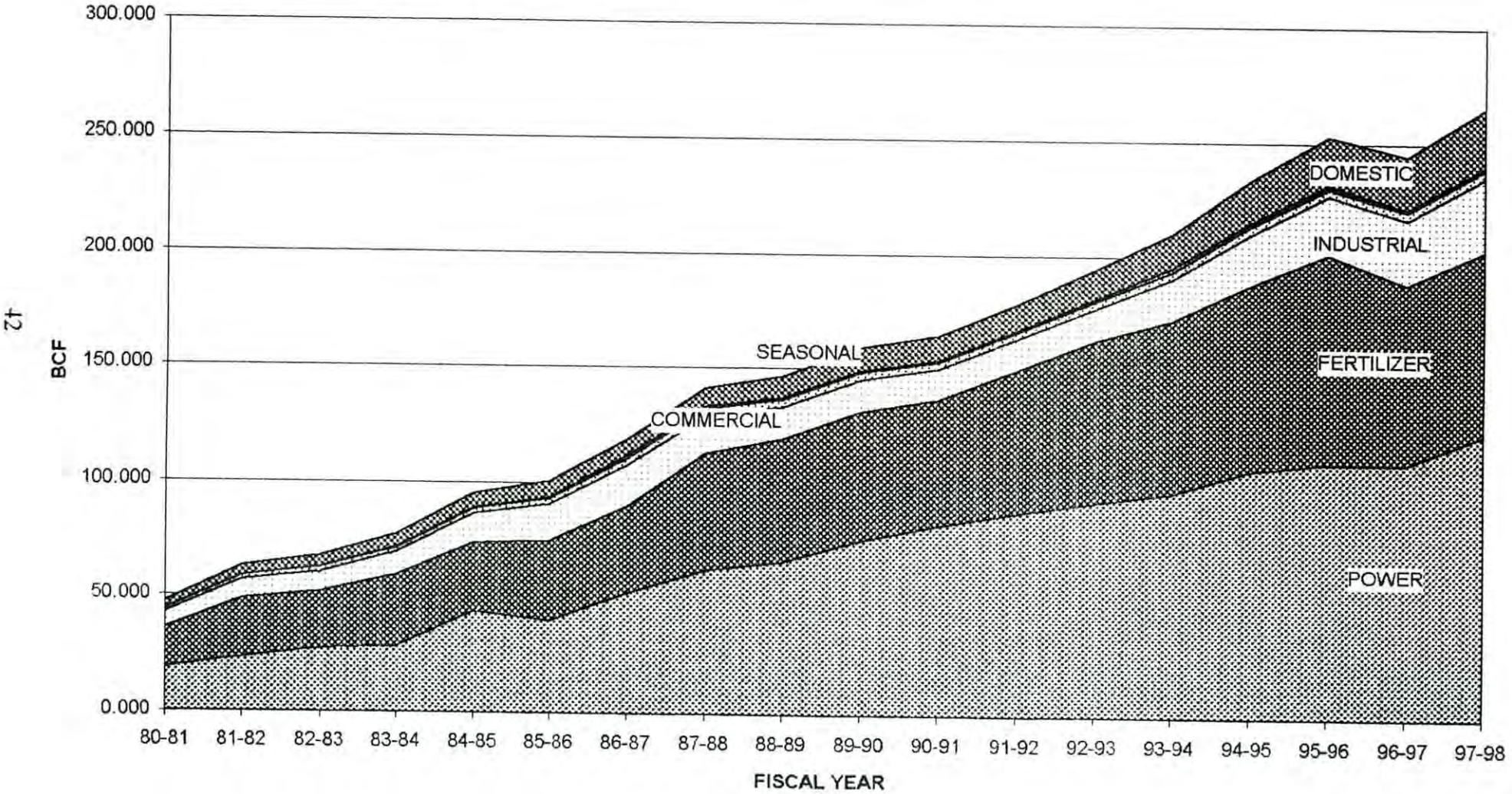


Table 5.3 : Daily Gas Demand During Fiscal Year 2000 - 2005

Fig. in MMCFD

	Fiscal Year					
SECTOR	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
1. POWER - DAILY AVERAGE	400	425	493	522	556	578
2. POWER - DAILY MAXIMUM PEAK	488	534	590	634	687	706
3. FERTILIZER - AVERAGE	260	260	287	287	287	287
4. FERTILIZER - MAXIMUM	287	287	317	317	317	317
5. INDUSTRY	147	164	188	202	213	225
6.COMERCIAL	12	13	14	15	16	17
7. DOMESTIC	80	86	92	98	105	112
8. TEA+BRICK FIELDS	9	9	10	10	11	11
9. TOTAL NON-BULK AVEGE (5+6+7+8)	248	272	304	325	345	365
10. TOTAL NON-BULK MAXIMUM	297	326	360	387	411	436
11. SYSTEM LOSS+ OWN USE	59	40	40	40	40	40
12. AVERAGE SYSTEM DEMAND	967	997	1124	1174	1228	1270
13. MAXIMUM SYSTEM DEMAND	1131	1187	1307	1378	1455	1499

SOURCE : PETROBANGLA,2000

Figure 5.3 : Gas Demand Forcast During 2004-05

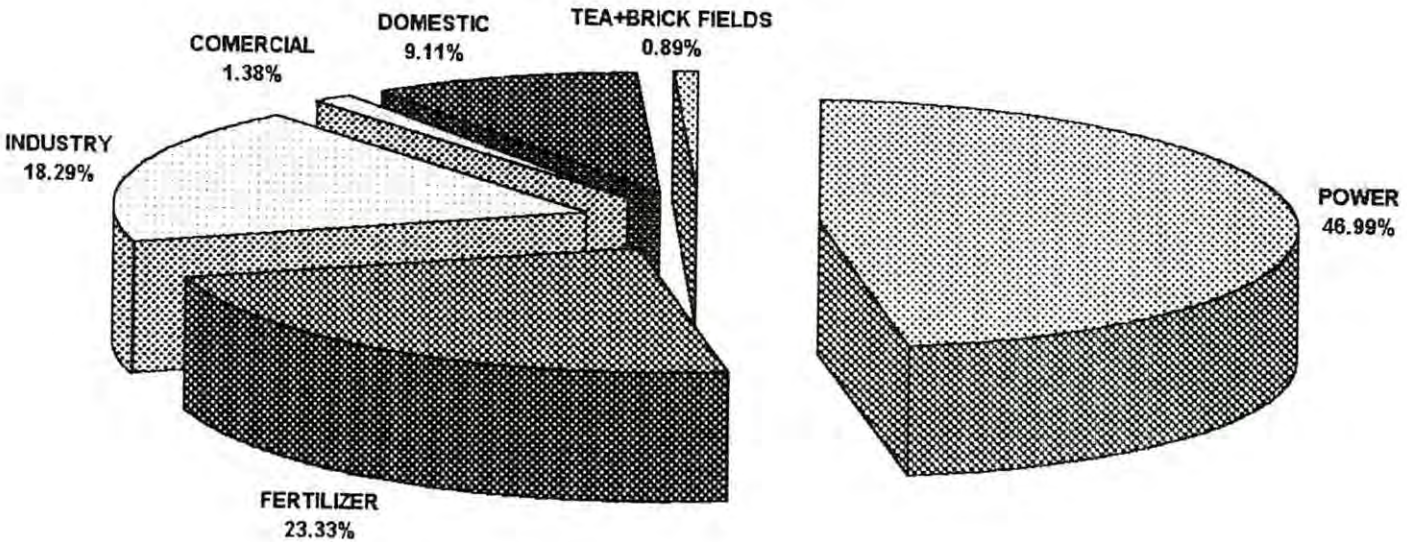
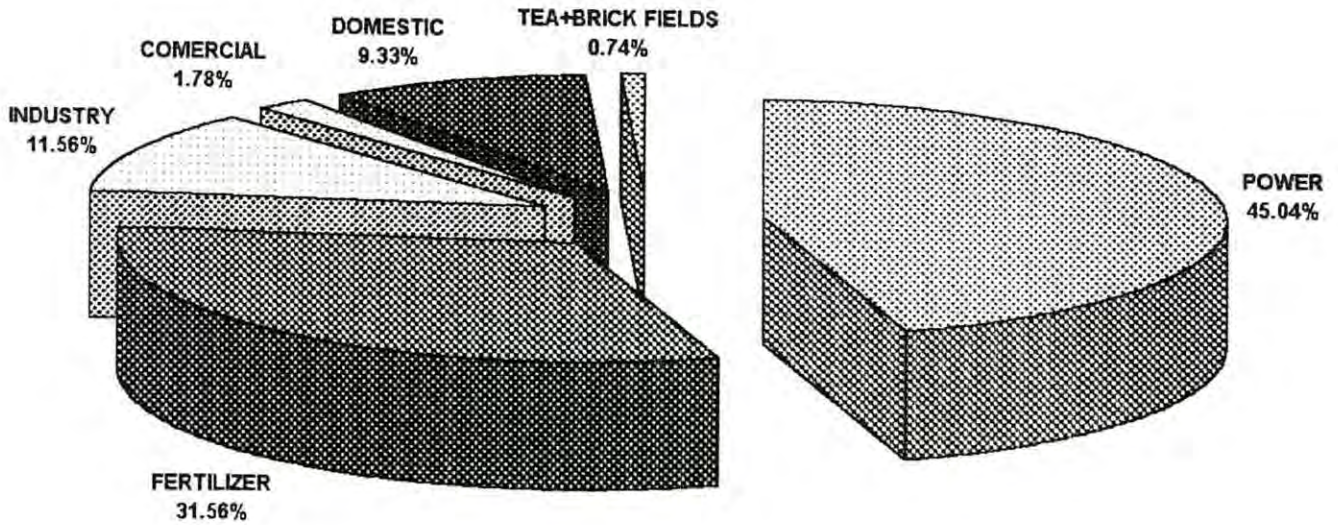


Figure 5.4 : Gas Demand During 1996-97



With the completion of the Bangabandhu Jamuna Multipurpose Bridge (including a natural gas pipeline) linking the Eastern and Western parts of Bangladesh, there has been renewed interest in the Western region's potential demand for gas.

Against the above demand in 1997-98, 987 MMSCFD gas was produced from 12 gas fields. The peak demand of the system was 1105 MMSCFD which was little above the total production capability of 987 MMSCFD for that period. Beanibazar gas field and Jalalabad gas field came into production recently which increased the gas production capability.

International Oil Companies (IOCs) through Production Sharing Contracts (PSC) signed with Petrobangla have started production. Carin Energy PLC/Shell is already delivering about 120 MMSCFD gas to Bakhrabad – Chittagong Transmission pipeline and is expected to increase the supply up to 150 MMSCFD. Occidental of Bangladesh Ltd./ Unocal is supplying 100 MMSCFD gas to the national gas grid. In addition, BGFCL is drilling six more wells at Habiganj gas field and Titas gas field under Third natural gas (TNG) project. SGFL is also drilling three new wells at Rashidpur gas field under gas infrastructure development project (GIDP). The country's projected total average supply (for fields operated by Petrobangla and IOCs) will increase from 1096 MMSCFD in 1998-99 to 1246 MMSCFD by the year 2004-05.

5.5 LPG Reserve Estimate

LPG is nothing but a mixture of propane and butane or its individuals. Reserve of propane and butane indicates the reserve of LPG. Amount of LPG can be estimated from the mole

fraction of propane and butane (please refer to Table 5.1 for mole fraction of propane and butane) with the help of Physical Constants of Hydrocarbons (Amyx, Bass and Whitting, 1988) and the calculation of the same is given below:

LPG content in bbl / MMSCF = Mole fraction of Propane X Physical Constant (in bbl liquid / MMSCF of gas) for Propane + Mole fraction of Butane X Physical Constant (in bbl liquid / MMSCF of gas) for Butane.

Physical Constants:

for propane : 651.90 bbl liquid / MMSCF of gas

for iso - butane : 775.40 bbl liquid / MMSCF of gas

for n- butane : 747.50 bbl liquid / MMSCF of gas

LPG Content in bbl / MMSCF =(Mole fraction of propane X 651.90) + (Mole fraction of iso-butane X 775.40) + (Mole fraction of n-butane X 747.50)

And

Remaining Reserve of LPG in MMbbl =

{(LPG Reserve in bbl / MMSCF) X (Remaining Reserve of Gas in BCF)}/ 1000

Sample Calculation:

Sylhet Gas Field

Mole % of propane = 0.05

Mole % of iso – butane = 0.14

Mole % of n- butane = 0.01

(Table 5.1, Petrobangla)

Remaining Reserve of Gas: 104.70 BCF

(Table 5.2, Petrobangla)

LPG Content = {(0.05/100)X651.90} + {(0.14/100) X 775.40} + {(0.01/ 100) X747.50}

= 1.49 bbl / MMSCF

Remaining Reserve of LPG ={(1.49 bbl/ MMSCF) X 99.757 BCF} / 1000 = 0.15 MMbbl

Similarly, LPG content as well as remaining reserve of LPG for all gas fields (excluding Bibiyana and Moulavibazar) has been calculated and furnished in Table 5.4. Total estimated remaining reserve of LPG is 58.55 MMbbl. Figure 5.5 shows field-wise LPG content in term of bbl/MMSCF and whereas Figure 5.6 shows remaining reserve of LPG in different fields. LPG content is the highest in Beanibazar i.e. 18.61 MMbbl/ MMSCF. Largest amount i.e. 21.26 MMbbl LPG reserve is in Kailashtilla field. Another LPG rich field is Jalalabad gas field. About 60.20 % of total remaining reserve of LPG contain in the fields of Kailashtilla, Jalalabad and Beanibazar.

5.6 LPG Production Forecast

LPG production depends on gas production and installation of LPG extraction facilities. Only twelve gas fields are in production at present. Forecasted gas production of these fields is provided in Table 5.5 (Petrobangla).

LPG production forecast and their market value has been estimated based on the gas production forecast and the following assumptions:

(1) LPG extraction facilities or plants will recover 90% of LPG

(2) Production period = 330 days per year

Table 5.4 : LPG Contents and Reserve of LPG in Bangladesh

Sl. No.	Name of Gas Fields	Natural Gas			Initial Reserve of LPG (MMbbl)	Remaining Reserve of LPG (MMbbl)	LPG Content (bbl / MMCF)
		Recoverable Reserve (BCF)	Cummulative Production (as on June '2000) (BCF)	Remaining Reserve (BCF)			
1	Sylhet	266	166.243	99.757	0.40	0.15	1.49
2	Rashidpur	1309	191.315	1117.685	2.04	1.74	1.56
3	Kailashtilla	2529	230.244	2298.756	23.39	21.26	9.25
4	Titas	2100	1721.177	378.823	6.89	1.24	3.28
5	Bakhrabad	867	580.272	286.728	6.06	2.00	6.99
6	Habiganj	1895	783.670	1111.330	5.08	2.98	2.68
7	Narsingdi	126	26.026	99.974	0.83	0.66	6.58
8	Meghna	104	20.107	83.893	0.61	0.49	5.82
9	Sangu	848	93.320	754.680	5.06	4.51	5.97
10	Shaldanadi	140	12.063	127.937	0.61	0.56	4.39
11	Chatak	1140	26.500	1113.500	1.48	1.45	1.3
12	Kamta	195	21.100	173.900	0.73	0.65	3.76
13	Feni	80	39.510	40.490	0.46	0.23	5.77
14	Beanibazar	167	3.355	163.645	3.11	3.05	18.61
15	Fenchugonj	210	0.000	210.000	1.10	1.10	5.26
16	Jalalabad	900	49.096	850.904	11.57	10.93	12.85
17	Begumgonj	15	0.000	15.000	0.09	0.09	5.79
18	Kutubdia	468	0.000	468.000	3.13	3.13	6.68
19	Semutang	98	0.000	98.000	0.10	0.10	0.99
20	Shahbazpur	333	0.000	333.000	2.23	2.23	6.7
	Total:	**13790**	**3964.00**	**9826.00**	**74.97**	**58.55**	

Source of Gas Reserve : Petrobangla,2000

Note :Furnished LPG reseve has been estimated base on gas reserve and gas composition.

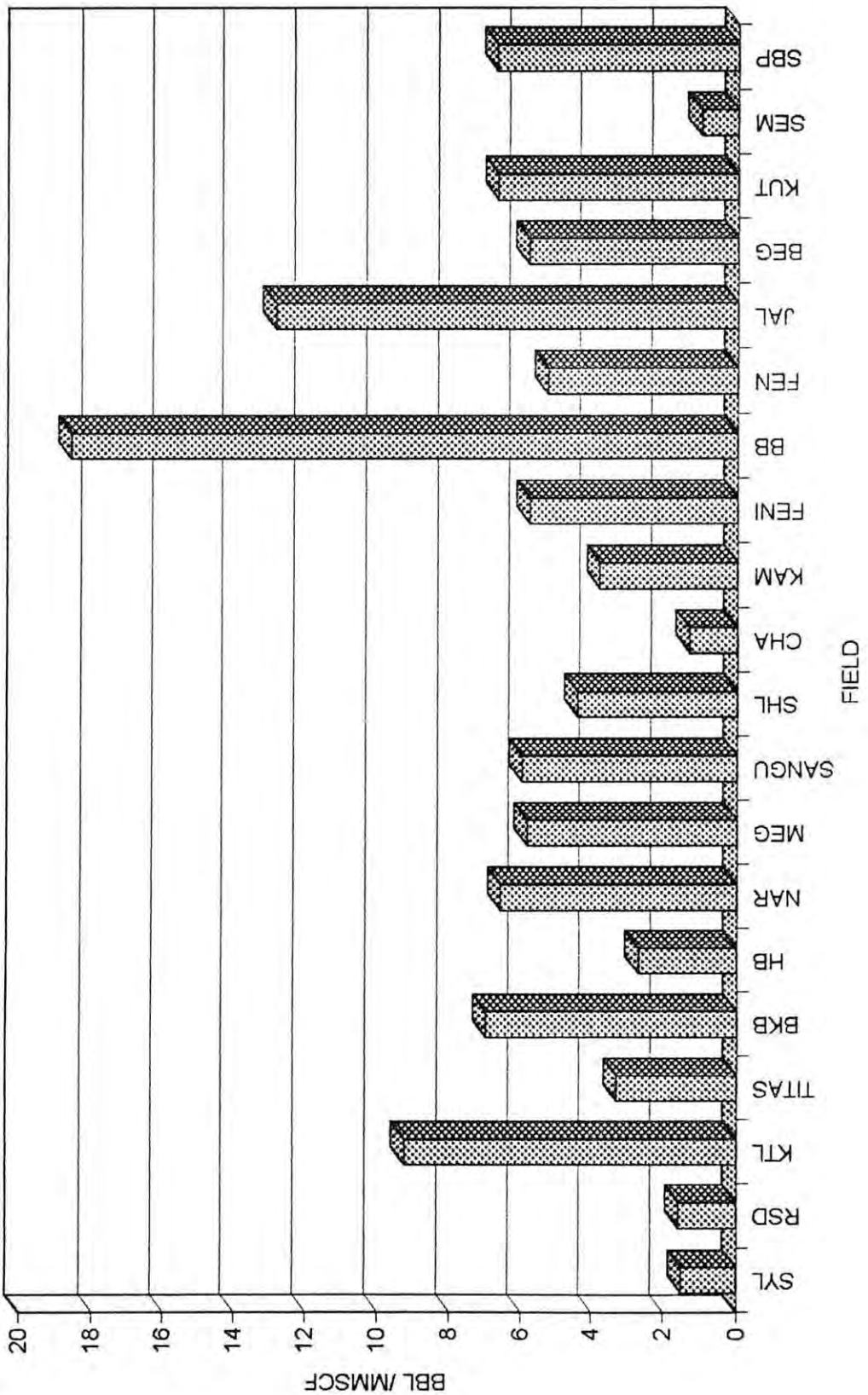


Figure 5.5 : Field Wise LPG Contents (bbl / MMSCF)

Figure 5.6 : Field Wise Remaining Reserve of LPG

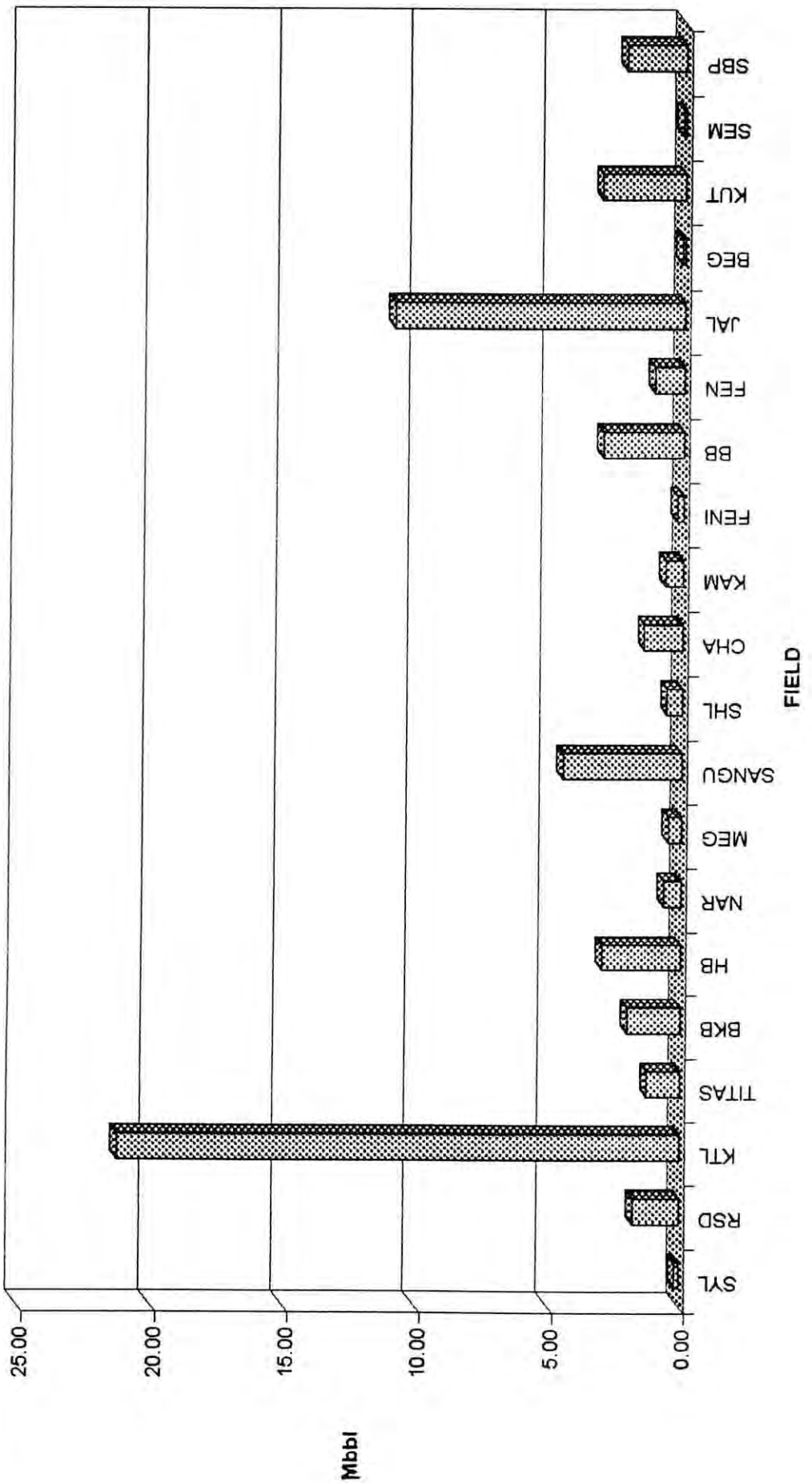


Table 5.5 :Field Wise Gas Production Forecast

Sl. No.	Name of Gas Field	Year - 2000-01		Year - 20001-02		Year - 2002-03		Year - 2003- 04		Year - 2004-05	
		No. of Well	Production Capacity (MMCFD)	No. of Well	Production Capacity (MMCFD)	No. of Well	Production Capacity (MMCFD)	No. of Well	Production Capacity (MMCFD)	No. of Well	Production Capacity (MMCFD)
1	Sylhet	1	6	1	6	1	6	1	6	1	6
2	Rashidpur	7	135	7	135	7	135	7	135	7	135
3	Kailashtilla	4	110	4	110	4	110	4	110	4	110
4	Titas	14	375	14	375	14	375	14	375	14	375
5	Bakhrabad	4	35	4	30	4	30	4	30	4	25
6	Habiganj	9	250	9	250	9	250	9	250	9	250
7	Narsingdi	1	20	1	20	1	20	1	20	1	20
8	Meghna	1	17	1	16	1	16	1	15	1	15
9	Sangu	4	150	4	150	4	150	4	150	4	150
10	Shaldanadi	2	30	2	30	2	30	2	25	2	25
11	Beanibazar	2	35	2	35	2	35	2	35	2	35
12	Jalalabad	4	100	4	100	4	100	4	100	4	100
	Total :	**53**	**1263**	**53**	**1257**	**53**	**1257**	**53**	**1251**	**53**	**1246**

Source : Production & Marketing Division, Petrobangla,2000.

(3) Specific gravity of LPG = 0.54

(4) Market price of LPG = Tk. 250 / Cylinder (i.e. 12.50 Kg)

Estimation of field-wise LPG production forecast and its market value:

Daily LPG Production = Daily Gas Production (in MMSCF)XLPG in bbl/MMSCF X 0.90

Annually LPG Production in MT =

{Daily LPG Production (in Bbl) X 330 X 159 X 0.54}/1000

[1 bbl = 159 liters]

Market Value in Lac Taka = {(Tk 250/12.50) * 1000 * LPG (in MT)}/ 100000

Sample Calculation:

Sylhet Gas Field

We have,

Forecasted gas production : 6 MMSCFD (Petrobangla)

Estimated LPG reserve : 1.49 bbl / MMSCF (Calculated)

So,

Daily LPG production = 6 MMSCFD X 1.49 bbl/MMSCF X 0.90 = 8 bbl

Annually LPG production = {(8 X 330 X 159 X0.54)/1000} MT = 228 MT

Market value of 228 MT LPG = [{ (250/12.50)*1000* 228}/ 100000] Lac Taka

= 46 Lac Taka

Similarly, daily as well as annual LPG production and its market value for the period 2000 - 01 to 2004 - 05 has been calculated and tabulated in Table 5.6 and Table 5.7. It is seen that daily 5918 bbl or 508 MT and annually 167,685 MT LPG would be produced from 12

Table 5.6 :Field Wise Daily LPG Production Forecast

Name of Gas Field	Year - 2000-01		Year - 20001-02		Year 2002-03		Year - 2003-04		Year - 2004-05	
	Gas Production Capacity (MMCFD)	Estimated LPG Production (BBLD)	Gas Production Capacity (MMCFD)	Estimated LPG Production (BBLD)	Gas Production Capacity (MMCFD)	Estimated LPG Production (BBLD)	Gas Production Capacity (MMCFD)	Estimated LPG Production (BBLD)	Gas Production Capacity (MMCFD)	Estimated LPG Production (BBLD)
Sylhet	6	8	6	8	6	8	6	8	6	8
Rashidpur	135	190	135	190	135	190	135	190	135	190
Kailashtilla	110	916	110	916	110	916	110	916	110	916
Titas	375	1107	375	1107	375	1107	375	1107	375	1107
Bakhrabad	35	220	30	189	30	189	30	189	25	157
Habiganj	250	603	250	603	250	603	250	603	250	603
Narsingdi	20	118	20	118	20	118	20	118	20	118
Meghna	17	89	16	84	16	84	16	84	15	79
Sangu	150	806	150	806	150	806	150	806	150	806
Shaldanadi	30	119	30	119	30	119	25	99	25	99
Beanibazar	35	586	35	586	35	586	35	586	35	586
Jalalabad	100	1157	100	1157	100	1157	100	1157	100	1157
Total :	**1263**	**5918**	**1257**	**5882**	**1257**	**5882**	**1252**	**5862**	**1246**	**5825**

Table 5.7 : Annual LPG Production Forecast and Its Market Value

Name of Gas Field	Year - 2000-01		Year - 2001-02		Year - 2002-03		Year - 2003-04		Year - 2004-05	
	Estimated LPG Production (MT)	Market Value of the Estimated LPG (LAC TK.)	Estimated LPG Production (MT)	Market Value of the Estimated LPG (LAC TK.)	Estimated LPG Production (MT)	Market Value of the Estimated LPG (LAC TK.)	Estimated LPG Production (MT)	Market Value of the Estimated LPG (LAC TK.)	Estimated LPG Production (MT)	Market Value of the Estimated LPG (LAC TK.)
Sylhet	228	46	228	46	228	46	228	46	228	46
Rashidpur	5370	1074	5370	1074	5370	1074	5370	1074	5370	1074
Kailashtilla	25947	5189	25947	5189	25947	5189	25947	5189	25947	5189
Titas	31366	6273	31366	6273	31366	6273	31366	6273	31366	6273
Bakhrabad	6239	1248	5347	1069	5347	1069	5347	1069	4456	891
Habiganj	17085	3417	17085	3417	17085	3417	17085	3417	17085	3417
Narsingdi	3356	671	3356	671	3356	671	3356	671	3356	671
Meghna	2523	505	2375	475	2375	475	2375	475	2226	445
Sangu	22836	4567	22836	4567	22836	4567	22836	4567	22836	4567
Shaldanadi	3358	672	3358	672	3358	672	2799	560	2799	560
Beanibazar	16610	3322	16610	3322	16610	3322	16610	3322	16610	3322
Jalalabad	32768	6554	32768	6554	32768	6554	32768	6554	32768	6554
Total :	**167685**	**33537**	**166645**	**33329**	**166645**	**33329**	**166086**	**33217**	**165046**	**33009**

producing fields with forecasted gas production of 1263 MMSCFD for the fiscal year 2000-01. The market value of those LPG (i.e. 167,685 MT) is 33537 Lack Taka. For this, all producing gas fields must be brought under LPG extraction program. LPG contents of gas produced from some fields are not very significant. LPG extraction is very expensive. So, it is not justifiable to consider all producing gas fields for LPG extraction.

LPG content of Kailashtilla gas field, Jalalabad gas field and Beanibazar gas field are 9.25 bbl/ MMSCF, 12.85 bbl/MMSCF and 18.61 bbl/ MMSCF respectively. Whereas LPG content of the rest of the producing gas fields is less than 7 bbl / MMSCF. Moreover, when average condensate production per MMSCF of gas of Kailashtilla, Jalalabad and Beanibazar gas fields are more than 11 bbl, then condensate production per MMSCF of the rest producing fields are less than 3.5 bbl. So, the most attractive fields for LPG/ NGL extraction are Beanibazar, Jalalabad and Kailashtilla. The rest of the nine producing gas fields can be eliminated from the LPG extraction program for the following reasons:

- The remaining reserves of Titas gas field will meet the forecasted production for about three years, which is not adequate to justify a LPG extraction plant at this field.
- Production of Bakhrabad gas field is declining day by day and forecasted production by 2005 will be 25 MMSCFD, which is very low. In this context, this field can be eliminated from the LPG extraction program.
- Gas produced from Habiganj gas field, Sangu gas field and Rashidpur gas field are very lean. Average condensate production per MMSCF of gas from these three fields is 0.05 bbl, 0.40 bbl and 1.48 bbl respectively.
- Only 334 bbl per day (5.64% of total forecasted LPG production) will be produced from the following five fields: Sylhet, Narsingdi, Meghna and Shaldanadi. Moreover,

remaining LPG reserve of these four fields is 2.08 MMBBL, which is about 3.35% of total remaining LPG reserve. These little amount of LPG would not justify the investment and operating costs of the LPG extraction Plants. For this, it is wise to exclude these four fields from the LPG extraction program.

If the above three NGL rich production gas fields would bring under LPG extraction program, then daily 2659 bbl or annual 75,325 MT LPG would be produced.

CHAPTER 6

LPG Extraction and Processing System

6.1 General

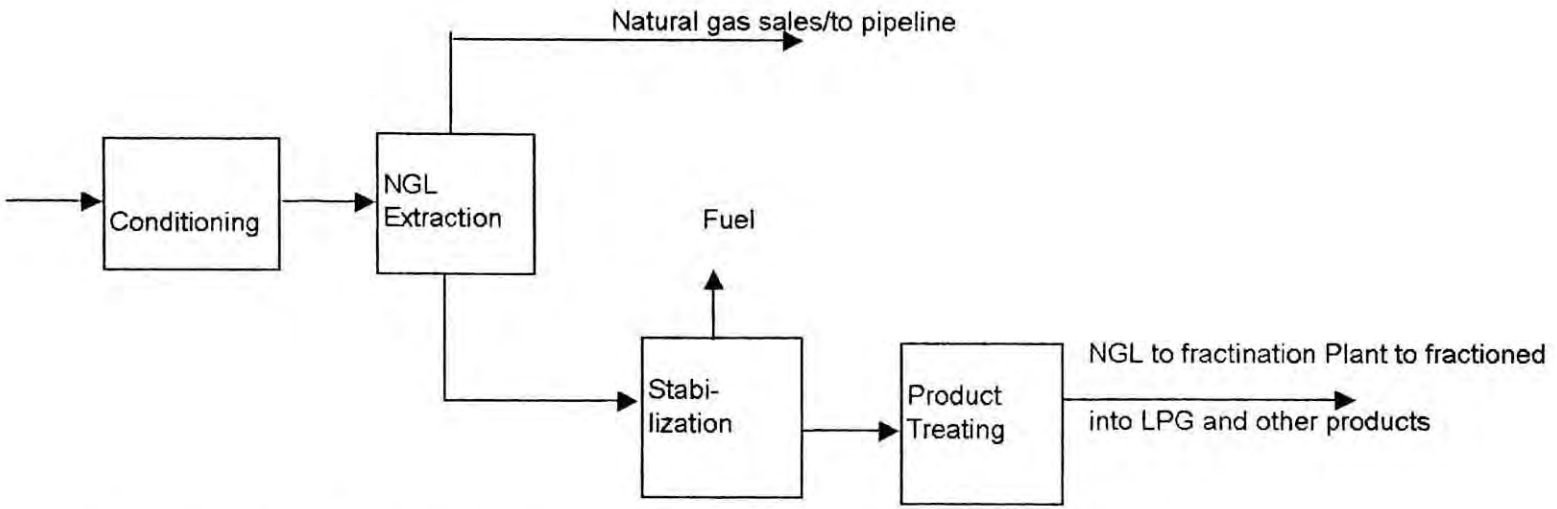
Natural gas is defined as gas obtained from a natural underground reservoir. It is a mixture of hydrocarbon gases along with some impurities that are the result of decomposed organic materials. When raw natural gas is withdrawn from the underground reservoirs, these impurities are considered disturbing elements and are usually removed by various processing schemes. These processing schemes make the raw gas marketable by removing of impurities and separation of certain valuable products. Figure 6.1 shows a schematic flow diagram for a gas processing plant with NGL/LPG extraction facilities. This module may be used to condition the gas for sales, to extract and recover NGL or both. The gas processing module may be divided into the following sub-module:

6.1.1 Gas Conditioning

This module typically exists at the inlet of the gas processing plant. It is generally designed to remove some or all of the following contaminants from the gas: water, sulfur compounds, carbon dioxide, nitrogen, dust, scale etc.

Removal of water is termed as gas dehydration. Several processes are used. The most common are:

Figure 6.1 : Schematic Flow Diagram for an NGL Extraction Plant



1) Absorption: In this process, highly concentrated glycol solutions (triethylene glycol, TEG is most commonly used) are used to physically absorb the water from the gas. This process is simple, effective and is probably the most widely used of the dehydration schemes.

2) Adsorption: This process utilizes a solid desiccant such as silica gel, alumina or molecular sieve (zeolite) to physically adsorb the water from the gas. It is typically used when very low (< 1 ppm) water contents are required.

3) Condensation: This process is actually integrated with the refrigeration module for NGL extraction. Water condenses as the gas is cooled. In order to prevent hydrate formation, an inhibitor such as mono ethylene glycol (MEG) or methanol is injected into the gas stream.

Removal of H_2S and CO_2 from the natural gas is called sweetening. Several processes are available. Frequently used methods are: (a) chemical absorption (b) physical adsorption and (c) solid bed.

6.1.2 NGL Extraction Module

Commercial NGL extraction processes are as follows:

a) Absorption: This process is frequently referred to as lean oil processing. NGL components are physically absorbed in a light hydrocarbon distillate stream and subsequently removed and recovered by stripping or distillation.

b) Adsorption: This process is typically applied for hydrocarbon dew-point control in special circumstances where other processes are not applicable or feasible. Recovery is limited to C_{5+} components. This process is frequently referred to as a hydrocarbon recovery unit (HRU) or a short cycle unit (SCU).

c) Condensation: These processes are the most widely used processes for the extraction of NGL from natural gas. These processes are: mechanical refrigeration, turbo-expander and valve expansion.

Mechanical refrigeration plants utilize a commercial refrigerant such as propane or R-22 to chill the gas. Process temperatures are seldom less than about – 40 ^{0} F. This process is used both for hydrocarbon dew-point control and NGL recovery.

Turbo-expanders are widely used for NGL extraction. The turbo-expander is typically a single stage radial – in – flow turbine. Expansion ratios vary from about 1.5 to 3.5 depending on the process objective. The process is employed for hydrocarbon dew point control as well as on deep NGL recovery. Minimum process temperatures vary from 32 ^{0} to –180 ^{0} F.

Valve expansion is similar to turbo-expansion except that the expansion device is a control valve rather than a turbine. This process is often referred to as LTX, LTS or Joule-Thomson process. It is sometimes used for hydrocarbon dew-point control when high pressure feed gas is available from the reservoir. It can also be used for deep NGL

recovery but this application is generally limited to small facilities. For similar expansion ratios, it is not as efficient as a turbo-expander in cooling the gas.

6.1.3 Stabilization Module

Once the NGL has been extracted from the gas, it must be stabilized to meet sale specifications. These specifications can vary significantly depending upon the markets or requirement of fractionation plant and transportation method. In deep NGL recovery plants, the NGL product is more likely a C_{2+} or C_{3+} product, which is transported to a fractionation plant for product separation, sale and distribution.

The stabilization of the extracted NGL is typically accomplished by distillation. The distillation process may be refluxed or non-refluxed. In some cases, particularly where the NGL product is a C_{5+} stream with a vapor pressure less than 1 atm, flash stabilization can be used.

6.1.4 Product Treating Module

NGL must meet certain specifications regarding contaminant levels prior to sale. In many cases, these contaminants are removed from the gas in the conditioning module up stream of NGL extraction and are therefore not present in the NGL product. In some cases, however, these contaminants can be present in the NGL and must be removed.

6.2 Status of Gas Processing Plant in Bangladesh

First gas processing facilities was developed in Bangladesh (erstwhile East Pakistan) with the discovery of Chatak gas field in 1959 where gas was processed only through a separator and a scrubber. In 1961, solid desiccant (Silica gel) type of 30 MMSCFD

dehydration facilities was installed in Sylhet gas field. Later, in the same gas field a 50 BBL capacity facility for fractionation was also installed to fractionate heavy condensate obtained as a by-product during processing of gas. In 1969, two glycol dehydration-processing plants were installed at Titas gas field. Gas processing plants are designed for dehydrating well stream to pipeline specification, where a moderate volume of hydrocarbon condensate is recovered as by-product which is further fractionated into diesel and motor spirit. Currently different types of dehydration plants are in use in both the production companies. These are: glycol dehydration, expansion refrigeration (low temperature separation) with or without hydrate inhibitor, solid desiccant dehydrator, turbo-expander refrigeration etc. Condensate recovery in latter three types of plant is much higher than that of glycol type plant.

Other than molecular sieve turbo-expander (MSTE) plant at Kailastilla, the existing wellhead treating facilities at the different production fields vary slightly, but they basically consist of simple liquid recovery from a separator and dehydration of the gas. These plants are not recovering NGL sufficiently, as a result of this, the natural gas transmission and distribution companies are experiencing some difficulty with the accumulation of liquids in the pipeline. Accumulation of liquids in pipelines not only creates a restriction in the line, but also causes burners to operate at a reduced efficiency. Among all existing gas process plants in Bangladesh, only Kailashtilla MSTE plant can extract NGL (C_{3+}) from gas stream. Some portion of the NGL produced from Kailashtilla MSTE plant are fractionated into LPG and MS by Kailashtilla LPG plant. Huge amount of C_3 and C_4 are left with the gas stream in all other processing facilities.

6.3 Proposed Gas Processing System for Augmenting LPG

At present, twelve gas fields are in production. Out of these gas fields, the following three gas fields are considered for LPG extraction program:

(1) Beanibazar gas field

(2) Jalalabad gas field

(3) Kailashtilla gas field

Turbo-expander plant technology and reliability have improved. Now Turbo-expander plants are mostly used for recovering NGL / LPG. A turbo-expander process has been suggested for all the fields considered for LPG recovery.

The proposed gas processing system allows for the extraction of NGL in each of the field production areas independently. All the NGL is transported to Ashuganj by a pipeline. NGL is fractionated into LPG and other petroleum products at Ashuganj. The Ashuganj facilities would consist of NGL fractionation plant, LPG storage tank and storage tanks for other petroleum products. The gas processing plant in independent areas will be a plant like that of Kailashtilla MSTE plant. NGL fractionation plant at Ashuganj will be a plant like that of Kailashtilla LPG plant.

The process flow diagram of Kailashtilla MSTE plant is provided in Figure 6.2. The process flow diagram of the proposed gas processing plants for Jalalabad and Beanibazar gas fields are shown in Figure 6.3.

Figure 6.2: Process Flow Diagram of Existing MSTE Plant at Kailashtilla

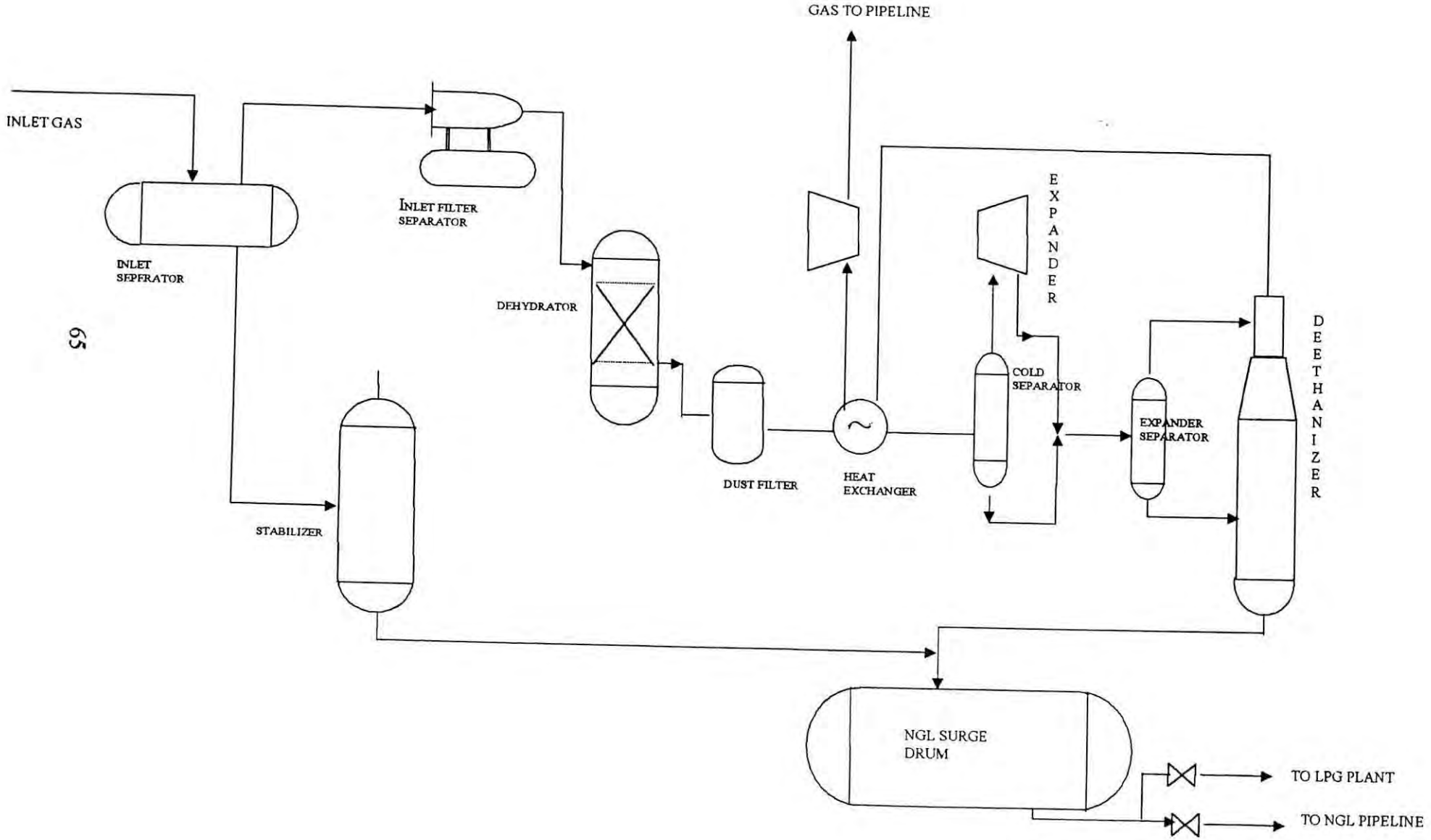
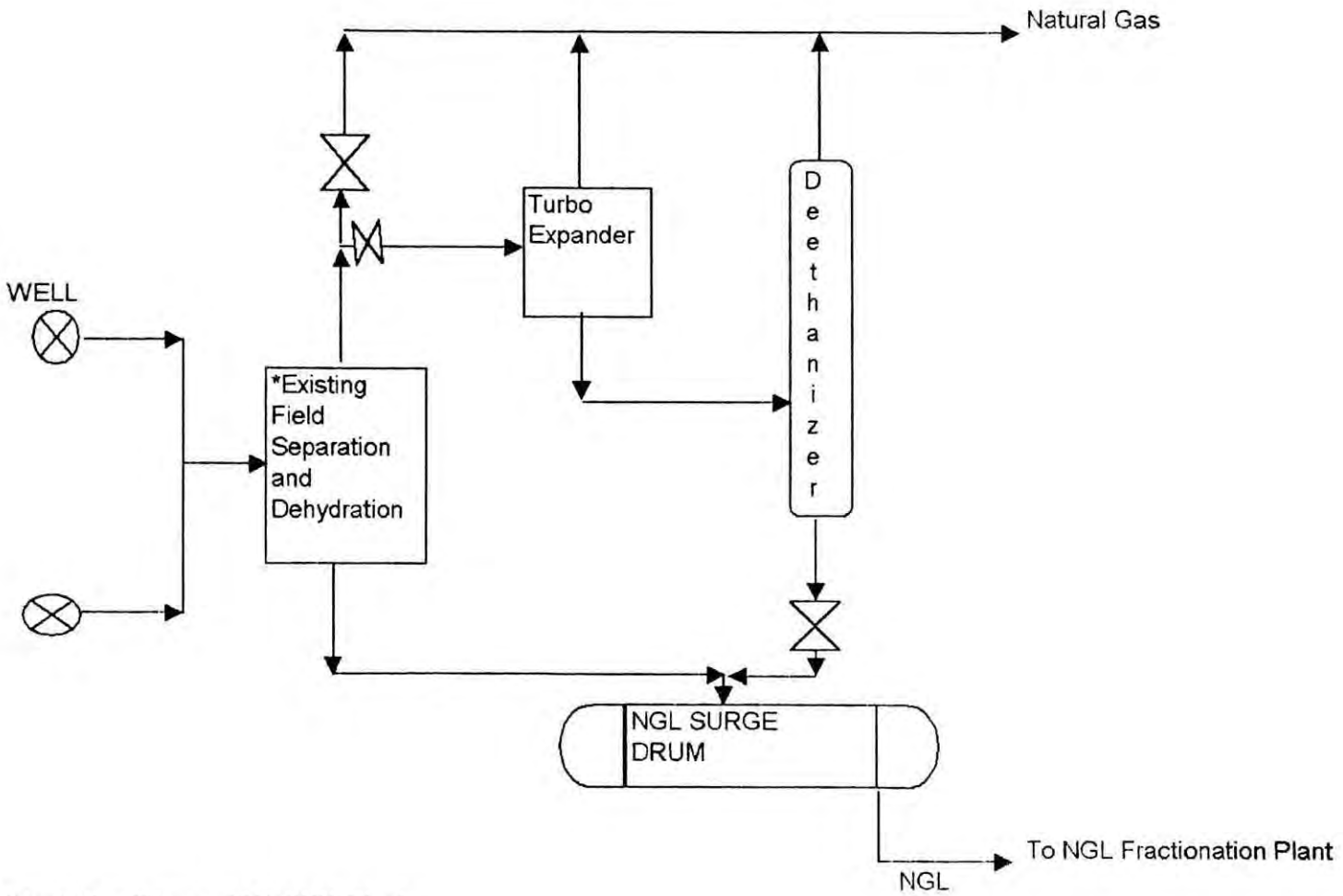


Figure 6.3 : Proposed Gas Processsing Plant at Jalalabad and Beanibazar



* Including Silica-gel / IFEXOL Plant

CHATER 7

Impact of LPG Use on Energy Scenario

7.1 Introduction

Energy is indispensable for attaining goals of socio-economic development of a country because of its role in increasing production and improving standards of life of the people. In Bangladesh, the economy is characterized by traditional to transitional mode of production and hence the energy intensiveness of its economy is still low (per capita commercial energy consumption was 56 kgoe in 1990: NEP, 1996). A transition from subsistence level of economy to development threshold would require a matching transition to mechanized modes of production, which will require comparatively, higher energy inputs.

7.2 Energy Balance of Bangladesh

Biomass, natural gas, oil and coal are the main sources of energy in this country. The present energy scenario of the country is dominated by traditional fuels or biomass fuels or non-commercial energy. Energy balance of Bangladesh in 1990 (Task Force Report, 1991) has been furnished in Table 7.1 and observation is stated here.

7.2.1 Primary Energy Supply

The primary commercial energy constitutes about 34.62% of total primary energy supply, of which natural gas shares are about 21.40%, imported crude oil 6.23%, mostly imported petroleum products 4.93%, imported coal 1.62%.

Table 7.1 :Energy Balance of Bangladesh in 1990

DESCRIPTION	COMERCIAL ENERGY					BIOMASS FUELS			
	NATU-RAL GAS MMCF	CRUDE OIL 1000 MT	PETRO-LEUM PRODUCTS 1000 MT	COAL 1000 MT	ELEC-TRI-CITY GWH	AGRIC. RESI-DUES 1000 MT	TREE RESI-DUES 1000 MT	FUEL WOOD 1000 MT	DUNG 1000 MT
Indigenous supply	165000	0	64	0	925	25327	1803	5843	6183
Import	0	1252	1125	454	0	0	0	0	0
Export	0	0	-147	0	0	0	0	0	0
Stock Exchange	0	-139	-160	4	0	0	0	0	0
Total Primary Supply	**165000**	**1113**	**882**	**458**	**925**	**25327**	**1803**	**5843**	**6183**
TRANSFORMATION									
Refinery	-1000	-1113	1032	0	0	0	0	0	0
Thermal Power	-70000	0	-205	0	6775	0	0	0	0
Losses & Own Use	-10000	0	-93	0	-2310	0	0	0	0
Total Final Supply	**84000**	**0**	**1616**	**458**	**5390**	**25327**	**1803**	**5843**	**6183**
CONSUMPTION									
Domestic	9415	0	553	0	1353	19440	1803	4460	6183
Industrial	14140	0	164	350	2790	5887	0	1262	0
Commercial	3142	0	0	13	1005	0	0	121	0
Transport	0	0	587	95	0	0	0	0	0
Agriculture	0	0	258		242	0	0	0	0
Others	0	0	7		0	0	0	0	0
Non - energy use	57303	0	47		0	0	0	0	0
Final Consumption	**84000**	**0**	**1616**	**458**	**5390**	**25327**	**1803**	**5843**	**6183**

Source: Task Force Report,1991

Biomass constitutes about 65.38% of total primary energy supply, of which fuelwood share are 11.56%, agriculture residues (such as plant residues, paddy husk, bagasse and jute sticks) 41.48%, tree residues (such as charcoal, twigs and leaves) 2.95% and animal dung (such as cattle-dung and buffalo-dung) 9.4%.

7.2.2 Transformation

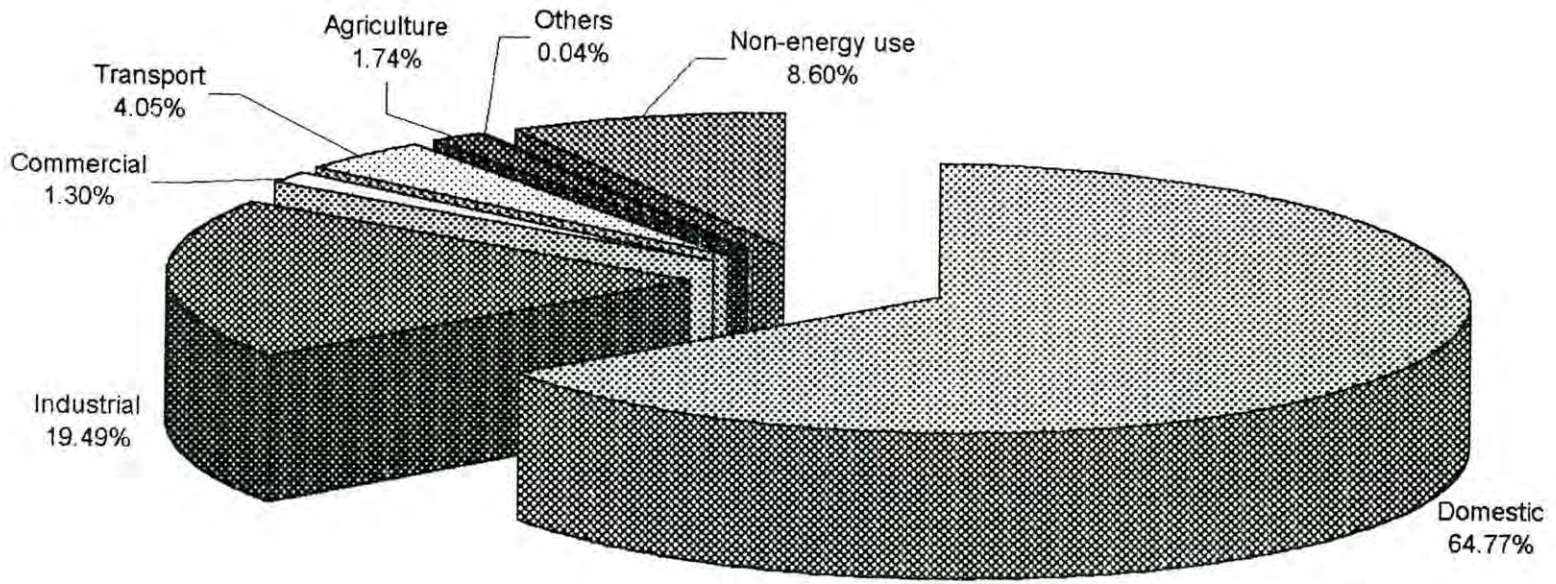
Crude oil is processed or transformed to petroleum products at the country's only refinery, ERL used 1000 MMSCF gas to perform its operation. 70000 MMSCF gas (i.e. 42.42 % of total gas supply) and 205000 MT petroleum products (i.e. furnace oil and diesel) are used to generate electricity.

7.2.3 Final Consumption

The traditional energy accounts for 73.07% of the total consumption, agricultural residues dominating with 46.35%, then by fuel wood with 12.92%, dung with 10.50% and tree residues 3.30%. Natural gas presents about 12.18% of the final energy consumption, where petroleum products 10.10%, electricity 2.48% and coal 1.81%. Various end uses of final energy consumption (Figure 7.1) are as follows:

Domestic sector accounted for 64.77 % of the total energy consumption and the share of different sources are biomass 91.45% (i.e. Agriculture residues 54.93%, Tree residues 5.09%, Fuel wood 15.22% & Dung 16.21%), electricity 1.10%, petroleum products (i.e., kerosene & LPG) 5.34% and natural gas 2.11% %. It is mentioned here that out of 553000 MT petroleum products, only 8563 MT LPG were used for domestic cooking which is insignificant compared to total petroleum products consumption in this sector.

Figure 7.1: Sector Wise Final Energy Consumption in Bangladesh in 1990



Industrial sector accounted for about 19.49 % of total final energy consumption, of which biomass share are about 69.58% (i.e. fuel wood14.31 % and agricultural residues 55.27%), electricity 7.54%, petroleum products 5.26%, natural gas 10.51% and coal (mostly used for brick burning) 7.10%.

Commercial sector accounted for 1.30% of the total energy consumption and the share of different sources are fuel wood 20.51%, electricity 40.62%, natural gas 34.92% and coal 3.94%.

Transport sector accounted for about 4.05% of the total energy consumption, of which petroleum products 90.72% and coal 9.28%.

Agricultural sector accounted for 1.74% of the total final energy consumption and share of different sources are electricity 7.33% and petroleum products (diesel and lubricant) 92.67%.

Non-energy use accounted for 8.60% of total final energy consumption. It is mostly natural gas used to produce fertilizer.

7.3 Future Potentiality of Difference Source of Energy

7.3.1 Biomass

Fuel wood as well as tree residues are obtained from two sources namely, state owned forests and privately owned village forests. Agricultural residues and animal dung are obtained, as by-product from privately owned agricultural land and livestock resources.

Availability of land and sustainability of their supply limit the total supply of Biomass. The over-use of agriculture residues and tree biomass is affecting the sustainability of supply, adverse effects on regeneration, soil nutrition and environment. The growth rate of population of the country is high. It is apprehended that per capita availability of biomass fuels will gradually decline in future.

7.3.2 Coal

The present demand of 0.1 to 0.15 million tones of coal is met by import and is almost exclusively used for brick burning. The following coalfields have been discovered in Bangladesh:

SL. No.	Name of the Coal Field	Estimated reserve
1	Jamalganj	1 Billion tones
2	Barapukuria	300 Million tones
3	Khalashpir	450 Million tones

A coal-mining project is under implementation to extract coal from Barapukuria coalfield.

7.3.3 Crude Oil and Petroleum Products

Small amount of petroleum fuel is produced from different gas fields in the form of condensate and final products: diesel, motor spirit and kerosene. Almost all of the petroleum fuels, which are used in Bangladesh, are imported as crude oil or refined products. Total yearly import of petroleum fuels is about 2 million tones, of which 1.2

million tones is imported as crude, while the import of refined diesel and kerosene account for the rest. The crude oil is refined in the ERL.

There is an imbalance between the domestic consumption pattern and the product yield from the ERL. So, Bangladesh have to export naphtha and import kerosene and diesel. She also imports lube base oil as it is not produced by the ERL.

7.3.4 Natural Gas and LPG

At present natural gas is the country's only indigenous non-renewable energy resource which is being produced and used in significant quantities. Reserve, production and consumption of natural gas as well as LPG have been stated in the respective chapter.

7.4 Impact of LPG Use

In national energy policy, two economic growth scenarios (Low scenario and Reference scenario) are considered to forecast future energy demand and demand for commercial energy is estimated 769 PJ and 827 PJ respectively in 2005 (NEP, 1996). If extraction facilities of LPG are installed in all producing gas field, 167685 MT/year (8.334 PJ) LPG will be produced; those LPG can meet 1.08 % or 1.01% of commercial energy demand. One the other hand, if LPG extraction facilities are installed in three LPG prospective fields (i.e. Jalalabad, Kailashtilla and Beanibazar), then 75,325 MT/year (3.744 PJ) LPG will be produced and about 0.50 % or 0.45 % demand of commercial energy will be met up by LPG. These LPG (75,325 MT) can replace 249000 MT of fuel-wood and thus it can prevent 3.56% of deforestation (Task Force Report, 1991: Demand of fuel wood in domestic sector for 2000 = 7.066 Million MT).

CHAPTER 8

LPG Marketing

8.1 Market Analysis

LPG demand in the country was sluggish in early 1980's. In mid 1980's LPG proved its acceptance as domestic cooking fuel as well as gained popularity and the demand pick up. Due to a limited LPG production, the government imposed a restriction on the use LPG in vehicles and gave preference to the use of LPG in the domestic sector. It should be mentioned that earlier LPG was used in vehicles. Based on the government policy and on the apparent large market and high price of alternate fuels in the urban household sector, it is decided to focus on urban household cooking as the basis for the LPG market assessment.

8.1.1 Existing Fuels for Domestic Sector

The following fuels are used in the domestic sector for cooking: traditional fuel (i.e. fuel wood, cowdung and agriculture wastes), kerosene, LPG and natural gas. The largest contribution to the fuel supply in domestic sector by far comes from traditional fuels. The distribution of urban and rural households with reference to type of fuel use for cooking and lighting in 1990 are presented in Table 8.1. It is seen that all the rural households use these traditional / biomass fuels for cooking, while 70.23% of urban households depend on biomass fuel (i.e. fuel-wood) as their primary cooking fuel.

Table 8.1: Distribution of Urban and Rural Households with Reference to Type of Fuel Use for Cooking and Lighting in 1990

	No. of Urban Households	% of Total Urban Household
Using Natural Gas for Cooking	4,00,000	10.77%
Using Kerosene for Cooking	7,04,000	19.00%
Using LPG for Cooking	Included in kerosene	
Using Biomass Fuels for Cooking	26,11,000	70.23%
Total	37,15,000	100.00%
Using Electricity for Lighting	8,73,440	23.53%
Using Kerosene for Lighting	28,41,560	76.47%
Total	37,15,000	100.00%

	No. of Rural Households	% of Total Rural Households
Using Natural Gas for Cooking	Nil	
Using Kerosene for Cooking	Nil	
Using LPG for Cooking	Nil	
Using Biomass Fuels for Cooking	441,78,000	100.00%
Total	141,78,000	100.00%
Using Electricity for Lighting	9,28,000	6.55%
Using Kerosene for Lighting	132,50,000	93.45%
Total	141,78,000	100%

Kerosene is one of the most important petroleum fuels, which is being used in the domestic sector. About 452 thousand MT of kerosene were consumed in the country during 1995-96 fiscal year. Almost the entire amount of kerosene was used as a household lighting and cooking fuel. From Table 8.1, it is seen that 19% of urban households use kerosene for cooking and 76.47%of urban households and 93.45% of rural households use kerosene for lighting. The source of kerosene is roughly 60% from the Eastern Refinery and 40% from direct import; the refinery is in a deficit position on this product. At present the official retail price of kerosene is about 15 Taka per liter. But unofficially the same is sold at 20 Taka per liter in the open market.

The only other household cooking petroleum fuel is LPG. Kailashtilla LPG Plant as well as ERL produces about 20 thousand MT annually and those LPG are marketed by state owned oil marketing companies. Recently, the government has decided to allow private parties to import and market LPG within the country. The following three private companies: ELPIJI - Malaysia Bangladesh Ltd , Bashudhara – Union LPG Ltd and Sumitt LPG Ltd have already been permitted to import LPG and to market the same in the country. Out of them, Bashundhara – Union LPG Ltd has already started to market LPG by bottling imported LPG with its LPG bottling plant at Mongla. The capacity of this bottling plant is about 36000 MT / annum. Other two private companies have started to set up their bottling plants at Mongla. The bottling capacity of ELPIJI- Malaysia is about 60,000 MT per year and that of Summit LPG is about 50,000 MT per year.

Natural gas used in household was started in 1972-73 and then gas consumption in domestic sector increases steadily. Gas consumed in domestic sector in 1981-82, 1990-91

and 1999-2000 were 4.2 BCF, 10.10BCF and 29.67 BCF respectively. The total number of domestic gas connections at end of June, 2000 in all three franchise area (Titas, Bakhrabad & Jalalabad) was about 974 thousand. The yearly connection in the last year (1999) was 71 thousand. This latter figure compares with the rate of urban household formations in the entire country variously estimated at a low of 190,000 (assumed growth rate 5%) to a high of 303,000 (assumed growth rate 8%) households per year.(The Bangladesh Energy Planning Project BGD81/064 suggested a household growth rate of 8% per annum).

So, the urban fuel shortfall must be met by fuel wood or kerosene, this provides a clear indication that natural gas will not be the answer to mitigation of the fuel-wood depletion and high foreign exchange cost of kerosene imports.

Fuel-wood is at least partially commercial in the rural areas and almost wholly a commercially traded fuel in the urban areas. Its major disposition as a fuel is in household cooking. It is also used in restaurants and teahouse, brick manufacturing and tobacco curing. The increasing scarcity of fuel wood is reflected in the rate of increase of fuel wood prices in recent years. Table 8.2 illustrates the estimated average retail prices of the fuel wood for Bangladesh as a whole for the city of Dhaka according to surveys conducted by the Bangladesh Bureau of statistics.

Table 8.2: Retail Price of Fuel wood as per Survey Conducted by Bangladesh Bureau of Statistics

Year	Fuel Wood Price (Taka/Mound) Bangladesh (avg.)	Fuel Wood Price (Taka/Mound) Dhaka City
1980-81	26.60	38.52
1981-82	31.72	47.92
1982-83	33.98	47.15
1983-84	35.24	48.29
1984-85	50.50	60.75
1985-86	58.92	71.81
1986-87	60.75	76.35
Annual rate of increase over period	14.80%	12.10%

Table 8.3: Evaluation in Retail Price of Fuel-wood in 1999-2000 with considering above rate of change

YEAR	FUELWOOD PRICE (Tk per mound)	
	Bangladesh(avg)	Dhaka City
1999-2000	250	260

8.1.2 Relative Price and Household Fuel Costs

The average urban household uses slightly less than the energy equivalent of 1.5 cylinder (12.50 Kg) of LPG per month. For purpose of the study the figure used is 1.45 cylinders per month. This amounts to some 18.10 Kg per month of LPG per household. Energy equivalents of household cooking fuels are shown in Table 8.4.

Table 8.4: Energy Equivalents of Household Cooking Fuels

	LPG	KEROSENE	FUELWOOD
*Heating Value(MJ/kg)	49.70	46.40	15.00
*Efficiency in House Hold Cooking	55.00%	35.00%	13.00%
LPG Weight Equivalents (Kg Fuel/Kg LPG)	1.00	1.68	14.02

*Source: RTM Engg., 1989

In Table 8.5, the estimated average urban cooking consumption for LPG has been converted to the equivalents of the alternate fuels in kg and then converted each fuel to the units in which they are normally sold. These quantities are then multiplied by the prevailing retail prices in Bangladesh to arrive at an estimated monthly cooking fuel cost. In the case of natural gas, the flat rates for single and double burner have been used. LPG is very competitive with kerosene and fuel-wood.

Table 8.5: Typical Urban Household Cooking Fuel Use and Cost
(Excluding Capital Cost)

	LPG	Natural Gas		Kerosene	Fuel wood		
		Single	Double		Khulna	North Bengal	Dhaka
Kg/Month	18.10	n/a	N/a	30.50	254	254	254
Normal Units/Month	1.45 Cylinder	n/a	N/a	38.10 Litre	6.80 Mound	6.80	6.80
Price/Unit	250	n/a	N/a	20.00	100	120	200
Taka/Month	360	210	330	762	680	816	1360

8.2 Potential LPG Market

During the month of march, 1989, an urban cooking fuel micro survey conducted by the RTM Engineering Limited, Canada. The findings of that survey is as follows:

(1) The urban cooking fuel market is predominated a 'commercial' market.

(2) Fuel-wood is the predominant cooking fuel, representing some 80% of cooking energy in this market.

(3) In the case of those areas not connected by natural gas, kerosene is the second most important cooking fuel representing close to 20% of the urban cooking market.

(4) Some 85% of the urban households appeared both financially capable of, and well disposed towards conversion to LPG.

(5) A reasonable basis to use for average LPG cooking use per household is 1.45 cylinders (12.5 kg) per month.

Based on the above findings and preliminary observations on statistics for the entire country as well as the government policies, it is better to concentrate on the urban household cooking market as the prime target. Now this market potential is to be quantified.

8.2.1 Urban Household Cooking Market

For this market analysis, it is to develop an estimate of total urban households by region for a particular year. The last census data for 1991 as well as cumulative domestic gas connection till June 2000 was available. On the basis of the findings of RTM Engineering Ltd, available population census1991 data and assuming urban household growth rate 5%

per annum (urban growth rate = 5.59%: Population Census 1991), LPG market potential is quantified as follows:

Step-1: Region- wise urban households in a particular year =

(Region wise urban households number as census 1991) X (1+ R)^N

Where, R = urban households growth rate

N = Time (in term of year) between 1991 and specified year for which households to be estimated

Step – 2: Financially capable urban households in a particular year =

Total urban households in the respective year X 0.85

Step – 3:

Total commercial urban fuel users = financially capable urban households

potential LPG market (in term of MT) in a particular =

(Total commercial urban fuel users in the respective year – cumulative domestic gas connection) X 1.45X12X(12.50/1000)

Region-wise estimated total urban households for June 2000 is provided in Table 8.6 and total number of urban households are about 5954 thousand. Table 8.7 shows the financial capable households for the year 2000 and Table 8.8 shows the potential LPG market, which is about 888.85 thousand MT for 2000.

8.3 Marketing System

Marketing System is referred to the downstream activity i.e., transportation and distribution from fractionation plant.

Table 8.6: Bangladesh Urban Households

(Fig. in Thousand)

Region	Urban Households on 12 -03-1991 (as per Cesus1991)	Urban Households on 30-06-2000 (Considered Growth Rate 5% p.a.)
TITAS FRANCISE AREA:		
MYMENSINGH		
Netrokona	26.09	41.07
Mymensingh	92.52	145.65
Sherpur	21	33.06
Kishoreganj	51.14	80.50
JAMALPUR	42.68	67.19
TANGAIL	53.56	84.31
DHAKA		
Manikganj	18.3	28.81
Dhaka	916.02	1442.00
Gazipur	124.83	196.51
Narsingdi	49.32	77.64
Narayanganj	166.54	262.17
Munshiganj	19.28	30.35
SUB-TOTAL -I :	1581.28	2489.25
FARIDPUR		
Faridpur	28.73	45.23
Rajbari	15.22	23.96
Gopalganj	13.61	21.42
Madaripur	16	25.19
Shariatpur	13.32	20.97
SUB-TOTAL-II:	86.88	136.77
DINAJPUR		
Panchagarh	11.3	17.79
Thakurgaon	18.21	28.67
Dinajpur	54.46	85.73
Nilphamari	33.97	53.48
SUB-TOTAL-III :	117.94	185.66

(Fig. in Thousand)

Region	Urban Households on 12 -03-1991 (as per Cesus1991)	Urban Households on 30-06-2000 (Considered Growth Rate 5% p.a.)
RANGPUR		
Lalmonirhat	20.15	31.72
Rangpur	65.06	102.42
Kurigram	42.18	66.40
Gaibandha	25.43	40.03
SUB-TOTAL-IV :	152.82	240.57
BOGRA		
Joypurhat	14.94	23.52
Bogra	54.00	85.01
SUB-TOTAL-V :	68.94	97.01
RAJSHAHI		
Noagaon	31.23	49.16
Natore	29.39	46.27
Nawabganj	37.71	59.36
Rajshahi	104.40	164.35
SUB-TOTAL-VI :	202.73	319.14
PABNA		
Sirajganj	47.36	74.55
Pabna	57.45	90.44
SUB-TOTAL-VII :	104.81	164.99
KUSHTIA		
Kushtia	29.50	46.44
Meherpur	8.64	13.60
Chuadanga	38.85	61.16
SUB-TOTAL-VIII :	76.99	121.20
JESSORE		
Jhenaidah	31.05	48.88
Magura	9.30	14.64
Narail	12.30	19.36
Jessore	51.56	81.17
SUB-TOTAL-IX :	104.21	164.05
KHULNA		
Satkhira	23.98	37.75
Khulna	195.21	307.30
Bagerhat	37.15	58.48
SUB-TOTAL-X :	256.34	403.53

(Fig. in Thousand)

Region	Urban Households on 12 -03-1991 (as per Cesus1991)	Urban Households on 30-06-2000 (Considered Growth Rate 5% p.a.)
BARISAL		
Pirojpur	24.69	38.87
Jhalokati	16.29	25.64
Barisal	60.56	95.33
Bhola	33.90	53.37
SUB-TOTAL-XI :	135.44	213.21
PATUAKHALI		
Patuakhali	24.07	37.89
Barguna	13.25	20.86
SUB-TOTAL-XII :	37.32	58.75
JGTDCL AREA :		
SYLHET		
Sunamganj	20.42	32.15
Sylhet	52.06	81.95
Maulavibazar	19.28	30.35
Habiganj	20.89	32.89
SUB-TOTAL-XIII:	112.65	177.33
BGSL AREA		
COMILLA		
Brahamanbaria	44.57	70.16
Comilla	61.62	97.00
Chandpur	33.30	52.42
NOAKHALI		0.00
Lakshmipur	34.05	53.60
Noakhali	40.16	63.22
Feni	16.80	26.45
CHITTAGONJ		
Chittagonj	424.61	668.42
Cox's Bazar	31.15	49.04
CH.HILL TRACTS		
Khagrachhari	22.24	35.01
Rangamati	28.89	45.48
Bandarban	13.63	21.46
SUB-TOTAL-XIV:	751.02	1182.26
TOTAL :	3789.37	5953.72

Table 8.7: Financially Capable Urban Households

(Fig. in Thousand)

Region	Estimated Urban Households No. (on June,2000)	Financially Capable Urban Households No. (on June,2000)
TGTDCL Area	2489.25	2115.86
Faridpur	136.77	116.25
Dinajpur	185.66	157.81
Ranpur	240.57	204.48
Bogra	97.01	82.46
Rajshahi	319.14	271.27
Pabna	164.99	140.24
Kushtia	121.20	103.02
Jessore	164.05	139.44
Khulna	403.53	343.00
Barisal	213.21	181.23
Patuakhali	58.75	49.94
JGTDCL Area	177.33	150.73
BGSL Area	1182.26	1004.92
Total :	5953.72	5060.65

Table 8.8: Potential LPG Market in 2000

(Fig. in Thousand)

Region	Total Comercial Urban Fuel User (Household No.)	Total Domestic Gas Connection (till June, 2000) (Household No.)	Resultant (Household No.)	Potential LPG Market (MT)
TGTDCL Area	2115.86	718.00	1397.86	304.03
Faripur	116.25	0.00	116.25	25.28
Dinajpur	157.81	0.00	157.81	34.32
Rangpur	204.48	0.00	204.48	44.47
Bogra	82.46	0.00	82.46	17.94
Rajshahi	271.27	0.00	271.27	59.00
Pabna	140.24	0.00	140.24	30.50
Kushtia	103.02	0.00	103.02	22.41
Jessore	139.44	0.00	139.44	30.33
Khulna	343.00	0.00	343.00	74.60
Barisal	181.23	0.00	181.23	39.42
Patuakhali	49.94	0.00	49.94	10.86
JGTDCL Area	150.73	62.00	88.73	19.30
BGSL Area	1004.92	194.00	810.92	176.38
Total :	**5060.65**	**974.00**	**4086.65**	**888.85**

8.3.1 Present Marketing System of LPG

Three oil marketing companies perform LPG marketing in Bangladesh. It is marketed in the bottled form. Those oil marketing companies take LPG (i.e. cylinder with full of LPG) from the LPG bottling plants at Chittagong and at Kailashtilla. LPG cylinders are transported to depots by the truck. There are 28 petroleum storage depots in the different location of the country. Out of these depots, only seven depots distribute the LPG cylinders. 5441 MT of LPG (which is 34.81% of total LPG sold) were distributed in Chittagong division through 125 dealers from main installation (MI) at Chittagong; 567MT (3.63%) distributed in Dhaka division through 27 dealers from Godnail and Fatulla depots; 719 MT (4.6%) distributed in Barisal division through 24 dealers from Barisal and Jhalakathi depots; 2976 MT (19.04%) distributed in Khulna division through 109 dealers from daulatpur depots and 5927 MT (37.92%) distributed in North Bengal through 191 dealers from Baghabari depots during 1994-95. Depot-wise LPG sale during 10 years last (from 1986-87 to 1995-96) is shown in Table 8.9.

12.5 Kg cylinder of LPG is distributed through dealers of three oil marketing companies. The dealers store a supply of full cylinders, when possible, to meet the needs of his customers. The customers must return an empty cylinder or purchase one from the dealers. The dealer collects the empty cylinders and exchanges them for full cylinders when the delivery truck arrives. For this service, the dealer receives a commission of Tk. 8.00 for each 12.50 Kg of LPG sold. A very small part of LPG of the LPGL is purchased by Bangladesh Oxygen Limited (BOL) for industrial consumers. BOL receives LPG (40 Kg cylinder) direct from the LP gas plant, Chittagong and distributes to industrial users.

Table 8.9: Depot-wise LPG Sale During Last Ten Years

Year	MI Chittagong		Godnail/ Fatulla		Barisal/ Jhalakathi		Daulatpur		Baghabari		Total	
	MT	%	MT	%	MT	%	MT	%	MT	%	MT	%
86-87	6419	73.05	147	1.67	38	0.43	302	3.44	1881	21.41	8787	100
87-88	6277	69.47	153	1.69	42	0.46	355	3.93	2209	28.45	9036	104
88-89	5690	62.56	125	1.37	57	0.63	510	5.61	2713	29.83	9095	100
89-90	4700	51.00	153	1.66	83	0.90	657	7.13	3623	39.31	9216	100
90-91	3257	41.17	205	2.59	116	1.47	899	11.36	3434	43.41	7911	100
91-92	2983	36.83	297	3.67	151	1.86	1087	13.42	3582	44.22	8100	100
92-93	3235	33.27	452	4.65	272	2.80	1532	15.75	4233	43.53	9724	100
93-94	4082	33.01	629	5.09	379	3.06	2279	18.43	4998	40.41	12367	100
94-95	5441	34.81	567	3.63	719	4.60	2976	19.04	5927	37.92	15630	100
95-96	6026	45.17	197	1.48	615	4.61	2843	21.31	3660	27.43	13341	100

Retail price of LPG (Cylinder: 12.5 kg) used for domestic cooking sold by dealer situated within 40 miles from the oil marketing companies' main installation center and depots (except Rangpur) are as follows:

(Price: Taka / 12.5 kg)

Description	Price: Taka
Ex Depot	235.60
Transportation charges	6.40
Dealer's/Agent commission	8.00
Retail price	250.00

In addition, transportation cost will be included at the rate of 0.80 Taka per kilometer to fix the retail price for a distance beyond 40 Km radius.

8.3.2 Proposed LPG Marketing System

Bangladesh can be divided into six LPG marketing districts as follows:

(1) North Bengal: covers Rajshahi division.

(2) Barisal: covers Barisal division and greater Faridpur.

(3) Khulna: covers Khulna division.

(4) Dhaka: covers Dhaka division excluding Greater Faridpur.

(5) Sylhet: covers Sylhet division.

(6) Chittagong: covers Chittagong division.

Option # 1: LPG will be transported from Ashuganj to terminals at Narayanganj, Barisal, Khulna and Baghabari by shallow draft self propelled barges. Cylinders will be filled at a central location near these terminals and distributed to dealers by flat bed (stake) tracks, with empties returning to the bottling plant. North Bengal is served by a terminal at Baghabari and Dhaka is served by a terminal at Narayanganj.

From the existing LPG bottling plants at Chittagong and Kailashtilla, LPG is distributed in Chittagong and Sylhet LPG marketing districts respectively through selected dealers/agents.

Option # 2: LPG will be transported from Ashuganj to terminals at Barisal and Khulna by shallow draft self propelled barges and to Elenga by LPG pipeline. Cylinders will be filled at a central location near these terminals as well as at Elenga and LPG cylinder will be distributed to agents by flat bed (stake) tracks, with empties returning to the bottling plant. North Bengal and Dhaka will be served by bottling plant at Elenga. Other LPG marketing districts will be served as option # 1.

Option # 3: LPG will be transported from Ashuganj to Elenga by LPG pipeline. Cylinders will be filled at Elenga and LPG cylinder will be distributed at North Bengal, Dhaka, Barisal and Khulna LPG marketing districts through existing marketing network. Other LPG marketing districts will be served as option # 1.

CHAPTER 9

Impact of the Extraction of LPG from the Gas Field

9.1 Technological

The project is expected to be implemented through the utilization of the services from internationally reputed consultant group, engineering and other service companies, therefore, technical and technological exchange will occur between either sides, as such it will enrich both skill and capabilities of the personnel of the concerned countries.

9.2 Productive

On successful implementation of the project, it is expected to enhance the present LPG production to 75325 MT / year from natural gas. Imported petroleum products consume a major share of the country's total export earning. With the implementation of the project, it is also to be increased condensate or other petroleum products, especially motor spirit. As such a sizable amount of foreign currency can be saved, as well as, supplies to the petroleum product based industries will be easier and thereby products of those industries will be cheaper and easily available. As a whole, it will expedite the economic development of Bangladesh.

9.3 Earning and Employment

On completion of the project, annual earnings of about Tk.1506 million are expected from sale of LPG. It will create direct employment opportunities for the operation of

the plant, also through linkage effect several hundred people will be employed in trading and transport of LPG.

9.4 Environmental Effect

LPG has a lower carbon content than motor spirit, kerosene and diesel. It is free from lead and sulfur. Its carbon monoxide and carbon dioxide emissions typically are somewhat low than those for above fuel due to the lower carbon contents. It has many of the same emission characteristics as natural gas (World Bank, 1996). Thus, it is an environmentally friendly commercial fuel like natural gas.

Bangladesh is probably the most densely populated country in the world. Its forest or tree covered area is extremely limited. Presently, it has a forest area of around 6-8 percent of the total land (FFYP, 1997). This is far below the minimum 25 percent of the forest/ tree covered area needed for maintaining ecological balance. The large scale disappearance of tree covered area has caused serious ecological imbalance resulting in recurrent natural hazards like floods and cyclones. The extraction of LPG from potential gas fields would replace the use of fuel wood for cooking. So, the use of LPG particularly in the domestic and commercial sectors will play a great role in the prevention of deforestation and thus will help to maintain the ecological balance.

CHAPTER 10

Conclusions and Recommendation

10.1 Conclusions

- LPG is one of the cleanest fuels available to domestic, commercial and industrial users.
- The remaining reserve of LPG in different gas fields in Bangladesh is 58.55 MMbbl.
- Beanibazar, Kailashtilla and Jalalabad gas fields are rich in LPG and about 60.20% of total remaining reserve of LPG are situated in these fields.
- If only three rich fields i. e. Jalalabad, Kailashtilla and Beanibazar are considered for LPG production, then 2659 bbl daily or 75325 MT yearly of LPG would be produced.
- LPG is very competitive with Kerosene and fuel wood. It will take over the kerosene and fuel wood market.
- LPG potential market in urban households for 2000 is estimated as 888850 MT. This indicates that even if all extraction and fractionation plants were on stream, this would only represent 18.87% of this potential market.
- Marketing of LPG would reduce the deforestation of the country.

10.2 Recommendation

- Three LPG prospective gas fields: Kailashtilla, Beanibazar and Jalalabad should be fully brought under LPG extraction program as early as possible for optimizing the use of natural resources. This will prevent deforestation and save valuable foreign currency.

Abbreviation

BPC – Bangladesh Petroleum Corporation

BAPEX – Bangladesh Petroleum Exploration and Production Company Ltd.

BGFCL – Bangladesh Gas Fields Company Ltd.

BGSL – Bakhrabad Gas Systems Ltd.

BCF – Billion Cubic Feet

ERL – Eastern Refinery Ltd.

ELBL – Eastern Lubricating Blenders Ltd.

JGTDSL – Jalalabad Gas Transmission & Distribution System Ltd.

JOCL – Jamuna Oil Company Ltd.

Kgoe – Kilogram of Oil Equivalent

LPG – Liquefied Petroleum Gas

LPGL – LP Gas Ltd.

LTX – Low Temperature Extraction

MOCL – Meghna Oil Company Ltd.

MSTE – Molecular Sieve Turbo- Expander

MJ – Mega Joule

MMCFD – Million Cubic Feet Per Day

MMBBL – Million Barrel

NGL – Natural Gas Liquid

NFPA – National Fire Protection Association

(NFPA59, An American National Standard)

POCL – Padma Oil Company Ltd.

PJ – Peta Joule

RPGCL – Rupantarita Prakritik Gas Company Ltd.

SGFL – Sylhet Gas Fields Ltd.

SAOCL – Standard Asiatic Oil Company Ltd.

SGDP – Second Gas Development Project

TGTDCL – Titas Gas Transmission & Distribution Company Ltd.

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TABLE 4-4. PHYSICAL CONSTANTS OF HYDROCARBONS

(Values from CNGA and NGAA. Modified for standard conditions of 60°F and 14.65 psia)

	Methane	Ethane	Propane	Iso-butane	Normal butane	Iso-pentane	Normal pentane	Normal hexane	Normal heptane	Heptanes plus C_{7+}
Molecular formula	CH_4	C_2H_6	C_3H_8	i-C_4H_{10}	n-C_4H_{10}	i-C_5H_{12}	n-C_5H_{12}	n-C_6H_{14}	n-C_7H_{16}	
Molecular weight	16.042	30.068	44.094	58.120	58.120	72.146	72.146	86.172	100.198	M
Critical temp, °F abs	343	550	666	733	765	830	847	914	972	
Critical pressure, psia	673	708	617	530	551	482	485	434	397	
Critical density, lb/gal	1.351	1.695	1.888	1.945	1.891	1.955	1.935	1.958	1.957	
Critical volume, (cu ft/lb-mole)	1.586	2.371	3.123	3.990	4.130	4.930	4.98	5.88	6.84	
SG gas (air = 1.00)	0.554	1.038	1.522	2.006	2.006	2.491	2.491	2.975	3.459	$M/28.966$
Cu ft/lb gas	23.73	12.66	8.63	6.55	6.55	5.28	5.28	4.42	3.80	$380.69/M$
Cu ft gas/gal of liquid	59.18	39.43	36.56	30.75	31.89	27.50	27.76	24.46	21.77	$3170\ S/M$
Lb Mcf of gas	42.14	78.98	115.83	152.67	152.67	189.51	189.51	226.36	263.20	$2.6268\ M$
Gal liquid per Mcf of gas	16.87	25.36	27.38	32.57	31.41	36.41	36.07	40.94	45.94	$0.3155\ M/S$
Bbl liquid/MMcf of gas	401.6	603.9	651.9	775.4	747.5	867.0	858.8	974.8	1094	$7.511\ M/S$
SG liquid (60/60)	0.3	0.374	0.508	0.563	0.584	0.625	0.631	0.664	0.688	S
Lb/gal liquid at 60°F	2.5	3.11	4.23	4.69	4.86	5.20	5.25	5.53	5.73	$8.327\ S$
Lb/bbl liquid at 60°F	105	130.6	177.7	197.0	204.1	218.4	220.5	232.3	240.7	$349.7\ S$
Lb/cu ft liquid at 60°F	18.70	23.26	31.64	35.08	36.35	38.90	39.27	41.36	42.86	$62.29\ S$
Cu ft liquid/lb at 60°F	0.0535	0.0430	0.0316	0.0285	0.0275	0.0257	0.0254	0.0242	0.0233	$0.01605/S$
Gal/lb-mole at 60°F	6.4	9.64	10.41	12.38	11.94	13.84	13.71	15.57	17.47	$0.120\ M/S$

Constants Used in Calculations

1 cu ft = 28.316 liters
1 cu ft = 7.480 gal
1 gal = 3,785.53 ml
760 mm Hg = 14.696 psi

0°F = 459.58°R
Density of water at 60°F = 8.327 lb per gal
Molecular weight of air = 28.966
1 mole = 380.69 cu ft of perfect gas at 14.65 psia and 60°F

Conversion Factors

Natural Gas: 1 MMCF = 0.00099 PJ

Crude Oil: 1000 Ton = 0.0427 PJ

Coal : 1000 Ton = 0.027 PJ

Agri. & Tree Res : 1000 Ton = 0.0125 PJ

Electricity : 1 GWh = 0.0036 PJ

Petroleum Product (Av.) : 1000 Ton = 0.0427 PJ

Fuel – wood : 1000 Ton = 0.0151 PJ

Dung : 1000 Ton = 0.0116 PJ

LPG : 1000 Ton = 0.0497 PJ