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NATURAL GAS SECTOR IN BANGLADESH: ISSUES AND OPTIONS

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ABSTRACT

The paper attempts to address the major debates surrounding the Bangladesh gas sector. It addresses the need for an unbiased Production Sharing Contract (PSC), an accurate estimate of gas reserves, and appropriate pricing strategies. As Bangladesh lacks the technical capability to conduct gas exploration on its own, she is forced to sign specific contracts (PSC) with foreign companies, which favor the International Oil Companies (IOC). The local companies are severely limited by their technological inadequacies. Bangladesh also needs to increase its per capita primary energy consumption. Hence, the fertilizer and power sectors need to implement their respective projects. The paper suggests that there is a need to supply power and fertilizer to the northwest region on a priority basis, since these are the areas where the poverty level is high. The analysis suggests that currently Bangladesh is no longer experiencing shortage in the supply of gas. Thus, the pricing of gas needs to be determined on the basis of economic cost and depletion premium. In addition, there is not enough gas to meet 50 years of domestic requirement and hence the question of pipeline export of gas does not arise. State monopoly in the domestic marketing of gas should be the preferred option in order to avoid distortion in end user prices. Before allowing exports of gas in the form of LNG, the tax administration needs to be strengthened. Moreover, a comprehensive gas policy should be developed with a proper regulatory body that has oversight responsibilities. Efficient gas marketing is the key to deriving numerous benefits from the gas reserves of Bangladesh.

Introduction

Natural gas is an important resource for the economic development of Bangladesh. Not only does it account for about 70 percent of primary commercial energy supply, it also meets about 45 percent of the final commercial energy demand. Per capita primary commercial energy consumption in Bangladesh is still one of the lowest in the world: 67 KGOE in Bangladesh compared to 260 and 243 in India and Pakistan respectively in 1995[1] (World Bank 1998). Hence, the real potential of natural gas has yet to be realized for the economic development of Bangladesh.

In the 1980s the country had a gas surplus while in the 1990s, as foreign aid dried up for exploration and drilling, there was fear that Bangladesh would face a shortage from the year 2010. But some studies suggest that besides the above factors, the shortage of gas in the 1990s was due to: (a) delay in completing a development-drilling program, (b) infrastructure limitations and (c) a decline in production in the Bakhrabad gas field. The gas infrastructure limitation was attributed to the absence of the Ashuganj-Bakhrabad gas pipeline (Khan and Imaduddin 1999). During this time various policies were devised for the energy sector, such as the Petroleum Policy in July 1993 and the National Energy Policy in January 1996. Moreover in the Fifth Five-Year Plan, a shift from government monopoly to participation of the private sector with the IOCs was encouraged as a shortage of gas was anticipated. A model Production Sharing Contract (PSC) was drawn in 1988 and was revised in 1993 and 1997.

Estimates[2] suggest that there was a gas shortage in 1997 equivalent to 15.8 bcf and 14.9 bcf respectively for the fertilizer and power sectors. In the year 2000, Bangladesh was faced with two crucial questions regarding natural gas: Would the country have sufficient gas to meet domestic demand and be able to benefit from export possibilities? If so, what should be the pricing strategy of gas and in what form would it be exported? This paper attempts to address these questions regarding the Bangladesh gas sector. It addresses three major issues: the need for an unbiased Production Sharing Contract (PSC), the need for an accurate estimate of gas reserves, and the appropriate pricing of gas.

Section II discusses the major issues surrounding Production Sharing Contracts. It discusses, critically, the terms and conditions of the PSC. Section III discusses the demand and supply situation by presenting the issue of gas reserves and discussing the present and future demand for gas in Bangladesh. The pricing of natural gas is discussed in Section IV, while Section V deals with the export of natural gas. Finally the summary and concluding remarks are presented in Section VI.

Table 1

Regional variation in the ratio of exploration wells to discovery

Regions	Area in sq. km available for exploration	Wells drilled	Ratio of exploration wells to discovery
Bangladesh	**1,77,570**	**60**	**2.8:1**
N-W or the Rajshahi region	34,513	5	5:0
South of Ganges or Khulna & Barisal Division (including Faridpur)	35,571	3	3:1
Central areas or Dhaka Division (excluding Faridpur)	24,111	4	4:2
Offshore	30,000	10	10:2
N-E,E and S-E or Chittagong and Sylhet Divisions	46,067	38	2.2:1

Source: Abdullah (1999)

Major Issues in Production Sharing Contracts

The country has been divided into 23 blocks for exploration. Surprisingly, there was little consideration to explore the 23 blocks in phases over a longer period of time (e.g., 25 years). Moreover instead of allocating the western areas (where the success ratio is low) to the International Oil Companies (IOC) in the first phase, the eastern areas (where the success ratio is high) were allocated on a first-come first-served basis (Table 1). Sylhet and Chittagong have high success ratios and should have been kept for Bangladesh Petroleum Exploration Company (BAPEX), Sylhet Gas Field Ltd (SGFL) and Bangladesh Gas Field Co. Ltd (BGFCL); instead they were given to the IOCs. In the early nineties, five PSCs were signed for eight blocks with the IOCs based on the modified PSC of 1993. Before resolving the issues of gas reserves and estimates of demand-supply, a second round bidding for the western and southern zones took place in 1997. Studies suggest that all gas fields outside Chittagong and Sylhet are insignificant, and with the exception of Shahbazpur and Sangu, all of them belong to the less than 0.3 bcf category. Moreover 75% of the discovered gas fields are of less than 1 trillion cubic feet (TCF) category. The greater districts of Khustia, Jessore and Khulna, which are adjacent to the Indian State of West Bengal, are likely to have a low exploration to discovery ratio, similar to West Bengal i.e., 14:0 (Abdullah 1999). Hence, Bangladesh has already decided to explore and extract all its natural gas at present rather than at some future date. Perhaps, the expectation is that there will be various forms of alternative energy sources in about 30 to 40 years, extraction technology will improve, and energy efficiency will rise.

The negotiations between Petrobangla and the IOCs are conducted through Production Sharing Contracts (PSC). The main features of the PSCs are given in Exhibit1. The cost of production of natural gas in Bangladesh has been high due to the way in which the PSC has been designed. Some of these design features are discussed below:

- The Petroleum Policy of 1993 states that local companies will be encouraged to seek joint ventures with foreign companies and/or with Bangladesh Petroleum Exploration Company (BAPEX) in exploration[5]. Quite surprisingly, the PSC does not require BAPEX to play a role in exploration or development. BAPEX was created in 1989 for carrying out hydrocarbon exploration in the country. The previously discovered fields should have been kept for BAPEX, but instead in Jalalabad, Shahbazpur, Kutubdia and Semutang, BAPEX has no role to play. Also, the share of the contractor is high in these PSCs. The inclusion of BAPEX would have increased Petrobangla's share to a large extent. The role of BAPEX was ensured only in the second round, as it has some role in exploration in Block 7. The violation of the Petroleum Policy of 1993 should be looked into immediately. Moreover, it is not clear whether Bangladesh is adopting policies that are economically sound, environmentally sustainable, and justified on the basis of social cost and benefit analysis for the optimal exploitation of natural gas.

- Of the natural gas fields mentioned in Table 1, Shahbazpur and Semutang were discovered by Petrobangla. Unfortunately, the IOCs have taken over these productive Petrobangla fields. As Petrobangla discovered these fields, if there is scope for revision of the PSC, then BAPEX's role in exploration and development needs to be ensured. Other productive fields, which Petrobangla could manage, are Sangu, Jalalabad and Moulavibazar.

- Table 2 shows that differences in cost recovery percentages depend on whether it is on shore or off shore. The difference in the prior exploration cost of Petrobangla and the contractor's share of profit gas[6] should be noted. So far the best deal has been with Semutang, followed by Jalalabad, Shahbazpur and Kutubdia.
- The price of gas has been set high to attract international oil and gas companies in exploration and production activities. The High Sulphur Fuel Oil (HSFO) price has been volatile and has almost reached the upper limit of $120 per metric ton. Soon the price will be US $ 2.50 per Million British Thermal Units (MMBTU) and hence utilization of gas will not be viable.

- Participation by the private sector in gas exploration has been limited to the IOCs. Local private entrepreneurs have been barred, as they do not have the financial or technical ability.

Exhibit 1. Main terms and conditions of the Production Sharing Contract (PSC)

Under the Production Sharing Contract (PSC) Model, Government of Bangladesh and Petrobangla enter into a contractual agreement with a contractor (the companies) for the exploration, development and production of hydrocarbons. The title of the assets and the hydrocarbon resources remain with Petrobangla and the Government; title passes to the PSC contractor at the wellhead. In exchange for the capital invested in exploration, development and production activities, the contractor obtains a share of the volume of gas to recover its costs (cost gas) and a profit (profit gas), at a predetermined gas price.

- Sales price of Natural Gas to Petrobangla shall be 75% for onshore discoveries and 93.75% for offshore discoveries of the BTU equivalent value of High Sulphur Fuel Oil (HSFO) 180 CST, FOB Singapore, as quoted on the APPI. Such fuel oil price will have a floor of $70 per metric ton and a ceiling of $120 per metric ton. Contractor has the option to sell contractor's share of Natural Gas in the domestic market to a third party, at a price equal to or higher than that offered to Petrobangla, subject to Petrobangla's right to first refusal within six months.
- The contractor recovers its costs and makes a profit essentially only if Petrobangla /third party buys the gas or the contractor is able to export it through a Liquefied Natural Gas (LNG) project.
- Under the competitive bidding process, contractors bid cost recovery and contractor's profit gas shares.
- Depending on the capital cost, size of the discovery (reserved), investment and profit gas for the particular license, and location of the field, the overall amount of gas retained by the contractor over the life of the field ranges from 25% to 55% net of taxes.
- Under this contractual system the costs of exploration, development and production are paid by the contractor but fully recovered, if sufficient gas is discovered.
- Through the profit sharing the contractor receives a return on his investment and a premium for the risk that has been taken. If no discovery is made, the contractor bears the exploration costs. Therefore, the risk premium includes compensation for unsuccessful exploration in other areas.
- In the event the contractor has discovered natural gas in the contract area, the production period shall be twenty-five years.
- Natural Gas for export in the form of Liquefied Natural Gas (LNG) is allowed. Within 30 days after the date of declaration of the first commercial discovery, a Joint Management Committee composed of eight members shall be established: three from Petrobangla, one from government and four from the contractor.
- Petrobangla shall assume, pay and discharge on behalf of the contractor, contractor's Bangladesh Income Taxes out of the sums received by Petrobangla from the sale or other disposition of the Petrobangla share of Natural Gas under the contract.
- The law of the People's Republic of Bangladesh shall govern the validity, interpretation and implementation of the contract. Any changes favorable to the contractor will be applicable.
- Upon commercial discovery of natural gas, Petrobangla receives bonuses in US dollars.
- Contractor shall have the right to produce annually a total volume of Gas up to seven and one-half percent (71/2%) of the proven recoverable gas reserves for each gas field.

Source: Gas Sector Development Strategy, 1998 and the Model Production Sharing Contract, 1997

Table 2

Selected gas field comparison

Gas field	PSC date	Recoverable gas	Prior investment Petrobangla (million US$)	Cost recovery Annual %	Profit gas (Contractors share)
Jalalabad	1995	900	22.603	55	22.5 to 10
Shahbazpur	1997*	333	9.640	55	28 to 27 37.5 to 32.5
Kutubdia	1994	468	18	60	35 to 10
Semutang	1995	98	5.695	55	22.5 to 10

* note: yet to be confirmed

- Annexure to PSC Article 13.5 relates to audit and adjustment. Petrobangla may require contractors to engage their parent company's auditors to verify accuracy and compliance with the terms of the contract[7]. The right to audit should have been with Petrobangla.

- In the PSC because of the high-risk perception, the profit margin is high. Bangladesh could instead get a credit rating from an international agency, which would lower the risk perception.

- Although in the model PSC the annual production is limited to 7.5 percent of the proven recoverable gas reserves, in some contracts signed earlier (e.g. Bibiana), it is of the Gas Initially In Place (GIIP). Due to this distortion, the contractor can recover cost at an accelerated rate. There is no safeguard against unchecked depletion of the IOCs' gas fields.

- In the PSC, the right to sell natural gas to a third party will distort the end user's gas price. In order to regulate this, Petrobangla should have been the sole buyer of gas from the International Oil Companies and then any third party would buy the gas from Petrobangla.

- The Petroleum Policy[8] of 1993 states that if the government does not give indication of outlet within 12 months of the declaration of commercial discovery, the contractor would be free to find a market within the country. However, the PSC has reduced the period to 6 months, which is a violation of the Petroleum Policy of 1993.

- Upon receipt of the Contractor's tax return and supporting documents, Petrobangla pays income taxes to the government on behalf of the contractors from its Profit Natural Gas share. Thus the government is earning the revenue and Petrobangla is bearing the cost. This incentive is provided in the Petroleum Policy 1993. This needs to be changed since National Board of Revenue (NBR) can claim high revenue collection while Petrobangla will incur losses. The Petroleum Policy indicates that companies will remain harmless of all corporate tax and such other taxes as are determined under the terms of the PSC. This does not seem to be a justified measure; it has also created accounting problems.

- Any changes in the existing Petroleum Policy are unlikely to favor Bangladesh. Without amending the Petroleum Policy, there have already been two violations of the act as mentioned earlier.

- One of the objectives of the Petroleum Policy was to adopt a uniform policy for both public and private sector (local and foreign) enterprises. Even in fiscal incentives, private and public sectors would be treated uniformly. Since the IOCs are getting tax-free gas, Petrobangla should also not pay tax on the sale of gas. But Petrobangla has to pay 55 percent as taxes on the sale of gas. This revenue loss of Petrobangla could be used to purchase the high priced International Oil Company (IOC) gas.

- There is a need to separate production from transmission and distribution. Hence, BAPEX, Sylhet Gas Field Ltd (SGFL) and Bangladesh Gas Field Co. Ltd (BGFCL) need to be separated as one unit under Petrobangla. There should be a

PSC between Petrobangla and these gas exploration and production companies.

- The entry of IOCs into the upstream gas sector has put an extra burden on Petrobangla's Petroleum Concession Department (PCD) which is responsible for handling all contracts including evaluating, negotiating, and monitoring the PSCs for all the gas exploration blocks. There is lack of sufficient skilled manpower and resources to cope with such work which may lead to less rigorous monitoring. Hence, Petrobangla's PCD must be strengthened.

Demand-Supply Situation

Gas Reserves

The proven and probable gas reserves of various discovered gas fields are shown in Table A1 (Appendix). At present the proven and probable recoverable reserve base is officially estimated to be 13.79 TCF[9], out of which about 3.73 TCF has already been consumed. Hence the available reserve is 10.06 TCF (Table A1). Other estimates suggest a higher reserve: 21.35 TCF in the BEICIP report, while UNOCAL claims a figure as high as 40 TCF. Given that the government has already taken steps to further develop existing field by the IOCs, the official estimated reserves are likely to increase in future. The potential gas reserves have attracted international gas companies under the second round of bidding for exploration. Although the potential gas reserves vary between official estimates of Petrobangla and the IOCs, it is generally agreed that Bangladesh is no longer in a shortage situation. Around 5 TCF of gas reserves is expected to be discovered in the next five years. There is also a need to conduct reserve assessment as the last one was conducted in 1993. Furthermore, there is a need to have one official figure quoted by Petrobangla Reservoir Study Cell.

Present Demand

Natural gas was used primarily for power generation (51.24%) and as a feedstock for fertilizer production (28.46%), followed by industry (9.35%) and residential consumers (9.33%) in 1998/99. By 1998/99, out of a total of 902763 connections, there were 15 customers for power, 8 for fertilizer, 2,773 for industry, and 890,387 for domestic use (see Table A6). The present demand of 967 million cubic feet per day (mmcfd) is short of the supply of 1075 mmcfd. In fact, the present supply can be increased to 1400 mmcfd. However, because of lack of demand, production has been limited. Since the demand for gas is derived, power generation and fertilizer should mainly drive this demand. Two public sector gas production operators, namely Sylhet Gas Fields Ltd. (SGFL) and Bangladesh Gas Fields Co. Ltd. (BGFCL) had to reduce their production level from 282 billion cubic feet (bcf) in 1997/98 to 269 bcf in 1998/99. This means that gas production capacity of SGFL and BGFCL will remain underutilized by about 15 to 25 percent in the coming years at least up to 2005 to accommodate the gas production by the IOCs. It is not clear why all the explorations have taken place if SGFL and BGFCL remain underutilized. Presently, Petrobangla has commitments to buy gas only from Occidental (Jalalabad) and Cairn (Shangu). In other PSCs, Petrobangla has first right of refusal to buy within six months.

In order to reach the consumers, investments also have to be made in transmission and distribution. Fig 1 shows that in the 1990s there has been an expansion of both transmission and distribution lines. By 1998/99, 10,730 kilometers of distribution lines and 1,586 kilometers of transmission lines have been installed (Table A7). But these have been mainly in the eastern areas. A huge investment has been made for a distribution network to provide connection to 902,763 customers of whom 890,387 are domestic users. Only about 4% of the population has access to gas for cooking. This is a waste of resources due to the huge infrastructure cost; instead, Liquefied Petroleum Gas (LPG) should meet the needs of domestic users in the long run. This will reduce monitoring costs and system loss of Titas. It will also protect the environmental and save women's time in gathering fuel wood. LPG should replace the use of kerosene for cooking and hence the pricing of LPG should not be more than that of kerosene. More investment is needed for transmission lines particularly for the western region.

Creating Future Demand

Efficient marketing is the key to deriving benefits from the gas reserves of Bangladesh. This is more of an implementation problem than that of projecting demand. Historically actual demand has been much lower than the projected demand in all the Five Year Plans, as the projects were not implemented on time (Center for Policy Dialogue 2000). Hence the projection as shown in Table A2 and Table A3 will only materialize if the power and fertilizer sector projects are implemented. In the case of fertilizer, the Natural Gas Fertilizer Factory located at Fenchugang will be closed. A new plant, the Shahjalal Fertilizer

Factory, will replace this plant with a higher capacity. Another new plant at Baghabari is expected to start in 2002/03. Four new plants, located at Chittagong, Chandpur, Bhola, and North Bengal have been included in Bangladesh Chemical Industries Corporation's (BCIC)'s forecasts of gas demand by fertilizer plants. It is unlikely that these four would be implemented by 2004/05 and hence are not included in Tables A2 and A3.

There is a need to increase demand for gas in the power and fertilizer sectors, especially in the western region on a priority basis. This is a very low-income area with extremely low level of electricity connection. At present, only 15% of the population enjoys electricity; of them very few do so without disruption. Failure to provide power to the northwest region has been a major factor retarding the growth of the agriculture and industrial sectors. Because diesel is used for irrigation, the cost is significantly higher than it would have been if gas were used.

With the opening of the Jamuna Bridge, it has become feasible to bring a gas pipeline across the river. Since a gas pipeline has been brought to the Baghabari area where it will be used to generate electricity, it is expected that there will be a rise in the demand for gas. There are plans for three power plants of 400 MW capacities. There is also a plan for a small pipeline to Bogra and Ishurdi. An Export Processing Zones is planned for Ishurdi. The proposed Western Region Integrated Project (WRIP) project would also bring gas into the Khulna region, and generate electricity for the northwest region (GOB and ADB 2000).

The northwest region consumes a large amount of urea fertilizer, being the major rice growing area. New High Yielding Variety (HYV) rice technology and the Green Revolution helped to accelerate agricultural growth in the area. This technology uses fertilizer and irrigation intensively. Locating fertilizer factories in this region would reduce transportation costs. A fertilizer factory north of Bogra could provide urea to the rice growing areas in the northwest region. The plants could also be located close to the Indian border in the northwest region to export electricity or fertilizer to the country.

Gas supply to the northwest region will increase the region's contribution to GDP. The persistent regional differences can only be corrected through judicious public interventions. The most poverty-stricken districts need to be prioritized in allocation of public resources and targeting assistance. Studies have shown that there are significant variations at the district level in the value of head-count index of poverty (HCI). The worst performing districts where the value of HCI was over 50% were: Jamalpur, Panchgarh, Rangpur, Sirajgonj, Kurigram, Gaibandha, Lalmonirhat, Nilphamari, and Sherpur. Most of these districts belong to the northern part of the country.

Moreover with the availability of micro credit and spread of education, the availability of electricity is going to be a critical factor in the development of the northwest region. Access to electricity in the northwest region would also reduce cost of irrigation because the average cost of electricity operated irrigation pumps is substantially lower than diesel operated machines especially for Low Lift Pump (LLP) and Deep Tube Well (DTW). More importantly affordable electricity can directly contribute to longer working hours for commercial production and for educational attainments. This will have a favorable impact on social development.

Future gas demand will therefore depend on how fast the power and fertilizer sectors implement their respective projects. Moreover these sectors would ask for a guarantee of gas supply for at least 20 years. This needs to be taken into account. Failure to implement these projects would create pressures on the government to allow pipeline export of gas.

Gas may also be used for the production of cement clinker and cement. Limestone across the Bangladesh-Indian border from Meghalaya could be used for pipeline gas. This would save foreign exchange needed to import cement clinker and finished cement. Iron ore could be imported from India or Australia and converted to sponge iron by using gas. This can be used by the steel based industry and could also be exported. Moreover, gas could be used for transport services.

Tables A4 and A5 show the supply-demand balance and a shortage in 2003/04 and 2004/05. But Bibiana is likely to add about 700 mmcfd by 2002/03. Petrobangla's own gas is likely to be augmented by 300 mmcdf around the same time. But there will hardly be any gas from the IOC fields for domestic use if their gas is used for LNG export, as discussed later.

Pricing of Gas[10]

It is very important to have the right pricing policy for natural gas. The Bangladesh Gas Sector Development Strategy (1998) suggested an estimate of Long Run Marginal Cost (LRMC) which could be

Exhibit 2 Economics of Gas

In a country where gas reserves are greater than present and expected gas demand, the economic price of gas is equivalent to its economic cost (LRMC) plus a depletion premium. Such depletion premium reflects the fact that natural gas is an exhaustible resource, and will deplete in a certain number of years. The cost of that fuel at that point of time in today's value is the depletion premium, which represents the cost of using the natural resources today rather than in the future.

In the case of a country in a gas shortage situation, the depletion cost is incurred today, because new consumers cannot be supplied. Natural gas is already replaced at the margin by the more expensive fuels or new discoveries, which represents the cost of using the natural resources today rather than in the future, i.e., the cost of an imported fuel for a new consumer. Thus, in a gas shortage situation, the economic cost of gas is equivalent to the cost of the imported fuel at the margin or to the opportunity cost of outages.

Source: Bangladesh Gas Sector Development Strategy, May 1998.

one of the guiding principles in determining the pricing policy in case of a surplus (see Exhibit 2).

The report suggests that in Bangladesh, as power generation and fertilizer plants are affected by severe gas shortages, the economic cost of gas is equivalent to the opportunity cost of outages or the cost of imported fuel at the margin. But analysis in the earlier section suggests that Bangladesh is no longer in a shortage situation and so LRMC would be the guiding pricing policy.

The volume of gas accruing to the contractor in the form of both cost gas and profit gas valued at the contractual price may form a basis to estimate the wellhead economic cost of natural gas. The wellhead price was assumed to be US $2.23/mcf and was based on specific assumptions about development costs. The report suggests that the total gas produced would be split into 48 percent for contractor and 52 percent for the Government. Thus, the contractor would be selling 48 percent of the total production to Petrobangla at US$2.23/mcf, but the remaining 52 percent of the gas produced would be flowing free of charge to Petrobangla. Hence, for Bangladesh, the wellhead cost of the total gas produced, less the cost of recovery payback to the contractor would be equivalent to only 48 percent of US$2.23/mcf, or US$1.07/mcf. The transmission and distribution cost has been calculated to be US$0.56/mcf. Thus the LRMC was US$1.63/mcf (Table 3). The average consumer gas tariff was equivalent to about 73 percent of the LRMC estimate in 1998 (Table 4). This is the price if the government allocates its entire portion of gas at zero cost to gas consumers. It is important to note that under the PSC the Government has exempted contractors (International Oil Companies) from income tax. If this is added to the final consumer price then the wellhead price comes to US$1.24/mcf and the total LRMC to US$1.80.

Table 3

LRMC for domestic user and for export

(US$)

	Domestic/mcf	**Export/MMBTU**
Production cost	1.07	2.46
Transmission cost	0.56	0.50
Total LRMC	**1.63**	**2.96**

Source: Gas Sector Development Strategy, May 1998

Table 4

Comparison of tariffs to LRMC and subsidy, 1997-98

Consumer category	Tariff Tk/Mcf	LRMC Tk./Mcf	Ratio Tariff/LRMC	Subsidy $ mill/ year
Power	47.6	68.4	0.70	56.9
Fertilizer	41.3	65.3	0.63	54.7
Industry	103.0	77.1	1.34	-21.3
Commercial	147.5	138.6	1.06	-1.1
Tea Garden	113.2	86.9	1.30	n.a
Brick Field	103.0	77.1	1.34	n.a
Brick Field (seasonal)	128.2	86.9	1.47	-2.3
Domestic (with meter)	82.1	132.3	0.62	30.1
-single burner fix charge	160/month			
-double burner fix charge	260/month			
System loss/own use	0	65	-	17.7
Average consumer price	54.0	73.8	0.73	136.5

Source: Gas Sector Development Strategy, May 1998.

Table 4 shows that the tariff is lower than LRMC for the power, fertilizer and domestic sectors. These are the sectors, which enjoy subsidy. Subsidy to fertilizer reaches all consumers through rice production, while those in the eastern region enjoy power subsidies. On the other hand domestic users are mostly concentrated in Dhaka and Chittagong. As they are mostly the non-poor, their tariff could be raised to the LRMC level. But raising the price for fertilizer and power will have a more pervasive socio-economic impact and hence needs to be avoided. Studies have shown that in the private sector power projects of the IPP's such as Meghna Ghat, Haripur, Baghabari, etc, the contract price of gas is US$ 2.40 per mcf, but the Power Development Board (PDB) is unable to pay this price. The inefficiency of PDB is pulling down the gas sector (Abdullah 1999).

Foreign exchange is also needed to pay the IOCs. This could be earned by appropriately pricing gas for export. The Gas Sector Development Strategy report suggests a conservative wellhead price of US$2.46/MMBTU (corresponding to offshore gas at 93.75% fuel oil parity price at US$100/ton in Exhibit 1). The delivery cost of gas for export would be US$2.96 (see Table 3). But it is not clear from the report to what extent the LRMC as derived in Table 3 is different from that of calculating LRMC in terms of the economic cost and depletion premium. Moreover linking LRMC to the High Sulphur Fuel Oil (HSFO) price would make LRMC volatile.

Export of Natural Gas

Export of raw gas

In the Gas Sector Development Strategy, two export options are considered: by pipeline, and as Liquefied Natural Gas (LNG). Both involve the export of raw gas. Other forms of exports after value addition in the form of fertilizer and electricity are not considered. Under the present contractual agreement under the PSC, Article 14.5 allows the IOCs to export natural gas in the form of LNG only. It is not clear from Exhibit 3 whether export in the form of LNG is allowed only after meeting domestic requirements. Studies suggest that the LNG scheme could be economically viable, but it would not generate much revenue for the government, compared to pipeline exports[11].

As the PSCs have already allowed the export of gas as LNG, the major concern should be how Bangladesh can benefit from the existing contract. Exhibit 3 shows that in case of export in the form of LNG, Petrobangla can only retain 20% of its profit gas for domestic consumption. For the rest of Petrobangla's gas, the contractor will pay Petrobangla a fixed price. Hence in the case of LNG export there will hardly be any natural gas available from the IOC fields for domestic consumption. BAPEX may therefore have to increase exploration in order to meet domestic requirement beyond 2005.

Exhibit 3
Export of Natural Gas as LNG

Article 14.5 of the contract gives the contractor the right to export any marketable natural gas in the form of Liquefied Natural Gas (LNG) which would consist of:

- Contractors cost recovery natural gas
- Contractors profit natural gas and
- Petrobangla's profit natural gas. Petrobangla will be entitled to retain only 20% of its profit share.

- The related LNG facilities shall be constructed and operated on the basis of a special LNG export agreement between the contractor and Petrobangla. For any natural gas from Petrobangla's share of profit gas, the contractor shall pay a price in US dollars equal to a price established in article 16.8.
- The contractor shall pay Petrobangla its share of the pipeline tariffs applicable to the transport of natural gas.
- Contractor shall not enter into any agreement for LNG export unless Petrobangla previously approves the price or the pricing formula and the agreement itself.

Source: Model Production Sharing Contract, 1997.

The pricing formula for export in the form of LNG has also not been fixed yet. There is a chance to seek technical assistance from Indonesia or Brunei to see how Bangladesh can benefit from the pricing of LNG gas. It is time to pay greater attention to the PSC and try to get the optimum benefit from it. Bangladesh could also benefit from regional trading arrangements such as the Organization of Islamic Countries (OIC) for seeking funds from the Islamic Development Bank (IDB) and importing machinery from other OIC countries for the construction of LNG plants.

In order to regulate end users prices, it is suggested that Petrobangla should be the single buyer and seller of gas in the domestic marketing of gas. Petrobangla may be restructured based on its functions: (a) gas exploration and production companies (b) gas transmission companies and (c) gas distribution companies. Before allowing the IOCs to market gas as LNG for export, Bangladesh needs to strengthen its tax administration and develop proper guidelines for gas policy. Also proper regulation regarding safety, land use, environmental issues, and social impact needs to be assessed and a regulatory body put in place with oversight responsibilities.

Studies have also noted a forthcoming LNG boom in India. West Bengal has a potential natural gas semand of 3-4 bcf/year. There is a plan for an LNG terminal near West Bangal in Paradeep (Fesharaki 2000). Hence, an LNG plant at Chittagong would be the nearest source for India to import LNG and transportation costs would be the lowest. Moreover, gas export in the form of LNG would reach the world market, but pipeline export would only limit the market to India.

Export of gas via pipeline is not allowed under the PSC or in the National Energy Policy. The government has declared that gas could be exported after meeting 50 yeares of domestic requirements. About 1 TCF of gas will be required in three years at the present rate of consumption. The reserve/production ratio suggests that Bangladesh has about 30 years of reserve. If another 5 TCF is commercially discovered, then this would rise to 45 years of reserves. But with a 5% increase in consumption, this reserve will be exhausted sooner. Hence, at present, the question of export of gas does not arise; instead, the domestic market needs to be developed. Also, the question of pipeline export of gas does not arise unless the government changes its policy due to pressure from the IOCs and the donors. The government of Bangladesh, therefore, faces formidable challenges in the gas sector.

Export after value addition

The National Energy Policy suggests fertilizer export. Currently, Bangladesh exports as well as imports gas in the form of fertilizer. The only joint venture firm, Karnafully Fertilizer Company (KAFCO) exports all its fertilizers. In KAFCO, 40% of its ownership is held by the state and its financing is guaranteed by the government. The price of gas purchased by the KAFCO plant is based on a formula linked to the FOB urea price with a floor price. The World Bank's Energy Strategy Note suggests that large manufacturing fertilizer plants could be established for exports only. But the commercial risks are high; and international prices of fertilizer are not stable. The margin between the economic cost of natural gas to fertilizer plants and the economic benefit is also small.

The World Bank's Energy Strategy Note further suggests that electricity exports would seem economically attractive. But technical issues need to

be addressed such as voltage standards, frequency regulation, and synchronization. If resolving the technical differences between the Indian and Bangladesh power systems proves to be too expensive, then natural gas could be used to fuel a power plant in Bangladesh to export electricity to India only. But a creditworthy buyer of electricity in India has to be ensured. Studies suggest that India's National Thermal Power Corporation has proposed construction of a 2000 MW power plant in Bangladesh, to export electricity to India (cited in Fesharaki 2000). The World Bank also suggests that, from the economic point of view, the benefit from pipeline export and electricity exports would be similar. A review of opinions expressed in the media suggests that export in the form of electricity would be politically more accepted than pipeline export. Bangladesh government or local entrepreneurs could export electricity, but as there is political risk, a government-to-government arrangement has to be made. Once arranged, it would be an assured market for 15 to 20 years.

Summary and Concluding Remarks

This paper attempts to address the major debates on the Bangladesh gas sector. It addresses the following issues: the need for an unbiased Production Sharing Contract (PSC), the need for an accurate estimate of gas reserves, and an appropriate pricing of gas. The paper suggests that the cost of production of gas has been high because of the way in which the PSC has been designed. The Petroleum Policy 1993 stated that local companies would be encouraged to seek joint ventures with foreign companies and/or with BAPEX in exploration. But in the first round of the bidding, there was no joint venture in exploration and development. The discovered fields should also have been reserved for BAPEX. Other problems with the PSC are related to auditing, lack of local private sector participation, tax return of the IOCs to be paid by Petrobangla, and differential fiscal incentives and lack of skilled manpower in the Petrobangla's PCD. There is a need to separate BAPEX, SGFL and BGFCL as gas exploration and production companies. Moreover the paper suggests that as the IOCs are exempted from tax, so should Petrobangla be exempted from tax on sale of gas.

The analysis suggests that Bangladesh is no longer in a shortage situation in the supply of gas. Thus, the pricing of gas needs to be done on the basis of economic cost (LRMC) and depletion premium. But there is not enough gas to meet 50 years of domestic requirement and hence the question of pipeline export of gas does not arise. Bangladesh desperately needs to increase energy utilization to foster economic growth and increase its per capita commercial energy level. In Bangladesh, natural gas is primarily being used for power generation, as feedstock for fertilizer production, and in industry. LPG in the long run should meet the needs of the domestic consumers. The gas projection demand will not hold if the gas consuming sectors especially power and fertilizer do not implement their respective projects. The paper suggests that there is a need to supply power and fertilizer to the northwest region on a priority basis. These are also areas where poverty levels are high. Failure to provide power to the northwest region has been a major factor retarding the growth of the agriculture and industrial sectors.

The paper suggests that in order to regulate end user prices, state monopoly in the domestic marketing of gas should be the preferred option. Petrobangla may be restructured based on different functions. Although export of pipeline gas is considered to generate more revenue, the present energy policy does not permit such export. Only export in the form of LNG is allowed. Before allowing export of gas in the form of LNG, the tax administration needs to be strengthened, a gas policy needs to be developed, and a regulatory body needs to be in place. An export tax or special Value Added Tax (VAT) on gas may be imposed on LNG export and Petrobangla may use the revenue to subsidize domestic users. Export after value addition could be done in the form of fertilizer and power, but pricing has to be administered correctly. Gas could also be used for the export of cement and sponge iron. Natural gas can be an important resource for economic development of Bangladesh if it can be efficiently marketed.

APPENDIX

Table A1.
Reserves of Natural Gas, Condensate/Ngl and Crude Oil Bangladesh
Dated: Jan. 2000

Gas Field	NATURAL GAS						CONDENSATE/NGL		
	Year of Discovery	Proven +Probable (In Place) (BCF)	Recoverable* (Proven +Probable) (BCF)	Cumulative Production (As of DEC. '99) (BCF)	Net Prc. Reserve (BCF)	Possible Reserve (In Place) (BCF)	Recoverable Reserve (MMBBL)	Cumulative Production (As of June'99) (MMBBL)	Net Rec. Reserve (MMBBL)
A. PRODUCING									
Bakhrabad	1969	1432	867	573.97	293.03	0	2.13	0.860	1.270
Habigonj	1963	3669	1895	751.60	1143.41	0	0.10	0.037	0.063
Kailastila	1962	3657	2529	199.11	2329.89	0	27.56	2.471	25.089
Rashidpur	1960	2242	1309	165.34	1143.66	2547	4.00	0.243	3.757
Sylhet	1955	444	266	164.27	101.73	0	0.89	0.562	0.328
Titas	1962	4138	2100	1668.22	431.78	0	3.02	2.255	0.765
Narshingdi	1990	194	126	23.75	102.25	30	0.31	0.052	0.265
Meghna	1990	159	104	16.94	87.06	128	0.21	0.028	0.182
Sangu*	1996	1031	848	49.80	798.20	318	N/A	0.014	0
Shaldanadi*	1996	200	140	9.79	130.21	0	0.42	0.008	0.412
Jalalabad	1989	1500	900	21.66	878.34	0	15.75	0.309	15.441
Beanibazar	1981	243	167	3.36	163.64	1320	1.82	0.050	1.770
Sub Total A:		**18909**	**11251**	**3647.82**	**7603.18**	**4343**	**56.21**	**6.890**	**49.342**
B. PRODUCTION SUSPENDED:									
Chattak	1959	1900	1140	26.50	1113.50	5273	0.08	0.000	0.080
Kamta	1981	325	195	21.10	173.90	0	0.04	0.000	0.040
Feni	1981	132	80	39.51	40.49	455	0.24	0.918	-0.675
Sub Total B:		**2357**	**1415**	**87.11**	**1327.89**	**5728**	**0.36**	**0.918**	**-0.555**
C. NON PRODUCING:									
Begumgonj	1977	25	15	0.00	15.00	0	0.01	0.000	0.010
Fenchugonj	1988	350	210	0.00	210.00	0	0.52	0.000	0.520
Kutubdia	1977	780	468	0.00	468.00	0	0.00	0.000	0.000
Shahbazpur	1995	514	333	0.00	333.00	0	N/A	0	0
Semutang	1969	164	98	0.00	98.00	0	0.02	0.000	0.020
Bibyana	1998	0	0	0	0	0	0	0	0
Moulavibazar	1999	0	0	0	0	0	0	0	0
Sub Total C:		**1833**	**1124**	**0.00**	**1124.00**	**0**	**0.550**	**0.000**	**0.550**
G. Total (BCF) (A+B+C)		**23099**	**13790**	**3734.93**	**10055.07**				
G. Total (TCF) (A+B+C)		**23.099**	**13.79**	**3.73**	**10.055**		**57.123**	**7.808**	**49.337**

*PROVISIONAL
SOURCE (RESERVE): IKM, HAITAT STUDY AND BAPEX
HARIPUR OIL FIELD:
YEAR OF DISCOVERY: 1996
RESVERS OF CRUDE OIL:
INITIAL OIL IN PLACE: 8.2 MMBBL (Ref. RSC of Petrobangla)
CUMMULATIVE PRODUCTION (AS OF JULY'94): 636956 BRLS
PRESENT STATUS: PRODUCTIION SUSPENDED FROM 14 JULY. 1994.
PRODUCTION & MARKETING DIVISION, PETROBANGLA

Table-A2
Total Average Gas Demand Projections by Sectors (MMcfd)

	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Power	399.690	452.375	474.304	492.737	521.764	544.260
Fertilizers	259.479	259.479	281.178	326.384	326.384	326.384
Industry	201.809	219.669	243.896	257.794	269.261	281.826
Commercial	17.091	18.031	18.804	19.906	20.939	22.174
Domestic	79.900	85.600	91.600	97.800	104.500	111.600
Seasonal	9.100	9.400	9.900	10.300	10.900	11.400
GRAND TOTAL	967.070	1,044.555	1,119.682	1,204.921	1,253.748	1,297.644

Source: BECHTEL 1999-Final Report, Bangladesh Fourth Natural Gas Development Project. ADB-TA No. 2801 BAN Volume-1

Table-A3
Total Peak Gas Demand Projections by Sector (MMcfd)

	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Power	499.613	565.469	592.880	615.921	652.205	680.325
Fertilizers	287.000	287.000	311.000	361.000	361.000	361.000
Industry	201.809	219.669	243.896	257.794	269.261	281.826
Commercial	17.091	18.031	18.804	19.906	20.939	22.174
Domestic	79.900	85.600	91.600	97.800	104.500	111.600
Seasonal	9.100	9.400	9.900	10.300	10.900	11.400
GRAND TOTAL	1,094.513	1,185.169	1,268.080	1,362.721	1,418.805	1,468.325

Source: BECHTEL-1999: Final Report, Bangladesh Fourth Natural Gas Development Project. ADB-TA No. 2801 BAN Volume-1

Table. A4
Average Base Case Supply/Demand Comparison with Individual Field Data (*) (in MMcfd)

Field	Fiscal Year					
	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Bakhrabad	50	50				
Beanibazar	40	40	40	40	40	40
Belabo	20	20	20	20	20	20
Fenchuganj		15	15	15	15	15
Feni	5	5	5	5	5	5
Habiganj	210	230	260	260	260	260
Jalalabad	100	100	100	100	100	100
Kailashtila	86	86	95	95	95	95
Meghna	15	15	15	15	15	15
Rashidpur	85	235	235	235	235	235
Sangu	160	160	160	160	160	160
Shalda	20	20	20	20	20	20
Sylhet	5	5	5	5	5	10
Titas	279	279	279	279	279	279
Total Supply	**1,075**	**1,260**	**1,249**	**1,249**	**1,249**	**1,254**
Total Demand	**967**	**1,045**	**1,120**	**1,205**	**1,254**	**1,298**
Balance	108	215	129	44	-5	-44

Source: BECHTEL 1999: Final Report, Bangladesh Fourth Natural Gas Development Project. ADB-TA No. 2801 BAN Volume-1 Part IV: Gas Supply Analysis Table-4.2
(*): Includes current capabilities plus expected 3rd NGDP, GIDP and others.

Table. A5
Peak Supply/Peak Demand Comparison with Individual Field Data (*) (in MMcfd)

Field	Fiscal Year					
	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05
Bakhrabad	50	50				
Beanibazar	50	50	50	50	50	50
Belabo	25	25	25	25	25	25
Fenchuganj		20	20	20	20	20
Feni	5	5	5	5	5	5
Habiganj	238	260	295	295	295	295
Jalalabad	100	100	100	100	100	100
Kailashtila	105	105	116	116	116	116
Meghna	25	25	25	25	25	25
Rashidpur	87	260	260	260	260	260
Sangu	160	160	160	160	160	160
Shalda	35	35	35	35	35	35
Sylhet	5	5	5	5	5	10
Titas	279	279	279	279	279	279
Total Supply	**1,164**	**1,379**	**1,375**	**1,375**	**1,375**	**1,380**
Total Demand	**1,095**	**1,185**	**1,268**	**1,363**	**1,419**	**1,468**
Balance	69	194	107	12	-44	-88

Source: BECHTEL 1999: Final Report, Bangladesh Fourth Natural Gas Development Project. ADB-TA No. 2801 BAN Volume-1 Part IV: Gas Supply Analysis Table-4.4
(*): Includes current capabilities plus expected 3rd NGDP, GIDP and others

Table A6
Sector wise gas connection

Year	Power	Fertilizer	Industrial	Brick Field	Tea Estate	Commercial	Domestic	Total
Up to								
1968-69	2	1	4	0	0	3	76	86
1969-70	1	1	7	0	0	10	274	293
1970-71	0	0	19	0	0	22	955	996
1971-72	0	0	13	0	0	20	1040	1073
1972-73	0	0	29	0	0	90	1791	1910
1973-74	1	0	35	0	0	92	2475	2603
1974-75	0	0	21	0	0	138	7947	8106
1975-76	0	0	48	0	0	175	12812	13035
1976-77	0	0	50	1	0	352	15064	15467
1977-78	0	0	71	4	0	540	20017	20632
1978-79	0	0	68	5	0	524	21735	22332
1979-80	0	0	57	22	0	542	28099	28720
1980-81	0	1	31	5	0	656	19635	20328
1981-82	0	0	66	33	0	455	29859	30413
1982-83	0	0	62	15	0	315	20733	21125
1983-84	0	0	32	20	21	423	33817	34313
1984-85	3	1	76	5	1	442	22275	22803
1985-86	0	1	187	27	12	751	33313	34291
1986-87	4	1	142	51	25	774	34785	35782
1987-88	1	0	99	15	1	705	39212	40033
1988-89	0	0	119	0	0	655	36575	37349
1989-90	0	0	164	0	1	661	30445	31271
1990-91	0	0	128	1	0	487	25964	26580
1991-92	0	1	131	40	0	344	27189	27705
1992-93	1	0	186	5	0	329	36727	37248
1993-94	0	1	232	11	1	360	43354	43959
1994-95	2	0	435	10	9	1443	52944	54843
1995-96	0	0	202	13	15	418	55265	55913
1996-97	0	0	215	5	8	460	69201	69889
1997-98	0	0	150	1	0	527	66605	67283
1998-99	0	0	162	0	0	429	70904	71495
Total:	15	8	3241	289	94	13142	861087	877876
Adjustment:	-	-	(-)468	(-)138	(-)5	(-)3802	(+)29300	(+)24887
Net Total:	15	8	2773	151	89	9340	890387	902763

Source: MIS Report Oct.98 Petrobangla
MIS Report, Jan.2000, Petrobangla

Table A7

CONSTRUCTION OF GAS TRANSMISSION AND DISTRUBUTION PIPE LINE

In Kilometer

Year		Transmission Line					Distribution Line		
	TGTDCL	JGTDSL	BGSL	GTCL	Total (T)	TGTDCL	JGTDSL	BGSL	Total (D)
Up to									
1967-68	93.17	0	0		93.17	61.36	0	0	61.36
1968-69	0.69	0	0		0.69	58.30	0	0	58.30
1969-70	1.94	0	0		1.94	106.24	0	0	106.24
1970-71	0	0	0		0	59.36	0	0	59.36
1971-72	0	0	0		0	16.48	0	0	16.48
1972-73	0	0	0		0	22.84	0	0	22.84
1973-74	0	0	0		0	67.26	0	0	67.26
1974-75	0	0	0		0	66.22	0	0	66.22
1975-76	0	0	0		0	198.86	0	0	198.86
1976-77	0	0	0		0	289.54	0	0	289.54
1977-78	2.14	0	0		2.14	290.54	58.37	0	348.91
1978-79	0	0	0		0	211.36	14.47	0	225.83
1979-80	0	0	0		0	209.88	32.19	0	242.07
1980-81	57.75	0	0		57.75	204.07	40.27	0	244.34
1981-82	0	0	0		0	187.27	14.26	0	201.53
1982-83	1.11	26.30	151.94		179.35	159.52	21.27	0	180.79
1983-84	23.85	19.00	22.71		65.56	112.11	6.35	102.57	221.03
1984-85	67.90	173.65	67.11		308.66	129.36	148.49	170.92	448.77
1985-86	9.64	0.81	1.61		12.06	147.12	118.61	338.84	604.57
1986-87	1.58	11.18	5.04		17.8	388.80	69.86	339.82	798.48
1987-88	0	0	0		0	161.89	55.82	359.42	577.13
1988-89	0	0	0		0	164.02	70.84	313.52	548.38
1989-90	0	0	0		0	106.22	24.97	250.74	381.93
1990-91	223.00	0	0		223	134.03	47.52	116.52	298.07
1991-92	0	0	0		0	196.93	67.51	114.50	378.94
1992-93	111.73	21.61	0		133.34	141.21	47.87	157.46	346.54
1993-94	6.60	22.84	0		29.44	495.88	48.03	208.79	752.70
1994-95	0	47.53	0		47.53	204.81	120.00	154.61	479.42
1995-96	13.72	0		1.25	14.97	301.65	55.84	217.88	575.37
1996-97	24.82	14.70	27.60	58.25	125.37	302.23	68.53	335.53	706.29
1997-98	44.46	45.90	34.80		125.16	307.12	131.07	130.93	569.12
1998-99	36.79	0	0	111.00	147.79	408.73	37.64	206.92	653.29
Total:	720.89	383.52	310.81	170.50	1585.72	5911.21	1299.78	3518.97	10729.96

* Figure of Brahmaputra Basin Project.

Source: MIS Report Oct.98 Petrobangla
MIS Report, Jan.2000, Petrobangla

Abbreviations

BAPEX :		Bangladesh Petroleum Exploration Company
BCIC	:	Bangladesh Chemical Industries Corporation
Bcf	:	Billion cubic feet
BGFCL :		Bangladesh Gas Field Co. Ltd.
BTU	:	British thermal unit
DTW	:	Deep Tube Well
GOB	:	Government of Bangladesh
GDP	:	Gross Domestic Product
GIIP	:	Gas Initially In Place
HCI	:	Head-count Index
HSFO	:	High Sulphur Fuel Oil
HYV	:	High Yielding Variety
IDB	:	Islamic Development Bank
IOC	:	International Oil Company
IPP	:	Independent Power Producer
KAFCO	:	Karnafully Fertilizer Company
KGOE	:	Kg of Oil Equivalent
LLP	:	Low lift pump
LNG	:	Liquefied Natural Gas
LRMC	:	Long Run Marginal Cost
Mcf	:	thousand cubic feet
MMBTU	:	Million British thermal unit
Mmcfd	:	million cubic feet per day
NBR	:	National Board of Revenue
PCD	:	Petroleum Concession Department
PDB	:	Power Development Board
PSC	:	Production Sharing Contract
SGFL	:	Sylhet Gas Field Ltd.
TCF	:	Trillion cubic feet
WRIP	:	Western Region Integrated Project

Endnotes

[1] Inclusion of fuel food in primary commercial energy in the World Development Report (2000) report has increased per capita primary commercial energy to 197, 476 and 446 KGOE in 1996 for Bangladesh, India and Pakistan respectively.

[2] See the Bangladesh Gas Sector Development Strategy, 1998.

[3] An opportunity cost of gas not supplied to fertilizer was US$3.1/mcf.

[4] An opportunity cost of gas not supplied to power was US$54/mcf.

[5] See article II.2.3 (commercial) (I) in the Petroleum Policy 1993

[6] Profit Gas is the natural gas produced and saved from the contract area and not used in incurring contractor's expenses prior to Commercial production. The shares are to be bid and negotiated.

[7] If supplies are done by the International Oil Company (IOC).

[8] See article II.2.3 (commercial) (iii) in the Petroleum Policy 1993

[9] This does not include the reserve of Bibiana field and Maulvibazar, which are under appraisal.

[10] This section is based heavily on the Bangladesh Gas Sector Development Strategy, May 1998.

[11] See Gas Sector Development Strategy, May 1998.

References

Abdullah, S.K.M. (1999): "Some thoughts on Natural Gas of Bangladesh", chapter in *Proceedings: 2nd Petroleum Engineering Symposium*, BUET, 1999.

BEICIP (1996): Preparation of Gas System Development Plan and Strengthening of the Organizational and Regulatory Framework for the Oil and Gas Sector in Bangladesh, Final Report.

Bangladesh Gas Sector Development Strategy, Final Draft, May 1998.

Bechtel (1999): *Bangladesh Fourth Natural Gas Development Project, ADB-TA No.2801 BAN. Vol. I,* May 1999.

Center for Policy Dialogue (2000): Bangladesh Gas Sector Development: Status, Policy Options, and Challenges, CPD Report No. 24, Dhaka, Bangladesh

Fesharak, F. (2000): "Bangladesh Natural Gas Exports to India: LNG alternative with narrow window", *Oil and Gas Journal*, June 19, 2000.

Government of Bangladesh (1996): *Natural Energy Policy*, Bangladesh Gazette, Jan 25, 1996.

Government of Bangladesh (1996) : *Petroleum Policy 1993*, Bangladesh Gazette, and January 25, 1996.

Government of Bangladesh and Asian Development Bank (2000): *Northwest Region Development and Investment Study*, Feb. 2000.

Khan, M.A.A. and M. Imaduddin (1999): "Midterm Gas Demand –Supply Scenario and Gas Reserve of Bangladesh", chapter in *Proceedings: 2nd Petroleum Engineering Symposium*, BUET, 1999.

Petrobangla (1997): Model Production Sharing Contract.

Petrobangla (undated): Annual Report 1997-98.

World Bank (undated) : Bangladesh Energy Strategy Note.

World Bank (1998) : *World Development Report*, World Bank, Washington D.C.

World Bank (2000): *World Development Report*, World Bank, Washington D.C.

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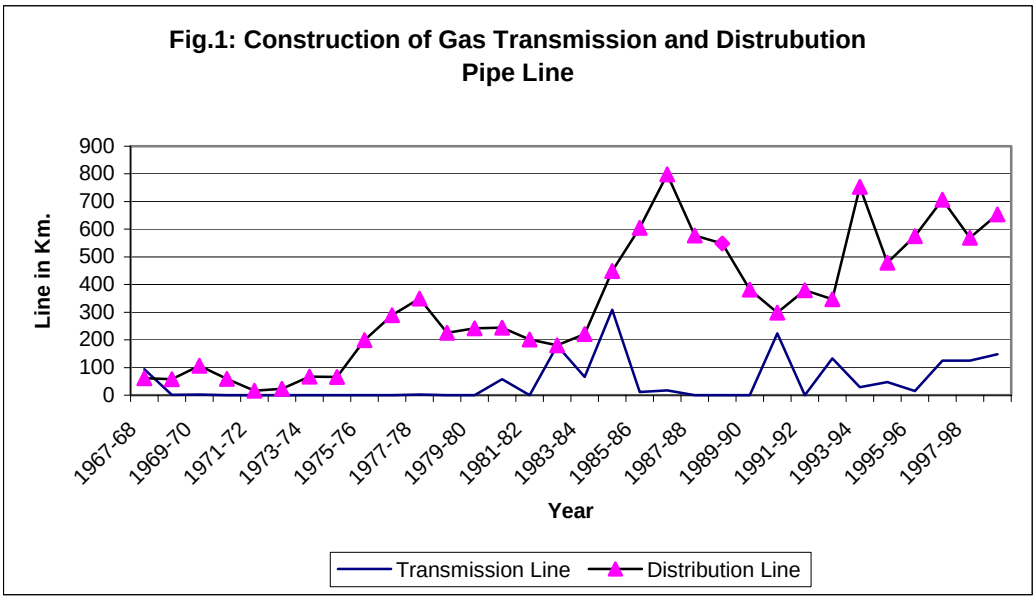
Fig.1: Construction of Gas Transmission and Distrubution Pipe Line
Line in Km.
900
800
700
600
500
400
300
200
100
0
1967-68
1969-70
1971-72
1973-74
1975-76
1977-78
1979-80
1981-82
1983-84
1985-86
1987-88
1989-90
1991-92
1993-94
1995-96
1997-98
Year
Transmission Line
Distribution Line