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**Energy Security for Bangladesh:
Prospects and Strategic Implications of Natural Gas**

Nawrin Samrina

Ford Fellow

Program in Arms Control, Disarmament,
and International Security

University of Illinois at Urbana-Champaign

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Energy Security for Bangladesh

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LIST OF ABBREVIATIONS

BAPEX: Bangladesh Petroleum Exploration and Production Company Ltd.

Bcf: billion cubic feet

CNG: concentrated natural gas

GTL: gas to liquids

GDP: gross domestic product

GNP: gross national product

HDI: Human Development Index

IOC: international oil companies

kgoe: kilogram of oil equivalent

kWh: kilowatt hour

LNG: liquefied natural gas

LPG: liquefied petroleum gas

MMcf: million cubic feet

MMcfd: million cubic feet per day

MW: megawatts

PSC: Product Sharing Contract

Tcf: trillion cubic feet

INTRODUCTION

When Bangladesh gained its independence in 1971, many experts questioned its long-term economic prospects and viability as an independent state. With one of the lowest per capita incomes and one of the highest population densities in the world, the country appeared to have become permanently locked in poverty. At the turn of the new century, however, as Bangladesh began a progression from its former status as poorest of the poor to lead performer among the least-developed countries, it began to appear that not all was lost in Bangladesh's developmental efforts, and that there was plausible reason for hope. Unfortunately, chronic energy shortages threaten to thwart the country's progress.

Although low energy consumption is, in itself, not a cause of poverty, multiple links exist between energy availability and consumption, poverty, and development. One indicator of a country's level of development is per capita energy consumption. For Bangladesh, that consumption has been recorded at approximately 197 kgoe (kilograms of oil equivalent) in 1997.¹ Additionally, there is a positive correlation between per capita energy consumption and per capita gross national product (GNP): countries having higher per capita GNP also have higher per capita energy. Examined from the perspective of energy use, Bangladesh is one of the least developed countries of the world. Worse still is that there are no firm statistics available to illustrate the country's demand, supply, and capability of power and gas generation.

The relationship between the United Nations Development Program's Human Development Index (HDI) and per capita commercial energy consumption also demonstrates that there is a steep increase in HDI correlated with increases in per capita energy consumption among countries whose per capita energy consumption is very low, as is the case with most developing countries. Therefore, modest increases in per capita energy consumption for the poorest countries can lead to tremendous improvements in the quality of life for people living in these countries.

In the past, energy development programs in Bangladesh suffered from a lack of long-term planning. Decisions made about energy sector projects, in particular, were influenced by foreign investors and political party agendas. In some cases, projects have remained heavily underutilized due to lack of implementation schedule synchronization, with the result that the nation entered into a state of energy crisis. All developmental activities of the West Zone (across the river Jamuna) have been severely affected due to serious shortages in the supply of primary (gas and coal, for example) and secondary (electricity) energy resources. The great majority of rural people have not been supplied with modern sources of energy such as electricity, gas, and petroleum products. Even worse, for the population of the Chittagong Hill Tract area, habitation has become untenable due to the Kaptai hydropower plant, which has resulted in the submersion of 40 percent of the area's arable land. More people will be made landless if an addition in hydro-generation capacity is planned at this site.

Therefore, there is a great necessity to implement optimum usage of the available energy sources to ensure energy security for sustainable human development, particularly in the case of natural gas reserves, which are the only significant commercial energy sources for the country.

PART ONE

Overview of the Energy Scenario in Bangladesh

Although low energy consumption is not identified as a cause of poverty, low-level energy consumption by a country correlates quite closely with many poverty indicators. It is no coincidence that countries having a higher per capita GNP have higher per capita energy consumption, and vice versa.

Bangladesh has one of the lowest rates of per capita energy consumption in the world. As is evident from Table 1.1, the 1997 Bangladeshi per capita energy consumption (197 kgoe) was less than the average per capita energy consumption of South Asia for the same period (443 kgoe), and far less than the averages for low income (563 kgoe) and lower middle income (1,178 kgoe) countries. It is also evident that during the 1990s, the energy consumption of Bangladesh grew at a slower pace (1.0% per annum) than the South Asian average (1.9% per annum).

Table 1.1: Comparison of Energy Use

Economy	Commercial energy use					Net energy imports	
	Thousand metric tons of oil equivalent		Per capita			% of commercial energy use	
			kg of oil equivalent	Avg. annual % growth			
	1990	1997		1990	1997	1990-97	1990
Bangladesh	20,936	24,327	190	197	1.0	10	10
Low income (average)	1,122,683	1,194,696	607	563	-1.2	-17	-9
Lower middle income (average)	2,426,917	2,384,856	1,302	1,178	-1.2	-18	-20
South Asia (average)	435,330	556,496	394	443	1.9	9	15
World	8,608,414	9,431,190	1,705	1,692	0.0	--	--

Source: World Bank, "World Development Report 2000/2001: Attacking Poverty," Selected World Development Indicators, Table 10, Energy Use and Emissions (New York: Oxford University Press, 2001), <http://www.worldbank.org/poverty/wdrpoverty/report/index.html>.

Different Sources of Energy Generation in Bangladesh

Bangladesh is not well endowed with conventional sources of energy. The country's energy sources are neither adequate nor varied. Non-commercial sources of energy include biomass fuels, agricultural residues, tree residues, and animal dung. The country receives 5.05 to 8.76 kWh (kilowatt hours) from solar radiation, but commercial photovoltaic generation is too expensive for Bangladesh. Conventional commercial sources of energy in the country include fossil fuels, such as coal, oil, natural gas and hydropower. A brief accounting of these commercial sources of energy in Bangladesh has been provided below.

- **Coal:** The total reserves of coal in the country are estimated at about 1.75 billion tons,² but at present underground mining has been initiated only at Barapukuria (one of the major coal deposits), with a production level of one million tons per year.

- **Peat:** Bangladesh has approximately 173 million tons of peat deposits throughout the country. Production has yet to begin because it has not been considered as cost effective as other energy sources, given the country's existing technology.
- **Oil:** A very insignificant reserve of oil was found in Bangladesh serendipitously, in 1986. The country possesses a small proven oil reserve of 56.9 million barrels.³ Between 1987–94, about 0.65 million barrels of crude oil was produced. But the production was suspended in 1994 and has remained inactive due to techno-economic considerations.
- **Hydropower:** Being essentially a delta, Bangladesh has limited hydropower potential. According to assessments reported in the Bangladeshi Government's Power System Master Plan 1995, the country has the potential to produce 755 MW (megawatts) of hydropower per day. At present, its sole hydropower plant's production capacity is 230 MW per day.
- **Natural gas:** In the overall energy picture, the country's natural gas endowment in comparison to other energy resources makes Bangladesh essentially a mono-energy country. It is estimated that Bangladesh's net recoverable reserves of natural gas (as of April 2002) lie in a range from 12.04 Tcf (trillion cubic feet) to 15.55 Tcf.

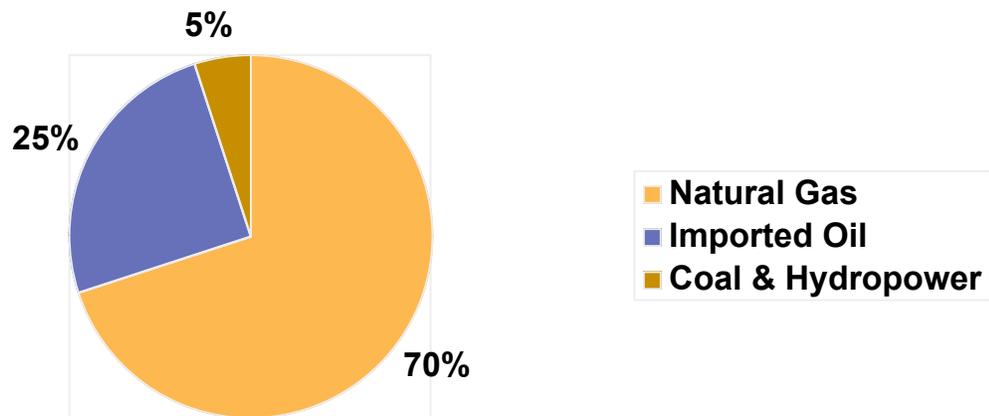
An Overview of the Energy Consumption Pattern in Bangladesh

Low availability of commercial energy can be a crucial obstacle to a country's economic development. Bangladesh's per capita energy use barely touched the 240 kgoe mark, which is the third lowest in South and South East Asia after Nepal and Cambodia. Most of it, however, is non-commercial energy. The country has huge unmet demand in commercial energy, reflecting the energy-starved condition of millions of people. Only 18 percent of the 134 million people in the country have access to electricity.⁴ The annual per capita consumption of electricity has been officially estimated at 112 kWh, which compares unfavorably with neighboring India's 440 kWh. Ironically, only 4 percent of the people in Bangladesh have access to indigenous natural gas.

Current Energy Balance

While the numbers are approximate, recent estimates for Bangladesh state that about 70 percent of energy needs are met by traditional or non-commercial sources of energy, which primarily come from agricultural residues, scrub wood, and animal dung. The remaining 30 percent of energy needs are met by commercial energy sources available in the country.

The trend of commercial energy consumption over the last ten years suggests that 70 percent of Bangladesh's total commercial energy was provided by natural gas, with the remainder almost entirely provided by imported oil, plus limited amounts of hydropower and coal (Figure 1.1).

Figure 1.1: Commercial Energy Consumption Trend in Bangladesh**Bangladesh: A Mono-Energy Country**

The national energy balance of Bangladesh clearly depicts that natural gas is Bangladesh's only significant indigenous source of commercial energy. It is the principal source of energy for the country's power, industry, commercial, and domestic sectors. Natural gas provides over 90 percent of Bangladesh's electricity, and is also the feedstock and fuel of the urea and ammonia fertilizer plants. Urea has helped Bangladesh attain self-sufficiency in rice production—the major local food crop. Natural gas at present is undoubtedly an important driving force of its economy. The future development of Bangladesh's economy depends largely on the government's ability to sketch out a natural gas strategy that offers the best prospects of utilization of this unique asset of the country.

PART TWO

Natural Gas: Exploration, Production and Consumption

Bangladesh is situated at the confluence of three major rivers—the Padma, the Jamuna, and the Meghna—that form one of the largest deltas in the world. The ongoing pressure of the Indian subcontinent tectonic plate against the Asian landmass over the millennia has created a north-south sedimentary fold-belt running the length of the eastern half of the country. This is a prime location for hydrocarbon resources.

Hydrocarbon exploration activity in this area has been ongoing since the beginning of the twentieth century. Natural gas was first discovered in Bangladesh in 1955 at Haripur. Since then, exploration of oil and gas resources has led to the drilling of sixty-four wells and discovery of twenty-two gas fields and one oil field. Petrobangla, a fully state owned corporation and its subsidiary companies, such as BAPEX, BGFCL and Titas Gas, are responsible for the exploration, production, transmission, distribution, and development of oil, gas, and other mineral resources of the country. Bangladesh Petroleum Corporation (BPC), another state-owned corporation, is responsible for the import of crude oil and other petroleum products, refining, and marketing of liquid petroleum products, including Liquefied Petroleum Gas (LPG). Recently, some private companies have been allowed to import bottles and market LPG for domestic consumption in areas where pipeline gas is not available.

BAPEX, a subsidiary organization of Petrobangla, is involved with gas exploration, although its financial resources are limited. Private sector interest and foreign direct investment in the gas sector became dramatically visible in the 1990s. At that time, the government of Bangladesh divided the country into twenty-three exploration blocks and offered them for private investment by international oil companies (IOCs) under Product Sharing Contracts (PSCs). The following five companies are producing gas:

1. Bangladesh Gas Fields Company Ltd. (BGFCL)
2. Sylhet Gas Fields Ltd. (SGFL)
3. Bangladesh Petroleum Exploration and Production Company Ltd. (BAPEX)
4. Shell Bangladesh Exploration and Development B.V. (SHELL)
5. UNOCAL Bangladesh Ltd. (UNOCAL)

Of these companies, the first three are state owned companies and the last two are IOCs involved in exploration and production of natural gas through PSCs with Petrobangla.

In the thirty-plus years since 1972, Bangladesh's national gas industry has received government funding of approximately Tk. 60 billion. The bulk of funding has been allocated to transmission and distribution, with only 16 percent, or around Tk. 9 billion (equivalent to about US\$ 300 million), expended upon exploration and development. The bulk of funding has been allocated to transmission and distribution, while the development and exploration activity are greatly underfunded for companies such as Petrobangla/BAPEX despite the discovery by Petrobangla of ten gas fields and one oil field. But the reserves of these fields are much smaller than those discovered by the IOCs. No discoveries took place after 1996 by Petrobangla. It is worth mentioning that the cessation of discoveries by Petrobangla coincides with cessation of exploration funding by the government to Petrobangla, which to some extent shows that available local expertise is not being used.

Product Sharing Contracts

The International Oil Companies engage in the exploration and production of the country's natural gas by signing Product Sharing Contracts with Petrobangla. An understanding of the relevant provisions of the PSCs would contribute substantively to a comprehension of the obligations of Petrobangla.

PSCs are structured so that an IOC makes an initial bid and, if successful, enters into negotiations with Petrobangla with respect to the contract's key elements. The initial bid proposes the critical features such as maximum cost recovery by the IOC, the share of production between the IOC and Petrobangla, and the price at which the IOC share of gas production would be sold to Petrobangla.

There are two elements of product sharing; one is termed as “cost recovery” and the other as “profit gas.” Under the PSCs, the IOC is similar to a contractor who gets paid for costs and risks from its share of the output from successful drilling. The IOCs are responsible for all losses related to unsuccessful drilling. In a successful field, the output is shared. First, up to some predefined maximum, the IOC receives a share of output characterized as “cost recovery” to compensate for the cost of exploration and production specific to that field. The residual quantum, known as the “profit gas,” is shared between the IOC and Petrobangla, based on the initial bid and subsequent negotiations.

Production costs are independently audited in each case of successful drilling, but in any case, the shareholders of the IOC have an incentive to keep costs down; cost overruns directly reduce the returns to shareholders. But it is worth mentioning here that the production costs of the international oil companies so far have been four to seven times higher than that of Petrobangla. The PSCs also stipulate that the price for offshore gas will be 25 percent higher than the price for onshore gas.

Under the PSC terms, Petrobangla is bound to purchase the IOC share of gas output. Currently Petrobangla is paying the IOCs at a rate of \$2.80 per 1,000 cubic feet, but selling the same at a subsidized rate of \$1.40 in the domestic market, resulting in a sizable burden for Petrobangla. By having to purchase 168 Bcf (billion cubic feet) of gas from mid-1998 up to April 2002, the corporation regressed from an initial position of profit to the point where it was showing a total loss of \$1.5 million.

The following tables demonstrate the results of product sharing in the case of two fields operated by international companies.

Table 2.1: Offshore and Onshore Profit Gas Volume Splits (Sangu Gas Field)

(note: CR=Cost Recovery; IOC=International Oil Company; PB=Petrobangla)

Block (field)	Type	CR % (Max)	Sharing of Profit Gas (For production level in MMcfd)									
			Up to 150		151 to 250		251 to 350		351 to 450		451 and above	
			IOC %	PB%	IOC %	PB%	IOC %	PB%	IOC %	PB%	IOC %	PB%
16 (Sangu)	On shore	55	45	55	35	65	25	75	15	85	12.5	87.5
	Off shore	60	Up to 100		35	65	25	75	15	85	12.5	87.5
			50	50								
			101 to 150									
			45	55								

Source: Article No. 13.6 (b) of the Product Sharing Contract

Table 2.2: Offshore and Onshore Profit Gas Volume Splits (Jalalabad Gas Field)

(note: CR=Cost Recovery; IOC=International Oil Company; PB=Petrobangla)

Field	Type	CR% (Max)	Sharing of Profit Gas (For production level in MMcfd)					
			Up to 150		151 to 300		301 and above	
			IOC%	PB%	IOC%	PB%	IOC%	PB%
			Jalalabad	Onshore	55	22.5	77.5	20

Source: Article No. 13.6 (b) of the Product Sharing Contract

Table 2.2 clearly shows that a sizable portion of profits is awarded to the oil companies operating in the fields. The Sangu PSC (Table 2.1) contains both onshore and offshore production splits during the major cost recovery period and afterwards. Because of relatively higher investment and a generally higher risk factor, the offshore provisions are comparatively more favorable to the contractor. The Jalalabad field, which was discovered by Petrobangla, was leased to an IOC for production. For that reason, and due to its being situated on shore, the contract provisions are relatively favorable to the Petrobangla corporation.

A History of Natural Gas Consumption in Bangladesh

The production of natural gas began in 1960, after its initial discovery in 1957. At that time, the annual consumption of natural gas in the country was only 1 Bcf, but this figure has risen so that natural gas is now the major fuel for power generation in the country. From only 67 Bcf in the first decade, the consumption of natural gas rose to 279 Bcf in the following decade, and thereafter to 1,067 Bcf during 1981–90. During the last decade (1991–2000), Bangladesh's natural gas consumption reached 2,490 Bcf.

Table 2.3: Gas Production and Consumption in Bangladesh

Year	Gas Production/Consumption (in billion cubic feet)
1961–1970	67
1971–1980	279
1981–1990	1,067
1991–2000	2,490

Until 1970, Bangladesh relied predominantly on oil for its energy needs. Beginning in the mid-1970s the country increasingly adapted to the use of gas. The increasingly high demand for natural gas during the 1980s reflected in Table 2.3 is clearly from fuel switching.

There are currently no exports or imports of natural gas, so the growth of domestic consumption tracks the growth of domestic production, demonstrating an overall growth rate of 7 percent per year over the last several decades. The initial level of consumption was so low that even with the rapid growth of demand, the total cumulative consumption of natural gas has only been 3.9 Tcf (trillion cubic feet).

In Bangladesh, natural gas has played a vital role in the development of both the power and fertilizer sectors, which consume almost 80 percent of total gas production. In the last decade (1991–2000), gas consumption for power was 1,103 Bcf, while the consumption for fertilizer production was 756 Bcf, out of a total consumption of 2,490 Bcf. Thus, the country's annual fertilizer production of more than two million tons, and annual power generation of 3,500 MW (megawatts) would have been very difficult and expensive without natural gas. Other consumers for natural gas have been industry, commercial concerns, and households (mainly for cooking).

Current Consumption of Natural Gas

During 2001–02, the average gas consumption of Bangladesh was 1,054 million cubic feet per day (MMcfd). Table 2.4 shows the sectoral distribution of daily average gas consumption of the country for the year 2001–02.

Table 2.4: Sectoral Breakdown of Average Gas Consumption of 2001–02

Sectors	Gas consumption in MMcfd (million cubic feet per day)
Power	475
Fertilizer	250
Domestic and Commercial	130
Industry	129
Others Plus Loss	70
Total Daily Average	1054

Source: Committee Report on Utilization of Natural Gas in Bangladesh, prepared for the Ministry of Energy and Mineral Resources, Government of Bangladesh, August 2002. Available from Government of Bangladesh, Energy and Mineral Resources Division, <http://www.emrd-gob.org/>.

Natural Gas Reserves and Future Consumption Projection in Bangladesh

Quantification of an energy source such as natural gas reserves is vital for both the short- and long-term energy sector planning and investment for Bangladesh. Reserve estimation is a dynamic process, since estimated reserves need to be updated with additional pressure/production data and with new appraisal and development related information. All estimated reserve figures are associated with certain degrees of uncertainties, since exact reserves of the country cannot be precisely known until the gas fields are actually depleted.

A number of studies have been conducted on the issue of gas field reserves in Bangladesh beginning in the mid-1970s. These studies have followed different methodologies, timelines, and criteria. Moreover, some of the studies conducted by various agencies/organizations were for a limited number of fields, while others were for countrywide assessment. A number of foreign countries provided technical assistance in gas sector development and in assessing the gas reserves of the country. In 1979, Petroconsultant undertook the first significant effort for a gas inventory in the country, after which many other studies were conducted.⁵ Apart from these studies, the only published data on a reserves study was from the Petroleum and Mineral Resources Engineering Department of Bangladesh University of Engineering and Technology (2001).

The Committee for Gas Demand Projections and Determination of Recoverable Reserve and Gas Resource Potential in Bangladesh, appointed by the Ministry of Energy and Mineral Resources, undertook the difficult task of reviewing all the existing studies in order to quantify more accurately the country's gas reserves. The committee, which submitted its report to the government in June 2002, concluded that as of April 2002 the proved plus probable reserves fell between 12.04 Tcf and 15.55 Tcf for the twenty-two gas fields. The possible gas initially in place (GIIP) was estimated to be in the range of 4.14 Tcf to 11.84 Tcf. According to this study, the undiscovered gas resources of the country range from 8.43 Tcf (95% probability) to 65.70 Tcf (5% probability).

The committee's findings include an energy demand projection for the country, estimating the need for natural gas to the year 2050 as follows:

- In the event of low growth rates (3% GDP), the total gas requirement will be between 40 and 44 Tcf.
- If the economic performance continues at around a 4.55% GDP growth rate, according to historical trends, gas requirements will be between 64 and 69 Tcf.
- At a higher growth rate of 6% GDP, gas requirements will be between 101 and 110 Tcf.
- Gas requirements are projected to be between 141 and 152 Tcf, given a 7% GDP growth rate.

PART THREE

Gas Utilization Strategy Options for Bangladesh

Natural gas is a versatile product that can be used as a fuel or as a feedstock for conversion to higher-priced products. Unlike other fuels such as oil, natural gas has a relatively low energy content per unit volume, making it expensive to transport. Therefore, the actual use of gas is dependent upon the location and size of the gas source and the surrounding market environment.

The government of Bangladesh recently formed a committee comprised of the country's top economists, researchers, and chemical and mineral resources engineers whose goal it was to examine and assess the most profitable domestic applications and alternatives for the country's gas, and its cross-border trade prospects. The end product of their study, entitled the "Committee Report on Utilization of Natural Gas in Bangladesh," was completed in August 2002, and examines several gas utilization options, differentiated here according to fuel forms.

Concentrated Natural Gas (CNG)

The use of CNG as a transport fuel holds great promise for Bangladesh. This fuel is a well-established method of natural gas utilization because of its low cost, environmental friendliness, and its clearly demonstrated financial viability. First, vehicles fueled by CNG have a far lower rate of toxic emissions than either gasoline- or diesel-fueled vehicles. Second, the direct and foreign exchange cost savings from making even a partial substitution of fuels would be considerable, due to the fact that operational costs are so much lower. For example, the cost for driving a gasoline-driven vehicle is Tk. 245 (\$4.20), compared to only Tk. 42 (\$0.72) for CNG over the same distance.

Although in theory CNG use in the transport sector is a completely viable option, in practice it can be quite difficult to achieve. The conversion from gasoline- to CNG-fueled vehicles may be a comparatively easier process than the conversion of diesel-fueled vehicles. The Committee Report provides figures for numbers of conversions, correlated with projections in associated gas demands in 2010:

Table 3.1: Gas Demand as Correlation of Number of Vehicles Converted to CNG Fuel

(Note: The conversions are for medium sized vehicles. Large [buses and minibuses] and small [three- and four-wheelers] sized vehicles have been made equivalent to medium sized vehicles according to their CNG use.)

Scenario	Number Converted	Daily Gas Demand in 2010
Low conversion	50,000	50 MMcfd
Medium conversion	75,000	75 MMcfd
High conversion	100,000	100 MMcfd

Source: Committee Report on Utilization of Natural Gas in Bangladesh, prepared for the Ministry of Energy and Mineral Resources, Government of Bangladesh, submitted on August 2002.

By examining the projected consumption figures for CNG, it is clear that even if the target of "medium conversion" is achieved by 2010, it will not have a very appreciable impact on the overall daily consumption of at least 1,500 MMcfd. It will contribute to only a 5 percent increase in the overall daily energy consumption.

Gas to Liquids (GTL)

GTL production is based on the Fischer-Tropsch process, which involves the conversion of natural gas to higher hydrocarbons like kerosene, gasoline, and naphtha, depending upon the operating conditions and catalysts used.

Unfortunately, the production technology is not very selective, so that during the process a wide variety of byproducts are created which have very little market value in Bangladesh.

The Committee Report concludes that even though GTL is a commercial technology, financing might be difficult to obtain due to the technical and commercial risks involved. Furthermore, Bangladesh may not be a suitable place for this venture, since the gas prices would be considerably higher than for other locations. The Committee Report also found that the netback to the wellhead for gas used in the GTL process is much lower than either power or pipeline export.

Liquefied Natural Gas (LNG)

For natural gas that is remote from its market, one of the most common forms of long distance transportation is its movement in liquid form. However, natural gas liquefaction is a costly process, particularly as the low temperatures (-139°F to -258°F) require specialty metals. For an LNG project to be economically feasible, the plant production capacity should be at least 2000-3000 kilotons per year, requiring 0.11-0.16 Tcf of gas. LNG export would thus require substantial investment and considerable captive gas. The Committee Report concludes that LNG netback appears to be poorer than other available options.

Ammonia and Urea Fertilizer

The production of urea is one of the best ways of utilizing natural gas, not only because the production technology is standard and mature, but also due to Bangladesh's extensive experience in operating urea fertilizer plants. Around 30 percent of the country's natural gas is being used for fertilizer production. The following factors conspire against any potential benefits with regard to the export of fertilizer by Bangladesh:

- The low world market price of urea (\$120-\$130 per million ton) and ammonia
- The existence of more than 1,400 Tcf of stranded gas, the price of which varies between US\$ 0.50 to US\$ 1.00 per MMcf.
- Limited demand for urea and ammonia in the world market (total market around twenty million tons) because of significant increase in domestic production around the world.
- The Committee Report's analysis of fertilizer plants shows that even in the best case (urea price US\$ 170, interest rate 10%), the netback to the wellhead is approximately one dollar less than the ceiling purchase of natural gas from the IOCs.

Table 3.2: Brief of Netback Calculation for Urea Fertilizer

	Urea Price (US\$ / Ton)	Interest Rate (%)	Netback (US\$ / MMcf)
Case I	130	12	-0.10
Case II	150	12	0.62
Case II	170	12	1.33
Pessimistic	130	14	-0.67
Optimistic	170	10	1.87

Source: Committee Report on Utilization of Natural Gas in Bangladesh, prepared for the Ministry of Energy and Mineral Resources, Government of Bangladesh, submitted on August 2002.

Electricity

Analysis of options related to the export of electricity is far more complex than that related to fertilizer exportation, due to the volatility of available technical and financial data. Profitability for this resource option is dependent on several parameters, including power plant capacity in megawatts, transmission charges, the price of electricity, and interest rates. Assuming the most optimistic values (high capacity, low transmission cost, high electricity price, and low interest rates), profitability as measured by the netback to the wellhead appears extremely favorable. Conversely, assuming the most pessimistic circumstance, netback drops sharply. Thus, if the project is designed in such a way that the parameters move towards their optimistic values, it might be possible to export electricity. For example, if the barriers to the construction of the long transmission line are carefully removed, the profitability of the project will increase.

PART FOUR

The Debate over Natural Gas Export from Bangladesh

Gas export has remained an issue of contention ever since a number of gas fields were discovered by Petrobangla, along with the involvement of the International Oil Companies in the late 1990s. Disagreements over the issue of gas exportation differ on various levels.

The question of gas export has remained a highly politicized issue. Public sentiment is generally against gas export and the expert community of the country is deeply divided over this issue. In recent years, the issue of natural gas export has been widely discussed in the media by the country's leading experts and economists. Intense domestic criticism of the idea of gas exportation has prompted successive governments in Dhaka to put off any decision in favor of exporting because of its potential political consequences. Interestingly, the two main political parties of Bangladesh—the Bangladesh Nationalist Party (BNP) and the Awami League (AL)—only vehemently oppose export while they are in the opposition, in order to gain popular support. Prime Minister Khaleda Zia's Bangladesh Nationalist Party opposed gas exports while it was in opposition from 1996 to 2001. After forming the new government in October 2001, the BNP lawmakers in a number of public statements demonstrated subtle indications of a possibility of gas exportation if needed. In an interview given to BBC, Bangladesh's Energy Minister, Mosharraf Hossain, commented that "if exporting is found to be economically beneficial, the government will definitely decide to allow it."⁶ Finance Minister Saifur Rahman also stated that the administration of Prime Minister Zia might go for natural gas export "provided that it is beneficial for the country" and that "no resource in the true sense is a resource if it remains under the soil."⁷ These indications have come under tremendous pressure from the general people and the government has now declared that the country should first be assured of fifty years of reserves before any decision on export is taken. Arguably, over-politicization of the issue is depriving the country of an effective policy framework to deal with the issue of export.

As previously mentioned, over a period of thirty years since 1972 the total government funding for Petrobangla has been only US\$ 300 million for exploration and field development purposes. Nevertheless, out of the twenty-two gas fields discovered in all, Petrobangla has discovered ten gas fields and one oil field. At the same time, it is true that reserves of these fields are smaller than reserves discovered by the International Oil Companies. BAPEX, the lone state-run exploration company in the country, is not getting sufficient government funding to undertake new exploration. A government decision on May 25, 1994 entitled BAPEX to receive four percent of revenue earned from the country's total gas sales, about half of which was allocated exclusively for exploration. Later, the share of new exploration was decreased to one percent, and BAPEX has yet to receive the money for exploration.⁸ These facts show that the country has the needed local expertise, but that the government is unable to provide the necessary funds for exploration and development of natural gas.

Under the present conditions, the equation is very simple: with a current proven reserve of 15.1 Tcf, and domestic consumption of 1,054 MMcfd, it will take little more than fifteen years to deplete the resource. It is clear that the availability of new gas must be ensured by 2015 at the latest. If further exploration and production does not take place, the country may have to consider importing gas after 2020, until production from newly discovered fields commences.

Finding new gas would mean undertaking costly and extensive exploration, which the government can hardly afford. At the same time, Bangladesh is under pressure from the IOCs, foreign aid donors, and development banks like the Asian Development Bank and the World Bank to generate revenue by exporting gas, mainly to its closest market, India.

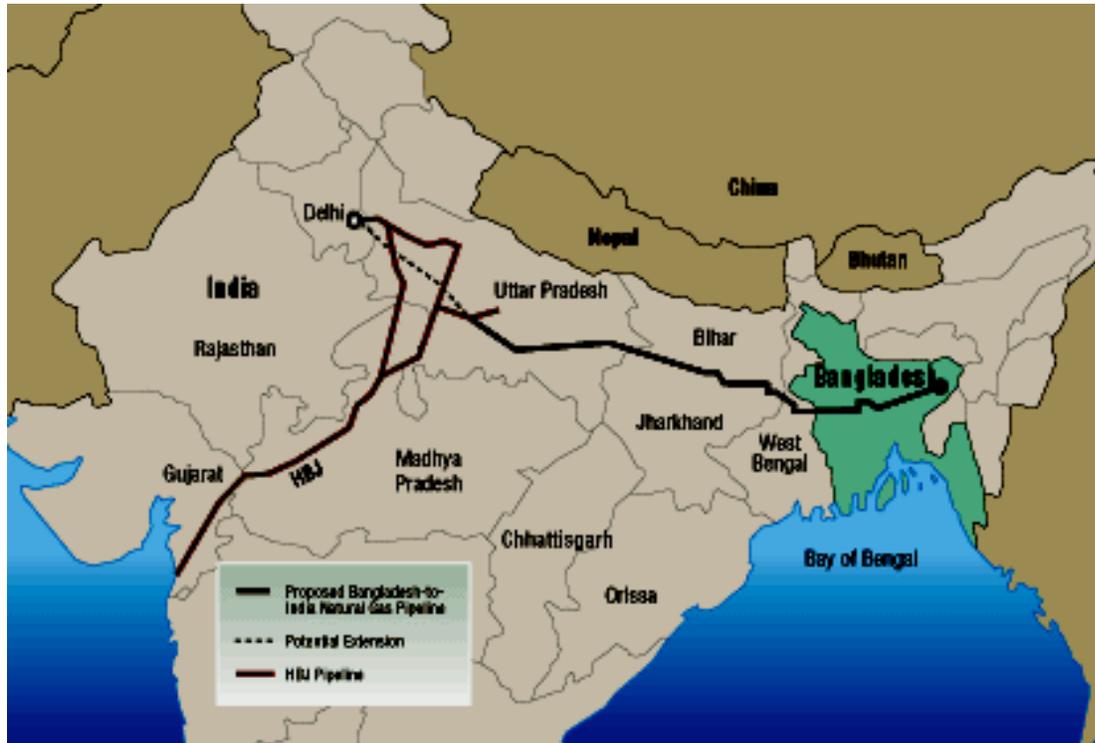
The government of Bangladesh is now facing competing pressures of financial obligation and gas reserve insufficiency, exacerbated by the urgent need for exploration and development.

The Issue of Gas Exportation to India

The issue of pipeline gas exportation to India was first raised three years ago by Unocal, an American oil company operating in Bangladesh. Unocal Corporation has submitted a gas pipeline proposal to the government of Bangladesh, which includes the construction of a thirty inch diameter, 847 mile (1,363 kilometer) long

pipeline with an initial capacity of 500 Mmcf of gas, from northeastern Bangladesh (from the Unocal-developed gas field Bibiyana) to New Delhi with an extension (Figure 4.1).

Figure 4.1: Proposed “Bangladesh-India Natural Gas Pipeline” by Unocal



Source: Unocal Corporation, Bangladesh-to-India Natural Gas Pipeline, <http://www.unocal.com/globalops/b-ipeline/index.htm>.

Through this pipeline, Unocal is proposing to export 3.65 Tcf of natural gas in twenty years at a rate of 500 MMcf. According to Unocal projections, the government of Bangladesh is expected to receive an estimated US\$ 3.7 billion (approximately 200 billion taka) in revenues and tax receipts. This proposal is still awaiting approval from the government of Bangladesh.

With scenarios such as the Unocal pipeline in the balance, two distinct groups have emerged who put forward their ideas and arguments for and against gas export by Bangladesh. These arguments can be summarized as follows:

Arguments Against Export

- The proven reserves of 15.5 Tcf of gas, by no means a huge amount, is inadequate to meet the country's mid-term domestic demand.
- Regarding the economy of gas export, taking the Unocal proposal as an example, the country's earnings are a projected US \$3.7 billion, but it will take twenty years to earn. When the country's annual export income is over US\$ 6 billion, annual income of US\$ 160-185 million from gas will not be very impressive.

- As mentioned earlier, purchasing gas from the IOCs has become too much of a burden for Petrobangla, for which export could be a possible solution. However, some economists assert that gas purchase liability can be managed by the government. The amount of money payable to IOCs is 2.3% of the current export earning and is likely to come down to only 0.64% in 2020.
- Domestic use of natural gas is far more beneficial for the Bangladeshi people as consumers than exportation, because this is the cheapest source of energy for the country.

Arguments in Favor of Export

- Immediate revenues, especially in foreign currency, are something the government needs urgently, as well as immediate investment for energy sector reform. The World Bank has estimated that Bangladesh loses around US\$ 1 billion per year due to power outages and unreliable energy supplies,⁹ It also needs money to provide necessary funding for Petrobangla so it can stand again as a viable institution and take the responsibility of gas exploration and production. These much needed dollars can come from gas export revenues.
- The government of Bangladesh at present does not have the funds to accelerate new exploration works to even keep pace with the country's domestic demand.
- IOCs have already discovered more than 4 Tcf of gas in the last five years, so there is no reason why they should develop these fields or explore more fields if they do not have the market for their production.
- IOCs are still not receiving their full and timely payment from the government for the gas sold to Petrobangla due to the government's financial constraints. Thus, export will be an incentive for the IOCs to invest more and accelerate the process of exploration and development.
- As a country heavily dependent on foreign aid, Bangladesh cannot ignore the external pressures from investors and donors who are in favor of exporting gas.

Under these circumstances, if put in a simplistic manner, the decision to export would depend upon the size of reserves and the future demand-supply projection of natural gas. In the case of reserves, vast differences prevail in estimates of the gas potential of the country. Although optimistic forecasts estimate the existence of 60 to even 100 Tcf of potential reserves, these forecasts remain speculative and need to be backed by more concrete studies. A number of active gas fields in Bangladesh have performed below their initial forecast. For example, Chattak gas field was estimated to have 1 Tcf of natural gas, but was abandoned after producing only 26.5 Bcf. Bakhrabad, another significant gas producing field of the country, has brought its realized yield down to 50 MMcfd instead of producing 200 MMcfd as originally estimated.¹⁰ An opposite view predicts a demand based on the level of energy consumption required for ensuring economic growth, and estimates a gas requirement of approximately 28 Tcf to increase per capita energy consumption from the current 197 kgoe to at least 260 kgoe (an energy consumption level currently prevailing in India).¹¹ The issue of natural gas export from Bangladesh, therefore, demands more examination and evaluation. The government needs to develop a pragmatic strategy that will fit into a long-term energy policy of the country, which can make "realistic assessments of the availability of gas and relate this to a dynamic forecast of the volume and composition of energy demand made under alternative assumptions."¹²

PART FIVE

Recommendations and Conclusion

It is clear that energy is a crucial national issue, and natural gas is an invaluable resource. The poverty-ridden country of Bangladesh, which is still struggling hard with its development, cannot afford to make mistakes regarding the utilization of natural gas. At present the whole country is intensely focused on this debate, but the solution to its long-term energy security does not depend only on the decision of whether or not to export. Whether it exports or not, Bangladesh is going to run out of conventional natural gas anyway, either within twenty years, or at best within fifty years. The country should focus more on its long-term energy security. The export decision should be a part of the country's broader energy policy. It is indeed a good sign that the people of Bangladesh are deeply concerned with the issue of export; such concerns prove the existence of democracy. In truth, the whole process of decision making should be more transparent and open to the public. The people of Bangladesh are demanding to see a comprehensive strategic plan from the government that clearly outlines how the government would address expansion of rural electrification, ensuring uninterrupted domestic energy supplies and increasing efficiency among the various energy agencies by means of a thorough energy sector reform plan.

The foreign oil companies are not well regarded by many Bangladeshi citizens. Most consider the Product Sharing Contracts under which the companies are operating to be disproportionately beneficial to the companies, depriving the people of their share. Therefore, the general people are suspicious about the IOC's pressure toward a quick export decision. Targeting the IOCs for blame is simplistic, ignoring the greater issues. Like any other investor, oil companies need to show return on investment for their shareholders. It is the role of Bangladesh itself to create all safeguards and uphold the country's interests.

Bangladesh has top quality gas, which is the country's most readily usable and least expensive commodity. If the country could find ways to connect each home and industry with uninterrupted supplies of natural gas, and at the same time export value added products, that will offer a competitive advantage for Bangladesh. In that way, the economic and social benefit would be immense. Although any source of electricity gives around thirty percent efficiency, the direct use of gas gives an efficiency better than ninety percent. It is indeed an irony that, despite being blessed with such an energy asset, Bangladesh is one of the most energy starved countries in the world, lagging far behind in its development process. It is incomprehensible why the whole country cannot be networked with natural gas. Concerns over what the government is doing to meet the country's future demand of electricity through increasing use of indigenous natural gas have remained unanswered. In the event that the government finds the option of export to be an economic imperative, the decision must be made in a convincing and transparent manner, free of ambiguity. In case of such a decision, citizens of Bangladesh would like to see how export activities fit into the country's larger long-term energy policies and how the common people—the owners of this resource—will benefit from export earnings. In this case, the need for transparency cannot be emphasized more strongly. Judging from the level of corruption that exists in the country, the potential for more of the same can hardly be ignored. The government should provide a straightforward accounting of what it intends to do with the moneys saved through gas export.

The whole export-economics should be made clear to the public before any policy decisions are made. A detailed risk analysis of the construction of pipelines and a cost-benefit analysis of different options of export has to be calculated. The people would like to know the mechanics of export and every detail of the contract signed with the oil company, and also with the importing country. Moreover, the long-term framework under which investors may operate—such as the rights of the companies engaged in gas exploration and production and their obligations in relation to the government—should be transparently developed and consistently implemented.

But export or no export, for the long-term energy security of the country the government needs to take some concrete steps. The following are recommended:

- There is a need for the government to launch a vigorous campaign to attract foreign and local investment in the energy sector. Bangladesh's energy sector has every potential to attract foreign direct investment for small and medium range industries, which use natural gas as raw material. For example, the Chinese Shenzhen Huxian Group has already shown interest in investing US\$ 600 million to set up

a methanol synthesis manufacturing company in Bangladesh.¹³ The government could provide various incentive packages to attract Specialized Engineering Firms, such as Lummus ABB, that are in the business of setting up petrochemical and other related factories.¹⁴

- At present, Petrobangla and its subsidiaries, like any other government organization, have become much less effective. The government fund allocations for these agencies are far from adequate. It is imperative that the government considerably increase funds and provide facilities to these organizations so that they can stand as viable and effective organizations again, and take up the role of gas exploration and production of gas, eventually ending the country's dependency on foreign oil companies.
- The government should develop institutions and train more people in the energy sector, particularly in the areas of petroleum and natural gas engineering, gas processing, transmission and distribution, in mining and refining, and in geological and economic studies. Doing so would be a long-term investment requiring sustained effort, but it would reap significant rewards in the future.
- Bangladesh should use gas export as a bargaining chip in negotiations with India to provide duty free access to the latter's products, a demand long denied by India.
- Regional cooperation is a major component of an efficient allocation of resources, as many of the energy resources yield optimal benefits when exploited by two or more countries based on their respective comparative advantage in gas production, processing, marketing, and distribution or utilization. Thus, effective and appropriate regional cooperation could be one possible solution to long-term energy provisions for the region in general and Bangladesh in particular. Bangladesh is strategically located between two major economic regions—South Asia and Southeast Asia. Surrounding areas have both huge demand for energy and rich potential for energy resources. Nepal, Bhutan, and northeast India have resources to support hydro-electricity generation. Despite all the limitations and imbalances within these countries, the prospects for long-term regional energy cooperation look attractive. In this regard, Bangladesh does not necessarily have to confine itself to cooperation within South Asia, but can also actively cooperate with neighboring Southeast Asian countries. Bangladesh is already a member of organizations like the South Asian Regional Energy Coalition (SAREC)—comprised of Bangladesh, Bhutan, India, Nepal, Maldives, and Sri Lanka—and Bangladesh, India, Myanmar, Sri Lanka, Thailand Economic Cooperation (BIMSTEC), where the energy sector is one of the priority areas. At present, Bangladesh needs to assess its options through detailed project analyses. Whether Bangladesh decides to export gas or not, any pipeline going through its land as a part of a regional pipeline network may have positive results for the country. A gas pipeline network in the South Asia region would also allow importation from member countries from outside the region. Thus it could be concluded that it is in the long-term interest of Bangladesh to actively situate itself in the emerging South Asia and Southeast Asian energy system as a supplier, delivery agent, and consumer.

NOTES

¹ World Bank, "World Development Report 2000/2001: Attacking Poverty," Selected World Development Indicators, Table 10, Energy Use and Emissions (New York: Oxford University Press, 2001), <http://www.worldbank.org/poverty/wdrpoverty/report/index.html>

² Shakti: Energy and Environment Related Information Source of Bangladesh, "Coal Reserves of Bangladesh," <http://web.archive.org/web/20030727205923/shakti.hypermart.net/fossil/coal.html>.

³ United States Department of Energy, Energy Information Administration, Country Analysis Brief on Bangladesh, May 2003, <http://www.eia.doe.gov/emeu/cabs/bangla.html>.

⁴ Energy Information Administration, Country Analysis Brief on Bangladesh, May 2003, <http://www.eia.doe.gov/emeu/cabs/bangla.html>.

⁵ Petrobangla (1981), Degolyer & MacNaughton (1984), German Geological Advisory Group (GGAG, 1986), Hydrocarbon Habitat Study of Bangladesh (HHSB, 1986), Gasuine (1989), Welldrill (1991), IKM (1991), Clyde Petroleum (1995), Nico/BAPEX (1997), Petrobangla/Biecip-Franlab (2000) and Hydrocarbon Unit/Norwegian Petroleum Directorate (HCU/NPD, 2001).

⁶ Walliur Rahman, "Bangladesh Edges toward Gas Export," BBC News, October 31, 2001, http://news.bbc.co.uk/1/hi/english/world/south_asia/newsid_1630000/1630925.stm

⁷ "Bangladesh in Debate over Natural Gas Export," Alexander's Gas and Oil Connections, News and Trends: East and Southeast Asia, Volume 6, Issue 24, December 19, 2001, <http://www.gasandoil.com/goc/news>.

⁸ "Bleak Future Awaits for Hydrocarbon Sector," *The Independent* (Dhaka), April 23, 2003.

⁹ United States Department of Energy, Energy Information Administration, Country Analysis Brief on Bangladesh, May 2003, <http://www.eia.doe.gov/emeu/cabs/bangla.html>.

¹⁰ Azim Uddin Ahmed, "Development of Gas Sector in Bangladesh: Status, Policy Options and Challenges," in *Changes and Challenges: A Review of Bangladesh's Development 2000*, ed. Rehman Sobhan (Dhaka: Centre for Policy Dialogue, University Press, 2001).

¹¹ Ibid.

¹² Ibid., 179.

¹³ "Chinese Firm Plans \$600M Energy Sector Investment," *The Daily Star* (Dhaka) 3, No. 1250, March 19, 2003, <http://www.thedailystar.net/dailystarnews/200303/19/n3031905.htm>.

¹⁴ Ibid., 11.

SELECTED BIBLIOGRAPHY

Books and Articles

- The Bangladesh Observer* (Dhaka). "Bangladesh—An Energy Hub in the Making?" December 23, 2002.
- Bhattacharya, Pallab. "Indian Firms Finalise Plan to Take in Bangladesh Gas." *The Daily Star* (Dhaka), November 20, 2002.
- The Daily Star* (Dhaka). "Gas Export Will Seriously Harm Energy Security" (editorial). November 13, 2002.
- . "International NGOs against Gas Export from Bangladesh" (editorial). January 22, 2003.
- Fesharaki, Fereidun. "Bangladesh Natural Gas Exports to India: LNG Alternative with Narrow Window." *Oil and Gas Journal*, June 19, 2000.
- Imam, Badrul. "How Much Gas Does Bangladesh Have?" *The Daily Star* (Dhaka), November 8, 2002.
- . "Why Gas Export Cannot Be Justified." *The Independent* (Dhaka), December 19, 2002.
- Jaccard, Mark, Mujibur Rahman Khan, and John Richards. *Natural Gas Options for Bangladesh*. CPR Commentary no. 1, Centre for Policy Research (Dhaka), winter 2000.
- Kamal, Nuruddin Mahmud. "Moving towards Gas Famine?" *The Daily Star* (Dhaka), November 15, 2002.
- . "Gas Export: Not a Window of Opportunity." *The News Today* (Dhaka), December 12, 2002.
- . "The Tricky Business of Gas Exploration." *The Daily Star* (Dhaka), December 13, 2002.
- Khan, Zayd Almer. "Gas Export to Sail through Current JS Session." *The Holiday* (Dhaka), January 31, 2003.
- Lama, Mahendra P. "Economic Reforms and the Energy Sector in South Asia: Scope for Cross-Border Power Trade." *South Asian Survey* 7, 1 (2000).
- . "Energy Cooperation in South Asia: Issues, Challenges and Potentials." *South-South Solidarity* (New Delhi), November, 1999.
- Lama, Mahendra P., and Rasul Bakhsh Rais. *Pipelines and Powergrids for Peace*. Mumbai: International Centre for Peace Initiatives, 2001.
- Mokkaram, Golam. "Can Bangladesh Afford to Export Gas?" *The Daily Star* (Dhaka), May 10, 2000.
- Rahaman, Mohammad Mozahidur. "Selling the Nation's Soul." *The Daily Star* (Dhaka), December 14, 2002.
- Shamsuddin, A.H.M. "Natural Gas Development Issues: The Need for Gas Export before Competition Destroys Demand." *The Holiday* (Dhaka), November 22, 2002. <http://www.weeklyholiday.net/221102/inret.html>.

Documents and Studies

- Asian Development Bank Bangladesh. "ADB's Proposed Gas Sector Development Project." ADB News Release. Dhaka, August 5, 2002.
- Centre for Policy Dialogue. "Energy Sector Restructuring: Current Issues." *CPD Dialogue Report*, no. 33. Dhaka, October 2000.
- . "Negotiating Strategies for the Development of Bangladesh's Energy Sector." *CPD Dialogue Report*, no. 7. Dhaka, September 1999.
- . Policy Brief on "Development and Governance of the Energy Sector," *CPD Task Force Report*. From "Election 2001: National Policy Forum," organized by Centre for Policy Dialogue, *Prothom Alo*, and *The Daily Star*, Dhaka, August 20-22, 2001.

- . “Optimising Use of Bangladesh’s Gas Resources.” *CPD Dialogue Report*, no. 14. Dhaka, October 1999.
- . “Regional Cooperation in the Energy Sector.” *CPD Dialogue Report*, no. 42. Dhaka, January 2002.
- Committee Report on Utilization of Natural Gas in Bangladesh*. Prepared for the Ministry of Energy and Mineral Resources, Government of the People’s Republic of Bangladesh. Dhaka: August 2002. Available from Government of Bangladesh, Energy and Mineral Resources Division, <http://www.emrd-gob.org/>.
- Goswami, Rajnish. “Bangladesh-India Gas Trade Potential: The Economics of Pipeline vs. LNG.” Paper presented at the Bangladesh-India Chamber of Commerce and Industry Energy Cooperation Roundtable, Dhaka, May 23, 2000.
- Khan, Aziz M.A., and Muhammad Imaduddin. “Midterm Gas Demand-Supply Scenario and Gas Reserve of Bangladesh.” Paper presented in the 2nd Petroleum Engineering Symposium 1999, organized by Petroleum and Mineral Resources Engineering Department, BUET, May 24-25, 1999.
- Klett, Timothy R. *USGS World Petroleum Resources Assessment Methodology*. U.S. Geological Survey. February 2001.
- Malla, Shanker K. “SACEPS Task Force Report on Energy Cooperation in South Asia.” Institute for Integrated Development Studies (IIDS), Katmandu, Nepal. South Asia Centre for Policy Studies (SACEPS), August 2002.
- Quader, A.K.M.A., and Edmond Gomes. “An Explanatory Review of Bangladesh Gas Sector: Latest Evidence and Areas of Further Research.” Paper presented at the CPD Dialogue on “Energy Sector of Bangladesh: What Are the Knowledge Gaps?” Centre for Policy Dialogue, Dhaka, January 24, 2002.
- Report of the Committee for Gas Demand Projections and Determination of Recoverable Reserve and Gas Resources Potential in Bangladesh*. Prepared for the Ministry of Energy and Mineral Resources, Government of the People’s Republic of Bangladesh. Dhaka: June 2002. Available from Government of Bangladesh, Energy and Mineral Resources Division, <http://www.emrd-gob.org/>.