Natural Gas Management of Bangladesh: Future Powerhouse of South-East Asia?

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Abstract

Already Bangladesh has proven to be a natural gas giant in the region and to the energy producing community of the world. The Bangladesh sub-surface is according to the present knowledge mainly gas prone, with some potential for future oil discoveries. Within the 1,44,549 sq km of its political territory, Bangladesh has 23 gas fields with some more fields yet to be declared officially as gas fields. Total of 67 exploratory wells including 13 in offshore area have been drilled so far in Bangladesh. The success ratio till now is very encouraging 1:3.

In the present energy policy, the present onshore and offshore area of the country has been divided in 23 exploration blocks. Under national and international seismic surveys already three new gas fields have been discovered with high reserve of gas and condensate.

The energy management of the country is thus become most vital for efficient use of its energy resources and the present energy management has been tested to be fruitful for future exploration, production, demand and supply. This sector therefore merits the more attention and importance in the planning of the country compared to any other sector. Under the present energy policy, the gas demand and supply forecast for the short, medium and long-term scenarios playing the "key role" in development of a gas field. Short and medium term gas demand would be normally met from gas fields close to the trunk lines that would call for a minimum project cost and time, while the long term customers would require dedicated large volume of reserves, field production facilities and transmission pipeline.

Development plan of a gas field is based on the initial evaluation of field reserves, well deliverabilities, reservoir fluid and reservoir driver. The essence of a gas field development and productions is to ensure maximizing recovery in a cost effective manner. That is why each field or reservoir is handled in an "asset management" approach during its life cycle right from discovery till its abandonment. In this southeast region, Bangladesh is comparatively in suitable position in terms of natural gas discovery and production that is powerful enough to lead a nation to gain economic boost. From the middle-east energy scenario, Bangladesh is determined to take important lessons to learn continuing its search for energy and to utilize the vast amount of energy resources that it has in a planned and systematic way.

This paper will show the ways to develop long term plans for effective management of the present and incoming gas fields of Bangladesh and will emphasize on the techniques to follow for proper development with time.

Introduction

Bangladesh is a country of opportunities, and the petroleum industry is one of the major sectors. Stable political climate, countrywide well established infrastructure, advanced telecommunication facilities, growing middle-class with substantial economic capacity and fast growing need for power have attracted International Oil Companies (IOC) to invest in the petroleum sector of Bangladesh. Bangladesh constitutes the largest deltaic basins of the world with up to 20,000 m of sediments deposited and has proven its ability to generate significant hydrocarbon resources through the discoveries of 23 gas fields **Fig.1** and 1 minor oil field.

Since 1984 several international oil companies were active in both onshore and offshore areas.

In addition to the state owned companies, Shell Bangladesh Exploration and Development B.V. (SBED) is producing gas from the offshore Sangu Gas Field. Occidental of Bangladesh (Oxy), a subsidiary of Unocol Corporation, is producing the Jalabad Gas Field. During the 2000-01 fiscal years SBED's average production was 129 Mmcfd and for Oxy the average production rate during the same year was 83 Mmcfd. In Bangladesh there is currently a well-developed system of pipelines for transport of gas in the northeastern and eastern part of the country. The total transport of gas through the country's pipeline system was in one year approximately 332 Bcf.

The block system was firstly introduced in Bangladesh in 1974 when six offshore blocks were awarded to six companies. They acquired 31,000 km (approx.) of seismic and drilled 7 wells. At present 9 National and International Oil Companies are working efficiently in the offshore blocks of Bangladesh.

Exploration History

The exploration activity of petroleum products is over 100 years old in Bangladesh first exploration activity started with some topographic maps of Chittagong Hill Tracts and some simplified surveys were done. The first exploration started from 1914 to 1933 by Burma Oil Company (BOC). The second of phase petroleum exploration began after partition of Indian subcontinent. Three international oil companies and the state owned oil company (OGDC) were active in different part of the country. During phase II, Shell Oil discovered the most successful drilling operation; Rashidpur, Kailashtila, Titas, Habigonj and Bakhrabad gas fields were discovered.

After the independence of Bangladesh in 1971, the petroleum exploration gathered pace. In this period, the first offshore gas field, Kutubdia was discovered. The country was first divided into 23 major blocks including offshore area. During 1995-2000, the foreign companies **Fig.2** drilled 10 exploratory wells and discovered 1 offshore gas field (Sangu in 1996 by Cairns Energy) and two onshore gas fields (Bibyana in 1997 and Moulovibazar in 1998). After some more successful drilling by Tullow Oil, Bangura gas field was discovered in 2004.

BAPEX, (Petrobangla exploratory subsidiary) drilled two wells and discovered two gas fields, i.e. Shahbazpur in 1995 and Saldanadi in 1996. BAPEX drilled one well in late 2004 and announced discovery of Srikail gas field in Comilla in January 2005. It is very interesting data that the national oil companies of Bangladesh have a discovery success rate over 80% **Fig.3** compared to the multinational oil companies. Digital multi fold seismic data acquisition started in 1977, when Prakla was engaged under the German technical Assistance Program. In 1978 Petrobangla started acquiring multi fold analog seismic data, **Fig.4** but in 1979 it moved into the digital domain. During 1986-87 Shell recorded over 1,500 km of multi fold data and these are available in BAPEX Data Center.

Geological Development

The geological history of Bengal Basin is related to the rifting and separation of the Indian Plate from the Gondwanaland. The separation of east Gondwanaland, comprising India,

Australia and Antarctica, took place in three major stages. During Paleocene/Eocene the present day Bengal Basin was part of a major basin streching from the Shan Massif in the east to the Indian Craton in the west. The initial collision with the Burmese Plate, probably during Late Eocene, resulted in rising of an Eocene island arc. This event created two basins; Errawady Basin in the east and Bengal Basin in the west.During Late Oligocene/Early Miocene the Bengal and Brrawady basins were finally separated. From then **Fig.5** onward due to subduction of the Indian Plate beneath the Burmese Plate and anticlockwise rotation, the basin started closing in the northeast and gradually turned into a remnant ocean basin.

The presence of source rocks is very crucial for any petroleum system, and in Bangladesh source rocks are present in Late Cretaceous through to Miocene strata. The discovery of the many gas fields in Bangladesh, testing of oil in a few, together with geochemical analysis of rocks, oil, condensate and gas, indicate that the sedimentary basin has passed through at least two phases of oil and gas generation. However, in two wells drilled in West Bengal just west of Meherpur-Chuadanga area of Bangladesh, the TOC content of Cretaceous sediments was 1.04-1.5%. The Cherra (Jalangi) Formation, deposited during Paleocene to Early Eocene, is considered to be a good source rock for the western region. However, in the vicinity of the Singra-Kutchma-Bogra, the unit has a good source rock potential, but is immature. TOC varies between 1 and 10%, and seismic data indicate that the sequence gradually dips down towards southwest, where it is expected to be mature and may generate hydrocarbon. TOC is 1-5%.

The Miocene Bhuban Shale is widely developed over the Bengal Basin, including the Eastern Foldbelt, and is probably the youngest source rock unit capable of generating gas. The sequence is poor to lean in terms of source rock potential, with TOC values averaging from 0.2-0.7%.

Proven reservoir rocks are known from wells drilled in the eastern folded belt of Bangladesh and they are all sandstone (clastic) reservoirs. The majority of these reservoir sandstones are Middle to Late Miocene of age, with porosities ranging from 15-33% and with permeability in the order between 20-330 md. In one gas field the permeability range between 1 and 4 dercy. These reservoir sandstones were deposited under generally coastal plain to shallow marine conditions, forming fluvial and tidal channel sandstones, tidal flat sands and sand bars, mostly wave dominated shore face deposits. In the eastern part the folded belt, upper part of the Upper Miocene sequence shows sandstone unit which is gas bearing in several fields.

The oldest reservoir rocks that can be considered prospective in Bangladesh are the Gondwana sandstones of Jurassic to Carboniferous age. The deposits also comprise subordinate clays and coal seams, the thickness of individual seams range up to 45 m or more. The Lower Gondwana succession was deposited in fluvio-deltaic environment and contains a high proportion of sandstones. The Upper Gondwana sandstones, deposited within a deltaic to shallow marine environment, can be regarded as a prospective reservoir rock.

Fields and Discoveries

At present 23 gas fields and 1 minor oil field have been discovered in Bangladesh of which 16 have been developed and set into production. The list below shows field, company and year of discovery of currently producing fields.

Sylhet (PPL,1955)
Rashidpur (Shell,1960)
Titas (Shell,1962)
Kailas Tila (Shell, 1962)
Habiganj (Shell,1963)
Bakhrabad (Shell,1969)
Beani Bazar (Petrobangla,1981)
Jalalabad (Scimitar,1989)
Narsingdi (Petrobangla,1990)
Meghna (Petrobangla,1990)
Salda Nadi (BAPEX,1996)
Sangu (Cairn,1996;offshore)
Bibiyana (Oxy/Unocal,1998)

In addition to the producing fields above, another seven are discoveries not yet in production, and these are:

Semutang (OGDC,1969)
Kutubdia (Union,1977;offshore)
Begumganj (Petrobangla,1977)
Fenchuganj (Petrobangla,1988)
Shahbazpur (BAPEX,1995)
Moulovibazar (Oxy/Unocal,1997)

The suspended fields are:

Chatak (PPL,1959)
Kamta (Petrobangla,1981)
Feni (Petrobangla,1981)

At present gas is being produced from 13 fields in Bangladesh: Titas, Sylhet, Rashidpur, Kailas Tila, Habiganj, Bakhrabad, Beani Bazar, Bibiyana, Jalalabad, Narsingdi, Meghna, Salda Nadi and Sangu.

Three national and two international companies are now operating the fields: Bangladesh Gas Fields Company Ltd.,Sylhet Gas Fields Ltd., Bangladesh Petroleum Exploration and Production Company Ltd., Occidental of Bangladesh and Shell Bangladesh Exploration and Development B.V. The current daily average gas production is approximately 1245 Mmcf.

All the gas fields produce some some condensate. The condensate production ratio varies from field to field within a range of 0.1-3.9bbl/mmcf except for Beani Bazar, Kailas Tila and Jalalabad Gas Fields. During 2000-01 Kailas Tila Gas Field produced 557,310 bbl condensate. The condensate/gas ratio is about 17.8 bbl/mmcf. Jalalabad is also rich in condensate and it produces at a rate of 12.3 bbl/mmcf. During 2000-01 condensate production was 337bbl/day or 1.231 mmbbl. Condensate reserves of the country were estimated 57 mmbl.

The gas production in Bangladesh has been increased significantly over the decades, driven by the domestic demand for production of electric power and further the needs of the fertilizer industry. The power industry is currently the major consumer, and the burning of natural gas produces 90% (approx.) of all electric power in Bangladesh. Gas consumption in other major industries; e.g. Cement, paper, tea states, pharmaceuticals, steel, brick fields are also steadily increasing, parallel to a distinct increase in the use of natural gas as a domestic fuel. At present **Fig.6** power industry consumes 48%, fertilizer 27%, other industries 13%, domestic fuel 10% and other system loss 2%.

The production of natural gas in Bangladesh commenced in 1961, when Chatak Field started production to supply gas to Chatak Cement Factory. This was followed by similar gas production from Sylhet Field in 1962, supplying Fenchuganj Fertilizer Factory with natural gas. In 1968 Titas Gas Gield started production, supplying gas to the Siddhirganj Power Station.

During these years the gas production has increased in manifolds; from 6 Bcf till 1970 to 4.3 Tcf till 2001. Bibyana gas Field is the latest to join in the production of gas fro discovered field. It is now producing at a rate of 220 Mmcf natural gas daily and expected to be doubled the production very soon.

Natural Gas Reserves

Natural gas reserve has been estimated by various companies or consultants for most of the gas fields of Bangladesh over the last two and half decades. Generally each field is evaluated upon its discovery and/or initial appraisal works. The working groups went through the SPE/WPC/AAPG adapted system as well as the CCOP system and prepared a proposal for Resources Classification System in Bangladesh. Of these works the IKM (Canada) study which was conducted during 1989-1992 constitutes the most comprehensive set of work.

Natural gas is presently playing the most vital role in the economic development of the country. The country so far has discovered 24 gas fields including two offshore ones. The total initial reserve in the 22 fields has been estimated almost 17 Tcf. The reserves of two gas fields discovered in the late 2004-early 2005 respectively are yet to be estimated (expected to be in the range of 0.2 Tcf –0.5 Tcf each). Cumulative gas produced till December 2003 is about 5.3 Tcf leaving a remaining gas reserve of 11.3 Tcf in the 22 gas fields.

Because of the increasing use of natural gas, the dependence on oil for electricity generation and other sectors has declined drastically over the past decade that saves a large amount of foreign exchange. During FY 2003, the 3.5 million ton oil import bill was about $600 million (Tk. 3600 crore). In this period consumption of gas was about 9.5 million-ton oil equivalent. If natural gas were not discovered, the country's oil import bill would have increased by another $1600 million (Tk. 9450 crore).

For the high potential of reserve yet to be discovered in the subsurface in Bangladesh, it has attracted several foreign investors in the hydrocarbon exploration sector and a number of International Oil Companies (IOCs) are active at present. These companies along with the national petroleum exploration company tend to express a seeming overoptimistic impression that Bangladesh is sitting on a huge natural gas reserve. For this the image of Bangladesh to the energy community of the world is changing from being a nation of too little wealth to one of the prospective natural gas province.

Gas reserves: Over the last few years, updating of the gas reserve of the country have been undertaken by more than one organization or government appointed body. The government appointed committee of experts, the "National Committee for Gas Demand Projection and Determination of gas Reserve and Resource Potential in Bangladesh", has done one of the comprehensive compilations of the up to date reserve data. In June 2002 the committee concluded its report and declared that the initial reserve (proved + probable) in 22 gas fields of the country is between 16.64 Tcf and 20.42 Tcf.

The gas reserve of Bangladesh by gas fields is shown in this table, which is 16.64 Tcf (proved + probable).

By December 2003, after consuming 5.31 Tcf of gas, the remaining gas reserve of the country, according to the estimate, stands at about 11.33 Tcf. A second estimate shows an initial reserve of 20.15 Tcf. By December 2003, after consuming 5.31 Tcf of gas, the remaining gas reserve of the country, according to the estimate, stands at about 14.84 Tcf.

The gas fields of Bangladesh may arbitrarily be divided into three size groups. Of the twenty four gas fields fields of Bangladesh, five are large fields (Titas, Habigonj, Kailashtila, Rashidpur and Bibiyana) each having initial reserve in excess of 1 Tcf gas and these, cumulatively contain about 68% of the total initial gas reserve of the country. According to the international classification of gas field by size (tiratsoo 1979) the Titas gas field falls in the 'Giant' class (at least 3.5 Tcf gas reserve by definition).

Bangladesh has a proved gas rich province in the eastern part. How much gas still remains undiscovered, has been a subject of much speculation and there have been several **Fig.7** studies by oil companies to suggest that. Among those studies two of the recent and widely publicized ones are: I) USGS-Petrobangla joint assessment of undiscovered gas resource and II) Hydrocarbon Unit-Norway Petroleum Directorate (HCU-NPD) joint assessment of undiscovered gas resources of the country.

I) Undiscovered resource estimate by USGS-Petrobangla: In 2000, an USGS-Petrobangla joint team of geoscientists conducted a 21 month long study to assess the undiscovered potential gas reserve. The report submitted by the team stated that Bangladesh has 95% possibility of finding 8.4 Tcf of yet undiscovered gas reserve. Of the above total undiscovered gas, 6.0 Tcf is assigned to the onshore area and about 2.4 Tcf is assigned to the offshore. The study also suggests a mean (50%) probability of finding 32.1 Tcf of yet undiscovered gas resource in the country.

II) *Undiscovered resource estimate by HCU-NPD:* In 2001, a join team of geoscientists from Hydrocarbon Unit (HCU) of Bangladesh and Norway Petroleum Directorate (NPD) conducted a gas assessment job on Bangladesh. Based on their study, the team suggested that the total undiscovered recoverable gas resource of the country at 90% possibility is 18.5 Tcf of which 10.6 Tcf is assigned to hypothetical estimate and 7.8 Tcf is assigned to speculative estimate. The study also suggested a mean (50%) possibility of finding 41.6 Tcf undiscovered gas resource of which hypothetical estimate on mapped prospects include 16.9 Tcf and speculative estimate of unmapped prospects include 24.7 Tcf.

Gas Sector Demand and Supply Forecast

Demand projection is usually based on certain assumptions on the variables related to that projection which requires developing a statistical model based on demographic data. National

Energy Policy of Bangladesh has forecasted energy demand for twenty-five years from 1996-2020. In Bangladesh primary commercial energy provides approximately 35% of the total energy need. Natural gas accounts for 65% of commercial energy use (excluding biomass) and about 90% of electricity generation. Total consumption of gas in 2000 was 332 Bcf (2.8 Mcf/person/yr, total population 126 million). Estimated consumption of different type of petroleum products in 2000 was about 3.3 million tons (25.8 kg/person/yr). Estimated total consumption of electricity was approximately 16549 Gwh (130 Kwh/person/yr). This may be compared with the projection made **Fig.8** by National Energy Policy (NEP), 1995.

Titas Gas T & D Co. Ltd. is the largest marketing company operating in the districts of greater Dhaka, Mymensingh and part of Brahmanbaria. Till June 2000 about 2.7 Tcf gas was consumed in TFA, which is 71% of country's total gas consumption. Ashuganj, Ghorasal, Haripur, Haripur barge-mounted, Siddhirganj and Mymensingh RPCL's power stations, and ZFCL, UFFL, PUFF and JFCL fertilizer plants **Fig.9** are the major consumers under TFA. There are over 0.74% million customers of various categories under TFA currently consuming about 755 Mmcfd which is about 68% of total national demand. Moreover new IPPs such as AES Haripur 360 MW, AES Meghnaghat 2X450 MW (1^{st} and 2^{nd} phases), Siddhirganj 210 MW and 100 MW, Tongi 80 MW and new peaking duty power plants are the most likely power plants coming on stream in the short run.

Bakhrabad Gas Systems Ltd. is the second largest company covering the districts of greater Comilla, Noakhali and Chittagong. It supplies gas to Sikalbaha and Rauzan Power Plants, CUFL and KAFCO fertilizer factories, Karnaphuli Paper Mills, Usmaina Glass Sheet Industry, TSP, Chittagong Steel Mill and Eastern Refinery. This company shares about 17% of total consumption of the country. Currently it supplies about 225 Mmcfd gas to over 0.2 million customers.

Gas consumption in present Jalalabad Gas T & D Systems area began in the early 1960s by supplying gas to Chatak Cement Factory and Natural Gas Fertilizer Factory (NGFF), Fenchuganj, JGTDSL covers the districts under greater Sylhet, Fenchuganj, Kumergaon, and Shahbazpur power stations NGFF, Chatak Cement Factory, Sylhet Pulp and Paper Mill and significant numbers of tea-estates are the major customers under JGTDSL. Till June 2000 a total of 0.43 Tcf gas was consumed in this franchise area which is about 12% of the country's total consumption. Present daily requirement of gas is about 75 Mmcfd and total customer numbers are about 65 thousand. Shahjalal fertilizer factory, which will replace NGFF by 2004, Lafarge-Surma Cement by 2003 and new peaking duty power plants will be the most likely new customers in short term.

The newest marketing company is WESGAS which began gas supply to the west of the river Jamuna and in late 1999. WESGAS's daily current gas requirement is 45 Mmcf and total number of customers 835. It will be responsible to cater gas to the northwestern districts. Major customers are BPDB's Baghabari 71 MW and Westmont's Baghabari Barge Mounted 90 MW powr plants. New plants such as BPDB's 100 MW, IPP's 170 MW, upcoming fertilizer factory at Sirajganj and Iswardi Export Processing Zone would be the major consumers of natural gas in the short run.

Gas Sector Development Strategy

Development of a gas field encompasses a wide variety of activities. Thses include geological and engineering characteristics of the field, estimates of its proved gas reserves and upside

potential, prospect of liquids recovery etc. This also takes in to account well planning, surface facilities and markets, compatibility with conservation and environmental regulations, and of course an economic evaluation.

Development of a gas field is primarily guided by the gas demand and supply forecast for the short, medium and long term scenerios. Short and medium term gas demand would be normally met from gas fields colse to the trunk lines that would call for a minimum project cost and time, while the long term customers would require dedicated larger volume of reserves, field production facilities and transmission pipeline. Development plan of a gas field is based on the initial evaluation of field reserves, well deliverabilities, reservoir fluid and reservoir driver. This is why each gas field or reservoir should be handled in an "asset management" approach during its life cycle right from the discovery till its abandonment.

A field development plan should be taken up covering,among others, Reservoir development plan, reserves and production profiles; well and drilling engineering plan; production and process facilities plan; hook-up and commissioning plan; project execution plan; reservoir management plan; operation and maintenance plan; field abandonment plan and development budget and economic analysis.

Infrastructure development is an integral part of the sector. This involves the pipeline network, the associated installations and a proper monitoring and safety system. The existing pipeline system of Bangladesh is adequate for the national demand for only the current situation. This network requires expansion and upgradation to ensure that supply can be matched with the demand side.

The current pipeline network of Bangladesh needs extensive modifications which needs national and foreign investments. The pipeline needs massive expansion. On the demand side new areas need to be connected to provide economic energy to the industry, on the supply side additional pipelines are necessary to carry extra gas as well as to have gas supply across Jamuna Bridge. A major transmission network supplemented by an extensive distribution system will be required to bring this region at par with the eastern region in respect to across to natural gas. Distribution lines in the main metropolitan and industrial areas should be replaced with higher capacity network to provide security of supply and to arrest methane emission. Where possible, all major metropolitan and industrial load centers should be brought under a distribution ring main with radial supply mains to ensure normal pressure.

The sector plan for the development of oil and gas industry is conveniently laid down in the five-year plans. Since the sector was opened to the private sector, such plan has become more conceptual than functional. However, the sectoral objectives and their implementation strategies have remained more or less unaffected. The mainstays of the objectives and policy supports are as below:

To substitute imported oil by indigenous fuel, mainly natural gas, to the extent possible and feasible;

To meet most part of increased demand for commercial energy through the development of indigenous gas;

To make a balanced development of the different components of gas activities, namely exploration, transmission and distribution etc;

To involve private sector in oil and gas development activates, particularly in exploration under product sharing contract (PSC), transportation and sale of gas based liquids LPG, condensate (diesel/motor spirit/kerosene) etc;
To build a national gas grid for equitable regional distribution;
To conserve energy resources and help maintain the ecological balance;
To conduct geological and geophysical surveys in order to explore and discover new sources of indigenous energy resources;
To strengthen research and development in the energy sector.

Gas Sector Marketing Strategy

It has been opined by the IOCs and some agencies that given the location, volume, price and situation involved, the best option for Bangladesh gas is pipeline export. This again is based mainly on the end user parameters without addressing the gas price and economics thereof. The logic is that LNG is not viable due to short distance and stiff competition from middle-east and south east Asia. Gas to wire is also considered to be not attractive, though there has been unconfirmed news of such propositions. Presence of extremely large associated and non associated gas reserve in middle-east, which is priced at a very low level for different reasons, would preclude Bangladesh gas to be a major input in the global urea industry. A recent attempt by India to finance a urea project in middle-east for export to India failed due to reluctance of lead bank citing unfavorable economics. In this circumstance, a pipeline to Jagdispur in India is being touted as only viable option. This option is based on the presumption that Bangladesh gas absolutely requires an external market, and that the gas price will be based on the end user tariff. This is rather cursory assumption, which assumes that gas can be sold to power and fertilizer plants on the way which are now using fuels at about US $ 4.5 to 7.0 mmbtu. The important point neglected here is that the present production cost is subsidized under retention pricing system (RPS) and the payment capacity of the consumers is also suspect. This has been voiced by the IOCs also.

At present Bangladesh is very much eager to develop mutual relationships and understandings with the middle-east energy giants. From now on it will be very vital to decide “where and how” the gas fields and exploration activites can be done by joint venture programs with large scale Oil companies of middle-east like Saudi Aramco, Qatar Petroleum, RasGas etc. If western companies like Chevron, Shell etc can exploit the resources of Bangladesh by involving their masterminds why the middle-east can not? It is perhaps a vital question which has rather a simple answer. It is responsibility of us to develop mutual agreements between our brotherly countries and it can be very beneficial for both the parties without any doubt. It is to be noted that if exploration and discovery activities between Bangladesh and the middle-east can make a way to begin, it will be a great boost for the Muslim nations altogether because by this way, we will be able to share our knowledge between us and can uplift the growth rate of the energy sector by incredible pace.

Since the government has declared that adequate gas reserve must be retained for the country's 50 years demand before any external marketing is considered. It is advisable to look for the market at home catering to the domestic demand. This might entail a slower growth in production and sales than is anticipated by the IOCs. However the question of natural security must get priority. Considering the governments goal of electricity to all by the year 2020, and

making the country food surplus, there is a vast future market within the country. This expansion will also require massive investment and will have to be supported by proper gas pricing. If the future power plants are all run on combined cycle and, where possible, power plants are integrated with fertilizer/steel plants, major savings in investment with resultant gain in IRR may be made. Diversification of gas use will be another major gap. In this respect large scale conversion of vehicles to CNG and introduction of cost effective technology to convert gas to liquids (GTL) will be important. This will decrease the import of liquid fuel providing energy stability and also contribute towards expansion of gas market.

Future Fifty Years of Gas Demand Scenerio

Energy experts always have different opinions on the energy demands with respect to the energy growth. Experts have predicted that as coal was the fuel of 19th century, oil in the 20th century, so natural gas has a great possibility to make its way as the primary fuel of the 21st century. The take off point for solar energy and other renewables as a mean of large scale energy source will be delayed and will not take position until 2050. Nuclear power and renewable energy sources will double their present contribution to global energy use by2050 from about 100 Gtoe to about 215 Gtoe but their share will still be not more than about 18% of the total global energy use.

In a recent report of the IAEA, it has been pointed out that oil will retain its position as the single most important source until about 2040 after which natural gas will be the near universal fuel. They forecasted that conventional natural gas use would peak around 2050 following which the use of natural gas will exceed that of oil and coal together. The analysis showed that the world natural gas use is foreseen to expand from about 50 Tcf in 1984 to around 123 Tcf by 2020 and thereafter this level will sustain for the following years to 2060. However the battle between gas and renewable energy will begin in earnest about 2060, and after 2070, the battle will swing in favour of the renewable energy including solar energy because of the cost reductions.

Gas demand for power sector for the next five decades has been estimated, and the projection indicates that about 40 Tcf gas would be required to generate electrical power from the years 2001 to 2050. As on 27.07.2000 the maximum generation was 2823 MW. The GOB's vision is to supply reliable electricity to all by 2020. To achieve and sustain expected growth of 6-7% per annum. Accordingly for the period from 2003 to 2015 PSMP's high demand forecast and for 2016-2050 an average annual growth rate of 3% have been used. As projected, demand for electricity would increase to about 16,808 MW by 2020 and 35,143 MW by 2050. The above projection is made based on 60% system load factor as stipulated in PSMP. This forecast uses energy efficient 450 MW capacity combined cycle and 150 MW capapcity gas turbine power plants. The plan includes also 250 MW coal based power plant at Barapukuria and 330 MW hydroelectricity at Karnafuli. It is estimated that 90% of electricity generation would be gas based and remaining 10% would be non-gas based.

The industrial sector includes **Fig.10** all industries except fertilizer. It is indicated by an analysis that industrial gas consumption will grow from 54.6 Bcf to 229.1 Bcf over the period of 2000-2020 at an average annual rate of 7%.

Gas consumption in domestic, commercial, seasonal and tea-estates have **Fig.11** been lumped together. It is auumed that the gas network would not be extended to rural areas for

domestic/commercial purposes, and besides seasonal brick fields, scope of expansion of tea gardens would also be very limited. As such, only urban areas particularly Dhaka metropolitan area and district towns would be important growth centers for gas consumption. Annual gas consumption growth rate of 4% has been estimated to forecast gas consumption to 2020 and thereafter 2%, 1% and 1% growth rates for the next three decades have been assumed.

Recommendations

#As a country of great future energy prospects, Bangladesh should have to take effective and efficient measure for conducting systematic exploration activity in the country. It can easily be said that we have not been acted according to our vast energy resources because there still remain a large amount of reserve for petroleum resources of Bangladesh. As the same time one can not loose sight of the fact that exploration is "high capital intensive" and risky venture. It should be remembered that the energy resources that we have, is far more capable of uplifting the energy status and overall the economic status of the country if proper action to explore and distribute are taken in time.

#Till now all development of gas fields had taken place separately. A decision for a national gas grid should be taken and development of gas fields undertaken on the basis of this national gas grid demand. A gas pipeline grid like the power grid is necessary for optimal utilization of facilities of the four systems i.e; Bakhrabad, Titas, Bibiyana and Jalalabad. Programs for this have been initiated but it should be much accelerated.

#Gas supply scenario indictates the urgency of intensifying exploration anddevelopment. GOB's current policy for participation of IOCs in this sector must be strengthened. Findings of the recent Natural Gas Assessment Study conducted by Petrobangla/USGS (mean of 32 Tcf undiscovered natural gas reserve) should be investigated (Hydrocarbon Unit of Bangladesh and NPD, Norway have shown 42 Tcf of reserve) through future development activities and joint research programs specially with the Persian Gulf countries.

Collaborative research activities within the OIC state universities could be proved very fruitful for the sector. Activities within the universities of Bangladesh and Middle-East should have a strong impact on the scenario. It is to be noted that Geology department of D.U. is playing one of the supreme roles in exploring and discovering undiscovered energy resources of Bangladesh. There are research works which are being conducted by universities in the western world and they are getting innovative ideas from the greater student community. So we can surely achieve something very significant if this can be done in our own innovative ways and it should be done in order to progress rapidly. Moreover it will certainly strengthen the brotherly relationships between the Muslim Nations and OIC can play a key role to organize the idea.

#Reserve growth potential of the existing fields must be examined by employing new technology. Gas reserves of the existing fields must be updated on regular basis in order to allow more realistic gas supply forecast and overall sectoral planning. To do that Reservoir Study Divisionof Petrobangla must be manned with adequate manpower and equipped properly. Appropriate training of the officials and staffs is a must in order to gain maximum work efficiency.

#Alternate source of primary energy, and/or energy mix would provide secured supply of electricity. Bangladesh has enormous potential for solar, wind and wave energies. Some recent feasibility studies have proved the high potential wind energy production capability of Bangladesh. For that Research and Development (R & D) activities should have to be taken seriously to make new ways of energy sources in order to achieve energy security.
#Gas consumption for power sector would be reduced at least by 10% if Bangladesh pursue over 50% energy efficient combined power plants or even further if technology improves. Demand of natural gas for power sector will be lower than the forecasted one if capital investment for power generation, transmission and distribution could not be made available. This could, however, be achieved if ongoing power sector reform and restructuring policy of GOB continues.
#Gas demand for fertilizer sector will also be dependent on capital investment in fertilizer sector. The forecasted demand will be lower than the normal if international market price of urea falls and/or subsidy on natural gas price for fertilizer is withdrawn.
#Natural gas demand as forecasted for industrial and domestic/commercial/other sectors will require huge investment for
network expansion in the north, west and southern districts of Bangladesh. Regulatory body for gas sector would encourage private sector inverment in transmission and distribution system.
#Gas price must be rationalized and set at its commercial value based on the production cost of gas.
#Nepal and Bhutan have tremendous potential for hydroelectric power.
Regional and sub-regional cooperation will allow Bangladesh to have access into regional and sub-regional electric grid system. Extensive
energy cooperation within SAARC countries may be an alternative option to follow.

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Abbreviations

OXY	*OccidentalOil*
BAPEX	*Bangladesh Petroleum Exploration and Production Company Ltd.*
bbl/day	*Barrel per day*
Bbl/MMcf	*Barrel per Million Cubic Feet*
Bcf	*Billion Cubic Feet*
BGFCL	*Bangladesh Gas Fields Company Ltd.*
BGSL	*Bakhrabad Gas Systems Ltd.*
BMEDC	*Bangladesh Mineral Exploration and Development Corporation*
BODC	*Bengal Oil Development Company*
BPC	*Bangladesh Petroleum Corporation*
CNG	*Compressed Natural Gas*
D.U.	*Dhaka University*
E & P	*Exploration and Production*
GIIP	*Gas Initially In Place*
HCU	*Hydrocarbon Unit*
IKM	*Interkomp Kanata Management*
JGTDCL	*Jalalabad Gas Transmission and Distribution Company Ltd.*
LPG	*Liquefied Petroleum Gas*
mmbbl	*Million Barrel*
MMcf	*Million Cubic Feet*
NPD	*Norwegian Petroleum Directorate*
OGDC	*Oil and Gas Development Corporation*
ONGC	*Oil and Natural Gas Corporation*
PPL	*Pakistan Petroleum Ltd.*
PSC	*Product Sharing Contract*
PSOC	*Pakistan Shell Oil Company*
RPGCL	*Rupantarita Prakitik (Converted) Gas Co. Ltd.*
SBED	*Shell Bangladesh Exploration and Development B.V.*
SGFL	*Sylhet Gas Fields Ltd.*
SPE	*Society of Petroleum Engineers*
SVOC	*Standard Vacuum Oil Co.*
Tcf	*Trillion Cubic Feet*
TGTDCL	*Titas Gas Transmission and Distribution Co. Ltd.*
TOC	*Total Organic Content*
UMC	*United Merdian Corporation*
UNOCAL	*Unocal Bangladesh Ltd.*
WESGAS	*Pashchimanchal (Western Region) Gas Co. Ltd.*
WPC	*World Petroleum Congress*

Fig.1- Energy blocks of Bangladesh

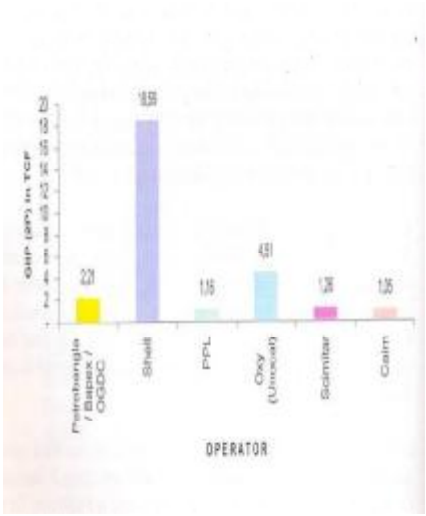

Fig.2- Different operators working in the energy blocks

hase	***Wells drilled***			***Gas Discovery***			***Success Ratio***		
	Onshore	***Offshore***	***Total***	***Onshore***	***Offshore***	***Total***	***Onshore***	***Offshore***	***Total***
1908-33	6	-	6	-	-	-	-	-	-
1947-71	21	1	22	8	-	8	1:2.63	0	1:2.75
1972-2001	27	12	39	12	2 (+1 Oil)	14	1:2.25	1:6.5	1:2.78
Total	54	13	67	20	2 (+1 Oil)	22	1:2.70	1:6.5	1:3.07
Petrobangla/BAPEX/ OGDC	20	NONE	20	10	-	10	1:2.00	-	1:2.00
IOCs	34	13	47	10	2	12	1:3.4	1:6.5	1:3.92

Fig.3- Exploration History

Operator	*Period*	*Area*	*Energy Source*	*Line Km*	*Recording type*
OGDC	1963-71	Onshore	Dynamite	971	Single fold,Analog
Petrobangla	1973-77	Onshore	Dynamite	2065	Single fold,Analog
Petrobangla	1976-78	Onshore	Dynamite	3606	Single fold
Petrobangla	1978-82	Onshore	Dynamite	2151	6/12 fold,Analog
Petrobangla	1979-87	Onshore	Dynamite	3809	12/24 fold, Digital
Petrobangla	1977-86	Onshore	Dynamite	3658	12 fold, Digital
Petrobangla	1983-86	Onshore	Dynamite	2646	12/24 fold, Digital
Petrobangla	1984-86	Onshore	Dynamite	1961	24 fold, Digital
BAPEX	1990-97	Onshore	Dynamite	2587	12/24/30 fold, Digital
Total				23454	
SVOC	1956-59	Onshore	Dynamite	900	Single fold,Analog
PSOC	1960-71	Onshore	Dynamite	7600	Single fold,Analog
INA-Nafthalin	1974-76	Offshore	Aquapulse	2957	24 fold, Digital
Union Oil	1974-76	Offshore	Airgun/D.mite	4926	48/24/12/6 Digital
Ashland	1974-76	Offshore	Airgun	5345	12/24 fold, Digital
ARCO	1974-76	Offshore	Airgun	3242	48 fold, Digital
BODC	1974-76	Offshore	Airgun	8163	24/48 fold, Digital
CSO	1974-76	Offshore	Airgun	6536	24 fold, Digital
Shell	1986-87	Onshore	Dynamite	1506	24 fold, Digital
Occidental	1995-97	Onshore	Dynamite	2317	Multi fold, Digital
Cairn/Shell	1996-97	Onshore/Offsh.	Airgun/D.mite	2500	Multi fold, Digital
Okland		Onshore	Airgun/D.mite	925	Multi fold, Digital
UMC	1998-99	Onshore	Dynamite	515	Multi fold, Digital
Total				47332	
Grand Total				70786	
Occidental	1995-97	Onshore	Dynamite	226 Sq.km	3D

Fig.4- Seismic Survey Database of Bangladesh

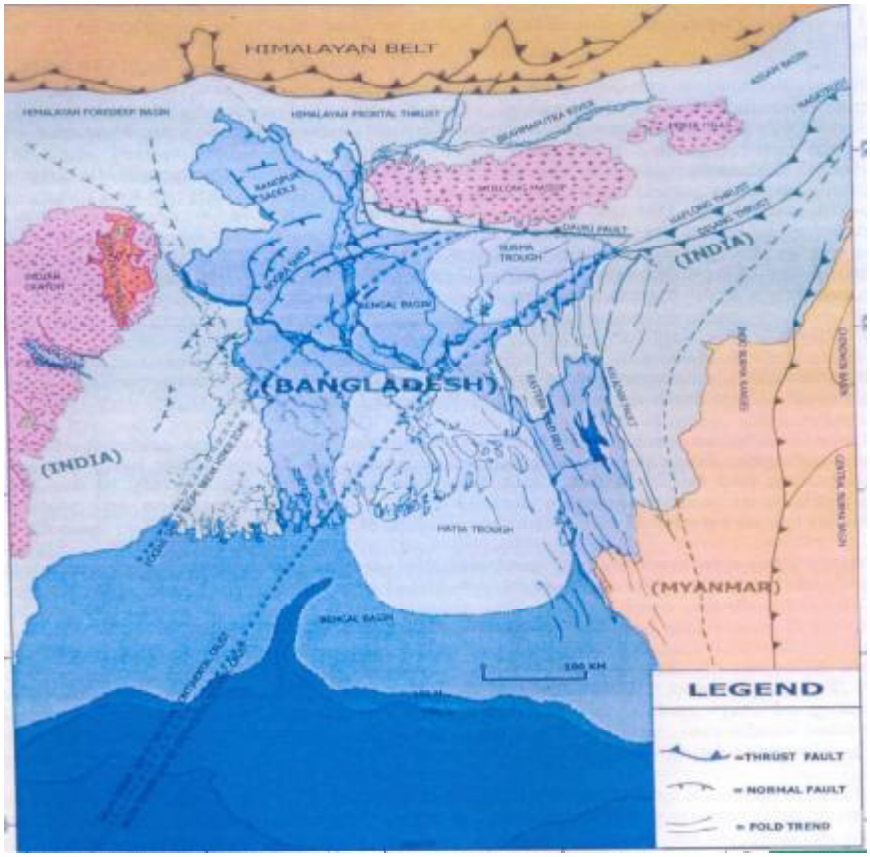

Fig. 5: Structural Elements of Bangladesh and Neighboring Areas

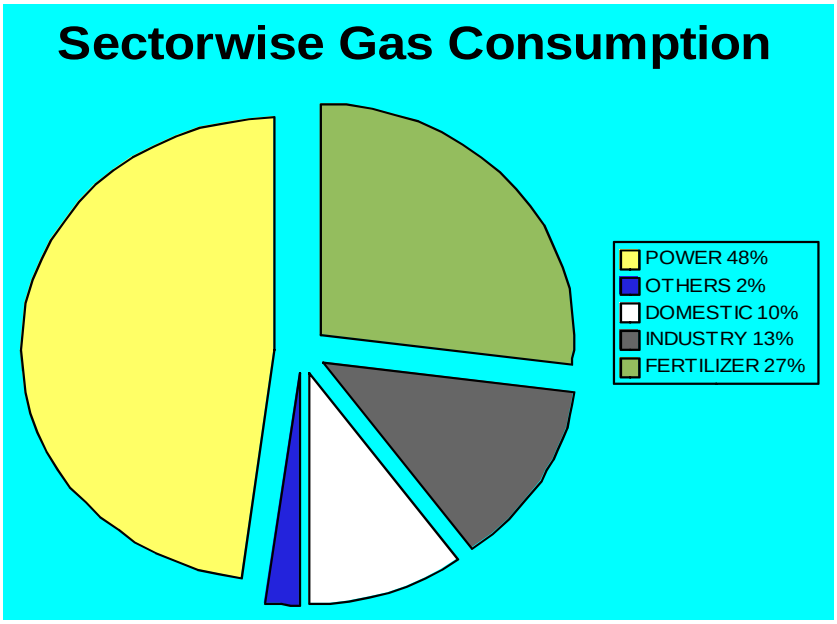

Fig.6-Sector wise gas consumtion

Resources		Recoverable Reserves/Resources	
		Proved+Probable(2P)	Proved+Probable+Possible(3P)
Discovered Resource (Reserved)	a. Produced upto June 2001	*4.3*	*4.3*
	b. Remaining in Fields	*11.6*	*16.2*
	c. Not in Production	*4.5*	*7.9*
	d. Remaining Reserves (b+c)	*16.1*	*24.1*
	e. Total Discovered (a+b+c)	*20.4*	*28.4*

		P90	*Mean*	*P10*
Undiscovered Resource (Risked)	f. Hypothetical (Mapped Prospects)	11	17	24
	g. Speculative (Leads/ Unmapped Prospects)	8	25	40
	h. Total Undiscovered (f+g)	19	42	64

Fig.7-Gas Resources of Bangladesh (Discovered+Undiscovered)

Factors	2000	2005	2010	2015	2020
Population(million)	130	141	153	165	177
GDP growth rate	6.4	7.2	7.7	8.2	8.7
Per capita GDP ($)	254	318	416	560	774
Energy coefficient	1.37	1.37	1.08	1.08	1.08
Energy growth rate	8.77	9.86	8.32	8.86	9.40
Per capita kgoe	94	131	194	269	384
Total energy (mtoe)	12	19	31	46	72

Fig.8-Energy consumption of Bangladesh

Fig.9-Hydrocarbon Related Infrastructures

Year	*2001-2010*	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*	*Total*
Industrial Gas Consumption (Bcf)	***822***	***1684***	***2861***	***3788***	***4368***	***13522***

Fig.10- Gas consumption in industrial sector

Years	*2001-2010*	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*	*Total*
Domestic/ Commercial/ Others Gas Consumption (Bcf)	*537*	*794*	*1051*	*1212*	*1339*	*4933*

Fig.11- Gas consumption in Domestic/ Commercial/Others