

Keynote Paper

ENERGY SCENARIO AND POLICY IN BANGLADESH

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1.0 INTRODUCTION

1.1 Energy Security Perspective

Energy is a strategic input necessary for socio-economic development. It is required in meeting basic needs and to enhance economic growth. There is a need to pay special attention to ensure energy security for different category of consumers and the people at large. In developing countries Government and people are sensitive to territorial security of the country, food-security of the people and personal security of individuals. However, there is lack of understanding about the need for and importance of energy security of the people for sustainable development and sustainable human development (WCED 1987, UNDP 1994, Suarez 1995).

Per capita energy consumption of the people of Bangladesh is one of the lowest in the world (Table 1.1). In 1997, it was only 197 kgOE per person per year in comparison to average per capita consumption of low-income countries of the world as 563 kgOE per person per year (WB 2001).

Great majority of the population of Bangladesh suffer from energy insecurity. Piped natural gas and electricity networks are accessible to only about 4% and 20% of households respectively. About 2-3% households use kerosene for cooking. More than 90% of households depend on unsustainable supply of biomassfuels for cooking.

The basic principle of energy security is to ensure the supply of appropriate type of energy to meet the demand of different end use sectors (domestic, commercial, industrial, transport, agriculture, non-energy use). In a particular situation if the supply of energy is less than (physical shortage) the demand an insecure situation arises. Energy insecurity may also take place due to lack of purchasing power. An imbalance between demand and supply of energy (energy insecurity) may occur at individual level, household level, community level, district level, division level and country level. Energy insecurity may take place at a particular time of the day, during certain period of the year, for some years. Energy insecurity is a multidimensional problem (Islam 2001).

In past energy development programmes have not been considered under long-term perspective in a comprehensive manner. Implementation of projects has been influenced with the availability of donor funds and political patronage. In many cases due to lack of synchronization of project implementation schedule, some completed projects have remained unutilized due to lack of completion and or absence of infrastructures in upstream and downstream sides. In recent years expansion of energy development programmes of the country have been constrained due to unavailability of traditional donor funds. As a consequence, the country as a whole has been facing multidimensional energy crises. Very often political government coming to power under 5 years time cycle is found to blame previous government for not doing enough to ensure energy security under long-term perspective. Energy planners and system managers are sensitive to meet the daily and seasonal peak demand of different type of energy (e.g. electricity, natural gas, petroleum fuels). However, in recent years they are finding it difficult to maintain reliable supply and to meet the increasing demand due to lack of attention paid to maintain reliable supply under medium-term development programmes. Periodically the consumers have been facing forced outage. As a consequence economic development of the country has been seriously affected due to energy crisis. Development activities of the West-Zone have been constrained due to lack of reliable energy supply. Great majority of the rural population has not been supplied with modern sources of energy. Millions of poor people are living miserable life due to energy shortage. Millions of women cooking with inferior biomassfuels have been exposed to harmful pollutive environment. Human security of the population of Chittagong Hill Tract Area has been seriously affected due to construction of the Kaptai dam to generate hydropower. About 40% of agricultural land of CHT area was inundated due to construction of hydropower project.

In Bangladesh, environmental aspects are comparatively less understood areas of energy security to the policy planners, decision-makers and development planners. Environmental issues are considered for discussions, remedial measures are not undertaken due to various reasons such as lack of institutional capacity, technological capability and financial resources; absence of enforcement capability and environmental quality standard. Various

environmental issues and its effect on energy security have been discussed for all type of fuels by Islam (2000).

1.2 Attributes to Energy Insecurity

Various attributes have been contributing to energy crises (energy insecurity) of the country as are presented as follows.

- (1) Lack of understanding about the importance of long-term energy security,
- (2) Political insensitivity to long-term energy planning ,
- (3) Absence of rational energy pricing policy,
- (4) Lack of good governance,
- (5) Weak institutional capabilities at planning level,
- (6) Weak institutional capabilities at implementation level,
- (7) Lack of financial capability,
- (8) Lack of technological capability and
- (9) Lack of management capabilities.

1.3 National Energy Policy

Considering the importance of energy in supporting sustainable economic development, Government approved the National Energy Policy (NEP) in 1995 to ensure long-term energy security for the country (GOB 1996). The objectives of NEP have been stated as follows:

- (i) To provide energy for sustainable economic growth so that the economic development activities of different sectors are not constrained due to shortage of energy.
- (ii) To meet the energy needs of different zones of the country and socio-economic groups.
- (iii) To ensure optimum development of all the indigenous energy sources (*e.g. commercial fuels, bio-fuels and other renewable energy sources*).
- (iv) To ensure sustainable operation of the energy utilities.
- (v) To ensure rational use of total energy sources.
- (vi) To ensure environmentally sound sustainable energy development programmes causing minimum damage to environment.
- (vii) To encourage public and private sector participation in the development and management of the energy sector.

1.4 Objectives

The objective of the present paper is to discuss the energy scenario of Bangladesh and related policy issues. Discussions have been limited to the use of natural gas and related policy issues.

2.0 ENERGY SCENARIO OF BANGLADESH

2.1 Energy Resources

Total in place reserves of coal in three locations (Jamalganj, Barapukuria, Khalaspir) is about 1750 million tonnes. Extraction of 1000 million tonnes of coal discovered at Jamalganj at a depth of 1000 metre was not found techno-economically feasible. A coal mining project is under implementation to extract Barapukuria coal (in-situ reserve of 300 million tons). It is expected to produce 1 million ton of coal per year from the year 2003 for a period 70 years. Total peat deposit of the country is 170 million ton. It has not yet been possible to extract peat due to techno-economic reasons (possible negative effects on agricultural land).

Total hydropower potential of the country in three locations (Kaptai, Sangu and Matamuhuri) is 1500 GWh/year (755 MW) (BPDB 1995). Of which 1000 GWh/yr (230 MW) has been harnessed at Kaptai. It may not be possible to harness additional hydropower potential of the country without inundation of human settlements and agricultural lands.

Total recoverable reserves of natural gas in 22 gas fields is 15.51 TCF (439.38 BCM). Total amount of gas consumed till June 2001 was 4.27 TCF (120.96 BCM). Remaining recoverable reserve on July 2001 was 11.24 TCF (318.41 BCM).

With total population of 135 million, per capita availability of recoverable commercial energy (e.g. coal, natural gas) reserves of the country is about 2.26 Tonne Oil Equivalent (TOE), which is only 1.65 year's average per capita energy consumption of Middle-Income Countries (1.37 TOE). Indigenous natural gas is the major source of commercial energy of the country to meet future energy needs.

In Bangladesh traditional energy sources (e.g. biomassfuels) supply a major share of total energy consumed in the country. Limited tree covered lands (reserve forests and village wood lots), agricultural lands and cattle population are the major sources of biomassfuels. Over exploitation of biomassfuels are contributing to environmental degradation. There is a need to substitute biomassfuels with commercial energy to maintain its regenerative supply.

Total cattle population of the country in 1989 was estimated as 20.39 million. Of which 12.33 million heads provided draught power required for cultivation. During peak agricultural season mechanized tillage devices meet shortage of draught animal power. About 40% of animal dung produced by cattle population has been used as fuel.

2.2 Energy Consumption

The total consumption of gas in 1999 was 0.248 TCF (1.938 MCF/person/year, total population = 128

million). Estimated consumption of different type of imported petroleum products in 1999 was about 3.3 million tonnes (25.8 kg/person/year). Annual consumption of coal was about 0.5 million tonne and was met from imported sources. The consumption of different type of commercial energy sources (e.g. coal, oil, natural gas, hydropower) was estimated as 3.16 GJ/person/year (74 kgOE/person/year). The consumption of biomassfuels was estimated as 5.86 GJ/person/year (137 kgOE/person/year). Total consumption of commercial energy and biomassfuels in 1999 has been estimated as 9.02 GJ/person/year (211 kgOE/person/year) and their relative shares were 35% and 65% respectively (Islam 2000).

In 1999 the production capacity of gas reached the level of 1000 Million Cubic Feet Per Day (MMCFD). The shares of gas supplied by the national companies (under Petrobangla) and International Oil Companies (IOCs) were 76% and 24% respectively.

Total installed capacity of power generation units in 1999 was 3603 MW of which the shares of Bangladesh Power Development Board (BPDB) plants and Independent Power Producer (IPP) plants were 92% and 8% respectively. Total consumption of electricity in 1999 was 11,352.3 GWh (89kWh/per capita/year).

2.3 Policy Issues on Natural Gas Use

It has been discussed in previous section that natural gas is the only indigenous commercial energy source to meet future energy needs of the country. Therefore, planned development of natural gas has become an important aspect of future energy policy. With the approval of Petroleum Policy in 1993 and subsequently National Energy Policy in 1995 some International Oil Companies (IOCs) have signed a number of Production Sharing Contracts (PSCs) for exploration and development of hydrocarbon. Since 1993, two International Oil Companies (IOCs) have discovered three new gas fields (e.g. Sanghu: 0.848 TCF, Bibiyana: 2.401 TCF and Maulavibazar: 0.40 TCF) with recoverable reserves of 3.649 TCF. In October 2001, with change of Government one of the IOCs (Unocal) has submitted a proposal to the Government to export 3.65 TCF of gas from Bibiyana gas field (with recoverable reserve 2.401 TCF) to India via pipe line over a period of 20 years (@ 500 MMCFD). It has initiated a national debate on the issue of allowing the export of gas to encourage further exploration against preserving the gas to ensure long-term energy security of the country. Some of the issues have been discussed during public deliberations are presented below:

- (a) Gas export has become a contractual obligation of the present (BNP) Government because of the conditions of PSC signed by the immediate past (Awami League) Government.
- (b) Export earnings from gas would enhance economic progress of the country.

- (c) Natural gas reserves in-place may become valueless due to substitution with alternate energy sources.
- (d) Export of gas would affect long-term energy security of the country.

Various issues related to use and possible export of gas have been discussed in the following paragraphs. Other policy issues related to overall development of energy sector have been discussed in Section 3.

2.4 Estimation of Long-Term Energy Demand

2.4.1 Estimation of Long-Term Energy Demand in NEP

National Energy Policy (NEP) has forecasted the energy need of the country up to the year 2020 (GOB 1996). Total energy demand of the country for the period from 2000-2020 has been estimated under Low Economic Scenario and Reference Economic Scenario as 558 MTOE (Million Tonne Oil Equivalent) or 24 TCFNGE (Trillion Cubic Feet Natural Gas Equivalent) and 772 MTOE (Million Tonne Oil Equivalent) or 31 TCFNGE respectively. It has been assumed that in future years 70% of total commercial energy need of the country will be met by indigenous natural gas. The amount of natural gas will be required to meet the demand for the period from 2000 to 2020 under the Low Economic Scenario and Reference Economic Scenario of NEP would be as 16.8 TCF and 21.7 TCF respectively (Islam 2000a).

2.4.2 Projection of Natural Gas Demand by Petrobangla

The projections of natural gas demand in different end use sectors for fifty years (from 2001 to 2050) have been shown in Table 2.1 (Petrobangla 2001). Total consumption of natural gas during fifty years has been estimated as 62.99 TCF. Of which the consumption in different end use sectors have been estimated as follows: power 39.79 TCF, fertilizer 4.75 TCF, industry 13.52 TCF, domestic and commercial 4.93 TCF. The consumption of natural gas during 10, 20, 30, 40 and 50 years have been reported as 4.84 TCF, 13.71 TCF, 26.76 TCF, 43.68 TCF and 62.99 TCF respectively.

2.4.3 Projection of Natural Gas Demand for Different Conditions

Rodekohl (2001) projected future demand of natural gas for five different scenarios considering economic growth, energy intensity of GDP and share of gas in total commercial energy. Projected natural gas demand for 30 years (2000-2030) varied from 25.5 TCF to 41.85 TCF and for 50 years (2000-2050) varied from 61.87 TCF to 183.63 TCF.

2.5 Estimation of Natural Gas Reserves and Resources

Estimations of natural gas reserves and resources made by different organizations are shown in Table 2.2. Total recoverable reserves of natural gas in 22 fields have

been reported by Petrobangla as 15.51 TCF. Of which 4.27 TCF was consumed up to June 2001. Net recoverable reserves in July 2001 was 11.24 TCF.

Initially Shell (1999) reported total gas resources of Bangladesh as 38 TCF. Of which 13 TCF from existing fields (number unspecified) and 25 TCF was termed as additional resources. In a subsequent publication Shell (2001) reported the total gas resources of Bangladesh varying between 43 TCF to 64 TCF. The composition of total resource base was reported as follows: cumulative production 4.5 TCF, existing reserve (number of gas fields unspecified) 13.5 TCF, field growth 5-6 TCF, undiscovered resources 20-40 TCF.

Unocal reported total gas resources of Bangladesh under three different categories. Total recoverable reserves from 21 gas fields (excluding Maulavibazar) as 16.1 TCF. Total gas resources available from discovered gas fields by field growth as 12.8 TCF. Total gas resources may be available from undiscovered areas as follows: 5.3 TCF (90% probability), 10.3 TCF (50% probability), 13.2 TCF (mean) and 22.6 TCF (10% probability). There is significant differences between gas resources and gas reserves. Total gas resources of the country have been reported by adding three categories of reserves and resources mentioned above. Total gas resources values varied between 34.2 TCF and 51.5 TCF with a mean of 42.1 TCF (Unocal 2000; Brown, Shamsuddin and Rickard 2001).

US Geological Survey/Petrobangla joint study has assessed that technically recoverable undiscovered gas resource of Bangladesh that might be found in 30 years period as follows: 8.4 TCF (95% probability), 29.20 TCF (50% probability), 32.1 TCF (mean) and 65.7 TCF (5% probability).

Publications of different values of gas reserves and gas resources by different organizations have created confusion among the concerned people about the status of gas availability for future use. Those who have been advocating in favour of gas export prefer to quote highest sum total of gas reserves and resources for future decisions. As there is no certainty about recoverability of gas resources, those who have been advocating against the export of gas prefer to quote recoverable reserve data for future decisions.

Confusion is further deepened when data on net recoverable reserves (recoverable reserves - cumulative consumption up to certain date), recoverable reserves and resources are used for arguments in favour of making decisions on future use of gas.

As for example in the proposal for Bangladesh Natural Gas Pipeline Project (BNGPP), Unocal has shown that 2.4 TCF gas from Bibiyana field is 15% (2.4 x 100/16.1) of proven and probable reserve and 4% (2.4 x 100/61.0) of overall resource base. It has been opined

that exporting Bibiyana resources will have little impact on the countries overall gas resource base of 61 TCF (16.1 TCF+12.8 TCF+32.1 TCF). At the rate of 500 MMCFD gas export total amount of gas to be committed for BNGPP over 20 years period is 3.65 TCF. If the proposed export volume of 3.65 TCF gas is compared with net recoverable reserve of 11.24 TCF, the computed value becomes 32.5% (3.65 x 100/11.24). It should be quite alarming for the people of Bangladesh to commit 32.5% of net recoverable reserve of gas for export.

An attempt has been made to compile net recoverable gas reserves and gas resources data published by different organizations on common bases and is shown in Table 2.3. Various assumptions made in presenting the data are as follows:

(a) Net recoverable reserves in 22 gas fields on July 2001, 11.24 TCF has been tabulated for all the cases (Petrobangla, Shell, Unocal and USGS/Petrobangla).

(b) Field growth data reported by Shell (5-6 TCF) has been tabulated accordingly. Field growth data reported by Unocal (12.8 TCF) has been tabulated for Unocal and USGS/Petrobangla database.

(c) Gas resources data of undiscovered areas reported by Shell, Unocal and USGS/Petrobangla studies have been tabulated respectively according to their original estimation.

Although there is significant difference between gas reserves and gas resources, summation of data estimated by different organizations have been shown in Table 2.3 for comparison only. A study undertaken by Hydrocarbon Unit of the Ministry of Energy and Mineral Resources with the assistance of Norwegian expert may also provide further information about inventory of hydrocarbon resources (Daily Jugantar, 8 November 2001). However, there is a need for authoritative assessment of total gas reserves of the country for making firm decisions on future use of gas.

2.6 Comparison of Supply and Demand Data of Natural Gas

The following observations may be made by comparing data on supply and demand of natural gas presented in previous section.

More optimistic gas resource potential reported by USGS/Petrobangla study 32.44 TCF may be sufficient to meet 30 years gas demand estimated by Petrobangla (26.76 TCF) and Rodekohl (25.56-41.85 TCF).

Mean gas resources potential reported by USGS/Petrobangla study 56.14 TCF may not be able to meet 50 years gas demand estimated by Petrobangla (62.99 TCF) and Rodekohl (61.87-183.63 TCF).

Therefore an ad-hoc decision to export natural gas at the present time may seriously affect the energy security of the country in the medium to long term time horizon. For a developing country like Bangladesh there is a need to develop national consensus to ensure long-term energy security of the country for sustainable development. Some of the points may be considered in deciding the time period (number of years) for long-term energy planning are as follows. USGS/Petrobangla joint study has made the gas resources assessment for the undiscovered areas with the time cycle of 30 years. In case of gas discovery generally Production Sharing Contracts (PSC) remain valid for 25 years and may be extended for a period for additional five years. Long-term gas export contracts are made for a period of 25-30 years. Former Prime Minister Sheikh Hasina declared that export of gas may be considered after keeping the reserve to meet 50 years need of the country. Recently Finance and Planning Minister Mr. Saifur Rahman has declared to preserve gas reserve for 35-40 years need of the country before considering for export (Daily Protham Allo, 27 November 2001).

2.7 Status of Production Sharing Contracts (PSC)

For exploration and development of hydrocarbon geographical area of the country was divided into 23 Blocks (including offshore areas). During 1990s Production Sharing Contracts (PSC) have been negotiated/finalized with different International Oil Companies (IOCs) in two occasions; first during the tenure of the BNP Government (1991-1996) and second during the tenure of the Awami League Government (1996-2001). Some of the information available about these PSCs are presented below.

After the approval of the Petroleum Policy-1993, under the First Round of Negotiation (FRON) 6 Production Sharing Contracts were finalized during the period 1993-96 for 8 exploration Blocks (12, 13 & 14, 15, 16, 17 & 18, 22). Among them 4 PSCs for 5 Blocks (12, 13 & 14, 15, 16) were actually signed during 1994-95 and 2 PSC for 3 Blocks (17 & 18, 22) were signed in 1997.

After the approval of National Energy Policy-1995 (GOB 1996) under the Second Round of Bidding (SROB) seven PSCs for 7 Blocks (5,7,8,9,10,19,20) have been negotiated during 1997-2001. Among them four PSCs for 4 Blocks (5,7,9,10) were actually signed up to July 2001 and the PSCs for the rest 3 Blocks (8,19,20) are to be signed in future.

Out of total 23 Blocks, PSCs have been finalized for the more prospective 15 Blocks. Among them PSCs for 12 Blocks have already been signed and for 3 Blocks are to be signed later on. There is provision of gas export via Liquefied Natural Gas (LNG) in the Production Sharing Contracts of all the 15 Blocks.

There is obligation for gas purchase in the PSCs of 5 Blocks (13,14,16,17 & 18) finalized under First Round of Negotiation (1993-96). Petrobangla has already signed Natural Gas Sale and Purchase Agreement for Jalalabad (Block 13) and Sanghu (Block 16) gas fields. There is obligation to purchase gas from Maulavibazar gas field (Block 14) and from Blocks 17 & 18 (if gas is discovered in future).

There is no gas purchase clause in the PSCs of 3 Blocks (12,15, 22) signed under First Round of Negotiation (1993-96) and 7 Blocks (5,7,9,10,8,19,20) signed/finalized under the Second Round of Bidding (1996-2001). It may be stressed that PSC for the Bibiyana gas field located in Block 12 was signed in January 1995 and there is no gas purchase commitment clause in the PSC. Some of the IOCs operating under First Round of Negotiation (1993-96) have already relinquished part of some of the Blocks (12,13,14,15,16) and the others may be in the process of relinquishing under the conditions of PSCs.

If market for gas is not assured before hand there is moratorium for five years on exploration activities for all the seven PSCs finalized under Second Round of Bidding (1997-2001). There is provision for BAPEX's partnership (with 10% carried interest) in all the PSC of seven Blocks (5,7,8,9,10,19,20) negotiated under Second Round of Bidding.

It may be noted from previous presentation that the newly elected BNP Government (installed in October 2001) is not under contractual obligation to allow Unocal to export gas from the Bibiyana gas field via pipeline. However, the IOC may consider exporting gas via LNG as per PSC (Article 14). If the present Government decides to allow export of gas from Bibiyana gas field (located in Block 12) via pipeline, similar conditions may also have to be considered for all the 7 PSCs finalized/signed under Second Round of Bidding (during the tenure of Awami League Government). In that case in future discovery of new gas fields under PSCs would not help in ensuring energy security of the country.

2.8 Possible Impacts of Natural Gas Export and Natural Gas Use

2.8.1 Gross & Net Income from Gas Export

Under Production Sharing Contract (PSC), the net share of natural gas to Bangladesh may vary between 30%-50% of total gas produced over the life cycle of a gas well. With an average export price of gas (at the wellhead) @\$3.0/MCF gross revenue earnings for export of 3.65 TCF gas over a period of 20 years (@ 500 million cubic feet per day) is US\$ 10,950 million. Total net income to the country for 30% and 50% shares are computed as US\$ 3,285 million and US\$ 5,475 million respectively. For 30% and 50% shares yearly income are US\$ 164.2 million and 243.75 million

respectively. For a total population of 135 million, yearly increase of per capita GNP on account gas export may be US\$ 1.22 for 30% share and US\$ 1.80 for 50% share. Incremental gain from gas export may have marginal effect in economic development of the country.

It has been mentioned in Unocal's proposal that over the 20 years life of the pipeline project, the Government of Bangladesh will receive an estimated total of US\$ 3,700 million in revenue and tax receipts. It has not been mentioned what percent of total revenue would come from gas sales and from the gas pipeline? What would be the ownership structure of the Bangladesh portion of the pipeline and the role of national gas transmission company, GTCL? However, it has been mentioned that the proposed sales price of gas at the Bangladesh-India border, subject to conclusion of a Gas Purchase and Sales Agreement (GPSA), will be at least the wellhead PSC price plus the transportation tariffs for the trans-Bangladesh section of the pipeline. It may be stressed that the wellhead price of gas offered to the IOCs operating in India is 25-30% higher than the price offered in Bangladesh. Therefore, wellhead price of Bangladesh gas for export should be higher than the wellhead price mentioned in PSC

2.8.2 Possible Impacts of Natural Gas Use

Energy intensity of GDP of Bangladesh in 1995 and 1996 were reported as \$ 3.0/kgOE and \$1.7/kgOE respectively (WB 1999, WB 2000). Heat equivalent of natural gas is 23.2 kgOE/MCF. By using energy intensity of GDP of 1996 (\$1.7/kgOE) the contribution of 1 MCF natural gas may be computed as US\$ 39.44. It may be possible to earn 13 times more by using natural gas in national production in comparison to export (US\$ 3.0/MCF). Because of this reason gas importing countries are found to import natural gas at a delivery price of US\$ 4.0 – US\$ 4.5/MCF (including US\$ 1.0-US\$ 1.5/MCF transport cost). There is a need to identify the process of increasing gas use in the national productive systems.

2.8.3 Comparison of Per Capita GNP of Some Selected Countries

Historical data of per capita GNP of 8 selected countries are shown in Table 2.4. It may be observed from the table that 6 countries (Bangladesh, India, Nepal, Pakistan, Sri Lanka and Thailand) importing commercial energy (oil) had steady growth of per capita GNP during the period from 1981 to 1999. Although as member of OPEC Nigeria and Indonesia have been exporting substantial quantity of energy resources even then they could not maintain steady growth of per capita GNP. Nigeria had continuous decline of per capita GNP from US\$ 870 in 1981 to US\$ 260 in 1997, it has started increasing since 1997. Per capita GNP of Indonesia increased from US\$ 530 in 1981 to US\$ 560 in 1983, then decreased to US\$ 440 in 1988, then increased to US\$ 1100 in 1997 then decreased to US\$ 580 in 1999.

Some important information about Nigeria and Indonesia are shown in Table 2.5 (Simpson 1998). Nigeria could not make economic progress by exporting a large quantity of oil (94 million ton in 1996) and the economic performance of Indonesia was also not very encouraging with the export of oil (39 million tons in 1996) and gas (1.26 TCF in 1996). Lack of good governance is generally attributed for the unsatisfactory economic performance of Nigeria and Indonesia. It may be noted that it has been proposed to export only 0.1825 TCF gas per year (@ 500 million cubic feet per day) from Bibiyana gas field. It would raise high expectation in people's mind about rapid economic development of the country. Similar to other developing countries lack of good governance may also aggravate the economic progress in Bangladesh.

2.9 Possibility of Substitution of Natural Gas with Alternate Energy Sources

Analyses of global energy scenario indicate that coal and oil were the dominant energy sources of the world in nineteenth and twentieth century respectively. Natural gas will be the dominant the energy source of the 21 century (Islam 2001a). There is a very limited prospect of substitution of fossil fuels with renewable energy sources within next fifty years (Hammonds 2000). It may be concluded that there is no possibility for Bangladesh's natural gas becoming value less in-place within 50 years due to substitution with alternate energy sources.

2.10 Natural Gas for Energy Security

Indigenous natural gas is the only reliable energy source to meet future energy needs of the country. It would be appropriate to conserve natural gas to ensure long-term energy security of the country. It was not appropriate to finalize 15 Production Sharing Contracts (PSCs) with International Oil Companies (IOCs) in two phases without considering the energy demand of the country. After the expiry of existing Production Sharing Contracts exploration and development of gas resources should be considered in phases by matching the energy demand of the country. Institutional capabilities of BAPEX should be strengthened for exploration and development of hydrocarbon.

3.0 RELATED POLICY ISSUES

In addition to policy on future use of natural gas, other related policy issues need to be considered for overall development of the energy sector of Bangladesh are presented below.

3.1 Policy Planning Issues

Tariffs of different type of final energy should be fixed on the basis of economic cost. When it is decided by the Government to give any subsidy necessary adjustment should be made with the respective utilities on this account. Introduction of rational energy pricing is necessary to support healthy commercial operation of

the utilities, encourage rational use of commercial energy and help in promoting renewable energy technologies.

A reliable database on different type of energy sources, their conversion, supply, consumption, prices etc. are to be established and maintained by the utilities, concerned agencies and the Planning Commission for systematic planning (e.g. forecasting) and development of energy resources of the country. Institutional capabilities of the Planning Commission and the utilities are to be strengthened to undertake energy plan under long-term time horizon.

3.2 Programme Planning Issues

Adequate attention is to be given to improve supply and distribution of energy in the West Zone of the country. There is a need to undertake systematic planning to meet the energy needs of different rural locations. Area based energy planning methodology recommended in NEP should be adopted to ensure energy security for rural population. Under the area based energy development programme optimum development and efficient use of all the locally available energy resources should be given priority. If local resources are not sufficient, additional resources should be imported (may be supplied by the national utilities). Energy needs of all socio-economic groups should be given due consideration. Demand management practice should be implemented with much seriousness to improve the operational efficiency of existing energy infrastructures. Promotion of efficient energy technologies should be considered to achieve energy conservation.

3.3 Project Planning Issues

Necessary actions should be taken to reduce system losses in gas and electricity sectors. There is a need to pay special attention to meet the energy needs of Chittagong Hill Tracts area. Target oriented energy projects should be undertaken to meet the energy needs of environmentally degraded locations and the poor on a priority basis. Human resources development (HRD) and research activities of different energy utilities should be given due consideration to improve management efficiency.

3.4 Institutional Issues

Various institutional reforms recommended in the National Energy Policy for improving the performance of the energy sector are presented below.

- o Establishment of an independent National Energy Regulatory Authority (NERA) to implement rational tariffs of different type of final energy for encouraging healthy participation of public sector and private sector enterprises.

- o Corporatization of public sector utilities (Petrobangla, Bangladesh Petroleum Corporation, Bangladesh Power Development Board, Dhaka Electric Supply Authority)

for competitive operation with private sector organizations.

- o Establishment of Renewable Energy Development Agency (REDA) for sustainable promotion of renewable energy technologies.

- o Development of local level institutions for planning, implement and management of area based energy development programme. Distribution and diffusion of small-scale technologies by a centralized extension agency may not be efficient and cost effective (Ramani, Islam & Reddy 1993, Ramani, Reddy & Islam 1995).

3.5 Legal Issues

Revision of the existing laws and/or enactment of new laws (e.g. Gas Act, Electricity Act, Energy Conservation Act etc.) is necessary for the development and management of energy sector programmes/projects to ensure energy security for sustainable human development.

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Table 1.1: Comparative Status of Per Capita Energy Consumption and GNP

Particulars	Energy kgOE (1997)	GNP US\$ (1999)
Low Income Countries (LIC)	563	410
Lower Middle Income Countries (LMIC)	1178	1200
Upper Middle Income Countries (UMIC)	2068	4900
Middle Income Countries (MIC)	1368	2000
High Income Countries (HIC)	5346	25,730
All the Countries of the World	1692	4890
Bangladesh	197	370
India	479	450
Nepal	321	220
Pakistan	442	470
Sri Lanka	386	820

Source: World Bank (2001).

Table 2.1 Natural Gas Demand for Fifty Years (2001-2050)

End Use Sectors	10 Years	20 Years	30 Years	40 Years	50 Years
Power	2.511	7.775	16.034	27.068	39.7
Fertilizer	0.973	2.096	2.977	3.864	4.75
Industry	0.822	2.506	5.367	9.155	13.52
Domestic/Commercial	0.537	1.331	2.382	3.594	4.93
Total	4.843	13.708	26.764	43.681	62.99

Source: Petrobangla (2001)

Table 2.2: Natural Gas Reserves and Resources

Particulars	Petrobangla	Shell	Unocal				USGS/Petrobangla			
			16.1	16.1	16.1	16.1				
Recoverable Reserves (TCF)	15.51	18.00	16.1	16.1	16.1	16.1				
Additional Gas Resources (TCF)										
Field Growth (TCF)		5-6	12.8	12.8	12.8	12.8				
Undiscovered Gas Resources (TCF)		20-40	5.3 (90%)	10.3 (50%)	13.2 (mean)	22.6 (10%)	8.4 (95%)	29.2 (50%)	32.1 (mean)	65.7 (5%)
Total (TCF)	15.51	43-64	34.2	39.2	42.1	51.5	8.4	29.2	32.1	65.7

*Recoverable Reserves

Petrobangla's Reserves include gas reserves of 22 gas fields

Shell's Reserves (number of gas fields has not been specified)

Unocal's Reserves include gas reserves of 21 gas fields (Reserve of Maulavibazar not included)

Table 2.3: Compilation of Gas Reserves and Resources Data of Different Organizations

Particulars	Petrobangla	Shell	Unocal				USGS/Petrobangla			
Net Recoverable Reserves in 22 Gas Fields ¹ (TCF)	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24
Additional Gas Resources (TCF)										
Field Growth ² (TCF)		5-6	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80
Undiscovered Gas Resources (TCF)		43-64	5.30 (90%)	10.30 (50%)	13.20 (mean)	22.60 (10%)	8.40 (95%)	29.20 (50%)	32.10 (mean)	65.70 (5%)
Total (TCF)	11.24	59.24 - 81.24	29.34	34.34	37.24	46.64	32.44	53.24	56.14	89.74

1- Net recoverable reserve from 22 gas fields on July 2001

2- Field growth reported by Unocal

Table 2.4: Per Capita GNP of Selected Eight Countries

Year	Bangladesh	India	Nepal	Pakistan	Sri Lanka	Indonesia	Nigeria	Thailand	Source
	1	2	3	4	5	6	7	8	
1981	140	260	150	350	360	530	870	770	WB 1983
1983	130	260	160	390	330	560	770	820	WB 1985
1984	130	260	160	380	360	540	730	860	WB 1986
1985	150	280	160	380	380	530	800	800	WB 1987
1986	160	290	150	350	400	490	640	810	WB 1988
1987	160	300	160	350	400	450	370	850	WB 1989
1988	170	340	180	350	420	440	290	1000	WB 1990
1989	180	340	180	370	430	500	250	1220	WB 1991
1990	210	350	170	380	470	570	290	1420	WB 1992
1991	220	330	180	400	500	610	340	1570	WB 1993
1992	220	310	170	420	540	670	320	1840	WB 1994
1993	220	300	190	430	600	740	300	2110	WB 1995
1994	220	320	200	430	640	880	280	2410	WB 1996
1995	240	340	200	460	700	980	260	2740	WB 1997
1997	270	390	210	490	800	1110	260	2800	WB 1999
1998	350	430	210	480	810	680	300	2200	WB 2000
1999	370	450	220	470	820	580	310	1960	WB 2001

Energy importing countries: Bangladesh, India, Nepal, Pakistan, Sri Lanka and Thailand

Energy exporting countries: Indonesia and Nigeria

Source: Compiled from World Development Reports

Table 2.5: Comparison of Energy Database of Nigeria and Indonesia in 1996

Particulars	Nigeria	Indonesia
Population (Million)	114.6	197
Crude Oil Reserve (MT)	2832	703
Natural Gas Reserve (TCF)	110	67
Consumption of Oil (MT)	14.7	42
Consumption of Gas (TCF)	0.19	1.14
Export of Oil (MT)	94	39
Export of Gas (TCF)		1.26

Source: Simpson (1998)

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