Country Profile of Bangladesh

Bangladesh is located between 20°34′ to 26 °38′ North latitude and 88°01′ to 92°42′ East longitude with an area of 147,570 sq. km. (BBS, 1999) and a population of about 128.0 million (Author's estimation). India surrounds the country in three sides (i.e., West, North and East), sharing some 3715.18 kilometers of common border. It should be noted here that this is about 93% of Bangladesh's entire land borderlines. The other neighbour being Myanmar, sharing mountainous border in the south-east. The Bay of Bengal lies to the south of Bangladesh. The coastal zone of Bangladesh consists of about 710 km coastline, the largest patch of natural mangrove forest shared with India, and a long sea beach along the south-east.

Three major types of landscapes are found in Bangladesh: floodplains (80%), terraces (8%), and hills (12%). Excepting the eastern hilly region, almost all of the country lies in the active delta of three of the world's major rivers i.e., the Brahmaputra, the Ganges and the Meghna (GBM). The water ecosystem of the country comprises the tributaries and distributaries of these major rivers and numerous perennial and seasonal wetlands like haors, baors and beels. Figure 1 presents the map of Bangladesh showing the major river systems. The floodplains of Bangladesh comprise only about 7% of the total area of the GBM catchment, but it discharge about 92% of the flow generated by the GBM system. The ironic fact is that over 80% of the 1350 billion cubic meters of rainfall runoff occur in the entire GBM catchment within five months (June to October) during monsoon, while in the dry period the country suffers from severe moisture stress due to negligible rainfall.

Most of the land area is being used for agriculture, forest and settlement. Very small fraction of the land area is being used to meet industrial and other miscellaneous social and administrative needs. In recent years, however, there is a growing tendency of changing land use from agricultural to other lands, especially to meet the increasing demands for industrial and urban areas. As a result, more and more agricultural lands are being transformed into other lands. The arable area constitutes 7.67 million hectares (out of 14.74 million hectares), which is about half of the total area, declined rapidly from 8.74 Mha in 1990. There are three cropping seasons which approximately coincide with the three meteorological seasons: Kharif I (pre-monsoon), Kharif II (monsoon), and Rabi (winter or dry). Aus, Aman and Boro are the three paddy varieties grown respectively in those three cropping seasons. Wheat, potato, jute, sugarcane, oilseeds and spices are other important crops grown. The country has a big livestock population, constituted by some 23 million bovine animals, but of very poor quality. Since 6.7% of the landmass consists of rivers and water bodies the country enjoys inland-fresh-water- and marine-fisheries-resources, both having a rich fish biodiversity. However, due to increased pollution in water bodies combined with shrinking wetland areas the fisheries resources have deteriorated significantly over the past two decades.

The large size of population is arguably the most critical problem of the country. With a size similar to that of Delaware, Bangladesh's total population is about half of the US population. About 50% of this population are below reproductive age (i.e., 15 years) meaning that it has a high growth potential. During the past two decades, however, Bangladesh successfully retarded its population growth rate and brought it down from some 3.0% to about 1.67%. Remarkable achievements have also been made in terms of decreasing child mortality rates and increasing life expectancy. Despite such success stories Bangladesh remains the most densely populated country. Apart from a few city-states, her population density (over 850 persons per square kilometers) is considered as the most in the world. Its population, however, are dispersed evenly across the country except for the hilly south-eastern districts. The growing pressure of increasing population added to the stress on natural resources including land and water.

Owing to fertile land, agriculture remained as the major occupation for over 60% of the population for centuries. Over 50% of the agricultural workers do not own any land and get paltry return only to maintain subsistence. Open water fishing is one of the major earning source for a significant proportion of population, especially in monsoon months. The industrial base of the country has remained in its nascent state despite incentives offered by the government. Although investment rates as a share of GDP improved steadily from 15% in 1981 to about 21% by 1995, the per capita GDP is still below US$ 400.

During the past three decades all the development efforts of Bangladesh was aimed at lifting the economy out of abject poverty. The country has followed the course of planned development since 1973 through its first Five Year Plan. This was followed by a Two Years Plan (1978-80) in the background of world-wide inflation and uncertainties and three other Five Year Plans were followed during 1980 and 2000. Every plan, including the recently adopted Fifth Five Year Plan (1997-2002) targeted at an average annual growth rate of around 5 percent but achieved an average growth rate of about 4 percent. Despite a large inflow of foreign assistance to augment domestic resources, the planned effort for development has not been able to free the economy from the low growth trap.

The human dimensions of overall development for Bangladesh are not appreciable, although some achievements have been made during the past decade in terms of spreading basic education, providing immunisation and sanitation services, enhancing health care facility and decreasing child mortality rates etc. Autocratic rules, rampant corruption, inefficient administration – all these vices worked against the development thrust of the common people of Bangladesh.

The following table gives some of the national statistics of Bangladesh for 1995.

Table-1 : National statistics on Bangladesh

Indicators	**1981**	**1991**	**1995**
Population (million)	89.9	111.45	119.8
Land Area (square kilometres)	144,000	147,570	147,570
-- Urban (percentage)	N/A	N/A	N/A
-- Forest (percentage)	15.00	12.80	12.74
-- Agricultural (percentage)	60.52	55.08	52.06
-- Cultivable Wasteland (percentage)	1.62	3.93	4.28
-- Current Fallow (percentage)	3.39	6.49	2.68
-- Other			
GDP (1995 US$ in million) in 1989-90 constant price		26500	32060
-- Industrial GDP (percentage)		22.14	24.18
-- Services GDP (percentage)		49.45	50.98
-- Agriculture GDP (percentage)		28.13	24.83
GDP per capita (1995 US$)		241	336
PPP per capita of GNP (Int'l 1995 US$) *			1380
Urban Population as percentage of Total Population	15.20	17.20	22.00
Livestock Population (Bovine) in million		22.5	
Population in below poverty level (%)	73%	47%	45.8%
Life Expectancy at Birth (years)	55	56	58
Literacy Rate	29.2	38.8	43.2

Source: World Bank, 1997

Bangladesh' per capita energy consumption is very low, the lowest within the Indian sub-continent. The 1996 energy consumption value stands at 197 kgOE, compared to 476 kgOE for India, 446 kgOE for Pakistan, and 371 kgOE for Sri Lanka (WB 1999/2000).

Approximately 60~65% of total energy demand of the country is supplied by indigenous biomass based fuels. Agricultural residues, animal dung and fuelwood are the most important biomass fuels. Although there is no reliable data in relation to sustainable supply of biomass fuel and their consumption, there are reports claiming that the quality of the productive resources is degrading gradually due to overexploitation. Since almost two-thirds of the energy demand is met by such indigenous traditional sources, it is obvious that these directly help the majority poor rural households to maintain their energy security throughout the year.

The country is endowed with a fairly large reserve of natural gas, a recent estimate claiming that the recoverable reserve could be as high as 31 TCF. The current rate of consumption of natural gas, mainly as a source of energy and raw material for fertiliser, is about a quarter TCF (0.248 TCF in 1999) per annum which equates to about 1.938 MCF/person/year (Islam, 2000). Despite having a good reserve of natural gas, only 3 to 4% of the households have connection of natural gas for cooking purposes. Only about 2~3% households use kerosene for the same purpose and the rest (over 90%) depend on traditional biomass sources. Table 2 provides information on known and exploitable primary indigenous energy resources of Bangladesh.

Table-2: Known and Exploitable Indigenous Primary Energy Resources

Resource (Location)	Specific location	Net recoverable reserve	Production/Supply		Comments
			Present	Projected	
Coal (West Zone)	Barapukuria	70 million tonnes	0	1 million tons/year	Reserve 300 million tonnes in place
Crude oil (East Zone)	Haripur	5.5 million barrels$^{\varphi}$	16.4 tonnes/day$^{\varphi}$	Not yet ascertained	Appraisal of the field needed
Natural gas* (East Zone)	17 Gas fields	10.44 TCF$^{\varphi}$	558 MMCFD$^{\varphi}$	1000 MMCFD by 2000	Reserve life time up to 2020
Natural gas – liquid* (East Zone)	Producing gas fields	53.5 million barrels$^{\varphi}$	137 tonnes/day$^{\varphi}$	479 tonnes/day	After commissioning of Kailashtila & Beanibazar fields
Hydropower (East Zone)	Kaptai	N/A	1000 GWh/year	1000 GWh/year	Only Kaptai site being exploited

Notes:* * *Values will change based on very recent developments (as of January 2001).* $^{\varphi}$ *Values represent June 1993 data, as present in National Energy Policy 1996.

In addition to natural gas, the estimated consumption of different type of petroleum products in 1999 was about 3.3 million tons, all imported from abroad. About 0.5 million tons of coal was also imported and consumed, mainly for brick burning. In 1999 total consumption of electricity was 11,352.3 GWh, some 90kWh on per capita basis. In 1999 the total installed electricity generation capacity was 3603 MW, although the maximum daily generation could not surpass 2700 MW. Only an insignificant fraction of generated electricity is generated from petroleum products, the rest is generated from natural gas. It is reported that in 1999 only about 14~15% of households enjoyed electricity connections, but the quality of energy service being extremely poor, especially in the rural areas.

The country use to harness hydropower from one power plant, located in Kaptai. Although the total potential of the resource is about 1000 GWh/year only a part of it is actually being harnessed. The government is contemplating to enhance the capacity of the reservoir and the plant and to produce more power, the feasibility of the

enhancement project is underway. In addition, there are two other potential sites from where another 500GWh/annum of hydroelectricity can be produced. Given the locations, their respective hydro-geological set up, socio-economic, cultural, and environmental considerations, it seems highly unlikely that those potentials could be realised in near future.

Currently, the country does not have any coal mine operation, but a project is now taken to provide 1.0 million tonnes of coal per annum from the Barapukuria coal field. It is planned that 85% of its annual production will be utilised to produce electricity, the rest will be used as fuel for brick making and other purposes. The mining operations may continue up to 70 years from its inception. Bangladesh also has two other coal fields: 1000 million tons at Jamalganj and 450 million tons at Khalaspur. Early estimations suggest that it will not be techno-economically feasible to extract coal from Jamalganj reserve. The country has about 170 million tons of peat reserve in its southern regions. However, recoverable reserve is yet to be determined and the energy resources are not likely to be tapped in near future (Khan and Imaduddin, 1999).

The Energy Policy of Bangladesh

Energy development appears to be a major constraint for continued development of a LDC such as Bangladesh. The major stumbling block is lack in terms of capital investment since energy development programmes are highly capital intensive. Traditionally these programmes have been implemented with support from the donors and/or multilateral banks. Since independence the government has given adequate priority and about 20% of total public sector investment has been allocated for the development of energy sector. Even then the achievements made in this sector have not been able to cope with the growing demand for energy services, in terms of both quality and quantity.

In response to non-cooperation for large-scale investment in energy development by the major donors, which was fuelled by unacceptably high level of 'system loss' by the major government managed energy utility companies, the government encouraged participation of the private sector in energy development and management programme. This was highlighted in the first ever National Energy Policy (NEP), completed and gazetted in 1996 (GOB, 1996). The NEP recognized that energy plays important roles for socio-economic development of the country and energy development and management should be brought under an integrated policy framework. The NEP set a number of objectives, which are outlined below:

1. To provide energy for sustainable economic growth so that the economic development activities of different sectors are not constrained due to shortage of energy.

2. To meet the energy needs of different zones of the country and socio-economic groups.

3. To ensure optimum development of all the indigenous energy sources.

4. To ensure sustainable operation of the energy utilities.

5. To ensure rational use of total energy sources.

6. To ensure environmentally sound sustainable energy development programmes causing minimum damage to environment.

7. To encourage public and private sector participation in the development and management of the energy sector.

►Demand Scenarios

Two economic growth scenarios (Low Scenario and Reference Scenario) were considered to forecast future energy demands, as presented in Table-3. Projected demands for commercial energy and electricity up to the year 2020 under both the scenarios are also presented in Tables 4 and 5, respectively.

Table-3: Economic Growth Rates Used in the NEP

Scenario definition	Time frame					
	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020
Low	4.44	5.25	5.24	5.24	6.65	6.65
Reference	5.0	6.0	6.7	7.2	7.5	8.0

***Note: Taken from NEP (GOB, 1996). Values are expressed in per cents*.**

Table-4: Projected Demand for Energy (Commercial and Electricity) under Low Economic Growth Scenario

	1990	1995	2000	2005	2010	2015	2020
	Commercial energy						
Population (million)	107	118	130	141	153	165	177
GNP Growth Rate (%)	4.44	5.25	5.24	5.24	5.24	6.65	6.65
Per capita GNP ($)	190	214	242	276	317	366	424
Energy Coefficient	1.62	1.37	1.37	1.37	1.08	1.08	1.08
Energy Growth Rate (%)	7.13	7.19	7.18	7.18	7.18	7.18	7.18
Per Capita use (kgOE)	56	68	92	127	157	219	272
Total Energy (MTOE)	6	8	12	18	24	36	48
Total Energy (PJ)	256	342	512	769	1025	1537	2050
Energy Productivity (MJ/$ GNP)	12.59	13.54	16.27	19.76	21.13	25.45	27.32
	Electricity						
Status in energy mix (%)	35	37	39	37	33	33	33
Total GWh	8207	11584	18315	26063	30994	46491	61988
Per capita kWh	77	98	141	185	203	282	351
Load factor (%)	55	57	57	57	58	59	60
Peak Load (MW)	1703	2320	3668	5220	6100	8995	11794

Table-5: Projected Demand for Energy (Commercial and Electricity) under Reference Economic Growth Scenario

	1990	1995	2000	2005	2010	2015	2020
	Commercial energy						
Population (million)	107	118	130	141	153	165	177
GNP Growth Rate (%)	4.5	5.4	6.4	7.2	7.7	8.2	8.7
Per capita GNP ($)	190	214	254	318	416	560	774
Energy Coefficient	1.62	1.37	1.37	1.37	1.08	1.08	1.08
Energy Growth Rate (%)	7.34	7.4	8.77	9.86	8.32	8.86	9.40
Per Capita use (kgOE)	56	72	94	131	194	269	384
Total Energy (MTOE)	6	8	12	19	31	46	72
Total Energy (PJ)	256	362	531	827	1314	1979	3055
Energy Intensity (MJ/$ GNP)	13	14	16	18	20	20	21
	Electricity						
Status in energy mix (%)	35	37	39	37	33	33	33
Total GWh	8207	12280	18971	28060	39750	59858	92402
Per capita kWh	77	104	146	199	260	363	523
Load factor (%)	55	57	57	57	58	59	60
Peak Load (MW)	1703	2459	3799	5620	7823	11581	17580

▸Supply Scenarios / Options

Keeping a common set of strategies two supply options (Current Option considering business-as-usual practices to continue, while the Reference Option considering few issues which are additional to the Current Option) were considered to meet the projected energy demand in the future. The salient features of the two supply options are presented below.

Current Option

The basic principle of Current Option, as presented in the NEP, was that the then existing practices of energy development programme would continue in the future. The conditions under this option were the following:

I. Development of known indigenous natural gas will continue.
II. Development of indigenous coal at Barapukuria will continue.
III. Development of known oil deposits and use of natural gas liquid will continue.
IV. Development of peat will continue.
V. Imported oil will meet the major energy needs of liquid fuels.
VI. Imported coal will meet part of the energy need mainly for brick industries.
VII. Indigenous natural gas, coal, hydropower and imported petroleum fuels will be used for power generation.
VIII. There will be no effective programme on energy conservation.
IX. Development and management of biomass fuels will be considered without having any linkages with commercial energy development programmes.

Under this supply option the policy clearly suggested that indigenous natural gas would continue to play a dominating role in meeting the non-renewable energy needs of the country. It was mentioned that by the year 2000 the daily supply of natural gas would reach its maximum level at 1000 MMCFD and it would remain so till 2020. Similarly it was hoped that development of indigenous coal from Barapukuria mines would ensure supply of 1 million tons since the year 2000 and continue well beyond the policy time frame.

The Current Option also anticipated that the dependence on imported liquid fuel would increase, even under the Low Scenario, and the gap between supply and demand would increase significantly past 2000. In order to reduce the gap between the projected demands and indigenous supply the NEP suggested that the country would have to implement a serious exploration programme and it mentioned that without this possibility it would be very difficult to meet the huge gap from imported sources.

Reference Option

The issues additional to those in the Current Option are the following: (a) enhancement of exploration, appraisal and extraction of indigenous non-renewable energy sources; (b) implementation of effective programmes on energy conservation; and (c) integration of commercial energy and biomass fuels programme to maintain sustainable supply of biomass fuels. Specific assumptions under the option were the following:

I. Exploration and appraisal of oil and natural gas will be continued;
II. Development of natural gas will continue;
III. Development of coal will be continued;
IV. Development of oil and natural gas liquid will continue;
V. Development of peat resources will be enhanced;
VI. Harnessing of new-renewable sources of energy will be undertaken;
VII. Imported oil will meet the major energy demand of liquid fuels;
VIII. Imported coal and gas will meet a part of total energy needs;
IX. Indigenous natural gas, coal, hydropower and imported coal, petroleum fuels and nuclear power will be used for electricity generation;
X. Effective programme will be undertaken for conservation of commercial energy and biomass fuels;

XI. Development of biomass fuels will be considered along with the development of commercial energy sources.

It was felt that implementation of the Current Option would (a) create strain on the macroeconomy by sharp increase in energy import bill, (b) require additional fuel due to absence of energy conservation measures, and (c) cause severe environmental degradation due to neglect of problems concerning biomass fuels under energy sector development programme. Considering such issues and for achieving sustainable energy development the policy recommended to follow the Reference Option.

The NEP also allocated the then and also the projected supply of natural gas (up to 1000 MMCFD) at the following ratios:

Power generation	45~50%
Fertiliser production (for local consumption only)	25~27%
Industry	13~18%
Commercial and domestic	8~10%

Table 6 gives primary energy mix for power generation and Table 7 provides demand supply balances of current option as presented in NEP (GOB, 1996).

Table-6: primary Energy Mix for Power Generation

Type	1990	1995	2000	2005	2010	2015	2020
Total Generation	(values given in GWh)						
Low scenario	8207	11584	18315	26063	30994	46491	61998
Reference scenario	8207	12280	18971	28060	39750	59858	92402
Gas	7285	10500	15000	15000	15000	15000	15000
Coal	0	0	1030	2000	2000	2000	2000
Hydro	800	800	1000	1000	1300	1300	1300
Total generation from indigenous fuel	8085	11300	17030	18000	18300	18300	18300
Deficit*							
Low scenario	122	284	1285	8063	12694	28191	43698
Reference scenario	122	980	1941	10060	21450	41558	74102

* ***To be generated by imported fuel.***

Table-7: Demand Supply Balances of Current Option

Description	Time frame						
	1990	1995	2000	2005	2010	2015	2020
Demand	PJ						
Low scenario	256.0	342.0	512.0	769.0	1025.0	1537.0	2050.0
Reference scenario	256.0	362.0	531.0	827.0	1314.0	1979.0	3055
Indigenous supply	PJ						
Natural gas	168.84	262.31	366.83	366.83	366.83	366.83	366.83
NGL & LPG	1.56	2.97	7.27	7.27	7.27	7.27	7.27
Oil	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	0.0	0.0	27.0	27.0	32.4	32.4	32.4
Peat	0.0	0.0	0.0	0.08	0.15	0.15	
Hydro	11.43	11.43	11.43	11.43	14.86	14.86	14.86
Sub-total	181.83	276.71	412.53	412.6	412.51	412.51	412.51
Deficit	PJ						
Low scenario	74.17	65.29	99.47	356.40	612.49	1124.49	1637.49
Reference scenario	74.17	85.29	118.47	414.40	901.49	1566.49	2642.49

Note: From NEP (GOB, 1996).

The Eight Indicators

►Indicator 1

Since approval of the NEP by the National Parliament, a number of policy recommendations have been implemented. First, the private sector is authorised to take part in production of electricity; exploration, production, and management of natural gas etc. As a result, a number of private companies are operating with small- to medium-scale power plants. Secondly, all the government owned new power generation units use natural gas as the base fuel and the old technologies involving coal fired and diesel based plants are being phased out. Moreover, the new installations are more efficient (combined cycle power generation units). Overall, the NEP has been very effective in terms of reduction of emissions of greenhouse gases from electricity production, although capital investments for improved technologies were much higher than that of old technologies.

In the latter half of the 1990s the demand was much higher than the peak load, especially during 6 and 10 PM. Since the time for both implementation and transfer of technology for a diesel run power plant was shorter than that for a modern natural gas based power plant, those investments resulted into a few power generation plants with petroleum based liquid fuel. One such 100 MW power plant is in the process of being converted into a natural gas based power plant in 2001. Such measures will certainly reduce the GHG emissions significantly.

Due to a number of reasons exploitation of the Barapukuria coal mine could not be started in 2000 as expected. However, it will come into operation from 2003-04 and GHG emissions from coal burning will increase significantly. The projection of GHG emissions are presented in figure-2 (ADB, 1998). Since the NEP calls for enhancing use of indigenous coal for power generation and other commercial/industrial/domestic purposes, an increase in the country's carbon emission will be a certainty in near future. But at the same time, a significant part of this indigenous coal, some 150,000 mt/annum, will be made available in the market to replace some biomass fuels. This will in turn reduce dependence on biomass fuels, reduce overall GHG emissions by achieving higher energy efficiency due to fuel switching (from biomass to coal) and thereby create conditions for biomass being recycled to enrich topsoil. The latter aspect will be extremely important for the long term sustainability of crop agriculture of the country (ADB, 1998).

In 1990-91 the per capita energy sector emission was 32.79 kg of C, an insignificant amount with respect to the then global per capita emission of 1130 kgC. In 1995-96 the value increased to 49.09 kg of C. The vector for energy sector emission, therefore, becomes 1.71, indicating high global energy sustainability.

▸Indicator 2

Bangladesh's indigenous fuels are, on an average, very clean in terms of contents of sulphur and nitrogen. Natural gas known to be a high grade fuel. It is thus expected that in terms of common energy-related pollution Bangladesh would not fare badly. The major source of pollutants are impurities laden imported liquid fuel and coal. In 1990-91 about half of the imported liquid fuel was refined in the only oil refinery of the country, the rest being imported directly as finished products. But the scenario has been changed somewhat by the year 1995-96 when about two-thirds of the imported liquid fuels came as finished product. Since the main subscriber of liquid fuel is the transport sector, non-point sources are the major polluters for Bangladesh. It is no wonder that the air quality of the capital city Dhaka is one of the worst amongst the Asian cities, because majority of the vehicles concentrate in the largest city and the economic heart of the country. Tables-8 gives permissible limits of pollutant concentrations in ambient air and Table-9 gives pollutant concentration in the ambient air at some locations of Dhaka city.

Table-8: Permissible limits of pollutant concentrations in ambient air

Pollutants	WHO Standard			8-Hr for commercial & mixed use zones		
	μ gm^{-3}			μ gm^{-3}		
	1-hr	8-hr	24-hr	Bangladesh	India	China
CO	30,000	10,000	--	5,000	5,000	4,000
Sox	350	--	105	100	120	150
Nox	400	--	150	100	120	100
SMP	--	--	150	400	500	500

Source: Alam et al., 2000.

But the other polluting fuel, coal, is being used in brick manufacturing industries all over the country, the highest concentration again is found around the capital city, which has been growing at 6~8% per annum during the 1990s. In 1996 the SO_2 concentration was recorded at 279μgm^{-3} in one of the busiest crossroads of Dhaka.

Table-9: Pollutant concentration in the ambient air at some specific locations in Dhaka city

Location	Area specification	CO	NOx	SOx	SPM
		μ gm^{-3}	μ gm^{-3}	μ gm^{-3}	μ gm^{-3}
Gulistan	Commercial	33200	500	800	1332
Jatrabari	Transport-intensive (TI) area	67000	500	1300	4667
Pantho Path	Residential TI area	85100	500	900	2666
Mohakhali	Transport-intensive (TI) area	69300	500	1200	2111

Note: Modified from Alam et al., 2000.

Since the level of SO_2 emissions depend on actual sulphur concentration in each of the imported fuel types and being unknown, a rough estimate provides a range of 2700 to 5500 metric tons in 1990-91, which rose to 5350 to 10800 metric tons in 1995-96. The vector for most significant energy-related local pollutant appears to be 1.88. This is perhaps an indication of 88% higher emission of SO_2 in 1995-96 compared to 1990-91.

▸Indicator 3

Majority of the country's population live in rural areas, meting most of their energy needs (for domestic, commercial, and industrial needs) from locally available biomass fuels. At present various marketing companies under the Bangladesh Petroleum Corporation (BPC) distribute kerosene and diesel throughout the country at a uniform tariff rate set by the government. The Rural Electrification Board (REB) is responsible for providing electricity to the rural communities through Rural Electricity Associations. But the quality of power services in rural areas is very poor; there are reports of frequent voltage fluctuations, unreliable and erratic supply. Due to lack of purchasing power very small proportion of rural households use to subscribe energy services from commercial sectors.

According to the statistics provided in the pocketbooks/yearbooks of the Bangladesh Bureau of Statistics (BBS) the total number of households with access to electricity increased from 1.34 million to 1.85 million between 1990-91 and 1995-96. The vector for households with access to electricity thus appears to have decreased from 0.935 in 1990-91 to o.823 in 1995-96.

▸Indicator 4

As mentioned earlier, the government is keen on investing on modern and cleaner technologies for electricity generation, which received impetus from the NEP. But there has not been any appreciable investment in clean technologies (both renewable and cleaner) between 1990-91 and 1995-96. Since 1996-97, with donor assistance, the government of Bangladesh has taken a pilot project to offer solar-power to about 1100 families in a riverine (char) island, an area which was otherwise deprived of grid-based electricity due to its remoteness. The initial success prompted to extend the idea and provide solar-based home systems in other island areas where grid system cannot be extended economically. A total of about 2000 families are now enjoying solar-photovoltaic (PV) system based electricity services.

Again in 1995-96 the government carried out a study on possibilities of harnessing wind power, especially from the coastal areas. The wind velocity was found to be erratic and unsuitable for continuing operation of conversion into electricity through wind turbines. The reliable wind speeds at suitable heights in a number of locations were found to be less than the threshold values and future of development of wind energy has virtually been shelved thereon.

The government is now contemplating to extend the capacity of the only hydroelectricity plant located in Kaptai lake area. The uncertainty of relocation of many adversely affected families and other socio-cultural and environmental aspects make the proposal particularly unsuitable for the country, despite potentials for high financial returns.

Since no significant investment is made between 1990-91 and 1995-96 in clean energy development, the indicator of sustainable energy development could not be worked out.

▸Indicator 5

Despite the fact that the energy security of the country is maintained by biomass based traditional fuels and indigenous natural gas, the importance of the imported fuels are increasing day by day. Following the acceptance of the NEP by the Parliament in 1995 a number of multinational companies have brought foreign direct investment for exploration of natural gas fields all over the country. A number of new gas fields are discovered, especially in the southern and eastern parts of the country, and the 'best estimate' shows a tripling of 'proven and recoverable' reserve, from less than 11 TCF to 31 TCF. Since Bangladesh' government cannot utilised all the natural gas being produced by the multinational companies, the temporary ban imposed on exporting natural gas in excess to national capacity to utilise is about to be lifted. The Prime Minister suggested that the government would allow export of natural gas only when it would ascertain that it has sufficient reserve in excess to its requirement for the coming 50 years. There are indications that Bangladesh will become a net energy exporting country within the next few years.

In 1990-91 the country's non-renewable energy imports amounted to about 97.5 PJ, which was increased to about 162.0 PJ in 1995-96. The metrices for the Indicator #5 therefore appear to be 0.374 for 1990-91 and 0.391 for 1995-96, suggesting that non-renewable energy trade has actually increased by less than 2% between 1990-91 and 1995-96. It is expected that this trend will be observed till, perhaps, 2001-02 and a reversal will be observed thereafter. There was no import of renewable energy both in 1990-91 and 1995-96, while the total energy consumption was 759.9 PJ and 929.4 PJ, respectively (worked out by the author, basic data are given in GOB, 1997 and GOB, 2000).

▸Indicator 6

In the past about 20% of all capital investment made by the government was for the development of energy sector. The vector value for the burden on energy investments also suggests a value of 0.20 for the year 1990-91. As discussed earlier, FDI came into play since 1995-96 through the multinational companies and private sector investment has become significant in the following years. The vector value for the year 1995-96 was estimated at 0.13, suggesting participation of private sector in energy development and management activities as recommended in the NEP.

So far, the initial trend for private sector participation was to invest in natural gas exploration. Since 2000-01, private sectors have become a significant player in natural gas production, production of liquefied petroleum gas (LPG) for small-scale commercial and cooking purposes, and production of electricity. Due to an increase in private sector participation the production of natural gas reached its NEP suggested maximum limit of 1000 MMCFD, 24% of which was supplied by the International Oil Companies (IOC). It is expected that private sector's role will increase even further in coming years.

▸Indicator 7

In terms of energy productivity, Bangladesh fared well with respect to global average. The vector value for 1995-96 was 1.30. Bangladesh consumed 27 per cent higher commercial energy with respect to the global average per dollar of its economic output in 1995-96. Considering a net increase in use of commercial energy in recent years and also the inherent management and institutional inefficiencies in actual use of energy, it is likely that the vector value might increase in the future.

▸Indicator 8

Although it is enshrined in the NEP that higher emphasis will be given on the promotion of renewable energy technologies very little has been done in the past. Two separate projects on promotion of solar photovoltaic (PV) electricity supply systems for individual households in remote rural areas have been taken between 1990 and 2000 and about 2000 households have been brought under the project with solar lights. But in both the cases the units are subsidised heavily because otherwise the initial investment costs appear to be much higher than the 'willingness to pay' of the poor customers for the energy services. The PV chips are imported and despite repeated plea to the government by the environmental advocacy groups, the government did not relax its import duties and other value added taxes and tariffs on those items. As a result the PV systems could not be promoted.

It was argued that if the government was willing to offer tax incentives in other renewable technologies such as solar-PV water pumps for irrigation, solar-PV based lanterns, water heaters etc. then renewable technologies could easily find its own place in the market (Ahmed, 2001).

The other potential GHG savings in large scale could be achieved through improvement of household and commercial cooking stoves, which generally use biomass as fuel. The household level cooking stoves are very poor in energy efficiency. An improved version of the traditional cooking stove already exists, having twice the efficiency of a traditional cooking stove, but the technology has never been transferred to the grassroots. It is believed that a significant amount of GHG could be saved by large-scale introduction of the improved cooking stove in about 21 to 23 million households. The saved biomass could be recycled in a number of possible ways which could have other environmental benefits. Despite having specific guidance in the NEP very little has been done in this regard.

It was found that the total renewable energy used in 1990-91 was about 499 PJ which subsequently increased to 515 PJ in 1995-96. The renewable energy deployment vector for 1990-91 and 1995-96 were estimated at 0.3393 and 0.4585, respectively.

Conclusions

The National Energy Policy of Bangladesh has made provisions that are efficient both in terms of energy and GHG emissions. The major shift from poor quality fuel to high quality natural gas has already taken place, thanks to abundant supplies from indigenous gas wells. There are trends that suggest that more energy efficient natural gas based power generation technologies are coming into Bangladesh. If the inherent managerial and institutional inefficiencies are tackled well and adequate investments are made by both the public and private sectors, it is believed that the people of Bangladesh will not only enjoy improved energy services, but also the efficiency of GHG emissions for the same energy services will be increased significantly, which will lead to sustainable energy future of the country.

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