Situation Analysis on Energy Security

DIALOGUE FOR SUSTAINABLE MANAGEMENT OF TRANS-BOUNDARY WATER REGIMES IN SOUTH ASIA

ECOSYSTEMS FOR LIFE
A BANGLADESH-INDIA INITIATIVE

Situation Analysis on Energy Security

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Ecosystems for Life: A Bangladesh - India Initiative

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Preface

Bangladesh and India share three major river systems: the Ganga, the Brahmaputra and the Meghna. Along with their tributaries, these rivers drain about 1.75 million sq km of land, with an average runoff of 1,200 cu km. The GBM system also supports over 620 million people. Thus, the need for cooperation on trans-boundary waters is crucial to the future well-being of these millions.

That is precisely the motivation for the *Ecosystems for Life: A Bangladesh- India Initiative* (Dialogue for Sustainable Management of Trans-boundary Water Regimes in South Asia) project. IUCN wishes to promote a better understanding of trans-boundary ecosystems between Bangladesh and India, by involving civil society in both counries and by providing a platform to discuss issues common and germane to the region. The overall goal is an improved, integrated management of trans-boundary water regimes in South Asia. This four-and-a-half year initiative is supported by the Minister for European Affairs and International Cooperation, the Netherlands.

Ecosystems for Life will develop, through dialogue and research, longer-term relationships between various stakeholder groups within and between the countries. It will develop a common understanding to generate policy options on how to develop and manage natural resources sustainably that livelihoods and water and food security improve. Inter-disciplinary research studies will be conducted by bringing together experts from various fields from both countries so that relevant issues are holistically grasped.

The initiative centres around five broad thematic areas:
• food security, water productivity and poverty;
• impacts of climate change;
• inland navigation;
• environmental security; and
• biodiversity conservation.

The first phase of the project concentrated on creating 'situation analyses' on each thematic area. Each analysis set identified core issues vis-a-vis a thematic area, their significance within the India-Bangladesh geographic focus, research gaps and needs and, ultimately, priority areas for joint research.

Studies were taken up in the later part of 2010 and early 2011. Authors discussed their points-of-view at a joint exercise; they shared their research. The ensuing material was further circulated among multiple stakeholders in both countries. All outcomes of this dialogic process are incorporated in the final papers. 16 situation analyses related to the five thematic areas were published in 2012. Further 4 papers have been completed in 2013 and ready for publication. We will also subsequently publish summary briefs, based on these studies. The initiative, thus, has taken a big step; now, the agenda for meaningful joint research is clear.

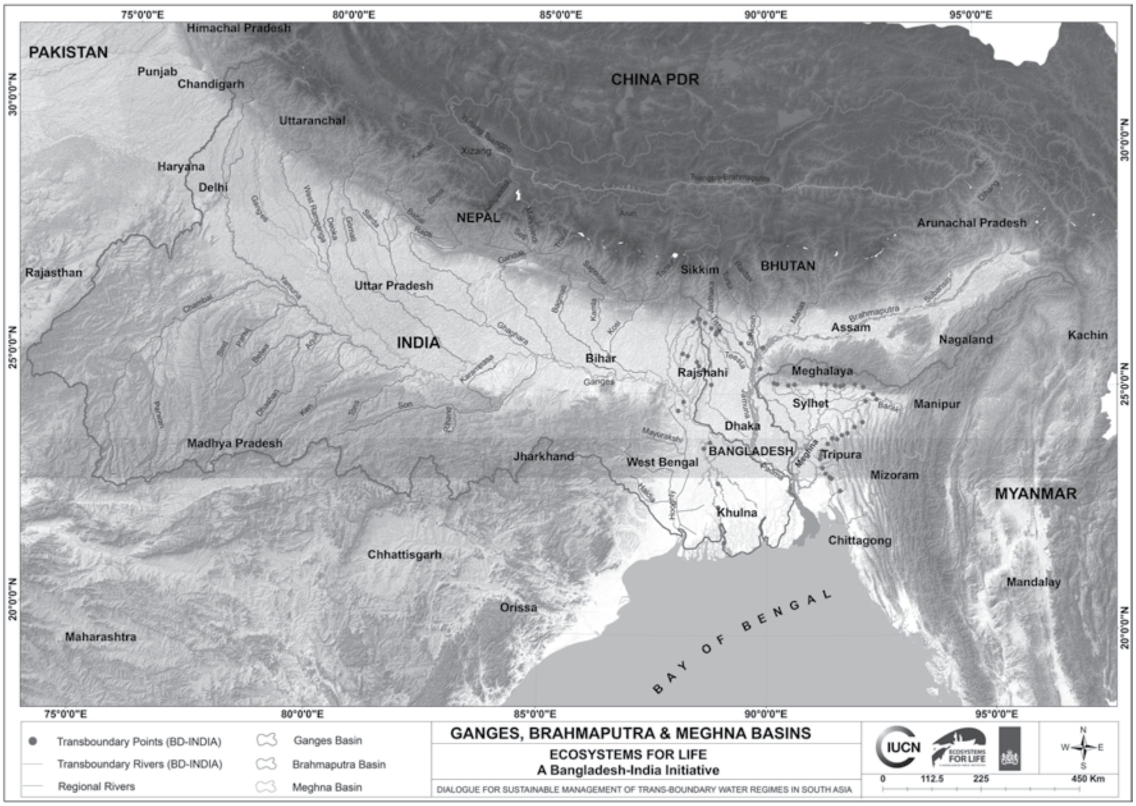
IUCN hopes these publications will be useful to academics, researchers and practitioners in the GBM region.

List of Abbreviations

ADB	Asian Development Bank
BCSIR	Bangladesh Council of Scientific and Industrial Research
BERC	Bangladesh Energy Regulatory Commission
Bapex	Bangladesh Petroleum Exploration Company
BPDB	Bangladesh Power Development Board
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
EDI	Energy Development Index
EMRD	Energy and Mineral Resources Division
ESCerts	Energy Saving Certificates
GBM	Ganga-Brahmaputra-Meghna
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GoB	Government of Bangladesh
GoI	Government of India
GRIHA	Green Rating for Integrated Habitat Assessment
HDI	Human Development Index
IEA	International Energy Agency
IC	Improved Cookstoves
IDA	International Development Association
IDCOL	Infrastructure Development Company Limited
IDCOL	Infrastructure Development Corporation Limited
IEP	Integrated Energy Policy
IFRD	Institute of Fuel Research and Development
IMF	International Monetary Fund

IRADe	Integrated Research for Action and Development
Kgoe	Kilogramme of Oil Equivalent
kWh	Kilowatt Hour
LGED	Local Government Engineering Department
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
mmcfd	Million Metric Cubic Feet per Day
MNRE	Ministry of New and Renewable Energy
MoF	Ministry of Finance
MoPEMR	Ministry of Petroleum Energy and Mineral Resources
mtoe	Million Tonnes Equivalent of Oil
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NTPC	National Thermal Power Corporation
NEP	National Energy Policy
PAT	Performance Achieve and Trade
R/P	Reserve to Production
RE	Renewable Energy
SAARC	South Asia Association for Regional Cooperation
SELCO	Solar Electric Light Company
SHS	Solar Home Systems
SREDA	Sustainable and Renewable Energy Development Authority
tcf	Trillion Cubic Feet
TERI	The Energy and Resources Institute
UNOCAL	Union Oil Company of California
VESP	Village Energy Security Programme

The Ganga-Brahmaputra-Meghna (GBM) Region



River	Ganga	Brahmaputra	Meghna
Length[1] (km)	2,510	2,900	210
Catchment[2] (sq km)	10,87,300	5,52,000	82,000

Total area of GBM region: 17,21,300 sq km

Source: 1. Average based on various data; 2. Joint River Commission figures

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An Exploration of Cooperation Potentials for Enegry Security in the GBM Region

Deepti Mahajan, Madhura Joshi, Nitya Nanda and G Mini

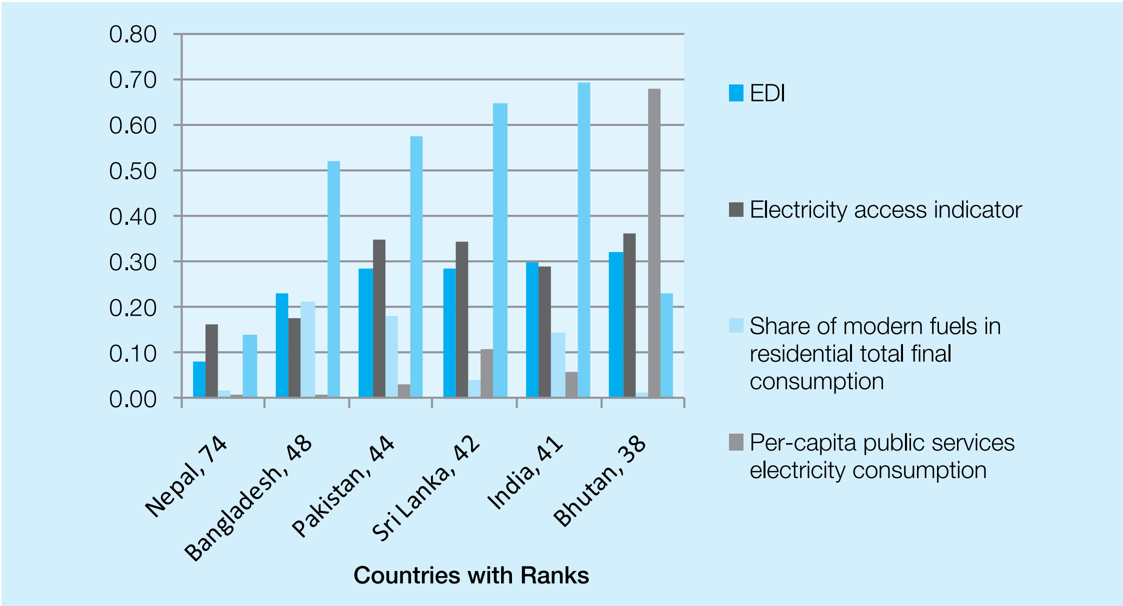
Bangladesh and India are both developing countries and as their economies grow their energy consumption is expected to increase. This is bound to put immense pressure on their limited energy reserves. The governments in both countries are undertaking steps to address energy challenges constrained by rising energy prices the world over and the need to bring in sustainable energy solutions.

The dual objectives of 'energy for subsistence' and 'energy for growth' mark policymaking in both countries as large segments of their populations are still untouched by modern energy forms.

Figure 1 gives the Energy Development Index (EDI)[1] of select countries in South Asia. The EDI helps measure energy poverty and understand the role energy plays in human development. Countries with a low score on the EDI generally demonstrate low results of clean cooking and public services indicators. On the Human Development Index 2011, Bangladesh falls amongst countries exhibiting low human development (with a HDI value of 0.5) while India is placed amongst countries with medium human development (with an HDI Value of 0.547) (UNDP, 2011a). The HDI is calculated on the basis of health (life expectancy), education (mean and expected years of schooling) and standard of living (Gross National Income per capita). However, energy provision has an impact on other social welfare indicators including education, health and livelihood (Gaye, 2007), which the EDI also tries to highlight. India and Bangladesh rank 41 and 48 respectively out of 80 countries demonstrating the need for prioritization of energy on the countries' development agenda.

[1] The EDI is calculated as a way to mirror the UNDP's Human Development Index. It is composed of the Household Indicator focusing on two key dimensions: access to electricity and access to clean cooking facilities; and Community level indicator: considering modern energy use for public services (e.g. schools, hospitals and clinics, water and sanitation, street lighting) and energy for productive use — modern energy use as part of economic activity (e.g. agriculture and manufacturing). 80 countries were considered in this EDI (IEA, 2012).

Figure 1: Energy Development Index, 2010



Source: IEA (2012)

Table 1: Fossil fuel reserves, production and consumption

Energy		Units	Bangladesh	India
Coal	Anthracite Reserves	Million Metric Tonnes	293	56,100
	Lignite reserves (million metric tonnes)		NA	4,500
	Peat reserves		NA	NA
	Production	Million Metric Tonnes of Coal Equivalent	0.61	452.09
	Consumption		0.86	499.0
Oil	Reserves	Million Metric Tonnes	3	740
	Production		NA	33.69
	Consumption		1	192.95
Gas	Reserves	Billion Cubic Metres	344	1074
	Production		18.27	41.16
	Consumption		18.27	41.16

Source: UNSD (2009)

Table 1 provides a snapshot of the fossil fuel reserves, production and consumption in Bangladesh and India. It is evident that the countries need to invest in the exploitation of their reserves and at the same time need to diversify away from the limited and depleting fossil fuels. Thus, regulatory and institutional support, technology and finance become crucial elements of an integrated energy plan aimed at addressing these energy challenges.

Methodology and outline

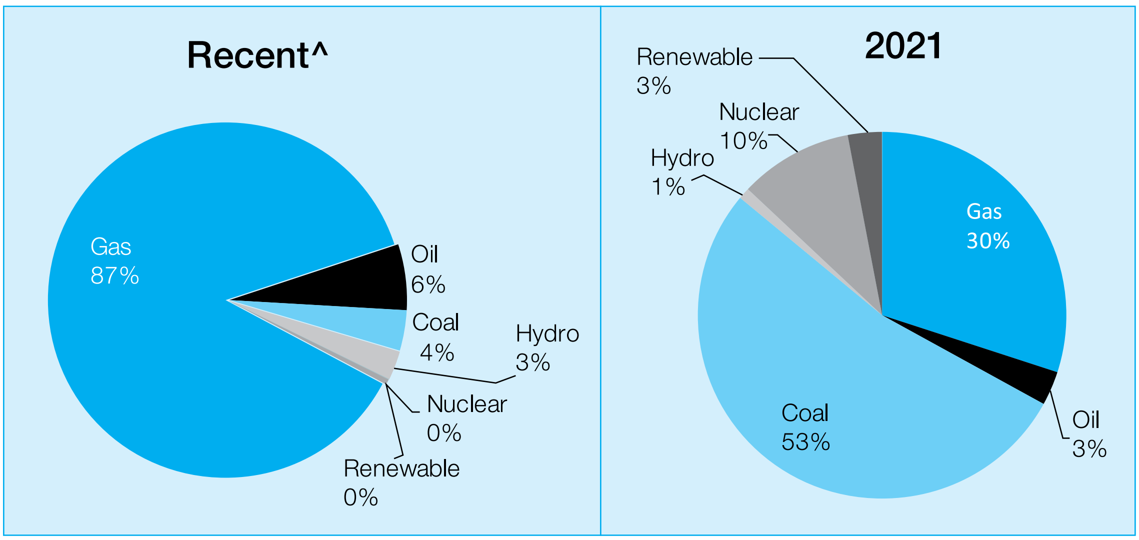
Extensive document analysis and secondary literature review has been conducted to present the situation of energy in both India and Bangladesh. Using existing studies and reports, it explores the issues between the two countries in the Ganga-Brahmaputra-Meghna region. Based on the review conducted, it recommends possibilities for energy cooperation between the two countries while also examining some of the current initiatives. Some key areas for joint research and action have also been identified.

Analysis of Country-wise Energy Situation

Bangladesh Energy Scenario

In 2011, Bangladesh's GDP growth rate was 6.3%. While IMF and ADB projections are lower, the Government of Bangladesh's budget for 2012-13 aims for around 7%growth rate (The Daily Star, 2012). Higher growth will lead to a higher demand for energy. The per capita energy consumption is only 201.3 kgoe which is not only lower than the global average but also lower than that of South Asia (514.3 kgoe) with more than 80% of the population dependent on biomass for its energy requirements. Aspirations for universal access to energy services (and the infrastructure required for it) coupled with economic development are expected to create pressures on energy supply.

Figure 2: Recent and Projected Commercial Energy Production Mix in Bangladesh.



^Figures based on data before 2010.
Source: Planning Commission, Bangladesh (2010)

Bangladesh economy has been reliant on domestically available natural gas for many years now. Figure 2 looks at the present and future commercial energy mix of Bangladesh. The country is resource constrained[2] and many of the country's gas fields are aging. Therefore, as Bangladesh seeks to move away from heavy reliance on natural gas and shift towards expanded coal use in the power sector, it will need to increase its coal imports significantly. An additional consideration which becomes important for Bangladesh is the environmental impact of these planned increases in energy consumption. Bangladesh, a low-lying country situated in a delta of many rivers marred with frequent and devastating floods, is susceptible to climate impacts. The Sunderbans region is particularly vulnerable. While Bangladesh's domestic energy choices are not the sole determinant of this vulnerability, the country needs to be conscious of the environmental impacts in making its energy choices. This section delves into the various aspects of the energy sector of Bangladesh.

Exploration of domestic resources

Oil and gas: Bangladesh depends on imports of crude oil, refined oil and petroleum products to meet its oil needs. This import burden may reduce slightly by the recent discovery of oil in the north-eastern region of the country. In May 2012, Bangladesh Petroleum Exploration Company (Bapex), a subsidiary of Petrobangla, discovered oil in two of its old gas reserves at Kailashtila and Sylhet with proven reserves of 137 million barrels of low sulphur crude oil (Economic Times, 2012, May 12). About 55 million barrels of this oil can be lifted commercially. Bapex will need to collaborate with a foreign firm for technical expertise to initiate drilling. Natural gas accounts for 81.6% of the total commercial energy of the country. Currently, there are 79 wells in 18 gas fields under production.[3]

One reason why the shores of Bangladesh have not been explored extensively is because of the unresolved maritime boundary issues with Myanmar and India. According to an Asia Times report (Chowdhury, 2012, March 20), Bangladesh had offered 28 blocks in the 2008 bidding, 20 of which were deep-water. However the response from international oil companies was poor due to the maritime disputes.

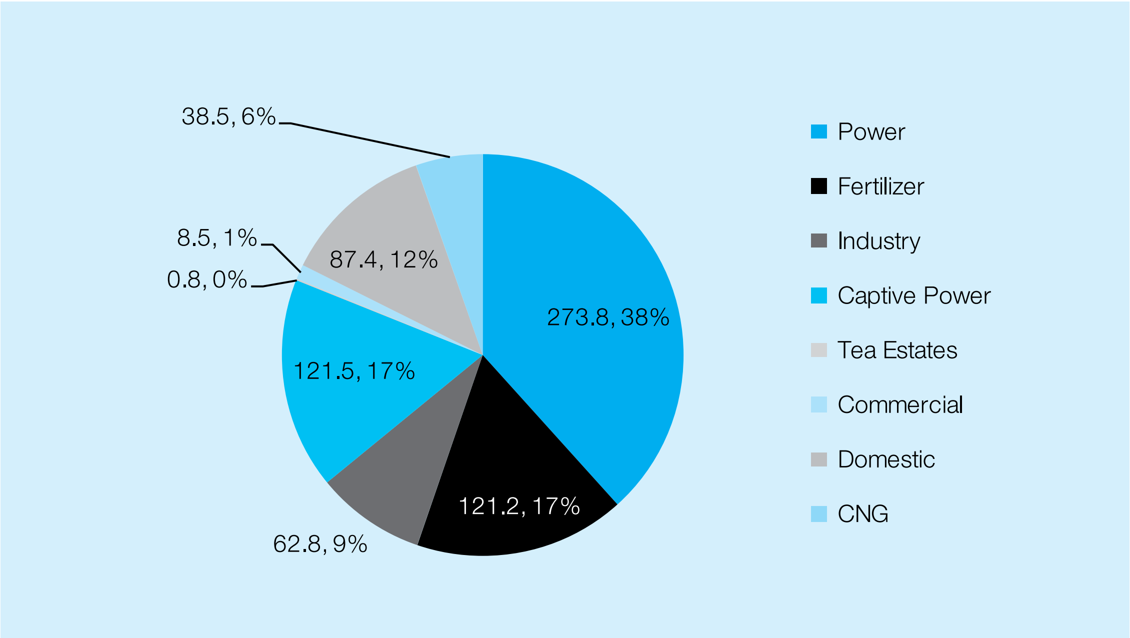
Varying estimates about available reserves, increasing gas demand for power, and rising supply shortages, have fuelled public opinion against gas exports

[2] Refer to Table 1 in section I.

[3] These fields include Titas, Bakhrabad, Habiganj, Rashidpur, Kailashtilla, Sylhet, Narsingdi, Meghna, Saldanadi, Fenchuganj, Sangu, Jalalabad, Beanibazar, Feni, Moulavibazar, Bangura, Shahbazpur and Bibiyana gas fields.

Although exploration of oil and natural gas has been historically carried out since a century, the intensity of exploration has remained low. Only 75 wells have been drilled till now, out of which 25 have been successful (Petrobangla, 2012). Insufficient funds for exploration led to opening up the field to international players. However, the regulation of international participation in the sector remains ambiguous. In 2001, Bangladesh's low buying capacity, inability to make timely payments for gas purchase and absence of short-term demand in the country, prompted Union Oil Company of California (UNOCAL) to propose export of gas to recover its investment (Tamim, 2003). While the *de jure* provision was for export of gas, the *de facto* position was against it. This duality and strong opposition to the export of gas led to a constraint on foreign investments, thus affecting the exploration and production activities. Varying estimates about available reserves, increasing gas demand for power, and rising supply shortages, have fuelled public opinion against gas exports.

Figure 3: Sector wise share of Natural Gas consumption, 2010-11



Source: MoF (2011)

As is seen in Figure 3, the power sector uses 38% (55%, including captive power) of the total gas produced. There have been massive shortages in the supply of gas to power plants leading to frequent power outages. While the government would like to reduce dependence on natural gas for power generation to free up its use for the fertilizer industry, and other industrial sectors, this is not expected to happen in the near future. Table 2 shows the demand for natural gas in different sectors for 2010-11 and future projections upto 2014-15. On the production side, however, there has been very little increase in recent years. With the productivity of the existing fields declining, unless extensive exploration is undertaken to find new reserves, the country will face a significant shortfall in gas supply.

Table 2: Sector-wise average gas demand 2010-11 to 2014-15 (in Billion Cubic Feet)

Sector	Fiscal Year				
	2010-11	2011-12	2012-13	2013-14	2014-15
Power	273.8	324.5	350.5	378.5	416.4
Captive Power*	121.2	164.0	188.6	216.9	234.3
Fertilizer	62.8	94.0	94.0	94.0	94
Industry	121.5	184.8	214.4	246.5	258.8
Commercial	8.5	10.8	11.7	12.6	13
Brick Field (Seasonal)	0	0	0.0	0.0	0
Domestic	87.5	111.4	124.8	139.8	148.2
Tea-Estate	0.8	1	1.0	1.0	1
CNG	38.5	51.4	56.5	113.0	120.9
**System Loss	-	20	20	20.0	20
Total	**708.9**	**962.0**	**1061.5**	**1222.4**	**1306.5**

*Non-grid. **Including own use.

Source: MoF (2011)

Coal: According to the Power System Master Plan 2010 (Power Division, 2011a) coal will be an important resource for primary energy supply in Bangladesh, due to i) its price stability and lower volatility compared to oil and natural gas, ii) longer reserve to production ratio compared to oil and natural gas, and iii) its widespread availability throughout the world, and thus the expected supply stability. The country's Vision 2021 document aims to increase coal's share in the energy mix to 53% by 2021 (Planning Commission, 2010). Domestically, this resource has not been explored extensively though significant potential reserves exist. The deposits of coal in Bangladesh are around 2700 million tonnes. Five coal fields have been discovered till now: Barapukuria, Khalashpir, Phulbari, Jamalgonj and Dihipara.

However, since the density of population in Bangladesh is high (1015 per sq. km) (Bureau of Statistics, 2011), exploitation of coal reserves will lead to large scale displacement and loss of livelihood. There have been protests at the Phulbari reserves against coal exploitation based on environmental concerns, loss of livelihood and insufficient attention to resettlement and rehabilitation (Cultural Survival, 2012; Accountability Project 2012). These coal mines are owned by Asia Energy PLC a subsidiary of Global Coal Management Resources, a London based firm. A lack of a well-defined regulatory framework impedes development of reserves. It is further suggested that the country may face difficulty in procuring funds for coal-based power plants (Financial Express, 2012, June 23).

Renewable Energy (RE): Renewable energy provides decentralized solutions for a country starved for energy. Bangladesh's Renewable Energy Policy Document (MoPEMR, 2008) aims to increase the contribution of RE to meet 5% (800 MW) of the total power demand by 2015. The RE policy document also recommends a dedicated agency for RE, and the Sustainable and Renewable Energy Development Authority (SREDA) will come into effect soon.[4] Currently Bangladesh's renewable power generation capacity is approximately 70MW (Alauddin, 2012). The breakdown of the RE power generation is given in Table 3.

Table 3: Breakdown of renewable energy power generation

Category	Achievement
Solar Home System (SHS)	62 MW (1.5 Million Units)
Other Solar PV Applications (e.g. Markets, Office Buildings etc.)	1 MW
Roof-top Solar PV Systems of New Electricity Consumers	3 MW
Wind Energy	2 MW
Biomass based electricity	1 MW
Biogas based electricity	1 MW
Total	70 MW

Source: Alauddin (2012)

The use of solar energy is increasing and is being encouraged, especially in rural areas with no access to power. Solar Home Systems were first introduced in 1996. In 2003, the solar energy development project was set up by Infrastructure Development Company Limited (IDCOL), an organization created by the government. This was supported by IDA and GEF. Since 2003, IDCOL has set up 1.5 million units (Alauddin, 2012; and see IDCOL, 2012). Further support to develop 500MW solar power has been provided by the ADB as a part of the Asia Solar Energy Forum initiative. This project is looking at the installation of solar irrigation pumps, solar powered irrigation systems, mini grid solar power systems, solar park, roof-top solar power solutions, as well as social sector projects like solar electrification of railway stations, solar LED street lights etc. (Power Division, 2011c)

In 2006, the contribution of biomass to the total primary energy consumption of Bangladesh was 60% with most of the country's poor using it as their source of energy. Traditional biomass (agricultural residues, wood and wood waste, and animal dung) is available in plenty in Bangladesh. There is a large scope for production of biogas from these sources which can help address some of the electricity access challenges, particularly in the rural areas. According to the Energy and Mineral Resources Division website (EMRD, 2009), 50,000 households and village-level biogas plants are in place in the country. The Power Division (2011b) estimates the potential of domestic biogas systems to be 8.6 million cubic metres of gas; rice husk and cattle waste based biogas plants have the potential of 300MW (2kg of biomass per kWh) and 350MW (0.52m^3/kWh) respectively.

[4] In June 2012, the Cabinet endorsed the draft on the formation of SREDA.

Hydro: Bangladesh has one hydropower plant in Kaptai. The total potential of the resource is about 900 MW depending upon the water flow, although the installed capacity is only 230MW. However, the country's flat terrain, and large social and environmental impacts of hydro projects place limits on this option as a significant source of energy (Gippner, 2010). While large hydropower plants are not possible in Bangladesh, the development of such projects by India in the Ganga-Brahmaputra-Meghna region on the Indian side has led to several debates (detailed discussion follows).

Nuclear: Bangladesh is investing in nuclear energy to address its power shortages. It has signed a deal with Russia to build two nuclear power plants of 1000MW each in Rooppur of Pabna district (Ahmed, 2011). In June 2012, the Bangladesh Parliament passed the first nuclear energy bill dealing with liability of the operators for accidents (Platts, 2012, June 01). The Vision 2021 document envisages that nuclear energy will contribute about 10% to the total energy mix by 2021.

Technology and infrastructure development

The Bangladesh energy sector has been dominated by the public sector utilities. Many of these have been unable to undertake extensive exploration of energy resources (natural gas, coal) either due to insufficient funds or lack of technology. Bangladesh has only one refinery - Eastern Refinery Limited, a subsidiary of Bangladesh Petroleum Corporation. It has also set up an LPG plant at Kailashtila and Sylhet (MoF, 2011). However, most of Bangladesh's requirement of petroleum and petroleum products is met through imports. The Finance Ministry, under the medium (up to June 2013) and long term plan (upto December 2015) envisages an addition of total of 2800 mmcfd gas, including 500 mmcfd gas through importation of LNG, to the national gas grid by 2013 (MoF, 2011). This would require considerable investments in development of LNG terminals.

The government document of Vision 2021 seeks to increase the share of coal from the current 3.7% in the total energy mix to 53% by 2021 (Planning Commission, Bangladesh, 2010). The document envisages construction of 13 coal-fired power plants, each of 600-MW capacity – two in Khulna, two in Chittagong, one in Chittagong South, four in Materbanri (Chittagong), one in Meghnaghat near Dhaka, two in Mawa near Dhaka, and one in Zajira (Shariatpur).

The government plans to enhance the country's power generation capacity from 6033 MW of installed capacity in 2010 (although power generated was 3900-4300 MW) to 8,500 MW by 2013, 11,500 MW by 2015 and 20,000 MW by 2021 (MoF, 2010). Conservative estimates of actual demand, system losses, and fuel supply shortage (exacerbated by the fact that the power sectors is primarily dependent on one fuel – natural gas) (Saleque, 2012), and inadequate maintenance are seen as reasons for the massive electricity shortages. Insufficient investment, especially by the private sector, is also seen to impede expansion in generation capacity. The government has drafted short term, medium term and long term plans for this purpose. However, in spite of these planned additions there has been an acute shortage of power in Bangladesh. The medium term and the long term goals of the Power Systems Master Plan (2010) are in trouble due to a dearth of finance and fuel supply assurances (Energy Bangla, 2012, August 25).

As mentioned above, the government is working towards increasing the share of RE in the energy mix of the country. As per the Renewable Energy Policy of GoB, it envisages developing 500MW power from RE by 2015. It plans to increase 260 MW (25MW from Solar and 235MW from Wind) through public sector participation and 206 MW (in SHS, biogas plant for cooking gas and power, solar mini grid, solar irrigation pump and biomass based power plan) through private sector participation (Power Division, 2011b).

Trade and investment

Decreasing supply of natural gas, and limited (as well as unexplored) reserves of oil and coal, make it necessary for Bangladesh to import heavily. Almost all of its petroleum needs are met through imports. Petroleum products, crude oil and coal form Bangladesh's major energy imports. Bangladesh imported approximately 1.4 million tonnes and 3.2 million tonnes of crude oil and refined petroleum products respectively in 2010-11 (BPC, 2012). These imports mainly came from Kuwait, Saudi Arabia, India and United Arab Emirates. In order to diversify its supply sources, the cabinet has also approved the purchase of petroleum products from Malaysia, Philippines and Singapore in 2011 (Energy and Power, 2011).

To deal with the increasing gas shortage in the country, Bangladesh is also keen on building an LNG terminal with a capacity to handle 5.0 million tonnes of LNG per annum. Petrobangla has signed an initial agreement with Qatar Petroleum to import 4.0 million tonnes of LNG per annum in January 2011 (Rahman, 2012, May 01). Bangladesh will have to step up its imports of coal too. Currently, Bangladesh imports coal from China, Indonesia and India. It has been importing coal from Meghalaya in India for a while. Ease of transportation and the proximity of the import source, makes this a viable choice. However, this relationship has been tumultuous.[5]

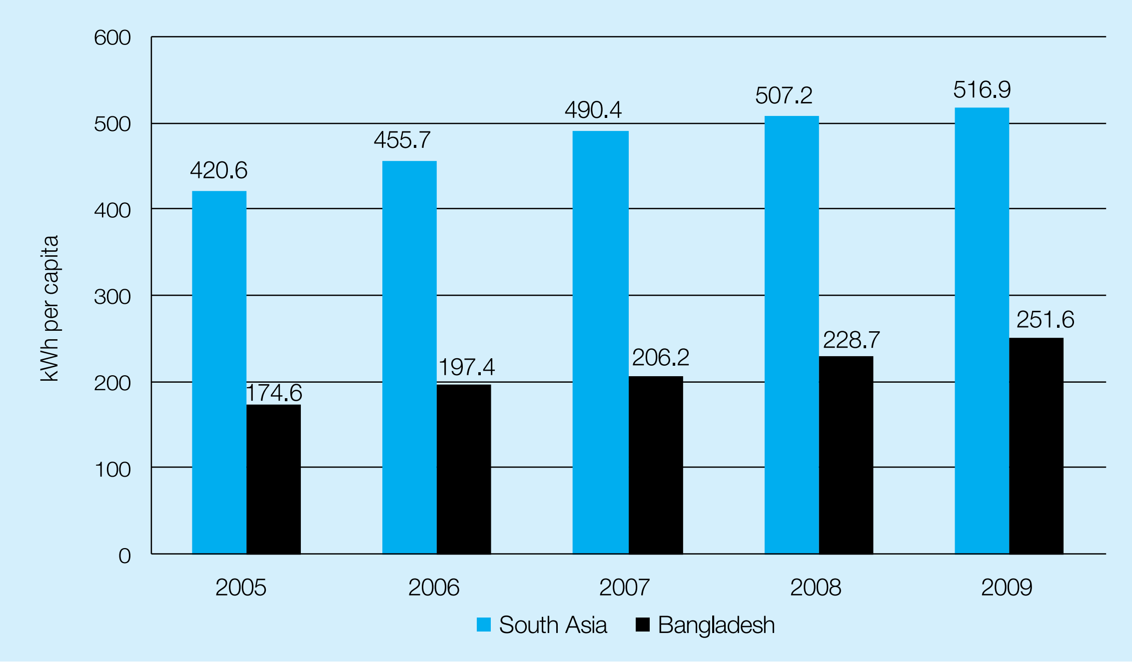
To help cope with the increasing shortages in the electricity sector, Bangladesh has also shown interest in importing electricity from India. In 2012, Power Development Board of Bangladesh signed an agreement with the Vidyut Vyapar Nigam Ltd, a subsidiary of India's National Thermal Power Corporation (NTPC) to import 250 MW of power through the under construction transmission line of Behrampur substation in Murshidabad in India to Bheramara grid substation of Kushtia in Bangladesh (BD News, 2012, July 14).

Energy Access

Access to reliable and clean energy services can be linked to the growth and standard of living of the citizens of a country. One of the important factors for improved human development (better health services, education etc.) is increased per capita energy use. Figure 4 shows that Bangladesh's per capita electricity consumption is lower than the average of the South Asian region (which itself is significantly lower than the world average). In terms of access to clean cooking facilities and lighting, Bangladesh still has a long way to go.

[5] Bangladesh has banned imports from Meghalaya 7 times in the past 9 years (the recent being between June 2010 and June 2011) due to the high sulphur content of the coal.

Figure 4: Per Capita Electricity Consumption



Source: World Bank (2012)

59% of the population was without access to electricity in 2009 (Table 4).[6] Even areas which have grid connected electricity are facing major electricity shortages, particularly in the rural areas. Taking this into cognizance, the government has initiated a number of schemes to address the inadequacy.

Table 4: Number and share of people without access to modern energy services in Bangladesh in 2009

Country	Without access to electricity		Relying on the traditional use of biomass for cooking	
	Population (million)	Share of population	Population (million)	Share of population
Bangladesh	96	59%	143	88%

Source: IEA (2011a)

The Vision 2021 document of the government aims to provide electricity to the entire population by 2021. While there have been hurdles in meeting the electricity generation targets of the Power System Master Plan (2010), efforts are on to provide off-grid solutions through solar home

[6] The Ministry of Finance document (MoF, 2011) says around half the population of the country has no access to electricity.

system programs, small biogas plants, roof-top solar PVs etc. The government subsidizes 26% of the total cost of an average size biogas plants for homes (IEA, 2011a). NGOs such as Grameen Shakti and government bodies like Local Government Engineering Department (LGED) and Institute of Fuel Research and Development (IFRD) are involved in setting up biogas plants in rural areas. The government has also undertaken initiatives to establish solar mini-grid for remote off-grid areas under Remote Area Power Supply System where grid expansion is not planned for the next 15-20 years (Power Division, 2011d)

Table 4 further shows that 88% of the population of Bangladesh still relies on traditional biomass such as fuelwood, and dung cakes for cooking purposes. This is a major cause of indoor pollution, affecting the health of women in particular.

Access to reliable and clean energy services can be linked to the growth and standard of living of the citizens of a country. One of the important factors for improved human development (better health services, education etc.) is increased per capita energy use

Energy Efficiency

Increasing and improving energy access for the population of Bangladesh is going to require further investment in improving and expanding the energy infrastructure in the country. As seen in the ‘Technology and Infrastructure’ section, there is big gap between the demand and supply for electricity. Some studies and surveys show that failure to properly manage the generation load has led to a loss of industrial output worth around USD 1 billion (MoPEMR & UNDP, 2011). Using efficient practices and new technologies in natural gas sector, conversion of simple cycle gas turbines to combined cycle to deal with fuel shortage problem, and improving the operations and maintenance, and upgrading the old and overloaded distribution infrastructure will help in large ways towards reducing the inefficiencies in the electricity sector in particular (MoPEMR & UNDP, 2011).

Table 5 shows the current sector wise consumption of electricity in the country. It is observed that the Domestic demand is the highest with around 45% electricity being consumed by this sector in 2009. Introducing building codes and green ratings, encouraging use of efficient lighting mechanisms will help increase the efficiency and reduce energy consumption. In addition, improving the use of energy in the transport and industrial sector and in energy utilities; and introducing energy rating systems are also ways in which energy efficiency can be promoted in a country.

The Ministry of Finance document (MoF, 2011) says around half the population of the country has no access to electricity.

There is big gap between the demand and supply for electricity. Some studies and surveys show that failure to properly manage the generation load has led to a loss of industrial output worth around USD 1 billion (MoPEMR & UNDP, 2011)

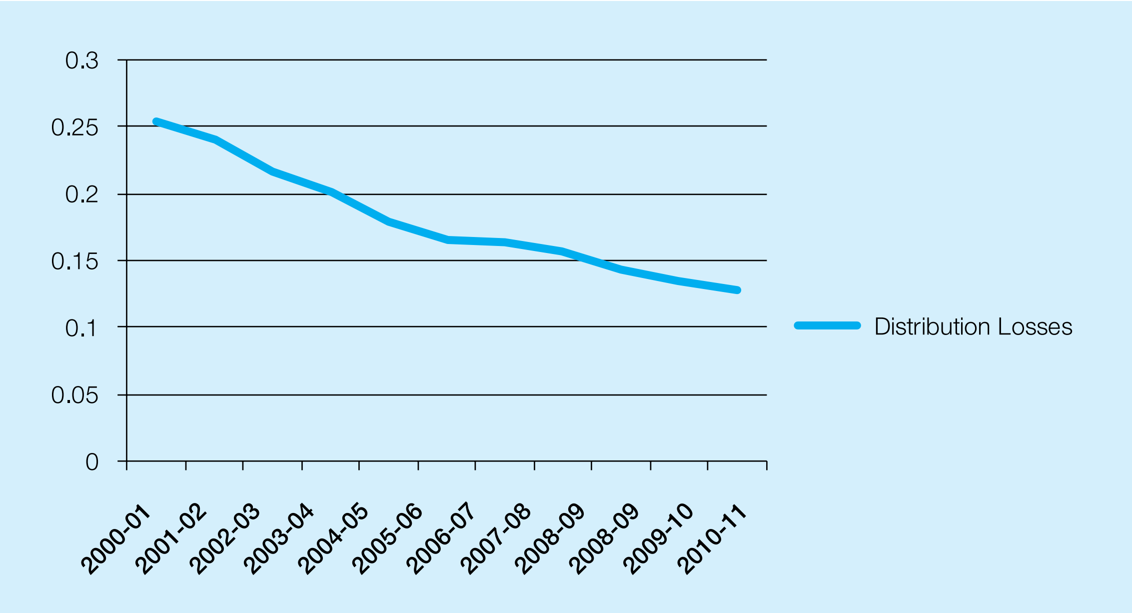
Table 5: Sector wise consumption of Electricity in Million Kilowatt Hour

Year	Domestic	Industrial	Commercial	Others	Total
2005	6946	7153	1243	994	16336
2006	8910	9175	1595	1274	20954
2007	9006	9275	1612	1288	21181
2008	9619	9906	1722	1375	22622
2009	10020	3734	2049	6908	22711

Source: MoPEMR & UNDP (2011)

Some steps have been taken by the GoB to improve the energy efficiency of the country's energy sector. Figure 5 shows that the distribution losses of electricity of BPDP since 2000-2001 have been decreasing since 2000-01.

Figure 5: Distribution losses of BPDB



Source: MoF (2011)

Even though the country lacks an energy conservation law, the Government of Bangladesh has undertaken some energy efficiency initiatives and is working towards good practices geared towards efficiency. Some of these are (Power Division, 2011e):

- Revision of the 'Building Code' with the insertion of energy efficiency and solar energy issues.
- Initiatives to spread awareness about energy efficiency and conservation.
- Energy star rating system for electric appliances.
- Installation of solar panels in government, semi-government and autonomous organizations within the next 3 years; as well as promotion of use of CFL bulbs in government organizations.
- Replacement of conventional street lights with LED and solar lights, and the gradual discontinuation of incandescent bulbs and electric heaters.
- Discouraging the use of neon signs in markets and shopping malls.
- Use of solar energy by businesses.

Energy Pricing

Optimal pricing of energy helps in minimizing inefficiencies, reducing the burden of subsidies on the government and promoting investment in the sector. In Bangladesh, the government controls the prices of electricity, final petroleum products, and natural gas. One of the main arguments for subsidized prices for power is to provide electricity access to those who cannot afford it and to expand access to power. Bangladesh has the highest energy subsidization rate in the SAARC region with subsidies forming 4.8% of the GDP (average subsidization rate is 46.1%) (IEA, 2011b)

Although the government periodically adjusts prices to bring them nearer to the world market level, subsidies continue to remain substantial (disregarding the subsidies on fertilizers and food consumption, the energy subsidy bill for the financial year 2012 was around \$3.8 billion) (BIDS & IISD, 2012). Various government subsidies such as direct subsidies, loans at favourable terms, equity injections etc. have been introduced to help the public energy enterprises to provide affordable energy services.

The Renewable Energy Policy (MoPEMR, 2008) also provides for the employment of subsidies (along with grants and funds from multilateral organizations) to develop RE facilities (such as biogas plants, SHS systems, clean cookstoves etc.).

India's Energy Scenario

Box 1: Energy in India: A snapshot*

- Total energy production in India: 502.46 mtoe
- Primary energy consumption: 675.83 mtoe
- Per capita energy consumption: 585 kgoe
- GDP per unit of energy use: USD 5.6/kgoe
- Fossil fuels account for 73% of the energy consumed in the country.
- Total installed power generation capacity (as on 30.04.12) is 201637 MW as compared to 147403 MW in 2008.

*Unless otherwise mentioned, figures are for 2009

Source: TERI (2012a)

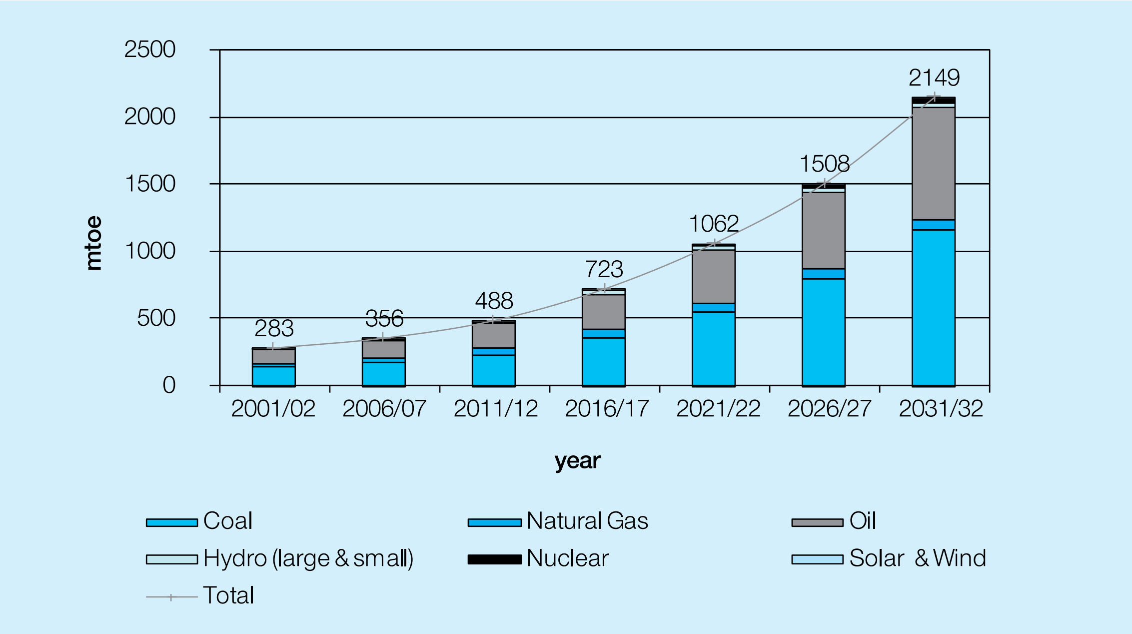
India's aspirations of achieving consistently high growth rates and meeting its social welfare objectives place a large demand on its dwindling energy resources. Already, the country is highly energy import dependent and this dependence is set to increase exponentially. TERI estimates of a Business As Usual (BAU) scenario peg the primary energy consumption at 2149 mtoe in 2031, starting with 283 mtoe in the base year of 2001 (Figure 6). The country's import dependence for coal, oil and gas is expected to be at 79%, 91% and 34% respectively in 2031. The recent grid failures in north and east of the country hold testimony to the country's precarious power condition. Power shortage was 8.5% in 2010-11, while the peak power deficit stood at 10.3% (TERI, 2012a). This, in spite of the fact that a large number of people in India remain untouched by modern energy forms, 400 million Indians do not have access to electricity and about 80% of the rural population relies on inefficient, traditional biomass for cooking. According to the *International Energy Agency (IEA),* more people lack access to electricity in India than in any other country in the world. Those with access to power too often see power outages and intermittent supply.

India is currently reliant on fossil fuels for over 70% of its energy requirements – a situation that will need

Clearly, the objectives highlighted here are far from being met, even though these signify a minimalist understanding of energy security. In the last few decades, the government has put in place a number of initiatives to reduce vulnerabilities in the energy sector, and deal with demand and supply constraints, yet the efforts remain piecemeal and have failed to have a significant impact. The following sections delve into some specific issues on the energy supply and demand fronts in India. Ensuring energy security in the short- and long-term is a function of optimal domestic resource exploitation; tapping available international resources – through trade and/or equity investments; building of necessary infrastructure for import, transport and service delivery; development and deployment of technologies for efficient production and use of energy; and appropriate actions for management of energy demand (Srivastava & Mahajan, 2011).

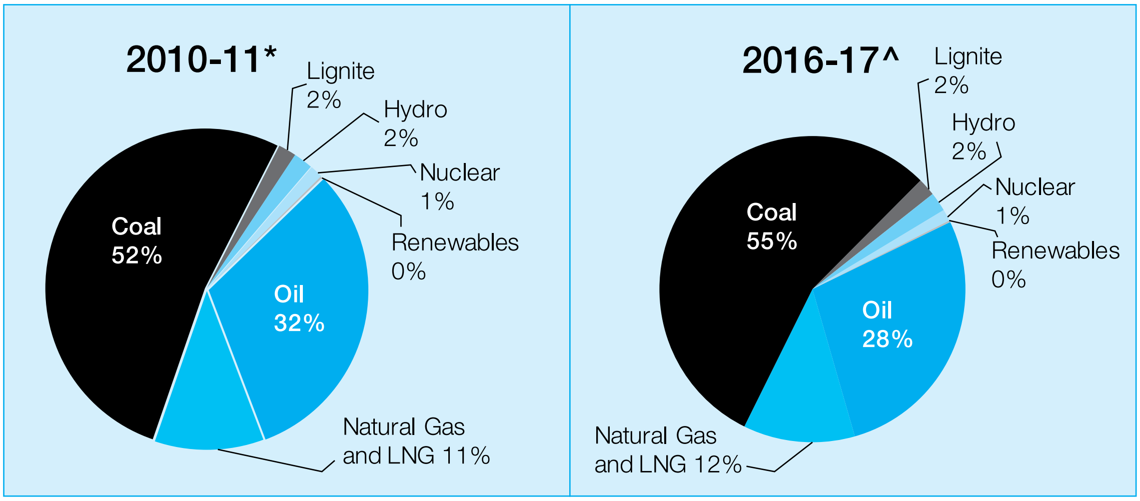
The opportunities offered by the RE sector, in terms of extending decentralized energy access, provide a sound rationale for catalyzing the uptake of RE. Alongside, given India's high dependence on imports, a significant component of its strategy of enhancing its supply is prudent planning and management of its energy imports

Figure 6: India's commercial energy requirement in a Business as Usual scenario



Source: TERI (2006)

Figure 7: Current and Projected commercial energy mix in India



*Provisional Numbers
^ On the assumption that annual demand /growth would be 6.5% up to 2016-17
The figures include oil and gas feed stock for fertilizer and other non-energy usage.

Source: Planning Commission (2011)

The immense energy demand in India necessitates the exploration and effective utilization of all available energy resources. Even though limited, the country's available energy resources need to be harnessed to their full potential. In the light of the dual objective of enhancing energy security and mitigating climate change, increasing the share of clean energy in the country's energy mix becomes a primary policy objective. The increasing strain on conventional resources and the opportunities offered by the RE sector, in terms of extending decentralized energy access, provide a sound rationale for catalyzing the uptake of RE. Alongside, given India's high dependence on imports, a significant component of its strategy of enhancing its supply is prudent planning and management of its energy imports. Both the domestic and external supply dimensions need to be paid attention to in order to maximize energy availability.

Exploration of domestic resources

Oil and gas: India's proved reserves of oil stand at 800 MT (BP, 2012). The domestic production of crude oil stood at 37.71 MT in 2010-11, registering an increase from the previous year's production of 33.67 MT. At the same time, however, it is notable that the country's crude oil import bill shot up from INR 3750 billion to INR 4540 billion (TERI, 2012a). The Reserves-to-Production ratio (R/P ratio) for oil in India is 18.2 years. The R/P ratio for gas is 26.9 years, and natural gas as a cleaner power option than coal, is being seen as an important transition fuel as India moves towards increasing the share of RE in its energy mix. The country saw a production of 47.55 BCM in 2011-12 MoPNG (2012), registering a growth of 10% from the previous year. Off-shore production comprised a majority of the gas produced (TERI, 2012a).

A number of long-standing regulatory issues remain to be resolved in the upstream oil and gas sector. Successive rounds inviting bids for exploration licenses have been witness to limited participation from private players and international oil companies. The status of regulatory authorities in the sector and their limited autonomy in functioning is a key concern.

Coal: India's coal production in 2010-11 was at 532.06 in 2009-10 but the total consumption topped 590 MT (TERI, 2012a). With increasing demand, particularly from the power sector, it is expected that the gap between coal production and consumption will widen.

India has been considered coal-rich for long, with resources expected to last 200 years. However, recently, doubts have been raised about this optimistic scenario. A recent TERI study concluded that

India's extractable coal, "taking into account geological, technical, and economic aspects - is only a small fraction of our total coal inventories," without considering delineation of no-go areas (Batra & Chand, 2011). The system adopted by India for estimation of reserves is an archaic one that does not discount coal that is economically and technically infeasible to reach. It is estimated that assuming a growth rate of 5% in domestic production, current extractable reserves, estimated at between 56-71 billion tons, will get exhausted in 45 years (Batra & Chand, 2011). It, further, needs to be factored in that social and environmental risks associated with coal mining too will constrain the exploitation of available resources. Coal, the mainstay of the power sector of the country, needs to be effectively managed and allocated in order to meet the growing power demand in the country. Increase in productivity and enhanced competition in the sector needs to be prioritized.

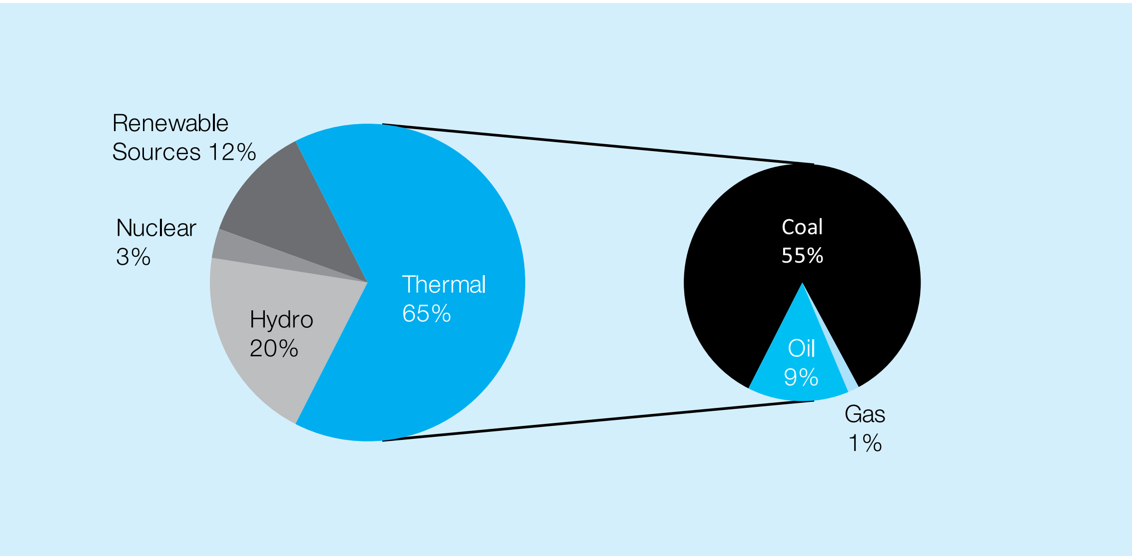
Renewables: Total installed power generation capacity (as on 30.04.12) is 201637 MW out of which only 12% is based on renewables (Figure 8). Including both grid-connected and off-grid capacity, the total RE-based capacity amounts to 25742.89 MW. Figure 9 details the share of different renewable energy sources in grid-connected power. While in the recent past, the country has taken steps to promote RE, including both generation and capacity based incentives such as feed-in tariffs, tax benefits, investment subsidies and quota obligations, a lot remains to be done in this area. Geothermal energy too is being developed and the Geological Survey of India, in collaboration with the Ministry of New and Renewable Energy, is working on producing a Geothermal Atlas for India. Though the wind energy sector has grown fast in the country, the installed wind generation capacity is a small proportion of the available potential of 48,561 MW. Under the National Action Plan on Climate Change (NAPCC), the country adopted the Jawaharlal Nehru National Solar Mission, setting a target of achieving 20,000 MW of solar capacity by 2022. Targets set under JNNSM for 2022 can be summarized as follows:

- Solar Thermal Collectors – 20 million square meters
- Off-grid solar – 2000 MW
- Grid power incl. rooftops – 20000 MW.

According to TERI analysis, an important market opportunity is offered by the replacement of diesel generators are being used in urban centres by rooftop solar PV installations. Fossil fuels' based captive power generation reaches 31,517 MW currently and solar rooftop systems provide an environment-friendly alternative for captive power generation and back-up power. Further, solar thermal in grid-connected mode can contribute towards reducing energy shortages (TERI, 2009).

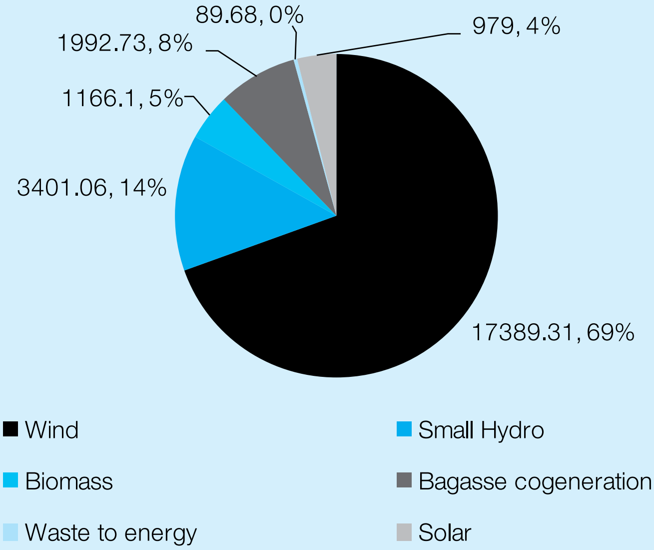
Though there is still a vast difference in the cost of solar power as compared to that from coal-fired thermal plants, the difference is fast decreasing and is expected to drop further: from Rs 18 per kWh a few years ago, solar PV auctions today are resulting in average tariff bids of less than Rs 10 per kWh. Globally, the past three decades have seen a 95% decrease in the costs of solar PV module and a doubling of the energy conversion efficiency of the PV system. An increased scale of production is expected to further push down costs.

Figure 8: Fuel mix in electricity generation, 2012



Source: Ministry of Power (2012a)

Figure 9: Grid-interactive RE-based capacity (MW) (as on April 30, 2012)



Source: Ministry of New and Renewable Energy (2012a)

Nuclear: With the country's current nuclear power capacity at 4800 MW, the country has set itself the target of generating 63000 MW from nuclear energy by 2032 (See Planning Commission, 2006). According to the Planning Commission (2006), the ambitious nuclear development scenario "is contingent on 6,000 MW of additional import of LWRs whose plutonium could be used in FBRs along with the plutonium from the 10,000 MWe reactors using our own Uranium." However, it is notable that a range of challenges will need to be dealt with in the development of nuclear energy. Following the Fukushima disaster in Japan, nuclear energy has come in for criticism the world over and India is no exception. The adverse public perception is evident in the mass protests against new plants. The Kudankulam power project that was originally scheduled to be commissioned end 2011, has been witness to public opposition. The proposed 2800 MW nuclear plant in Fatehabad district, and the Jaitapur plant where the government has in-principle approved six reactors of 1650 MW each, is facing opposition as well. While it is agreed that nuclear energy, a low-carbon energy source, is critical for meeting India's energy demand, safety and security protocols need to be a priority in nuclear planning. Public disclosure of information and community engagement in decision-making is critical for nuclear energy development.

Hydropower: Large hydro projects contribute 38,706 MW to the installed generation capacity in India which is 21% of the total installed capacity (Press Information Bureau, 2011). The country has a large hydropower potential, only 33% of which has been exploited. Hydro-electricity plays an important role in meeting India's growing power demand but there is need for attention to be paid to the social and environmental costs associated with the construction of large reservoirs and dams.

The northeastern states of the country have substantial hydropower based electricity generation potential, however, only a small proportion of this potential has been utilized by constructing power plants in the region. A total of 1200 MW[7] of hydropower generation capacity has been established in the region (Lok Sabha, 2012). In addition to these large hydro based power plants, the government is also encouraging development of smaller plants (under 25 MW of installed capacity). North Eastern Electric Power Corporation (NEEPCO) and National Hydroelectric Power Corporation (NHPC) are all engaged in developing hydropower plants in the region.

Some of the key issues that have affected the development of hydropower in the region include among others, a slow pace of obtaining environmental clearances, protests from local residents, uncertainty of water flow and difficult geographical terrain. There are 70 small and big hydro projects on the Ganga (14 of these are under construction and 39 more are in the pipeline). These have led to several protests by religious organizations; local communities and environmentalists who have raised concerns about the availability of enough water for free flow of the river to sustain the various activities and livelihoods it supports. The Ministry of Environment and Forests has put a moratorium on environmental clearances for hydroelectric projects as a result of these protests. All hydroelectric projects on the Ganga may be asked to reduce their power generation capacity to try and address these concerns. The capacity reduction could be up to 50% (Jebaraj, 2012, May 31).

Concerns around resettlement and rehabilitation (R&R) have also come to dominate the discourse on large hydropower. The lack of inclusive development in the region has adversely affected the opinion of the local population regarding these projects (World Bank, 2007). The socio-economic and environmental problems in this context call for the establishment of an R&R expert committee to review, revise, and monitor the R&R plans put in place for major hydro projects including both compensation and capacity building. A thorough assessment of environmental and social impacts needs to be undertaken at various stages of project development.

Energy trade and investment

As mentioned above, given India's rising demand and dwindling resources, India's import dependence is high and is set to rise further. Coal imports in 2010-11 were at 86 MT and are expected to increase. In 2010-11, the country's imports of crude oil rose to 163.13 MT, registering a 2% growth over the previous year. The natural gas imports stood at 11.4 BCM, with 10.1 BCM coming from Qatar (TERI, 2012).

Petronet LNG, India's largest natural gas importer, has also contracted gas from Australia. Over 65% of India's crude oil comes from politically volatile West Asia, followed by Africa (led by Nigeria and Angola). For most of the country's oil and gas imports, India is reliant on two critical shipping routes, the Strait of

Hormuz and the Malacca Straits. The former has been at the centre of blockade threats due to the Iran-US confrontation, and the latter has been impacted by piracy at sea.

[7] This number does not take into account Sikkim

India is also engaged in power trade though not in significant quantities, with Bhutan (imports from) and Nepal (exports to). India is assisting Bhutan in developing it hydropower potential with the target of developing 10,000 MW by 2020, a significant proportion of which would be exported to India.

Long-term contracts for LNG, diversification of sources of oil imports, infrastructure development for growing coal and gas imports, are all policy priorities that the government needs to pay attention to. While the limitations imposed by geographical distances impede energy cooperation with disparate countries, swap arrangements and equity investments allow one way of engaging with a diversity of energy partners (Srivastava and Mahajan, 2011). The India Hydrocarbon Vision 2025 urged the government both to accelerate domestic production of oil, and to empower Indian companies to invest in equity abroad. Indian companies are making equity investments in energy in diverse countries across continents. ONGC Videsh Limited, the overseas arm of Oil and Natural Gas Corporation, India, recently, acquired a participating interest in an exploration block in Kazakhstan, and reached an agreement with Uzbekneftegas, the national oil company of Uzbekistan, for cooperation in the area of E&P. As in March

2011, OVL's interests were spread across 33 projects in 14 countries. In the light of domestic supply limitations, transport and handling capacity bottlenecks, and long duration of time required for developing mines to market, Indian power companies are acquiring coal mines abroad (TERI, 2012a). Coal India Limited too acquired two blocks in Mozambique in 2009, and Coal India Africana Limited, a wholly acquired subsidiary of CIL, is working to expand CIL's presence in the country's coal sector. Equity investments in coal include equity in operational coal mines, off-take deals and joint ventures for projects to be initiated.

Given India's rising demand and dwindling resources, India's (energy) import dependence is high and is set to rise further. While the limitations imposed by geographical distances impede energy cooperation with disparate countries, swap arrangements and equity investments allow one way of engaging with a diversity of energy partner

Energy infrastructure

Energy supply cannot be enhanced without the establishment of infrastructure for energy production, processing and delivery. For coal, the development of railways carrying capacity and port capacity for imports are crucial. Table 6 provides a snapshot of the planned increase in port capacity during the Twelfth Five Year Plan in order to handle imports of coal.

Table 6: Planned increase in port capacity

Name of the port and scheme	Capacity (MTPA)	Status as on 31 March 2011
Construction of deep draught berth for handling coal on BOT (build-operate-transfer) basis at Paradip Port	10.00	Environmental clearance has been accorded by The Ministry of Environment and Forests. Forest clearance is under processing. Anticipated date of completion is June 2014.
Mechanized coal-handling facilities and upgrade of general-cum-bulk cargo berth in outer harbour on DBFOT (design-build-finance-operate and transfer) basis	10.18	Agreement was signed on 10 June 2010 with the Vizag General Cargo Berth Pvt. Ltd. Concession was awarded on 8 October 2010. Expected to be completed by December 2012.
Development of second coal-handling terminal at the port of Mormugao, Goa	4.61	Physical progress of the overall project is 13.75%. Financial progress of the overall project is 19.62% (Rs. 796.5 million)
Construction of coal jetty at the New Mangalore port on captive basis	3.00	Work in progress. About 90% of work stands completed.

Source: TERI (2012a)

India currently has no piped oil/gas coming into the country. In order to create a buffer against supply shocks, the country is also pursuing a strategic oil reserves program. Phase I of this program includes the setting up of a 5 MT strategic storage by 2012 in three locations – Mangalore, Padur and Vishakhapatnam.

Gas imports require the construction of pipelines and LNG terminals. The two major gas pipelines under discussion, the Iran-Pakistan-India (IPI) pipeline and the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline, have remained matters of international consultation and diplomacy. The IPI pipeline is now being pursued more as a bilateral project between Iran and Pakistan. The TAPI pipeline has seen reinvigorated discussions in the last one year. The Gas Sale Purchase Agreement has been signed between the participating countries and it is expected that the pipeline will be operational by 2018. It is envisaged that the pipeline, extending from the Dauletabad gas fields to Fazilka at the Pakistan-India border, will transport 90 mmscmd of gas, out of which 38 mmscmd each will be meant for India and Pakistan, and the remaining for Afghanistan. The contract price of the piped gas from TAPI pipeline is linked to a formula that contains indices based on fuel basket and other indices that are not as volatile as crude oil (The Hindu, 2012). In addition to transnational pipelines, the importance of a national gas grid too needs to be highlighted – an initiative that would facilitate handling multiple sources of gas meant for multiple consumers (Duggal, 2009). For LNG imports, the Kochi terminal is expected to be operational in 2013, while an expansion of the capacity of the Hazira terminal is under discussion.

In the power sector, infrastructural requirements include both expansion of grid connectivity and establishment of off-grid systems (largely RE-based). Table 7 depicts the planned increase in transmission lines in the Twelfth Plan. Providing electricity access to unelectrified pockets presents a huge infrastructural challenge. The power sector also needs to address challenges associated with transmission and distribution (T&D) losses and power theft.

Table 7: Planned transmission lines expansion

Transmission Lines (both AC and HVDC systems) expected in 12th Plan (values in ckm)	Expected addition during 12th Plan	Expected by end of 12th Plan
HDVC Bipole lines	9440	18892
765 kV	27000	31164
400 kV	38000	152979
220 kV	35000	175976
Total Transmission Line (ckm)	**109440**	**379011**

Source: Ministry of Power (2012b)

Energy access

Of India's total population, 33.7% do not have access to electricity (Ministry of Finance, IEA, 2012 cited in TERI, 2012a). As of 2009, 289 million people in the country did not have access to electricity and about 836 million people (which is 72% of India's population) rely on traditional biomass for their cooking needs.

The per capita energy consumption in the country stood at 585 kgoe in 2009, in comparison to a world average of 1802 kgoe per capita (World Bank, 2011). The per capita electricity consumption was 755 kWh in 2009 against a world average of 2963 kWh (UNSD, 2009). These dismal energy access figures suggest that a concerted effort needs to be made to improve the standard of living of large segments of the population. Inappropriately targeted subsidies have been unsuccessful in providing affordable modern energy to those who need it most. The subsidy on liquefied petroleum gas has mostly benefited urban consumers who can afford to pay a higher price. This holds for petroleum too. Maintenance of low diesel prices has led to a "dieselization" of the economy with urban households investing in diesel-run cars. Cheap kerosene, used by the poor for lighting, is often siphoned off for adulteration into diesel.

With the launch of rural electrification programs, in the Rajiv Gandhi Grameen Vidyutikaran Yojana, and programs for delivery of clean cooking fuels to the poor, such as the Rajiv Gandhi Grameen LPG Vitrak Yojana, an effort has been made to affect change, yet there is a long way to go. A comprehensive, well-targeted program for rural cooking energy access needs to be initiated. Further, alongside efforts to increase grid-connectivity, renewable energy should be tapped wherever possible, in a decentralized manner. About 67.5 million rural households and 3.7 million urban households in India rely on kerosene for lighting needs. A solar lantern provides a cleaner and more efficient alternative.

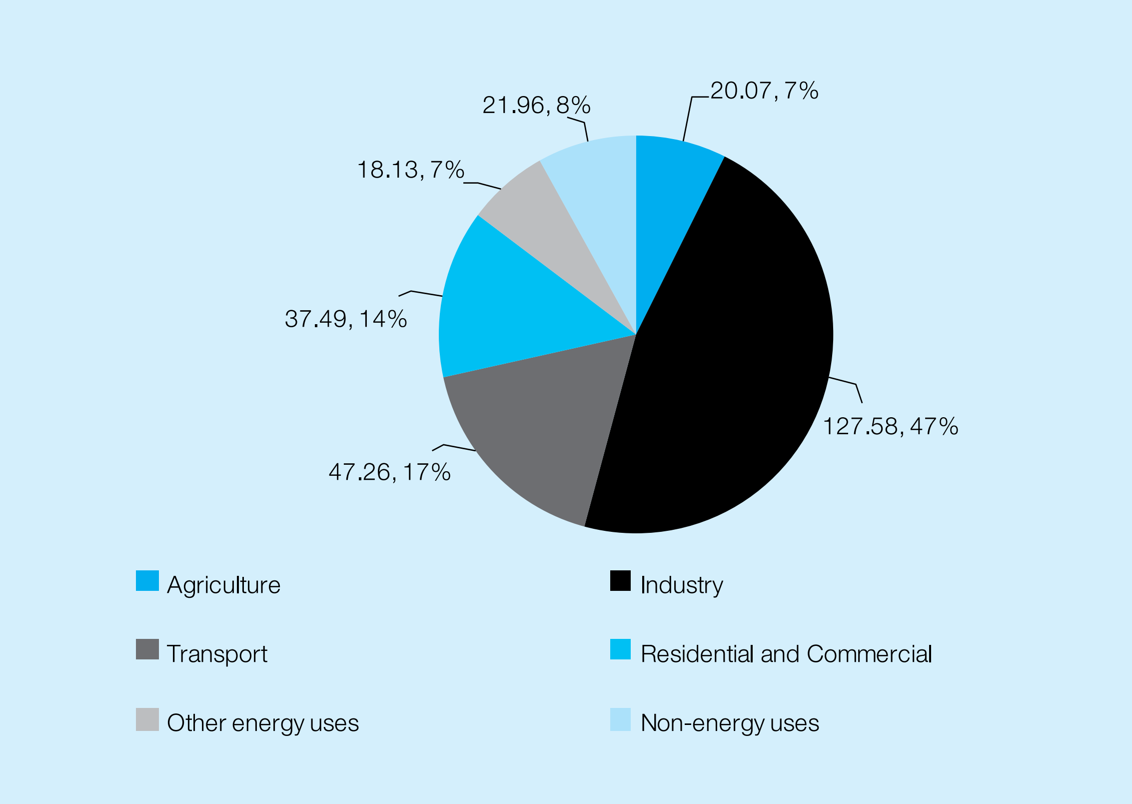
The recent changes in the pricing regime of petroleum products have sparked fresh debates on the efficacy of subsidies, and mechanisms that need to be established to increase access while making way for targeted subsidies. The government has initiated the design of a cash transfer scheme which seeks to address the leakages that currently exist in the system.

Energy efficiency

Along with the management of energy supply options, a significant contributor to energy security is also management of energy demand – energy efficiency and energy conservation. Measures geared towards efficient use of energy need to be introduced across all major consumption sectors (See Figure 10).

In India, the industrial sector is the largest energy consumer. The National Action Plan on Climate Change (NAPCC) includes the National Mission on Energy Efficiency, which lays down the Perform, Achieve and Trade (PAT) market mechanism that will cover facilities that account for more than 50% of the fossil fuel used in India, and help reduce CO2 emissions by 25 million tons per year by 2014-15 (Ministry of Environment and Forests, 2010). Under the mechanism, select industrial units with high energy consumption will be mandated to reduce energy consumed by a specified percentage. Industrial facilities that achieve savings in excess of the unique mandated reduction would be issued Energy Savings Certificate (ESCerts). The issued ESCerts will be tradable amongst the mandated entities. Apart from large industrial units, immense scope for energy efficiency improvements is offered by the small and micro enterprises. According to TERI estimates, it is possible to reduce energy consumption by up to 30%–35%, with the development and deployment of cluster/sector-specific technologies.

Figure 10: Final commercial energy consumption[8] by sector, 2008/09 (mtoe & %)



Source: TERI (2012a)

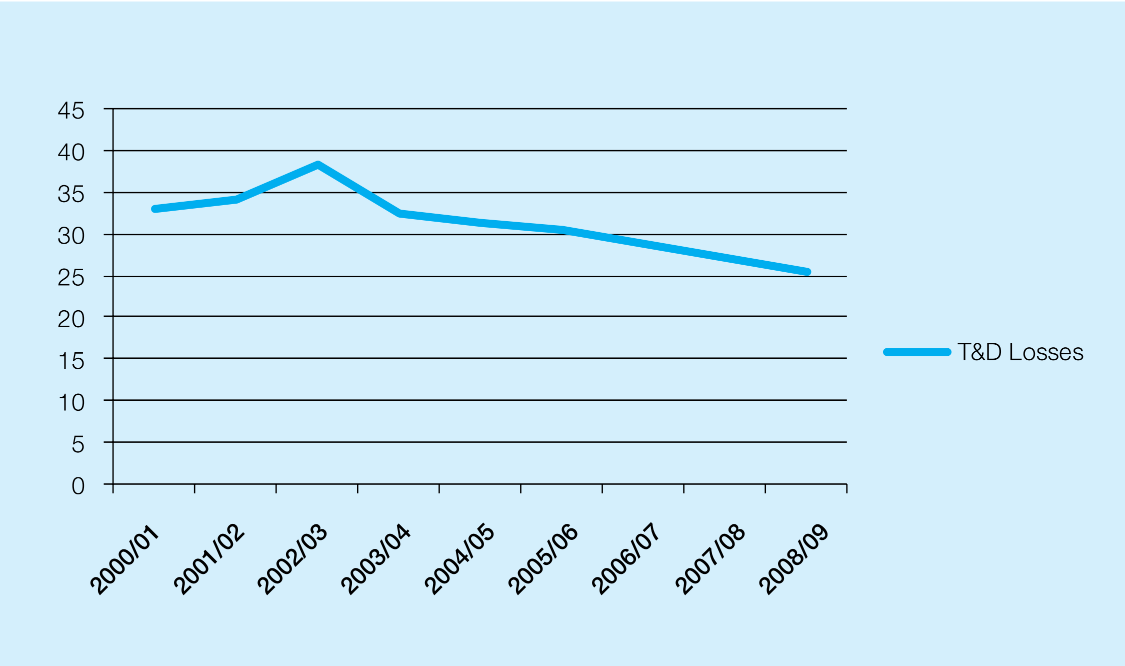
In the agriculture sector, energy saving potential is offered by the deployment of energy efficient pumps. Further, in the buildings sector, significant amounts of energy can be saved by the introduction of green building design and integration of RE systems like solar water heaters. About 50–60% of energy consumed in an air-conditioned building is by air-conditioning followed by 20% for lighting. TERI analysis has shown that over 20% of energy savings are possible in existing buildings by retrofitting with efficient lighting, air-conditioning and other electrical systems. New residential buildings can save up to 30% energy with the implementation of energy efficiency measures, and new commercial buildings can save

up to 40% (TERI, 2009). The government's initiative of introducing green rating for buildings, Green Rating for Integrated Habitat Assessment (GRIHA), is a step in the right direction. However, awareness about green building design needs to be raised across the range of stakeholders including architects, construction businesses and buyers. The Bureau of Energy Efficiency, a statutory body under the Ministry of Power, has introduced an energy labelling and certification program for select household electrical appliances. Efforts are also on to reduce the T&D losses. The all India losses for

[8] Final energy consumption is defined as the total energy consumed by end users such as households, industry and agriculture.

2008/09 were 25.47% compared to 27.20% in 2007/08 (decrease of 1.73%). Most of the regional zones have also managed to reduce system losses. Figure 11 shows the gradual decline in T&D losses since 2000/01.

Figure 11: T&D Losses as a Percentage of availability



Source: TERI (2012a)

In the transport sector, efforts need to be directed towards increasing the fuel efficiency of motor vehicles, altering the modal mix towards public transport, promoting the use of rail for freight movement, and investing in R&D to expand alternative fuels for transport. With rising aspirations and improving lifestyles, energy consumption in centres of economic growth is increasing and needs to be bridled.

Energy pricing

The institution of an appropriate energy pricing regime can help direct investments to the energy sector while directing energy consumption downward. Rationalization of petroleum products' pricing, in conjunction with targeted subsidies for kerosene and LPG, has characterized energy policy debates in India for long. Given the inefficiencies and leakages that mark the current system, with diesel being appropriated for personal vehicular transport and kerosene being used to adulterate diesel, and subsidized LPG cylinders being deployed for commercial use, rationalization of energy products' pricing is a policy priority. Growing subsidies have had various adverse consequences, including loss of government revenues, growth in oil companies' under-recoveries, and inefficient consumption of fossil fuels. In 2011–2012, oil marketing companies in India incurred under-recoveries to the order of INR1,38,541 crore (US$27.06 billion) (TERI, 2012b). With the dismantling of the current subsidy regime, improvement in the financial health of OMCs will make available capital for investment in the oil and gas sector, and appropriate pricing will attract private interests to retail.

In the power sector, it is agreed that a minimum differential needs to be stipulated between off-peak and peak tariff, and well-defined time of day pricing needs to be introduced. Lighting, space conditioning and water heating demands which form a substantial large part of residential energy demand coincide largely with peak load periods. Well-defined time of day pricing can help affect energy savings of about 30% (TERI, 2009). With the exception of lifeline consumers, it is recommended that all other consumers must be liable to pay a peak tariff that is at least a factor of two or three higher than the off-peak tariff and a recommendation on the minimum differential must be stipulated in the National Electricity Policy (TERI, 2009). Losses incurred by state electricity distribution companies have been mounting with large loan repayments, pending subsidy receipts, payments to be made to power producers, growing utility losses, and pressures created by fuel price rise (Mehdudia, 2012, June 29). Lack of timely revisions in power tariff is a critical concern.

With the exception of lifeline consumers, it is recommended that all other consumers must be liable to pay a peak tariff that is at least a factor of two or three higher than the off-peak tariff and a recommendation on the minimum differential must be stipulated in the National Electricity Policy (TERI, 2009)

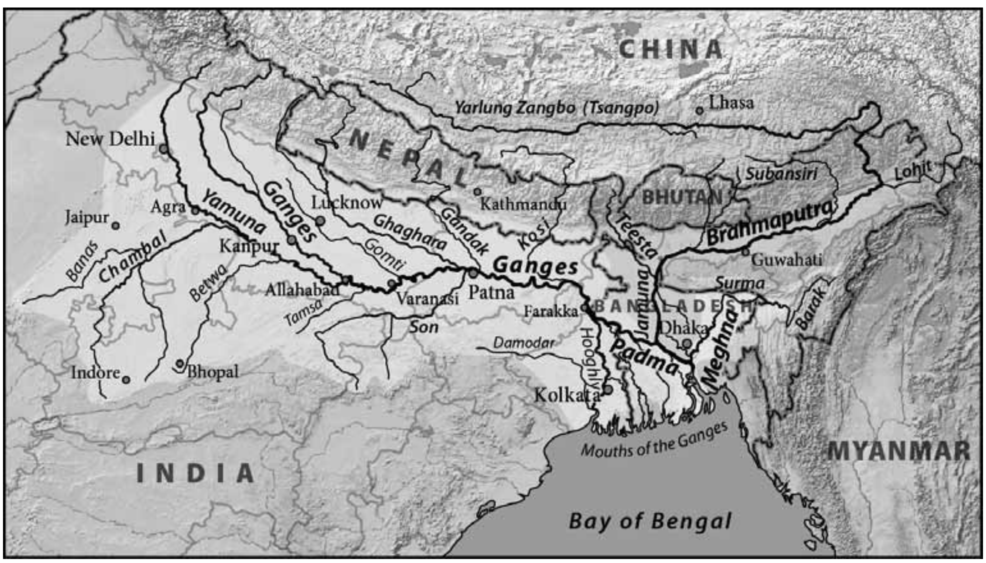
The Ganga-Brahmaputra-Meghna Region: Focus on India-Bangladesh concerns

Description of the region

Despite a wealth of resources – water, fertile land, forests, the countries in the Ganga-Brahmaputra-Meghna (GBM) region have not been able to use their full potential. The GBM region is one of the most populous river basins in the world and it also has the dubious distinction of being one of the poorest and most depressed in the world. The irony of the Paradox of Plenty or the resource curse is clearly observed here. The GBM river basin is considered to be one transboundary river basin stretching across 1.75 million square kilometers. These three rivers flow through different regions in different countries for most parts of their respective lengths. It is the second largest hydrological system in the world after the Amazon (Bandopadhyay & Gosh, 2009). These three rivers, while large in themselves, have a number of tributaries which are essential too. They contribute to the water availability in the region and are also important in social, economic, political (Biswas, 2008) as well as religious terms. The three rivers, a number of tributaries (many of which are transboundary), the five countries and the different regions involved, make management and planning of this area extremely complex. However, this complexity is the very reason why joint-management and regional cooperation is extremely important in the area as unilateral action on any of the tributaries in any of the regions can have major consequences for other countries, especially the lower riparian ones.

The key issues that have emerged between India and Bangladesh - the only two countries which share all the three rivers, as well as a number of tributaries- needs to be looked into. As Bangladesh is the lowest riparian country, its vulnerability to any developments by India on these rivers is extremely high. The two countries have had several disputes over water sharing, river damming, river diversion, hydropower projects undertaken by India.

Figure 12: The Ganga-Brahmaputra-Meghna region



Source: Wikimedia Commons

Recommendations and Conclusion: Possibilities for energy cooperation between Bangladesh and India[9]

It is clear from the above analysis of the energy scenarios of the two countries that adequate energy supply presents a challenge to both Bangladesh and India as they chart their development trajectory. Though the extent of vulnerability may differ and the country energy contexts are unique, the countries share many common concerns. Both overlapping areas of weakness, and corresponding policy successes and failures, offer scope for cooperation. Further trans-boundary concerns such as water sharing and hydropower development too need to be addressed in a collaborative framework. This section highlights the main energy issues where the two countries can cooperate.

Cooperation on hydropower development

Water resource development is an important issue in Bangladesh-India ties; 54 rivers crisscross the borders of the two countries at various points (IDSA, 2010). Many studies have shown that a joint, coordinated management of the Ganga basin by the riparian countries could promote social, economic and environmental development and wellbeing in the region (Biswas, 2008; Rahaman 2009).

Hydropower development is one area where the two countries can cooperate. As mentioned above, Bangladesh has negligible hydropower capacity within the country due to its flat terrain. Joint projects can benefit both the countries; for India, it gets Bangladesh's consent to develop the water resources and

Bangladesh gets a say in the developments of the project which may impact it while also benefiting from power generation. Benefits and costs of joint hydropower development such as submergence of land, displacement of upstream people, downstream benefits resulting from flood control, flow regulation, power generation (Rahaman, 2009) should be studied in detail.

The Tipaimukh project which India has undertaken is a run-of-the-river project, and is meant for power generation and not as a water diversion project. The provision of water storage is for not more than 10 days during the monsoon. According to Indian government reports, the Tipaimukh dam would not only control floods in Bangladesh, but the excess water stored will help augment the lean season flows thus making more water available to Bangladesh when they need it most. But counter claims from the Bangladeshi side about the probable impacts are also strong. Since, this region sees heavy monsoons and is extremely flood prone, cooperation in better utilising and managing the available water resources will help save and even avert some of devastation seen here. If the results of the joint study on the probable impacts of this project seem favourable to Bangladesh, it provides all the more grounds for Bangladesh to consider being a part of the project.

An important point that needs to be stressed upon while discussing hydropower projects in the GBM region is that a holistic approach needs to be adopted while managing the river systems. While the rivers have hydropower generation potential, they also provide extremely important and extensive ecosystems services on which many livelihoods and human survival are linked. 'The new paradigm of water resource management underscores managing demand for water while stressing on the need for the right type of allocation creating the right type of trade-off between economic and ecosystem services of water' (Bandopadhyay & Ghosh, 2009).

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[9] Important recommendations for collaborations are highlighted in bold.

Climate change considerations should also be paramount while considering human interventions (dams, large hydro projects, river diversion) in the GBM system as this basin is already susceptible and is witnessing the negative impacts of climate change. Bandopadhyay and Ghosh (2009) insist on **considering ecological engineering which takes a holistic perspective of the ecosystem.** Knowledge of the dynamics of the sediments with the flow of water, sharing of transboundary hydrological flows (treated as 'classified' in South Asia and outside public domain) will help ecological engineering in this region.

Multilateral hydropower development and electricity trade (Bangladesh, Bhutan, Nepal and India)

Bangladesh has shown keen interest in importing hydropower from Bhutan and Nepal. Bhutan has been desirous of diversifying its markets. Nepal, though has huge potential to generate hydropower, is currently a net importer of electricity from India and has expressed its interest in receiving electricity from Bhutan and also gas-based thermal power from Bangladesh. India is already inter-connected to Bhutan and Nepal and is developing its power inter-connection with Bangladesh. The SAARC Regional Energy Trade Study (SRETS) proposed four concrete courses of action: creation of (sub-) regional refinery; (sub-) regional LNG terminal; (sub-) regional power plant; and most importantly (sub-) regional power market (SAARC, 2010). **The geographic location and the country energy resource distribution in Nepal (hydropower), Bhutan (hydropower), Bangladesh (natural gas) and India (coal) are conducive to establish a power exchange amongst all four countries, building regional grid for a multilateral electricity trade arrangement.**[10]

The borders of Nepal, Bhutan and Bangladesh converge near Siliguri in the state of West Bengal in India. Considering this, a study under the SARI-E program suggested connecting Siliguri (India) to Anarmani (Nepal) and Thakurgaon (Bangladesh). It also suggested the alternative of connecting Purnea (India) to Duhabi (Nepal) and Ishurdi (Bangladesh). Connections from Chhukha (Bhutan) to Siliguri and then on to Purnea which already exist. Bilateral discussions between India and Bangladesh during the last 20 years focused on inter-connections from Jessore, Rangpur, and Sylhet, but did not result in any action. In March 1999 Power Grid Corporation of India conducted a feasibility study for enabling an exchange of power between India and Bangladesh of the order of 150 MW proposing transmission links between Farakka (India) and Ishurdi (Bangladesh) and Kurnarghat (India) and Shahjibazar (Bangladesh) (World Bank, 2007). Finally, a transmission line of 500MW capacity is being constructed between Berhampore (India) and Bheramara (Bangladesh) which is roughly in line with Farakka-Ishurdi link suggested earlier. ADB has offered a US$100 million loan to Bangladesh for building the transmission line.

Seasonality in power supply and demand in a year as well as variations in demand within a day can also be the source of mutual cooperation across South Asian countries (see Annexure for proposed electricity trade in the region). For instance, in Bangladesh, sizable generation capacities of about 1200 MW remain unutilized during the off-peak hours though the country faces shortage of power during peak hours. This capacity can be a source for regional cooperation for import-export of electricity (Nanda and Goswami, 2008). India, by virtue of being a large country, can manage such fluctuations better. Nevertheless, there exists clear seasonality in power generation, particularly in hydelpower generation. The peak months for hydro-power generation are August-September while the lean remain from January to June.

[10] See Annexure 1 for the existing and proposed bilateral electricity trade in the region.

However, the possibility of extensive power trade remains far-fetched for now as power resources in the region are not adequately developed. Bhutan is the only country in the region to have substantial surplus in capacity and generation. With India's assistance, Bhutan has developed some of its available hydropower resources. Even then, a large proportion of the country's hydro resources remain undeveloped. The desire of Bangladesh and Nepal to import electricity from Bhutan through Indian Territory has not received a warm reception in India. This is not just because it was not ready to allow the use of Indian Territory, but because the existing capacity of Bhutan has been created with assistance from India, Bhutan has, in turn, committed to supply the surplus electricity to India. This situation may change with the development of additional capacity in Bhutan. It may be noted that Bhutan signed a Framework Agreement with India in March 2009, whereby India committed to develop 10,000 MW of installed capacity in Bhutan by the year 2020 (PIB, 2011, November 25).

India already cooperates with Bhutan in hydropower and Bangladesh has already shown interest in importing power from Nepal and Bhutan. One of Bangladesh's private companies has also expressed an interest in developing a hydropower project in Bhutan. **Given the existing and developing electricity connections of India with the other countries in the region, the potential of joint development and sharing of hydropower can be explored. While the political barriers for such a project are evident, the countries can move towards information sharing and joint water resource management.**

Consultative and coordinative development of hydropower projects in this region will be beneficial for all. Studies can be undertaken to address gaps in knowledge about the ecological processes associated with Himalayan regions (Bandyopadhyay 1992, 1995; Bandopadhyay, Rodda, Kattelmann, Kundzewicz, Kraemer, 1997 as cited in Bandopadhyay and Gosh, 2009)

Energy provision – RE development interface

World over, 1.3 b people are without access to electricity. Of these 289 m are in India and 96 m are in Bangladesh. Further, 2.7 b people, globally, are without access to clean cooking facilities, of which 840 m are in India and more than a 100 m are in Bangladesh (IEA, 2011a). **Improvement in modern energy access is, therefore, a policy priority for both the countries. The potential to implement these technologies could also be explored in the GBM region within the two countries which faces extreme poverty.**

For access to electricity, while it is important for the countries to expand grid connectivity, decentralized electricity solutions need to be implemented on a large scale to reach non-electrified households and meet peak load shortages. Renewable energy based decentralised power generation holds immense potential here. Bangladesh's National Energy Policy (NEP) declared way back in the year 1996 has identified renewable energy as a major priority intervention. Numerous renewable energy projects on biogas (biogas pilot plant project by IFRD and LGED), solar electrification (Chittagong Hill Tracts solar electrification project by BPBD), hydro, wind (wind resource assessment program by BPDP) and technologies (diffusion of renewable energy technologies project by REB) were commissioned by the government. In addition, several renewable projects were undertaken by NGOs (renewable energy technology programs by Grameen Shakti, dissemination program by CMES etc.) and bilateral and multilateral development partners (sustainable rural energy project, renewable energy technologies in Asia by SIDA, opportunities for women in renewable energy technology etc.). Grameen Shakti has been successful in installing biogas plants, SHS systems and promoting clean cookstoves through soft credit and training of local entrepreneurs. However, attempts to develop such renewable energy interventions have met with limited success due to policy impediments, lack of finance and institutional capacity.

In India, in order to expand access to electricity, the government has launched the Rajiv Gandhi Grameen Vidyutikaran Yojana (initiated in 2005) and the Remote Village Electrification Program (initiated in 2001) that look to provide lifeline electricity to rural/remote areas by extending free power connections to households subsisting below the poverty line and by subsidizing capital costs by 90% through government grants (Government of India, cited in Shenoy, Jain, Parthasarathy, 2011). The Government has also sought to deploy renewable resources for improving energy access. The government invested in a National Biogas Program (1981-82) though the program achieved limited success. The National Solar Mission has set the country the target of achieving 20 GW of power from solar energy by 2022. Initiatives such as SELCO India have put forth financial solutions that make solar technology affordable for poor households. SELCO provides solar PV modules for varied applications (See SELCO, 2012). TERI's Lighting a Billion Lives campaign has focused on providing unelectrified and semi-electrified rural homes with solar lanterns through a local entrepreneur model (TERI, 2012c). A note also needs to be made of the work being done by the Barefoot College that, since 1989, has been pioneering solar electrification in unelectrified villages (Barefoot College, 2012**). Best practices in the use of biomass gasifiers and solar modules need to be shared across the two countries. India has a strong manufacturing base in solar systems and thermal technologies, which can be employed for RE-based, distributed generation in Bangladesh. Similarly, business models being implemented in Bangladesh, for instance by Grameen Shakti, offer lessons for India.**

Household energy consumption patterns in rural areas indicate that majority of households rely primarily on biomass fuels - twigs, leaves and virtually all components of agricultural residues (e.g. cow dung, jute sticks, rice straw, rice husks) and natural resources (e.g. firewood) for energy. However, most of the agricultural residues have competing uses in Bangladesh, either for animal feed, construction material, fertilizer or compost which often leads to a resource trade-off within a household or village that limits residue availabilities for fuel (Fatema, 2005). This holds in the case of India too. Also, **the burning of biomass is a significant cause of indoor pollution and health hazards. Dissemination of clean, efficient cook stoves can help address this concern.**

Various governmental and non-governmental initiatives have been taken in both countries for deployment of clean cooking technologies, and need to be promoted. Development programs that address Improved Cookstoves (ICs) have been undertaken in Bangladesh since the 1970s through the research of the Bangladesh Council of Scientific and Industrial Research (BCSIR). In recent times, the government has taken a step back as larger NGOs have pushed the sector forward. However, the programs/projects have not reaped the desired outcomes. In India, the Ministry of New and Renewable Energy funded the National Program on Improved Chulha from 1984 to 2002. The program targeted a reduction in the use of fuel-wood. Yet, from 1988 to 1994, an increase in the per capita consumption of firewood in rural areas was reported (Alam, Sathaye, Barnes, 1998; Pachauri and Jiang. 2008; National Sample Survey Office, 1997 as cited in Shenoy, Jain, Parthasarathy, 2011). The low impact of the scheme has been attributed to lack of coordination amongst governmental agencies and implementing bodies; production of defective cookstoves; inadequate capacity building and lack of after sales service (Eregeneman, 2003; Moghe, 1993 cited in Shenoy, Jain, Parthasarathy, 2011).

A host of research has shown that one of the main causes for the failure of acceptance of ICs programmes has been the invisibility attributed to the 'gender-energy nexus' (See Miller and Mobarak, 2011; and Mobarak, Dwivedi, Bailis, Hildemann, Miller, 2012). **The gendered impacts of energy challenges and the place that 'gender' needs to be accorded in policymaking and implementation are often missed. Box 1 highlights the significance of taking a gender-sensitized approach to energy policy, and lists some examples of governmental and non-governmental initiatives in this regard.**

Off grid micro hydro power projects, better designed traditional water mills used to generate electricity as well can also help provide sustainable electricity solutions. The water mills developed for mechanical use as well as electricity generation would serve dual purpose of a farmer. They have a 3-5 kW capacity. Uttarakhand, in India, has already installed more than 500 such watermills in remote and isolated areas in the state (Ministry of New and Renewable Energy, 2012b). Though the program is still in its initial stage and has not seen country wide application, it has been much appreciated in Uttarakhand where old water mills are now being restored and upgraded with some aid from the government. Given the numerous rivers and canals, this is one option which can be considered for Bangladesh as well. Razan, Islam, Hasan, Hasan, Islam (2012) in their paper look at the potential of micro-hydropower plants in Bangladesh and identify the potential at select sites. Experiences from here can be shared with Bangladesh and areas of possible use can be identified.

Women's need to access modern energy services for productive and other activities is not a primary concern of energy projects/ programs. However, in recent decades in an attempt to mainstream gender issues, attention is increasingly being paid to women's needs in national program and policies. A host of options on renewable energy technologies has been provided with an aim to directly target the strategic needs of women so as to raise them to an empowered position

Box 2: Engendering energy interventions

Women carry a disproportionate weight of the world's poverty. Statistics indicate that women represent almost 70%of those trapped in the cyclical nature of poverty. Energy poverty is well acknowledged and it interacts with other manifestations of poverty (Barnes, Khandker, & Samad, 2011). Reliance on traditional energy forms like fuelwood, dung cakes etc. have well documented gender implications. It affects girl child education, women's health, time available to them for other personal and economic activities (Saghir 2005; Barnes and Toman, 2006; World Bank 2002 in addition to the rest of the house work, women need to undertake fuelwood collection as well. This task can generally take hours daily, sometimes, the entire day, depending upon how far the woman must walk to collect fuelwood. Rural women of the house are involved in multiple tasks such cooking, taking care of children, health care, contributing to agricultural activities, animal husbandry etc. Thus, younger children, particularly girls are roped in to help with the time consuming work of fuelwood collection due to energy scarcity keeping them away from school. Thus, access to modern fuels would help reduce the time required for fuelwood collection and help free up time for school and study (UNDP, 2011b). This has also been established by projects carried out by UNDP. Also, increased efficiency of modern fuels or improved cookstoves would help reduce indoor air pollution and the related health issues.

Both energy-related development interventions and gender equality goals are important for poverty reduction, and sustainable development, more so in the developing countries since energy planning and projects do not explicitly address the differential needs of men and women. Even governmental energy programs often reap misbalanced gendered results. In particular, although electricity has many benefits, it does not help address the major energy problems that most women in rural areas face in terms of their practical needs. A few studies have pointed out that in rural Bangladesh, access to electricity have neither brought a real reduction in women's workload nor influenced the prevailing gender of labour. However, women did report that they had more flexibility in organizing their work according to their convenience which women considered a benefit (Clancy, 2003; HDRC, 2002). Thus with a specific impetus on the role of women, electricity can empower them only when the necessary complementary factors are available.

By and large the energy policies and programs have assumed that the benefits will trickle down and benefit equally to both men and women. In most cases energy service delivery for women is almost exclusively equated with household energy and meeting the practical needs of cooking and heating.

Women's need to access modern energy services for productive and other activities like livelihood, entertainment, safety and security is not a primary concern of energy projects/ programs. However, in recent decades in an attempt to mainstream gender issues, attention is increasingly being paid to women's needs in national program and policies. A host of options on renewable energy technologies has been provided with an aim to directly target the strategic needs of women so as to raise them to an empowered position.

Various initiatives have been undertaken both at the macro and the micro level for gender inclusion in energy development planning and programs. For instance, in India, a gender rating system has been designed by IRADe to rank the effectiveness of MNRE's (Ministry of New and Renewable Energy) various programmes in delivering benefits to women relative to the budget outlay in MNRE's 10th Five Year Plan (IRADe 2009). The rating system provides a quantifiable indicator that identifies the gender-responsiveness of a programme. India's Integrated Energy Policy (IEP) explicitly acknowledges and includes a gender approach and promotes the wider purpose of ensuring women's access to and control over energy assets and resources. In this respect it is the first of its kind in the energy sector in India.

At the local level numerous initiatives have attempted gender considerations in energy planning and implementation. For instance, the two projects awarded to IRADe under Village Energy Security Programme (VESP) of MNRE incorporated gender considerations by way of involving more number of women as Village Energy Committee members. Women SHGs were involved in the development of livelihood activities and in the operation and maintenance of renewable technologies Likewise, Lighting a Billion Lives, a flagship program of TERI which aims to provide solar energy based lighting solutions has a strong gender component weaved into the program. This program has created numerous livelihood options for women in addition to creating women energy entrepreneurs (TERI, 2012c). TERI has also been at the forefront of promoting improved cook stoves by way of research, development and dissemination. The initiatives primarily focus on women as consumers and addresses the entire product life cycle, where the improved cook stoves are seen as a technology that provided concrete and observable benefits. CATALIS, a Development Focus (DF) initiative in India, has also been working with poor communities to gain access to home lighting through solar lanterns. The program was designed and implemented by the women members of the community and highlights how women's engagement in microenterprise energy initiatives can change their economic and social standing within their communities

Cooperation in energy development and trade

Being import dependent, trade is an important component of the energy securing strategies of both Bangladesh and India. The South Asian region has lagged in developing trade ties amongst countries and this holds for Bangladesh and India as well. There is some existing trade in energy goods, and some specific areas offer scope for expansion. An analysis of opportunities and challenges follows.

Table 8: Current India-Bangladesh Energy Trade

India- Bangladesh, (petroleum products)	Bangladesh imports from India
India- Bangladesh (Coal)	Bangladesh imports 4-5 MT from India
Electricity	No trade
Gas	No trade

Source: TERI Compilation

Trade in coal

Bangladesh imports coal from India in limited quantity. However, the trade relationship has been far from smooth. Bangladesh has banned coal imports from Meghalaya 7 times in the past 9 years (the recent being between June 2010 and June 2011) due to the high sulphur content of the coal. The coal, however, is found to be cheaper than coal from both China and Indonesia. Considering that India is now facing coal shortages and is importing coal from other countries, there is not much scope for India enhancing its coal exports to Bangladesh. However, Bangladesh has found coal resources of its own much of which are not yet utilized. **There is potential for India to assist Bangladesh in exploiting these resources. India can also help build capacity in the mining sector in Bangladesh.**

Trade in petroleum products

Both India and Bangladesh are heavily dependent on external sources for their oil requirements. **There is not much scope for trade in oil but the situation is quite different if one looks at refined petroleum products**. Bangladesh consumes much more than its refining capacity. India, on the other hand, is an exporter of refined petroleum products. While Bangladesh imports from India, it also imports a large part of its refined products from Singapore which is among the major export destinations for Indian refined petroleum products. Thus, there is significant scope for trading in petroleum products between them that is still unutilized. In 2011, a 100 km long petroleum products pipeline was proposed to be built by the Assam-based Numaligarh Refinery Ltd (NRL) for the export of high speed diesel (HSD) to Bangladesh. The proposed pipeline will connect Siliguri, West Bengal, to Parbatipur in Bangladesh and will require investment to the tune of Rs 150 crore. It will connect to an existing pipeline in Siliguri which extends up to Numaligarh (Singh, 2011, April 15).

Trade in natural gas

India being one of the most energy hungry countries in the world has long been keen on exploring various options for accessing energy. There is a belief that Bangladesh has substantial gas reserves and India can tap part of it. The first proposal to export natural gas from Bangladesh to India came from one of the foreign producers operating in Bangladesh. Unocal (now Chevron) which had developed a gas field in north-eastern Bangladesh proposed the construction of 847 mile (1363km) gas pipeline from Bibiyana to New Delhi. It proposed to export 3.65 tcf of natural gas over a period of 20 years which according to projections would have given Bangladesh an estimated US$3.7 billion in revenues and taxes (Bose 2007). However, the issue became politically contentious in Bangladesh and the proposal was nipped in the bud. The opponents of the idea also argued that Bangladesh did not have enough natural gas to meet its own requirements on a long-term basis.

A report *Gas Strategy for Bangladesh* (January 2006) prepared for Petrobangla by Wood Mackenzie Ltd assumes a proved level of 9.2 tcf, proven plus probable reserve of 14.4 tcf, and a proven plus probable plus possible reserve of 22.2 tcf. This appears to be the most conservative estimate**.** The government has been reluctant to make any commitment for the export of gas or gas based electricity on account of the uncertainty of its reserves position and the fear that the country may run out of its only major energy resource sooner than expected. **It is claimed that if coal mining and coal based power development takes root, and if the country has access to the hydropower of Nepal, Bhutan and Myanmar, it might adopt a little more liberal approach to gas exports or the exports of gas based power or fertilizers and steel products made using gas as fuel (World Bank 2007).**

Myanmar-Bangladesh-India gas trade[11]

The Myanmar-Bangladesh-India gas pipeline was expected to be a watershed for regional cooperation in South Asia but could not be implemented due to differences between Bangladesh and India. It is clear that Bangladesh, because of its geographical location, is critical for any energy infrastructure projects that involve the territories of India and Myanmar. The gas pipeline was expected to bring gas from Rakhine, Myanmar to Kolkata, India, through the Indian states of Mizoram and Tripura and the territory of Bangladesh. To transport this gas to the state of West Bengal in India, negotiations were held with Bangladesh government to provide transit facilities. In January 2005, Bangladesh agreed to allow the 559 mile pipeline to pass through its territory. Bangladesh Gas Transmission Company was slated to own the responsibility of managing the 180 mile pipeline in its territory and to receive an annual transit fee of $ 125 million. Such acceptance by the Bangladesh government, however, was subject to several conditions such as grant of several trade concessions including removal of tariff, non-tariff and administrative barriers to Bangladesh exports to India, provision of access to hydroelectricity from Nepal and Bhutan and an establishment of the free trade corridor to these countries (World Bank, 2007). India, at that point of time, was unwilling to offer these concessions to Bangladesh. However, now India has agreed to all these demands made by Bangladesh.

Given that India's discussion with Bangladesh on the proposed gas corridor was not making much progress, India started considering other alternatives to bypass Bangladesh. However, the delay in getting its act together worked against India, and Myanmar decided to sell the available gas to China in 2008. The construction of the Myanmar-China pipeline project which consists of dual oil and gas pipelines originate at Kyaukryu port on the west coast of Myanmar and enter China at Yunnan's border city of Ruili.

Meanwhile, the energy situation has changed significantly in Bangladesh. It has started facing a shortage of gas, mainly due to its inability to tap full potential as well as failure to find significant additional reserves due to lack of funds. With this, there was a discussion on importing gas from Myanmar through pipelines, excluding India from the picture. However, soon it was realized that a Myanmar Bangladesh pipeline was not economically viable. In 2010, the Bangladesh government had finally given its approval of a potential Myanmar-Bangladesh-India pipeline (Chandra, 2012).

The lack of convergence in the energy security policies of India and Bangladesh led to the failure of Myanmar-Bangladesh-India (MBI) pipeline project. Though the interests seem to converge now, it may be too late. The natural gas reserves in Myanmar are limited – and at this stage Myanmar is not in a position to accommodate the needs of both China and the Indo-Bangladesh partnership. The future of the latter depends on availability of additional gas reserves in Myanmar. If the project is revived at a future date as both Bangladesh and India find common interest, it could possibly pave the way for multilateral gas trade among the eastern nations of South Asia.

Electricity trade

Though an issue linked with the availability of gas in Bangladesh, the possibility of exporting gas based power to India, while augmenting supplies in Bangladesh, has long been discussed. A pre-feasibility study prepared for the government of Bangladesh under the USAID SARI-E program started in 2000 demonstrated that a gas fired combined cycle power plant of 500MW to 1000MW capacity located at Bheramara or Sirajganj and exporting a minimum of 400 MW to the eastern grid of India would be competitive in the Indian power market with a delivered power cost of about 4.4

[11] See Annexure for various gas trade projects proposed in the region.

to 4.7 cents/kWh (Financial Express, 2007, November 11). Similar power plants located at Sylhet or Fenchuganj exporting power to the northeastern grid of India were also estimated to be economic and competitive. Since then several proposals have been made to the government for similar power plants in Bangladesh which will be primarily for export to India and partly for meeting local demand. In 2000, NTPC of India proposed to build a 1000 MW thermal power plant at Bheramara.

The most talked about proposal in this context came from the Tata Group of India. The proposal of the Tata Group made in 2004-2005 to invest $2 billion to $3 billion in Bangladesh in a 1000 MW gas fired combined cycle power plant, a 500 MW coal fired power plant, a fertilizer factory using gas and a steel finishing mill using gas, which would also involve export of electricity to India (World Bank, 2007). However, the Bangladesh authorities have not been able to respond positively to any of these proposals. Barring the Tata proposal, most of the proposals did not receive any serious consideration in the Bangladesh government quarters. Eventually, the Tata proposal too did not see the light of the day. While the price of natural gas that the Tatas were willing to offer was a concern, it was also the fact that natural gas is the only energy resource (apart from the recently developed coal resources) available to meet domestic energy demands and the government did not want to make any commitment on supply of gas till it was sure of the true size of the gas available in the country.

Developments of the recent past have altered the situation, creating possibilities of export of power from India. Since the mid-1990s, due to unprecedented economic growth in the country, Bangladesh has also been experiencing an annual growth in power demand of about 9%. Financial resource constraints (arising mostly from poor operational efficiency) slow down the pace of capacity additions in generation, transmission and distribution, resulting in a perpetual shortage situation. Import of power from the Eastern and North Eastern regional grids of India are being considered an option to meet the shortages in Bangladesh. Recently, there has been an agreement between India and Bangladesh for export of electricity from India to Bangladesh. Vidyut Vyapar Nigam Limited (NVVN), a wholly owned subsidiary of NTPC and BPDB signed a power purchase agreement, signed a power purchase agreement with BPDB in early 2012. Construction of transmission line (Berhampore in India and Bheramara in Bangladesh) is on in both India and Bangladesh. Though initial supply of power from India to Bangladesh would 250MW, the transmission line would have a capacity of 500MW (BD News, 2012, July 14). However, the implementation of the agreement might get delayed as the construction of the transmission line is facing trouble due to land acquisition difficulties in the state of West Bengal in India. The issue of pricing and power purchase agreement, despite some initial differences, has been resolved. India is also building a coal based power plant near Khulna in Bangladesh as a joint venture. Discussions are on for another coal based power plant as India-Bangladesh joint venture in south eastern Bangladesh.

The construction of these transmission lines could also help in the joint development of hydropower projects and give a further incentive for joint engagement.

Conclusion

The scope to leverage each country's strengths and positions in the region to develop successful and mutually beneficial energy trade relations, both bilaterally and regionally is immense. It is however, clear from the above analysis that possibilities for **cooperation between Bangladesh and India have been constrained by varied factors: historical lack of political will**, **bureaucratic processes; bilateral tensions; and technical difficulties in energy trade (such as synchronization of grids and building of investment-heavy pipeline projects; lack of adequate, credible information etc.).**

The energy situation in these two countries, marked by severe shortages and infrastructural handicaps, calls for a collaborative approach. Though the platforms in South Asia such as the South Asia Association for Regional Cooperation (SAARC) and Bay of Bengal Initiative for Multi-sectoral Technical and Economic Cooperation (BIMSTEC), have failed to establish themselves as strong political entities, the two countries can utilize the frameworks and platforms offered by these organizations to bolster bilateral ties.

Possible areas for further research

The energy challenges that Bangladesh and India face and the inherent richness of energy as a policy arena bring forth a range of issues that can be the subject of further research. The governments in both the countries have brought out a number of policy documents in the recent past. At the same time, a number of non-government organizations and private entities are conducting both policy and action research and implementing energy projects at the grassroots level. For details on some such initiatives, refer to the Annotated Bibliography included at the end of this document.

On the basis of the review of energy issues conducted as part of this project, following is an indicative list of topics that can be pursued as part of joint research initiatives:

Research for the GBM region

On the basis of the analysis conducted in Section III the key areas which present opportunities for joint research are:

- Development of integrated water resource management plans
- Opportunities for ecological engineering of hydropower projects between the two countries, in particular, and the region as a whole
- Studying environmental and social impacts of hydropower project development particularly in the GBM region
- Studies on Joint Resource Management are crucial for this region.

Renewable Energy

India has significant expertise in the Wind Sector, and is rapidly developing its capacity in the Solar Sector as well. As seen in Section II, Bangladesh too, has plans for expansion of solar capacity. Given the energy access questions in both the countries, research needs to be undertaken to see where synergies can be developed.

Renewables provide a desirable option to address energy access issues. Given the access issues in both countries, exploring all forms of renewables and joint research and knowledge sharing on the various options will be beneficial. Some of the fields, in addition to solar and wind mentioned above are listed below.

- Assessment of the potential and use of renewable energy technologies for development of the GBM region in particular
- Research on the potential to cooperate on setting up mini/micro hydel projects particularly in the GBM region, especially given the abundant water resources in the area, and the recurring problems with large dams.

- Research on successful business models for renewable energy-based decentralized energy interventions.

Conventional Energy and Energy Efficiency

- Research for opportunities of cooperation for improvement of power plants and technologies in Bangladesh's coal sector, particularly for technology access and capability enhancement in mining. Since Bangladesh is looking to expand into coal it will be fruitful to draw on India's extensive experience with coal mining and coal based power plants. India is also undertaking efforts to improve the efficiency of existing power plants and establish cleaner and more efficient coal based power plants. Joint research and sharing of lessons here would provide opportunities for both.

Gender equity in energy

- Identification of gender specific parameters and indicators that may be employed to capture the direct and indirect impacts of energy projects Energy access is a concern that resonates across the two countries. It is an issue that has significant linkages with other welfare sectors, including health and education. The Millennium Development Goals set to be achieved by 2015 all have an intrinsic link with energy. This common concern provides the springboard for the two countries to invest energies in collaborative research and development activities in clean energy, domestic energy pricing and subsidies, gender and energy programs, and infrastructure for energy delivery. At the same time, supply policies that are geared towards harnessing complementarities in the energy sectors of the two countries too need to be paid adequate attention.

A multi-pronged effort is required for the development of a paradigm of secure and sustainable energy in the region. Needless to say, the success of any such venture should not only involve inter-state interaction but should also take on board multiple stakeholders and domestic constituencies including industry and business, media, academia, technical experts and citizen groups.

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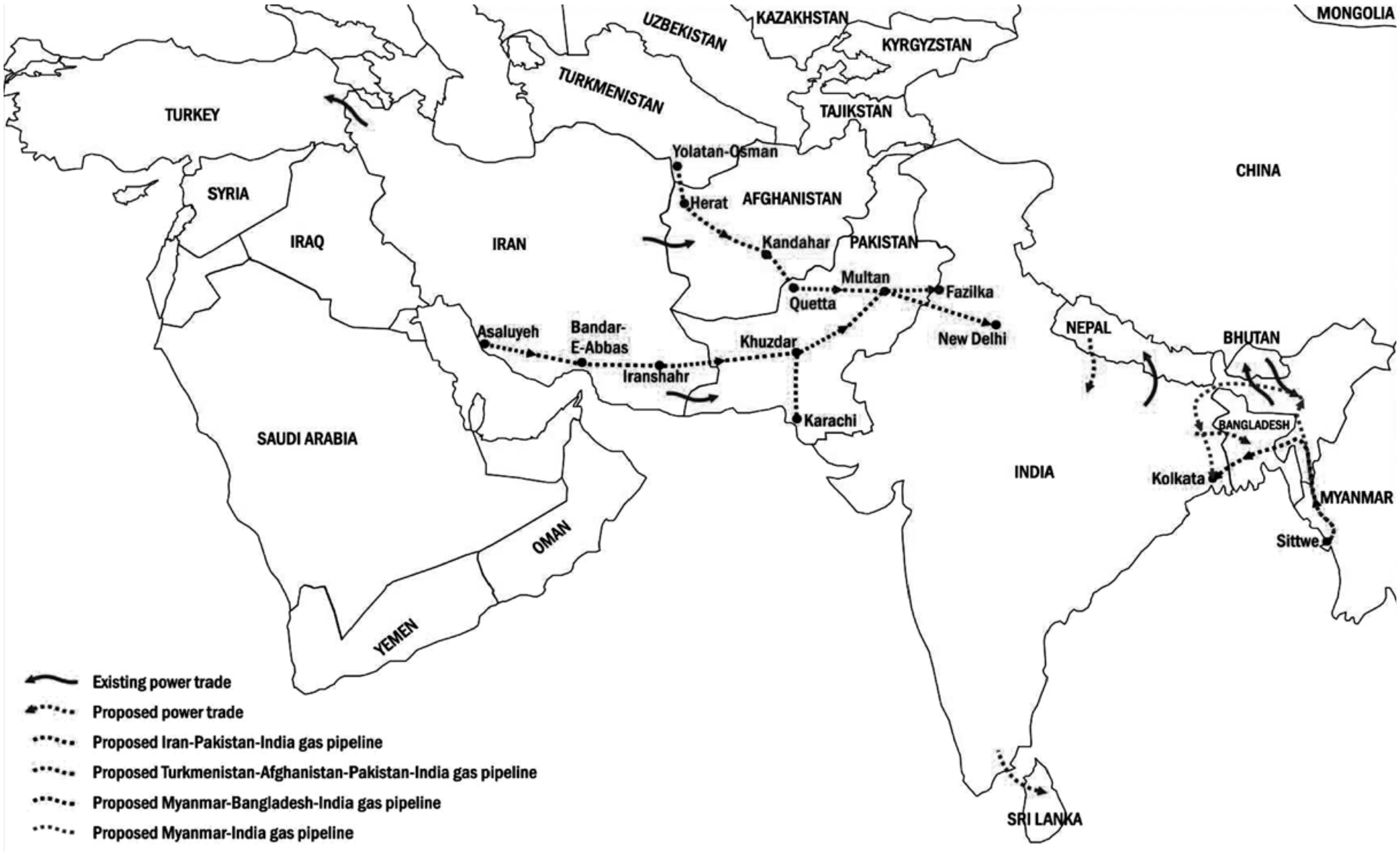
Annexure: Existing and Proposed Power Trade in the Region



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Energy Security in the Ganges, Brahmaputra and the Meghna (GBM) Basins: Bangladesh Perspective

M Nurul Islam

Energy issues in both Bangladesh and India focus around concerns on fuel supply and improvement of access to reliable energy at the local and national levels. As a priority development goal, provisioning for energy resources, in addition to service expansion and policy reform for diverse institutional partnerships, has been envisaged by both the countries to address energy poverty and gaps in achieving targets of making modern energy accessible to increasing proportion of population. The challenge to energy security, however, goes beyond increasing supply targets and country specific budgetary allocation. Rapid increase in demand for energy in developing economy has driven the two neighbouring countries to rethink about potential national and regional strategies in terms of infrastructural measures, energy trade, regulatory services, privatization plan, securing renewable resources, and seeking diverse opportunities in unbundling of functional areas of energy and power sector. This makes way for a holistic understanding of issues retarding or facilitating aspects of energy security at the national and regional levels of Bangladesh and India within the context of the Ganges, Brahmaputra and Meghna (GBM) River Basins.

The assays of the present study on situation analysis will help identify core issues of energy security of Bangladesh in relation to the GBM region including trans-boundary issues and opportunities, as well as identify research gaps and needs. At the end, a way forward as to the common/trans-boundary issues to be taken up for joint research/action within the Bangladesh-India sub-region will be recommended. The report will present the aforementioned aspects under the following focused areas:

- Brief overview of the core issues with respect to energy security.
- Review of previous studies and research on energy.
- Energy situation in Bangladesh.
- Energy import to ensure energy security.
- Priority areas for future research.

Bangladesh

It is estimated that the GBM River Systems have a total area of catchments of approximately 1.72 million square kilometer (sq km) in the Indian sub-continent. Bangladesh accounts for only about 8 percent of this region while the rest lies in upper-riparian countries (Bhutan, China, India and Nepal) [BUP 2011].

In terms of drainage area, the size of the Ganges basin is the largest as it covers 62 percent of the total drainage area. This is followed by the Brahmaputra basin with 33 percent of the total coverage, and then the Meghna basin with the remaining 5 percent.

Bangladesh, which is located between $20^{0}34'$-$26^{0}38'$ north latitude and $88^{0}01'$-$92^{0}41'$ east longitude, has a total area of 147,570 sq km. Total estimated population in 2012 is reported as 154.7 million[12]. Average population density is 1048 person per sq km. Per capita income in 2012-2013 is reported as US$ 1044[13].

Almost 93 percent of the total geographical area of Bangladesh is located in the GBM Basins. An aspect of Bangladesh related to inhabitation and energy security, is the fact that 32 percent of its surface area is located in the coastal zone in the south of the country which is home to about 28 percent of the total population. On one hand, majority of the people living in coastal zone are suffering from the scarcity of modern energy resources, while on the other hand, they will have to suffer most due to climate change effects caused by the fossil fuel consumption of the industrialized countries.

Overview Of Core Issues Of Energy Security

Both Bangladesh and India are located in the most energy starved (Asia-Pacific) region of the world and depend on increasing proportion of imported energy to maintain energy need.

India has established a large energy infrastructure of global standard and has also adopted appropriate policy strategies to meet growing energy demand of the country. The concept of energy security has been highlighted in their Integrated Energy Policy (2006) as such: "We are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected".

In subsequent policy document, it has been reiterated that to meet the challenges of energy security, focused interventions and clearly articulated policy initiatives would be required in the Indian energy sector, both on the demand as well as the supply side. In the short term, energy efficiency and effective demand side management would play a key role in meeting India's energy demands with minimum dependence on imports. In the long term, augmenting energy resources would be crucial for increased energy security. Energy resources can be augmented by exploration to find more coal, oil, and gas, or by developing other sources of energy (such as nuclear power) and non-conventional energy (such as solar and wind power). Acquiring energy equities abroad and boosting energy related research and development (R&D) would also be necessary (TEDDY 2010).

The concept of Energy Security has not yet been adopted in Bangladesh, as a result, the country has been suffering from multiple energy crises. The basic principle of energy security is to ensure the supply of appropriate sources of energy to meet the demand of different end use

[12] http://data.worldbank.org/country/bangladesh

[13] http://archive.thedailystar.net/beta2/news/gdp-swells-per-capita-income-crosses-1000/

sectors. In a particular situation, energy insecurity may occur due to physical shortage of energy (availability), absence of energy delivery infrastructures (accessibility), and lack of purchasing power (affordability). It is thus, prudent that during the planning process all the three factors (availability, accessibility, affordability) affecting energy security be addressed at all the steps of energy supply chain (exploration-production-transmission-distribution) in such a way that the consumer can use his choice of energy at an affordable price whenever he needs.

It is thus, prudent that during the planning process all the three factors (availability, accessibility, affordability) affecting energy security be addressed at all the steps of energy supply chain (exploration-production-transmission-distribution) in such a way that the consumer can use his choice of energy at an affordable price whenever he needs

In order to ensure energy supply for sustainable development, the following perspectives of energy security need to be considered during planning and implementation of energy development programs:

Temporal Dimension

Considering long lead-time required in implementing energy development programs, energy planning activities are to be considered under long term perspectives and implementation under medium to short term planning horizons. At the implementation stage, investment for different components of energy development projects are to be considered in a synchronized manner with due attention to supply chain of primary energy sources (exploration-production-transmission-distribution) and supply chain of power (generation-transmission-distribution etc.). When distribution projects are implemented, neglecting generation and transmission projects, power crisis follows as a consequence for all the consumers. Demand and supply of energy vary under yearly (seasonal) and daily time cycle; appropriate energy infrastructures (e.g. higher capacity) and storage capacity are to be established to ensure energy security.

In the power sector under daily cycle, demand for electricity peaks during evening. To meet the increased power demand during evening peak hours (e.g. 6pm – 11pm), peaking power plants are established to ensure reliable power supply (energy security). Moreover, in order to ensure reliable power supply it is necessary to install at least 20 percent extra capacity of power plants to allow regular routine maintenance (by keeping 20 percent power plant in idle condition).

Again, in the petroleum sector, demand for diesel used for irrigation increases during dry months (January-March). Additional storage capacities for diesel are to be established in different locations of the country to ensure reliable supply of diesel (energy security).

It may be stressed that it requires extra costs in meeting the daily and seasonal demands of electricity (additional power generation capacity) and diesel (storage of extra diesel) respectively. These extra costs are to be included in the energy tariff for sustainable operation of the utility and to ensure reliable supply of energy. These parameters seem to have been neglected in Bangladesh and thus have been among the contributing factors in energy crises.

Spatial Dimension

With reference to spatial dimension of energy security, it was suggested (Islam 2003) to consider the following issues in Bangladesh: All the known gas reserves and hydropower resources are located in the East zone of the country. Special attention should be given to make energy accessible to meet the energy needs of the West-zone by making appropriate infrastructures (e.g. natural gas pipelines, electricity transmission lines) and developing energy resources discovered in the West-zone (e.g. coal, coal bed methane).

Majority of the population live in rural areas of the country. Special attention should be given to make appropriate type of energy accessible to meet the energy needs of rural population. Considering the dispersed nature of rural settlements, it may be appropriate to consider decentralized energy systems to ensure energy security for rural areas.

Electricity generated by the Kaptai Hydro Power Plant was not made available to the people living behind the dam from the beginning of operation the project. Moreover, they have been suffering due to negative environmental impacts. Special attention should be given to make electricity accessible to the population of the hilly areas of the country even if it does not become economically feasible due to higher costs for the delivery of electricity by constructing power lines. Installation of solar- PV technology may meet their electricity need for household use.

Under conventional energy planning method (centralized planning), energy plan is prepared at the country level on the basis of overall balance of energy demand of different end use sectors and supply of different type of energy sources. A major limitation of this method is that it fails to ensure area specific energy security of different locations (e.g. division, district, upazila etc.). Alternatively under the decentralized energy planning method it may be possible to consider energy security of lower administrative and production levels (e.g. division, district, upazila, village, homestead, household etc).

Considering the dispersed nature of rural settlements, it may be appropriate to consider decentralized energy systems to ensure energy security for rural areas

Socio- Economic Dimension

In rural areas poor households generally depend on gathered fuels (e.g. fuel-wood, twigs etc.) from private and public lands. When the poor need to collect biomass fuels from privately owned lands (e.g. homestead wood lots, agricultural land) they need to share their gathered fuel resources with the landowners under patron-client relations. When traditional biomass fuels generated in public lands (e.g. reserve forests, state owned land etc.) are made accessible to the poor it helps them meet their needs. Three inter-related parameters (availability, accessibility, affordability) are to be considered to ensure energy security (commercial energy) of different socio-economic groups.

It is known that higher income urban households spend smaller proportion of their income to meet cooking energy need and they use better quality fuel (e.g. natural gas). On the other hand poor household spend higher proportion of their meager income to meet cooking energy need and they use inferior quality fuel (e.g. agricultural residues, animal dung). They also suffer from the effects of indoor air pollution due to burning of inferior fuels. It is necessary to develop special project to meet the energy needs of the poor. During energy planning, due consideration should be given to the concept of energy ladder (changing to better form of energy) along with economic progress of the consumers. It is argued that available and accessible commercial energy sources (e.g. natural gas, oil, LPG) should be made affordable within the purchasing capability of poor households. These factors have not been given due consideration in Bangladesh.

> ***During energy planning, due consideration should be given to the concept of energy ladder (changing to better form of energy) along with economic progress of the consumers***

Environmental Dimension

Environmental aspects of energy development projects (e.g. EIA and EMP reports) are generally considered during preparation and approval of energy development projects. It is neglected during implementation and subsequent levels due to weak institutional capabilities of the Department of Environment (DOE) and also due to weak technological and financial capabilities of the enterprises. Environmental sustainability is an important step to ensure energy for sustainable development. Environmental aspects should be considered for the development of all type of fuels and for each and every step of primary fuel supply chain (exploration-production-transmission-distribution) and power supply chain (generation-transmission-distribution etc.), throughout the lifecycle of energy development project. It is also necessary to give attention to environmental aspects of neighbouring countries.

Combustion of fossil fuels (coal, oil, gas) produces Green House Gases (GHGs), that affect global environment has drawn the attention of the policy planners and the decision makers around the globe. Negative environmental impacts of upstream areas of energy development (exploration and production- processing- transportation- distribution) are not considered as seriously to that of the combustion step. Similarly indoor air pollution caused due to combustion of biomass fuels affecting the life of women has also not been considered effectively.

Renewable energy sources (e.g. biomass, solar, wind, hydro etc.) do not generate green house gases. These are generally considered as environmentally benign. Rate of extraction of fuel wood beyond regenerative limit causes deforestation. Deforestation in hill- areas causes rapid loss of topsoil, which is carried away by the flow of the rivers and deposited in downstream plain land and improve their soil quality. Development of hydropower causes submersion of human settlement and agricultural lands that affect the livelihood of the local population living in hilly areas. People living downstream of hydropower plants enjoy the benefit of using generated electricity to improve their economic condition. Downstream people hardly realize the environmental distress of upstream population. Negative environmental impacts of these renewable energy technologies on people living in upstream locations should not be overlooked within and beyond the border of the country.

Gender Dimension

About 50 percent of total fuel is consumed in household sector for domestic cooking. Women are responsible for the management of all the fuels consumed at household level. In rural areas biomass fuels are gathered from local sources and in urban area they are purchased. During cooking women suffer due to air pollution of un-combustible fuels. Cooking with improved stoves improve the quality of life of women, because it requires less fuel to cook and smoke is removed outside the kitchen. Availability of electricity at household level provides personal security and income earning opportunity to women. They also can use television for amusement. During mid 1980s provision of reliable electricity in the Dhaka city facilitated establishing thousands of readymade garment factories. These industries employed more than three million women. National planners are positively responsive to provide better quality energy for women.

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Sources Dimension

At the country level, indigenous energy sources provide better energy security in comparison to imported energy sources. In this respect it may be mentioned that major portion (about 50 percent) of petroleum fuels is used in the transport sector. Introduction of indigenous compressed natural gas in automobiles in place of imported petroleum fuels improved energy security in transport sector. In future use of CNG may also be considered in railway and water transport. Choice of a particular type of fuel for transport sector should be decided through appropriate tariffs of petroleum fuels and CNG. Environmental impacts of using a particular type of fuel for specific end use should also be given consideration. Within a country, at consumer level local energy sources provide better energy security in comparison to energy delivered from outside the locality. Distribution of locally available energy resources through decentralized energy systems provide better energy security for isolated locations.

When a country needs to meet energy security from imported sources, it follows various strategies which are as follows: use of different energy mix (type of fuels); use of diverse supply sources; maintain long-term energy supply contract; maintain strategic reserves (e.g. petroleum); interconnect national energy grids (e.g. electricity, natural gas, petroleum etc.) with respective energy grids of regional countries. Tariff of specific type of energy delivered at the national energy grid is the key parameter for energy import. Energy being a strategic commodity, long term energy security of the country based on indigenous energy sources should not be sacrificed for short term financial gain through export.

Apart from the different dimensions of energy security mentioned above, eight factors contributing to energy insecurity in Bangladesh, have been identified (Islam 2003) as well:

- Weak institutional capability at planning level
- Weak institutional capability at implementation level
- Lack of financial capability
- Lack of technological capability
- Lack of management capability
- Lack of rational tariff policy due to political sensitivity

- Undue political intervention
- Lack of good governance

Conceptual Framework of Integrated National Energy Plan

Coordinated actions of a large number of stakeholders are necessary on a continuing basis to ensure energy security of a country. This could be made possible when there is a framework for a national integrated energy plan. Functional activities/responsibilities of different organizations are presented below.

- Energy plan needs to be integrated with national development plan.
- National development planners to decide on the projected GDP growth (e.g. 7%) and composition of GDP (domestic, agriculture, industry, commercial, transport, power).
- Energy demands of different sectors to be estimated to compute sectoral energy demands of different sectors.
- Energy demands of different sectors to be re-estimated considering the prospects of energy conservation through use of efficient energy technologies.
- Sum total of sectoral energy demand will indicate total energy demand of the country (in heat equivalent unit of primary energy).
- Energy demands are to be balanced with different energy resources to ensure energy security (energy demand = energy supply).

Priority attention needs to be given to ensure energy security by supplying energy from indigenous energy sources as:

- they provide better and effective energy security
- they are available in both renewable and non-renewable forms:
    - Organizations responsible for specific types renewable energy resources and their supply:
      - Woody biomass: Bangladesh Forest Department (BFD)
      - Agricultural residues: Department of Agriculture (DOA)
      - Animal dung: Department of Livestock (DOL)
      - Hydropower: Bangladesh Power Development Board (BPDB)
      - Solar PV and Biogas technology: Infrastructural Development Company Ltd. (IDCOL)
    - Organizations for specific types of non-renewable energy resources and their supply are:
      - Coal and natural gas: Petrobangla
      - Locally produced oil: Bangladesh Petroleum Corporation (BPC)

When the energy supply from indigenous sources is insufficient to meet total energy demands, balance quantity is met from imported sources. At present different organizations responsible for import and supply of different types of imported energy sources are:

- Bangladesh Petroleum Corporation (BPC) for imported oil from the Middle-East,
- Private enterprises for import of coal from India.
- Bangladesh Power Development Board (BPDB) and Power Generation Company of

Bangladesh (PGCB) for import of electricity from India.

- Petrobangla for the import of LNG from Qatar.

It may be noted that the organizations now involved or will be involved in the import of different type of energy sources, will play leading roles in regional energy cooperation leading to development of Regional Energy Projects (REP).

In Bangladesh, due to the absence of an integrated energy plan, different energy utilities have been trying to supply specific type of energy according to their respective deliverable capacity. They assume their deliverable capacity as projected demands. Actual demands of energy have been much more than the suppressed demand projected by the utilities. As a result, the consumers face energy crises due to weakness of national energy planning system. Moreover, in the absence of rational tariff policy, tariffs of different types of energy sources are fixed on ad-hoc basis. Consumers' choice of using a particular fuel is affected by its tariff at the place of use, which also makes energy balance unpredictable. In addition, there is no national institution to oversee the formulation and implementation of the aforementioned national integrated energy plan necessary to ensure energy security.

Furthermore, conceptual framework of integrated national energy plan may also be considered at decentralized levels (e.g. district, upazila etc.). In that case, sum total of decentralized energy plans may be considered as the national energy plan. It may be easier to ensure energy security to greater number of people through decentralized energy plan. For example, decentralized energy planning would have led to the opportunity for consideration of development of coal bed methane in the West-zone of Bangladesh in place of transportation of natural gas from the East-zone through pipeline. Similarly, locally generated hydropower, at the time of initial operation of the Kaptai Hydropower plant, would have met the electricity need of the people of Chittagong Hill Tracts (e.g. area behind the embankment).

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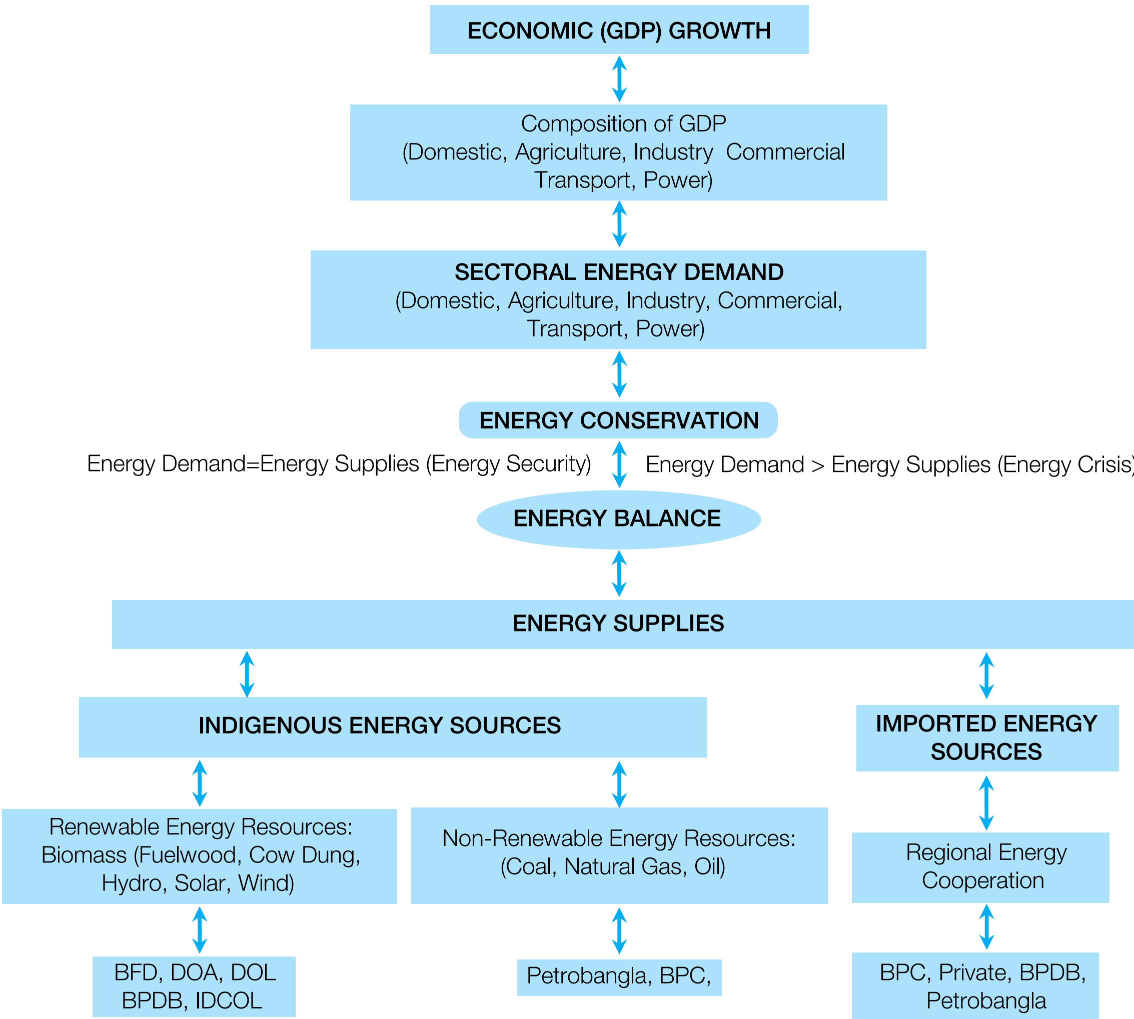
At present, in the absence of any agreed upon conceptual framework for country's energy development, national energy planning and delivery systems are found to pay priority attention to maintain energy security of the capital city and to provide electricity for irrigation.

A diagram of the conceptual framework of a National Integrated Energy Plan is presented below in Figure-1, which could be used to explain the interrelation of various sectors, functions, and responsibilities for ensuring energy security in Bangladesh.

Figure 1: Conceptual Framework of National Integrated Energy Plan



Review of Previous Studies and Research on Energy

Studies on Energy carried out in Bangladesh have been classified under the following categories:

Energy Policy
Energy Master Plan
Energy Studies.

Energy Policy

Petroleum Policy

Government of Bangladesh approved the Petroleum Policy on July 18, 1993 in order to provide guidelines for exploration and development of hydrocarbon (oil and natural gas) resources. Various bidding rounds for hydrocarbon exploration were implemented under Production Sharing Contract (PSC) with the International Oil Companies (IOCs).

Since 1993, IOCs discovered four new gas fields (Sangu, Moulavibazar, Bibiyana, Bangura) with recoverable reserves of 6.42tcf (22.57 percent of total recoverable reserves). In 2013, 55 percent of total gas consumed in the country was supplied by the IOCs.

National Energy Policy

National Energy Policy (NEP) was approved by the Government on September 11,1995 and was published in the Gazette on 15 January, 1996. Previously approved Petroleum Policy was also incorporated in the National Energy Policy.

[In the last 17 years, no updated version of government approved NEP has been made available to the public. A number of drafts are however, available].

Private Power Policy

Private Power Generation Policy was approved in 1996, which provided necessary guidelines for development of power generation plants by Independent Power Producers (IPP).

Renewable Energy Policy

Renewable Energy Policy (GOB 2008) was approved by the government in 2008 for the development of renewable energy resources. It is estimated in REP that 5 percent and 10 percent of total electricity generation will be made by renewable energy sources in 2015 and 2020 respectively.

For promotion of renewable energy and energy efficiency programs, the government has enacted SREDA (Sustainable and Renewable Energy Development Authority) Act 2012. SREDA is expected to be functional during 2014.

Coal Policy

Since 2005, several attempts were made to draft a Coal Policy. During last 8 years, eleven draft versions of coal policy were made available for public discussions and approval of the government. It may be argued that there seems no justification to formulate an independent Coal Policy when it [coal policy] could be appropriately included as a part of integrated national energy policy along with the policies of other energy resources.

Observations on the Different Policies

In Bangladesh, specific laws, rules and regulations enacted and approved for these purposes, govern development of different types of energy resources (e.g. petroleum, coal etc.). For example, the Bangladesh Petroleum Act 1974 and Model PSCs regulated development of hydrocarbon (oil and gas). The Mines & Minerals (Control & Development) Act 1992 and The Mines & Mineral Rules 2012 regulated development of coal and other mineral resources. Different policies mentioned above express the intent of the government. The policies have limited legal status in comparison to laws, rules and regulations.

There is a need to assess status of implementation and effectiveness of the National Energy Policy 1996 and formulate an Integrated National Energy Policy (INEP) including all the sub-sectoral policies such as coal policy, petroleum (including natural gas) policy, renewable energy policy, power policy. It is not justifiable to formulate an independent Coal Policy to decide appropriate strategies for coal development only.

Energy Master Plans

First Energy Master Plan

The First Energy Plan of the country, known as Bangladesh Energy Study (BES), was carried out by a consortium of foreign consulting companies. The planning horizon considered by the study was 1974-1994. The study considered both commercial energy resources and traditional energy resources (GOB 1976). Later the findings of the study were published in a book (deLucia, Jacoby & others 1982).

Second Energy Master Plan

The Second Energy Master Plan (Bangladesh Energy Planning Project) was prepared by group of expatriate consulting companies in association with two local consulting companies. The final report of the study was submitted in seven volumes. The plan document consisted of short-term projects covering the period 1986-1990 and medium term projects covering the period from 1991-2000. Separate recommendations were made for the development of commercial energy and rural energy. The commercial energy plan consisted of Natural Gas Development Plan and Power Sector Plan (GOB1987).

Gas Sector Master Plan

The study was carried out in 2005 by a foreign consulting company in association with a local consulting company; and the final report was submitted in 2006. The study covered gas development plan for the period from 2005-2025. On the basis of demand-supply analysis of natural gas, the study recommended investment for the production and transmission of natural gas for the plan period (Petrobangla 2006). The study also recommended that if definite gas development program was not undertaken, national energy security will be threatened and gas crisis would start as early as 2011.

Power System Master Plan

Power System Master Plan (PSMP) 1995 was prepared to update the Power System Master Plan prepared in 1985. It was undertaken to develop a least-cost, long-term power expansion program of Bangladesh. The final report of the study was submitted in three volumes. The study covered power sector planning for twenty years covering the period 1995-2015. The study assessed energy resources for power generation and recommended generation and transmission plans for the period

(BPDB 1995). Power System Master Plan Update was prepared in 2005 to update the PSMP prepared in 1995. The study recommended generation and transmission expansion plan up to 2025. It was suggested to review the implementation status of the plan annually and take corrective measures (BPDB 2006).

Japan International Cooperation Agency (JICA) prepared the Power System Master Plan [PSMP] 2010 for power development from 2010-2030. The study was carried out during September 2009 to January 2011. The government approved the PSMP 2010 in February 2011 (JICA 2011).

The main objective of the PSMP was to formulate a Master Plan (MP) in order to prepare a long-term power development strategy ensuring stable power supply by 2030. Six important aspects considered in preparing the plan are presented below.

- Develop domestic primary energy resources to supply over 50% of energy requirement for power generation.
- Diversify energy mix for power generation.
- Improve thermal efficiency for power generation by 10% to reduce emission of carbon dioxide.
- Build necessary infrastructure for stable power supply including a deep-sea port facility for power, industry and commercial sectors.
- Build an efficient and effective organizational mechanism and regulations for stable power supply.
- Reduce poverty through socioeconomic growth.

Three scenarios were considered for power demand forecast based on energy intensity method:

i. Government policy scenario
ii. GDP at 7% scenario
iii. GDP at 6% scenario

Result of demand forecast is shown in Table 1. Considering the uncertainties, different fuel supply options considered by the study are shown in Table 2. Indicative Composition of fuels for different supply options is shown in Figure 2.

Table 1: Three Scenarios for Power Demand Forecast

Financial Year	Government Policy Scenario		Comparison GDP 7% Scenario		Comparison GDP 6% Scenario	
	Peak Demand (MW)	Generation (GWh)	Peak Demand (MW)	Generation (GWh)	Peak Demand (MW)	Generation (GWh)
2010	6,454	33,922	6,454	33,922	6,454	33,922
2011	6,765	35,557	6,869	36,103	6,756	35,510
2012	7,518	39,515	7,329	38,521	7,083	37,228
2013	8,349	43,882	7,837	41,191	7,436	39,084
2014	9,268	48,713	8,398	44,140	7,819	41,097
2015	10,283	54,047	9,019	47,404	8,232	43,267
2016	11,405	59,945	9,705	51,009	8,680	45,622
2017	12,644	66,457	10,463	54,994	9,165	48,171
2018	14,014	73,658	11,300	59,393	9,689	50,925
2019	15,527	81,610	12,224	64,249	10,255	53,900
2020	17,304	90,950	13,244	69,610	10,868	57,122
2021	18,838	99,838	14,249	75,517	11,442	60,640
2022	20,443	109,239	15,344	81,992	12,056	64,422
2023	21,993	118,485	16,539	89,102	12,713	68,490
2024	23,581	128,073	17,840	96,893	13,416	72,865
2025	25,199	137,965	19,257	105,432	14,167	77,564
2026	26,838	148,114	20,814	114,868	14,979	82,666
2027	28,487	158,462	22,509	125,209	15,848	88,156
2028	30,134	168,943	24,353	136,533	16,776	94,053
2029	31,873	180,089	26,358	148,928	17,768	100,393
2030	33,708	191,933	28,537	162,490	18,828	107,207

Source: PSMP Study Team (JICA 2011)

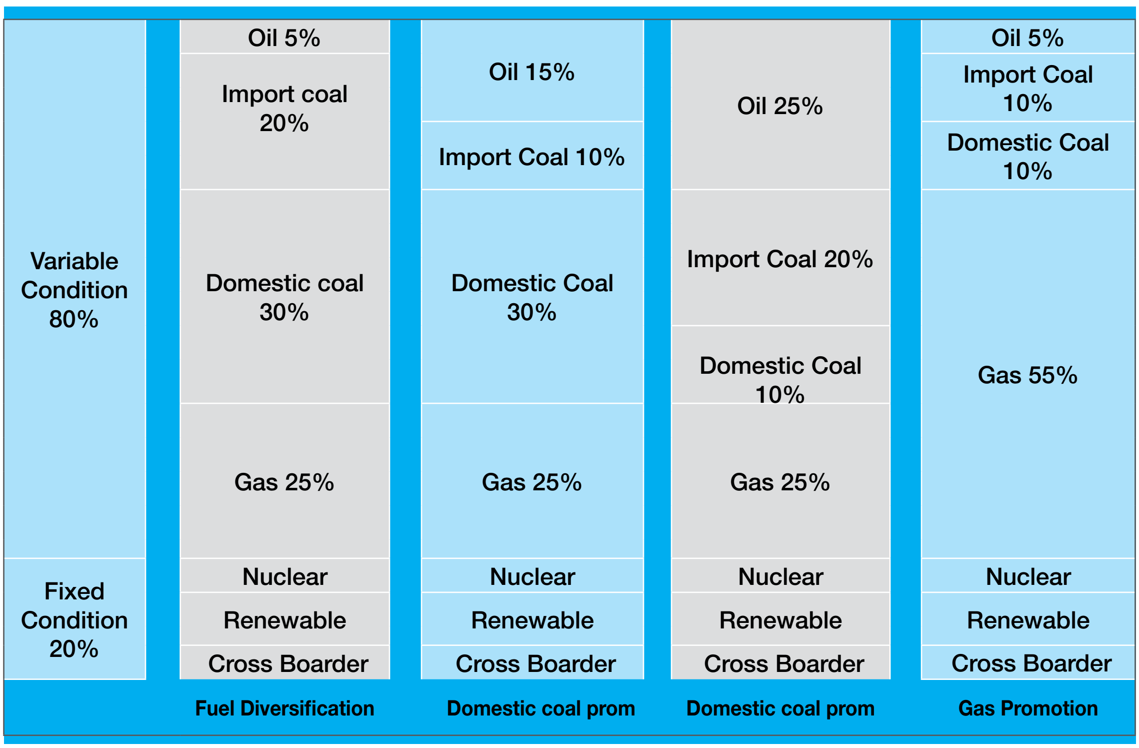
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Table 2: Fuel Supply Options Considered for the Master Plan

Scenario	Concept
Fuel Diversified Scenario (Base case)	Optimum power sources development plan, securing fuel supply via multiple sources based on coal development (developing new domestic mining, increasing existing mining capacity, securing imported coal) ; natural gases, fossil fuels (heavy and light oil), renewable energy.
Domestic Coal Promotion Scenario	For the Base Scenario, fuel supply mainly via a large-scale increase in production at domestic mining including strip mining is considered.
Import Coal Promotion Scenario	For the Base Scenario, fuel supply comes mainly from imported coal due to considerations regarding the impossibility or a long period to develop domestic mining.
Gas Promotion Scenario	For the Base Scenario, fuel supply mainly comes from new domestic gas development, and gas procurement secured from a long-term perspective.

Source: PSMP Study Team

Figure 2: Indicative Composition of Fuels for Different Supply Options



Source: PSMP Study Team (JICA 2011)
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

The aggregated amount of investment for the development of the generation, transmissions and the related facilities to implement the Master Plan are shown in Table 3. The aggregated investments for the development of the generation, transmission and related facilities are estimated to be Taka 4.9 trillion (US$ 70.5 billion). The annual average of the investment amounts to Tk 245 billion (US$ 3.5 billion). The roadmap for implementation of short, mid and long-term projects has been included in the plan.

Table 3: Aggregated Amount of Investment

Executing Agency	Generation Capacity (MW)	Total Investment (Taka Billion)	Annual Average of Investment (Taka billion)	ditto (US$ million)
Generation & Transmission				
Public Sector	5787	947	47.4	681
Private Sector	9436	710	35.5	510
Pub/Private Unclassified	17600	1776	88.8	1276
Renewable Energy+ & Intl Connection	3611	25	1.3	19
Sub-total	36434	3458	173	2486
Related Facilities		1449	72.5	1042
Total	36434	4907	245.5	3528

+ Hydropower is excluded from renewable energy, included in “Generation & Transmission, Public Sector”.
Source: PSMP Study Team (JICA 2011).
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

For sustainable development of the energy sector it is necessary to develop local capabilities for preparation and updating of Energy Master Plan on a regular basis

Observations on the Master Plans

In Bangladesh, generally the Master Plans are prepared by expatriate consulting companies. In some cases local consulting companies have been associated. There is no permanent institutional mechanism within the country or under national planning system to transfer/accumulate the knowledge and experience of preparation of the Master Plans. As a result, the country is to depend continuously on foreign experts to prepare the Master Plans. Energy master plans are prepared on the basis of many assumptions. When the assumed actions do not take place, progress is affected.

Moreover, there is lack of capacity in reviewing the progress of implementation of the plans on continuing basis and take corrective actions whenever necessary. For sustainable development of the energy sector it is necessary to develop local capabilities for preparation and updating of Energy Master Plan on a regular basis. Different sub-sectoral master plans (e.g. gas sector, power sector, coal sector, renewable energy sector etc.) should be prepared as an integral part of Energy Master Plan of the country.

Energy Studies

Different energy studies carried out to draw the attention of policy planners and decision makers in implementing different strategies and development programs are presented below.

IUCN Sponsored Study

Islam (1991) prepared a comprehensive review of the energy situation of Bangladesh for the National Conservation Strategy of Bangladesh undertaken by International Union for Conservation of Nature IUCN, Bangladesh. On the basis of review of the then demand and supply status of energy, the author made recommendations linked to implementing agency/(ies) towards addressing the energy issues of the country. Status of implementation of those recommendations after twenty-two years is presented below (Table 4).

Table 4: Status of Implementation of Recommendations of an IUCN Sponsored Study Carried out in 1991

Item No	Recommendation	Implementation Status	Comment /Observation
1	Adoption of rational energy pricing policy.	Partial	Bangladesh Energy Regulatory Commission established to fix consumers' tariffs.
2	Adoption of rational forestry pricing policy	Not implemented	-
3	Mandatory Environmental Impact Assessment [EIA]	Implemented	The Bangladesh Environment Conservation Act 1995 & The Environment Conservation Rules, 1997 [enacted].
4	Rapid plantation in un-classed and other denuded forest lands	Partial	-
5	Public awareness programs on energy conservation	Partial	SREDA Act 2012 enacted to implement energy conservation measures. Action Plan for Energy Efficiency and Energy Conservation has been prepared in 2013.
6	Efficient management of existing forests	Partial	
7	Diffusion of improved cooking stoves.	Partial	Country Action Plan for Clean Cookstoves has been prepared in 2013.

Item No	Recommendation	Implementation Status	Comment /Observation
8	Reduction of system losses in power sector.	Partial	The utilities had to take effective actions to comply with the orders of Bangladesh Energy Regulator Commission]
9	Energy conservation in industries.	Not implemented	Due to lack of Energy Conservation Act and Rules
10	Energy conservation in agriculture.	Not implemented	Due to lack of awareness
11	Diffusion of improved kerosene cookers.	Not implemented	Due to lack of awareness
12	Use of power house cooling water for irrigation.	Partial	In adjacent areas of the Ashuganj Power Plant
13	Environmental Impact Assessment of using agricultural residues as fuels.	Not implemented	Due to lack of research and awareness
14	Substitution of fuel wood with coal in brick industries.	Partial	Relevant law has been enacted to restrict the use of fuel wood for brick burning
15	Substitution of biomass fuels with coal for domestic cooking.	Not implemented	
16	Substitution of biomass fuels with LPG for domestic cooking.	Partial	Private companies have started importing and marketing LPG
17	Substitution of bricks with hard rock as building materials.	Partial	Madhayapara Hard Rock Mine provides rocks as building material.
18	Substitution of timber with alternate building materials.	Implemented	Different type of plastic materials used in place of wood.
19	Substitution of pulp wood with alternate materials.	Implemented	
20	Reliable assessment of energy and mineral resources.	Partial	Hydrocarbon (oil & gas) resources are being assessed.
21	Reliable assessment of biomass energy resources.	Partial	
22	Development of indigenous coal.	Partial	Out of total 5 discovered coal mines, only one mine is under production.
23	Development of indigenous peat.	Not implemented	
24	Expansion of indigenous natural gas pipelines.	Partial	GTCL is involved in development of natural gas transmission lines.
25	Diffusion of renewable energy technologies.	Partial	SREDA Act 2012 enacted for promotion of renewable energy resources.

It may be noted that during last 22 years, of the total 25 recommendations of the study, 12 percent have been implemented, 60 percent partially implemented and 28 percent not implemented. It takes considerable time to implement research outputs into national development programs/ projects.

ESMAP Sponsored Study

A rural energy study was undertaken by Energy Sector Management Assistance Program (ESMAP), the World Bank, to identify ways to improve the living standard in rural Bangladesh through better and more efficient use of energy, while creating an environment conducive to growth and poverty reduction. The study undertook the following background studies to review rural energy situation, develop strategies for rural energy development and to recommend an appropriate institutional setup (Asaduzzaman, Barnes, and Khandaker 2010):

- rural households' energy survey.
- energy use pattern of village micro-enterprises and rural growth center.
- market structure for macro-level dimensions of biomass supply and demand.

Major observations of the ESMAP study are presented below:

- Bangladesh continues to depend heavily on biomass fuels to meet households cooking energy needs. Some 95 percent of the rural households collect or purchase biomass fuels to cook all or part of their meals, mainly using traditional mud stoves. Switching to improved biomass cook stoves and modern cooking fuels can enable rural families, especially women to improve their quality of life. In addition to time and costs savings, cooking with cleaner fuels mitigate the health risks occurring due to indoor air pollution (IAP).
- In rural areas 70 percent of lighting energy is derived from kerosene, while electricity account for remaining 30 percent. Electricity provides better quality of life and makes positive impact on household income.
- *68* percent of villages used mechanized irrigation methods; *70* percent of them used diesel fuel, 10 percent used electricity and 20 percent used both. Majority of the farmers used diesel due to absence of electricity connections in villages.
- Rural businesses that use modern energy generally have more revenue and earn more profit then those relying on traditional energy sources.
- Of the sixty six percent of the villages surveyed, 29 percent rural household reported to have electricity connections.
- Higher income households used modern energy more efficiently, which puts them into an advantageous position. Income disparity also contributes to energy disparity and vise-versa.

The study suggested consideration of the following strategies for rural energy development.

- Pay more attention to rural energy services;
- Pay attention to conservation of biomass-fuel resources through the use of efficient energy technology (improved cook stoves);
- Pay attention to augmentation of supply of biomass fuels;
- Undertake pro-poor rural electrification;
- Provide equitable access to household petroleum fuels
- Adopt sound pricing and subsidy policy for energy.

Due to the absence of a designated national research institution(s) linked to national energy planning system, the suggestions and recommendations of the research findings were not effectively used by the planners and decision makers

The study underscored the need for urgent actions for rural energy development not only for rural development but also for equitable and overall economic growth of Bangladesh. It was emphasized that Bangladesh has a need for better institutional coordination to implement a comprehensive rural energy program. Institutional coordination, combined with market development, appropriate subsidy, pricing policy, government and donor supports can make notable success.

Observations on the Research Studies

It may be noted that there is a time gap of about 20 years between the study carried out by Islam (1991) and the ESMAP study (Asaduzzaman, Barnes, and Khandaker 2010). Some of the strategies identified by both the studies are similar. Due to the absence of a designated national research institution(s) linked to national energy planning system, the suggestions and recommendations of the research findings were not effectively used by the planners and decision makers. Adoption of rational energy tariff policy, recommended by both the studies for addressing the critical issue for sustainable development of energy sector, has not been given due consideration until date.

Regional Energy Studies

Regional Energy Studies carried out with the initiatives of different regional and international organizations and participated by the researchers of Bangladesh, research carried out for advocating regional energy cooperation and, other related studies carried out in various other regions of the world, are presented below.

***Rural Energy Studies by Resource System Institute (RSI)* -** With the initiative of the researchers of the Resource System Institute (RSI), East-West Center, Hawaii, the experiences of rural energy studies carried out in different countries of the region (Bangladesh, Nepal, Indonesia) were discussed and the outcome of the study was published in a book (Islam, Morese & Soesastro 1984).

***Energy Policy Study by Asian Institute of Technology (AIT)* -** With the initiative of Regional Energy Development Program (REDP), UN-ESCAP; researchers of the Energy Technology Division (ETD), AIT played leading role in carrying out a study on Comparative study of Energy Policies in Asia. A large number of energy experts participated in the study under different functional capacities (e.g. advisors, members of committee, researchers, reviewers etc.). Energy policy issues of the following countries were assessed by the study- Bangladesh, China, Hong Kong, India, Indonesia, Korea, Malaysia, Nepal, Pakistan, Sri Lanka and Thailand (Lucas et al 1987)

***Rural Energy Studies by Asian & Pacific Development Center (APDC)* -** A survey of rural energy status, planning and management of sixteen Asian countries (Bangladesh, China, Fiji, India, Nepal, Pakistan, Indonesia, Malaysia, Micronesia, Myanmar, Philippines, Sri Lanka, Thailand, Tuvalu, Vanuatu, Viet Nam) were compiled in a book published by APDC. At least one researcher from each of the participating countries took part in the research study (Ramani, Islam & Reddy 1993). Based on the experiences of survey of the country studies, a second book on Rural Energy Planning- A Government Enabled Market Based Approach was published by APDC (Ramani, Reddy & Islam 1995).

***Study by USAID's South Asia Initiative for Energy (SARI/Energy)* -** A study on Regional Energy Security for South Asia (RES) was carried out in 2005 with the initiative of USAID's South Asia Initiative for Energy (SARI/Energy). Researchers of 8 South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) participated in the research project. The main focus of the study was to identify the strategies to provide energy security for each individual country and for the region as a whole. Key steps to achieve energy security were suggested as follows (SARIE 2005).

- Diversify the sources of fuels supply.
- Develop an Energy Sector Master Plan, including a Hydropower Master Plan for South Asia
- Develop a regional power grid for power exchanges/trading with-in the region and with neighboring countries around the region.
- Develop a regional gas grid and promote regional trade in natural gas.
- Establish a South Asia Infrastructure Development Financing Institution to promote and facilitate inter-country energy development opportunities.
- Strengthen SAARC Energy Center (SEC), Islamabad to develop research capabilities addressing regional energy development.
- Establish mechanism for joint procurement and transportation of crude oil and petroleum products.
- Explore development of regional and in-country strategic oil reserves.

***Advocacy for Regional Hydropower Development in the GBM Basins* -** Total hydropower potentials of Bhutan and Nepal have been reported as 20,000MW and 42,000MW respectively. Researchers working on development of the GBM Basins have been advocating in undertaking regional hydropower development programs for the benefit of the people of the countries of the GBM region. Bhutan-India and Nepal-India already implemented hydropower development projects in Bhutan and Nepal, respectively. It was opined that there are opportunities for further development of remaining hydropower resources. It is advocated that Bangladesh should endeavor to tap all major hydropower development projects in Bhutan and Nepal, in which Bangladesh can claim a stake as a co-riparian (Ahmad 2005). There is a need to undertake feasibility study to assess the prospect of developing regional hydropower projects with due attention to socio political situations.

***Advocacy for Cooperation in the Energy Sector between Bangladesh and India* -** Quader (2009) reviewed the energy consumption of Bangladesh and advocated for cooperation in energy sector between Bangladesh and India. On geographical reality the author advocated for bi-lateral cooperation between Bangladesh and India; triangular and quadrangular cooperation among Bangladesh, India, Bhutan and Nepal. The author identified the major barriers for cooperation as- (a) Lack of trust (b) Outstanding disputes, (c) Lack of political wisdom and maturity of the leadership. Various strategies identified for cooperation are presented below.

- Promoting trade in petroleum products on long-term basis at private and state level.
- Removing all the barriers that block the land connectivity between the North Eastern Indian and Eastern India through Bangladesh.

- Removing barriers for the land connectivity between Nepal-Bangladesh and Bhutan-Bangladesh through India.
- Getting the proposed natural gas pipeline from Myanmar to India through Bangladesh.
- Finding best ways for getting natural gas from the North Eastern side to Eastern India through Bangladesh.
- Establishing interconnecting transmission systems between India and Bangladesh along the border at convenient points.
- Promoting bilateral/multilateral cooperation with Bangladesh and Bhutan, or Bangladesh and Nepal for electricity and transportation of goods through India.
- Identification of common power projects in Nepal and Bhutan with equity participation.
- Identification of interconnecting transmission systems for making a regional power grid systems for transferring electricity between India (Eastern and North East) and Bangladesh.
- Identification of trans-boundary natural gas pipelines serving the region, especially India and Bangladesh.
- Having a common strategic reserves of crude oil and petroleum products.
- Mobilizing technological and financial resources for exploration, development and production of hydrocarbon resources.

Regional Renewable Energy Study (RRES) by SAARC Energy Center - As decided in the SAARC summit held in Dhaka in 2005, SAARC Energy Center (SEC) was established in Islamabad, Pakistan in 2006 to promote development of energy resources including hydropower and energy trade in the region, develop renewable and alternative resources and promote energy efficiency and conservation in the region. It is envisaged that subsequently the IUCN Ecosystems Study will move towards undertaking bilateral collaborative projects including energy by Bangladesh and India.

A set of recommendations has been put forward in RRES for consideration of individual countries and countries collectively, as stated below:

Recommendations for individual countries

- as no country in the region is endowed with fossil fuel resources adequate to meet its total energy needs, all countries of the region should undertake a comprehensive time bound survey of all indigenously available energy resources-fossil fuels as well as renewable energy resources- as per the international energy resource measurement standards.
- every country should examine the economic and physical features of the country and frame a comprehensive energy policy. This should have a separate section on the policy for developing RE resources.
- each country should set up a separate organization to deal with all issues connected with renewable energy resources.
- all countries have in the last decade set up some RE projects and programs small and big. The performance of these projects has varied from very successful to total failure.

Before launching a new program for accelerated development of RE sources each country should make a detailed examination of the successful projects and programs and explore the scope for expanding the scope and coverage of the successful projects and programmes.

- each country should examine the RE projects/programs which have performed very successfully in other countries and consider the feasibility of establishing similar projects/programs in their countries.

- biomass both as solid biomass and as liquid Biofuel is available in its raw form in all countries. The technology of its transformation, purification and utilization for different end uses in providing heat electricity and transport fuel is yet to be developed to the stage of large-scale commercial use. In view of the important role biomass and bio-fuel are likely to play in the future all countries must initiate action for study and utilization of these fuels.

- each country should as part of the new RE Policy have an agency/sub-agency to make special effort to induce private sector players to participate actively in all stages of RE policy formulation and its implementation. The systems of incentive have to be carefully drawn up so that they are seen as equitable, transparent and easy to understand by all stakeholders and easy to administer by the Government agencies.

- the importance of renewable energy in the future needs to be recognized by all countries and human resources needs in the sector have to be properly anticipated and educational programs have to be launched and implemented by the respective Governments.

Recommendations for group and collective efforts

- the Study reveals there are a few countries which have achieved good success in some RE Project or program. In some type of projects more than one country has shown remarkable progress. It is necessary that such project experience be made to serve the interests of the other countries. To the extent possible the transfer of the best practice and the transfer of "Technology" are achieved by bilateral arrangements. A regional Institution like SEC is best suited to provide facilitation services to bring about the bilateral agreements.

- all countries should endeavor to help the academics, activists and policy makers to meet frequently in official and academic discussions on renewable energy resource development in the region.

- all countries of the region should come to a common understanding that with a view to learn from the successful experience of a few countries, some selected Regional demonstration projects should be set up. Examples of some successful projects are presented below.

    - Grameen Shakti Project in Bangladesh.
    - Village Energy Security in India.
    - Megawatt Size Grid Interactive Photovoltaic based Power Plants in India.
    - Aga Khan Rural Support Programme (AKRSP) in Pakistan.

Recommendations were also made for expanding the role of SEC as such:

Bringing the countries to meet frequently to discuss issues of mutual interest, to develop RE resources through collaborative action on the lines delineated in the recommendations above will require the intermediation of strong competent regional inter-governmental body devoted to the RE sector activities, in which all the SAARC countries are represented. Fortunately, there is already such a body, namely SAARC Energy Centre (SEC) which within a short period has established its credibility and competence**.**

SRETS by SAARC Secretariat, Kathmandu - During 2007-2010 SAARC-Secretariat, Kathmandu successfully completed the SAARC Regional Energy Trade Study (SRETS). Considering the applicability of the experiences of SRETS in the IUCN study, to develop collaboration on energy between Bangladesh and India, detailed summary of the SRETS report is presented below (SAARC Secretariat 2010).

The First Energy Minister's Meeting held in Islamabad in October 2005, decided to conduct a study on options, benefits and constraints of energy trade in the region. Recognizing the importance of energy trade in the region and at the request of the SMCs, the Asian Development Bank (ADB) approved a Regional Technical Assistance (RETA) in December 2006 to promote energy cooperation in the SAARC region and to strengthen the SAARC Energy Centre (SEC). The major component of the RETA is to undertake a SAARC Regional Energy Trade Study (SRETS).

Implementation of the study started in 2007 in selecting national experts to prepare country reports for the respective SAARC Member Countries (SMCs); M. Jamaluddin, former Managing Director, BAPEX prepared the Bangladesh country report. Subsequently eight country reports were synthesized by a regional expert (Leena Srivastava). At different stages of preparation of the regional report, drafts prepared by the regional expert were reviewed by senior government officials and national experts in review meetings held at Colombo, Male and Islamabad. Two independent experts (P.N. Fernando and D.N. Raina) also helped in the review process. An inter-governmental meeting held at Colombo in March 2010 finalized the SRETS report. The SAARC secretariat, Katmandu coordinated the implementation of the study. The final report was released in March, 2010 (SAARC Secretariat 2010).

Conclusion and Recommendations of SRETS –

The SAARC region is rich in hydropower and renewable energy resources, but is deficient in hydrocarbon resources. The region has not been able to exploit the indigenous energy resources due to various constraints including lack of: (i) financial resources to undertake capital intensive projects, (ii) cross border energy infrastructure to facilitate regional energy trade, (iii) spirit of cooperation to collectively address energy issues, and (iv) institutional mechanisms that could promote inter and intra regional energy trade. SMCs could benefit by sharing their experiences and success stories in addressing energy challenges faced by the individual Member States, but there is no mechanism to facilitate such a process.

The region is surrounded by energy resource rich countries/regions, such as West Asia, the Central Asian Region, Iran and Myanmar. There is significant potential for importing energy in various forms from these regions/countries at competitive rates to meet the growing energy demand of the SAARC region. Tapping this potential is vital for not only sustaining, but also accelerating the economic growth of the SAARC region.

Except in certain cases, initiatives undertaken so far to promote inter and intra regional energy trade have yet to reach a stage where, actual execution of projects could take place for improving the energy supply situation in the SAARC region.

The major policy initiatives recommended by the study (SRETS) are listed below:

- Develop SAARC Regional Energy Trade and Cooperation Agreement
- Harmonize Legal and Regulatory Frameworks
- Build a comprehensive and reliable energy database
- Promote alternative financing mechanisms for developing regional energy trade and cooperation initiatives
- Develop a regional trade treaty similar to the Energy Charter Treaty.

It was further recommended that SMCs need to have a time bound action plan to implement the energy infrastructure projects. These projects or initiatives were listed under three suitable time-bound categories (given below) for implementation to reap the benefits of regional energy trade and energy cooperation.

- Short Term Initiatives (less than 5 years)
    - India-Nepal oil products pipeline.
    - Feasibility Study to explore/identify possible Pakistan-India power transmission interconnection.
    - Dhalkebar (Nepal)– Muzaffarpur (India) power transmission interconnection.
    - Feasibility studies for joint development of regional hydropower, gas and coal based power plants.
    - Development of wind power projects to augment energy supplies for remote areas.
    - Feasibility study for possibility of connecting the Maldives with other SAARC countries through submarine cable.
    - Feasibility study for setting up of joint LNG terminal(s).
    - Strengthening of in-country gas truck transmissions systems to facilitate transmission of additional gas supplies as and when they become available as a result of implementation of the inter-regional gas pipelines/LNG projects.
    - Preparation of a “Least Cost Energy Sector Master Plan for SAARC Region”.
    - India-Bangladesh Power Transmission Interconnections:
        - Baharampur, India to Bheramara, Bangladesh.
- Medium Term Initiatives (5-15 years)
    - India - Sri Lanka power transmission interconnection.
    - Pakistan - India power transmission interconnection.

- Additional India-Nepal Power Transmission interconnection.
- CASA 1000 Project for Central Asia–Afghanistan–Pakistan power transmission interconnection.
- Phase-II of CASA project that could bring electricity from Central Asian Republics up to the Indian power grid.
- Iran-Pakistan-India gas pipeline.
- Power Grid interconnections between India-Bangladesh.
- Eastern Gas Pipeline Infrastructure.
- Additional power transmission interconnections between Bhutan and India.
- Implementation of joint LNG Terminal(s) for procurement of LNG for the region.
- Turkmenistan-Afghanistan-Pakistan-India pipeline.
- Regional/ Sub-regional Power Market.
- Regional/ Sub-regional Refinery.
- Regional/ Sub-regional LNG terminal and gas transmission expansion.
- Regional/ Sub- regional Power plant.

- Long Term Initiatives (greater than 15 years)
    - Qatar-Iran-Pakistan-India gas pipeline.
    - SAARC Oil Pipeline grid.

Observations on SRETS

From conceptualization of the SAARC Regional Energy Trade Study (SRETS) to its completion, the Study went through various stages, which are:

- Need for undertaking the study was recognized by the Energy Ministers in 2005.
- SAARC Secretariat, Katmandu sought for ADB's assistance to implement the study in 2006.
- ADB approved a Technical Assistance Project to implement the study in 2006.
- TOR of the study prepared by the experts of SAARC Energy Working Group in 2007.
- TOR was approved by the Energy Ministers in 2007.
- Teams of national experts were selected to prepare country reports.
- Regional expert and additional consultants were selected to prepare the synthesis report.
- A number of expert group meetings were held to review the draft SRETS report
- Draft Final Report was approved by the inter-governmental Energy Working Group Meeting.
- Approved report was endorsed by the Senior Officials of the SMCs.
- Final report of SRETS was endorsed by the Energy Ministers in 2010
- SAARC Secretariat released the report to the public in 2010.

A large number of stakeholders with different official and functional responsibilities (e.g. ministers, bureaucrats, professionals, academics, researchers) from different SMCs took part in the study. Over a period of five years (2005-2010) keeping the official title of the group same, the participants taking part in different meetings varied. It has been a challenging task for SAARC Secretariat to steer the implementation of the study to completion and successfully approving the study report. It is envisaged that under the umbrella of the SAARC the findings of the report will be translated into actions for the benefit of the people of SMCs.

The following projects identified and recommended by SRETS are already in the process of implementation between Bangladesh and India:

- India-Bangladesh Power Transmission Interconnections:
    - Baharampur, India to Bheramara, Bangladesh

- Feasibility studies for joint development of regional hydropower, gas and coal based power plants.
    - Coal based power plant is jointly implemented by Bangladesh and India at Rampal, Bagerhat district.

Experiences of Regional Power Sector Integration

In order to develop strategies in solving energy challenges through regional cooperation, the ESMAP study assessed the success factors and constraints of 12 Regional Power System Integration (RPSI) Project implemented in different countries of the world. It was concluded that RPSI process require both perseverance and flexibility of approach to succeed. It was highlighted that the case studies differ in their immediate characteristics, such as size, stage of electricity sector reforms, ownership, resource usage, and environmental impact. The socio political context of the projects also varied. It was concluded that there were no unique RPSI institutions or processes, and no hard-and-fast-rules about issues, such as ownership, financing and pricing that would ensure the success of regional integration efforts (ESMAP 2010).

Development of Hydropower Plants under SAARC System

A study carried out by the SAARC Energy Center (SEC), Islamabad, critically reviewed existing electricity laws, rules, regulations and policies related to hydropower development in Bhutan and Nepal. It was opined that both the countries have specific laws and policies on license, transfer of properties, royalty, land acquisition, investment model, risk compensation, power evacuation, environmental aspect and rehabilitation and resettlement issues. Mechanisms of royalty payment for exporting energy are different for Bhutan and Nepal. SAARC may consider the experience of Bhutan and Nepal for developing common legal framework for regional and sub-regional hydropower development in consultation with Bhutan and Nepal (Obaidullah 2010).

European Coal and Steel Community (ECSC) to the European Union (EU)

Bangladesh and India are closest neighbors for centuries. Cooperation between two neighbors varied over the years due to variation of political changes. Both the countries are founder members of the SAARC, established in 1985 with the objective of regional cooperation. In recent years various attempts were made to develop regional cooperation in many different areas of economy including water and energy. It is envisaged that successful cooperation would develop in all the areas for mutual benefits of the people of the two countries. In this respect establishment of the European Coal and Steel Community (ECSC) and its subsequent transformation to the European Union (EU) may be considered as a role model to follow.

Observations on Regional Energy Studies

Energy Studies carried out by Regional Academic and Research Institutions (RSI, AIT, APDC), have been implemented with the participation of individual researchers of the regional countries. The outcomes of these studies ended up in generation and synthesis of knowledge reported in research publications; for which the research grants were available from the sponsors. There have been limited scopes to use the outcomes of the studies by the respective national planners for improving the quality of life of common people. The objective of the IUCN study is similar to the above research studies, to accumulate knowledge on the subject through collaborative research.

Regional energy studies carried out by SAARC Secretariat, Kathmandu and SAARC Energy Center, Islamabad have been implemented with active participation of the respective governments and the researchers of the SAARC member countries. It is envisaged that there are better prospects for utilization of the outcomes of these studies for improving the quality of life of common people.

If the process of energy cooperation is pursued with perseverance and flexibility it may be possible to achieve success. In this respect sixty four years' experiences of regional cooperation that lead European Coal and Steel Community (ECSC) to the European Union (EU) may be considered as an example to be followed

By analyzing the experiences of 12 regional power system integration projects, the ESMAP study has identified the interrelated factors that contribute to success and acts as barriers for regional power integration. The study concluded that there is no unique prescription to lead the integration process to success; it requires both perseverance and flexibility of approach to succeed.

Researchers working on development of the GBM Basins have been advocating in undertaking regional hydropower development programs in Bhutan and Nepal for the benefit of the people of the countries of the GBM region. The study carried out by the SAARC Energy Center has suggested institutional measures to be considered in this respect.

SAARC Regional Energy Trade Study (SRETS) has presented detailed time based work plan and strategies for comprehensive regional energy trade. Some bi-lateral projects are already under implementation between Bangladesh and India. SAARC was established in 1985 and the initiative for regional energy trade was undertaken during 2007-2010. If the process of energy cooperation is pursued with perseverance and flexibility it may be possible to achieve success. In this respect sixty four years' experiences of regional cooperation that lead European Coal and Steel Community (ECSC) to the European Union (EU) may be considered as an example to be followed.

Among all of the above-mentioned regional studies the following recommendations presented by the Regional Renewable Energy Study (RRES) seems to be pragmatic for all the countries to consider.

- As no country in the region is endowed with fossil fuel resources adequate to meet its total energy needs, all countries of the region should undertake a comprehensive time bound survey of all indigenously available energy resources-fossil fuels as well as renewable energy resources- as per the international energy resource measurement standards.
- Every country should examine the economic and physical features of the country and frame a comprehensive energy policy. This should have a separate section on the policy for developing RE resources.
- Each country should set up a separate organization to deal with all issues connected with renewable energy resources.
- The Study reveals that there are a few countries, which have achieved good success in some RE project or program. It is necessary that such project experience be made to serve the interests of the other countries. To the extent possible the transfer of the best practice and the transfer of "technology" are achieved through bilateral arrangements.
- All countries should endeavor to help the academics, activists and policy makers to meet frequently in official and academic discussions on renewable energy resource development in the region.

Establishment of National Energy Research Institute

In order to improve overall performance of the energy sector there is a need to undertake different type of research and studies (e.g. policy research; research-development & demonstration of technologies; adaptation of imported technologies; diffusion of energy technologies etc.) for different sub-sectors of the energy sector on a continuing basis. Due to lack of capabilities and absence of institutions very little research works are undertaken for development and management of energy. With reference to the objectives of the present study, in order to strengthen regional cooperation it would be necessary to undertake research on national issues to be carried out by national organizations and joint research works to be carried out by national researchers in collaboration with the researchers of regional countries.

There is a need to establish a National Energy Research Institute (NERI), in Bangladesh on a permanent basis to accumulate the experiences of different research and studies and also to carryout further research to support energy development programs of the country[14].

[14] In 2013, Government has decided to establish the Bangladesh Energy and Power Research Council to undertake comprehensive research program for the energy sector, a draft act has been prepared to establish the council.

Energy Situation in Bangladesh

Critical studies of all the Five Year Plan documents (FYPs) of Bangladesh, including the Sixth Five Year Plan document (SFYP), reveal that development plan of the Energy Sector is generally presented first with the development plan of the Power Sub-sector, followed by the development plan of Energy and Mineral Resources Sub-sector. It seemed to the policy planners and decision makers that energy and power are synonymous. Therefore, development of power sub-sector would be sufficient to ensure energy security of the country. Development of power sub-sector got priority attention over development of primary energy resources. As a consequence, the country has serious power crisis, resulting due to shortage of primary energy, although the country has reasonable reserves of natural gas and coal to meet its substantial part of total energy needs at least for the next ten years. The consequence of low priority of Energy and Mineral Resources Sub-sector over power is that indigenous fossil fuels (coal & natural gas) could not be developed in due time to meet the needs of power sub-sector as well as all other end-use sectors. In this context, current energy situation in Bangladesh is presented below first analyzing different types of primary energy resources situation and then the power sub-sector.

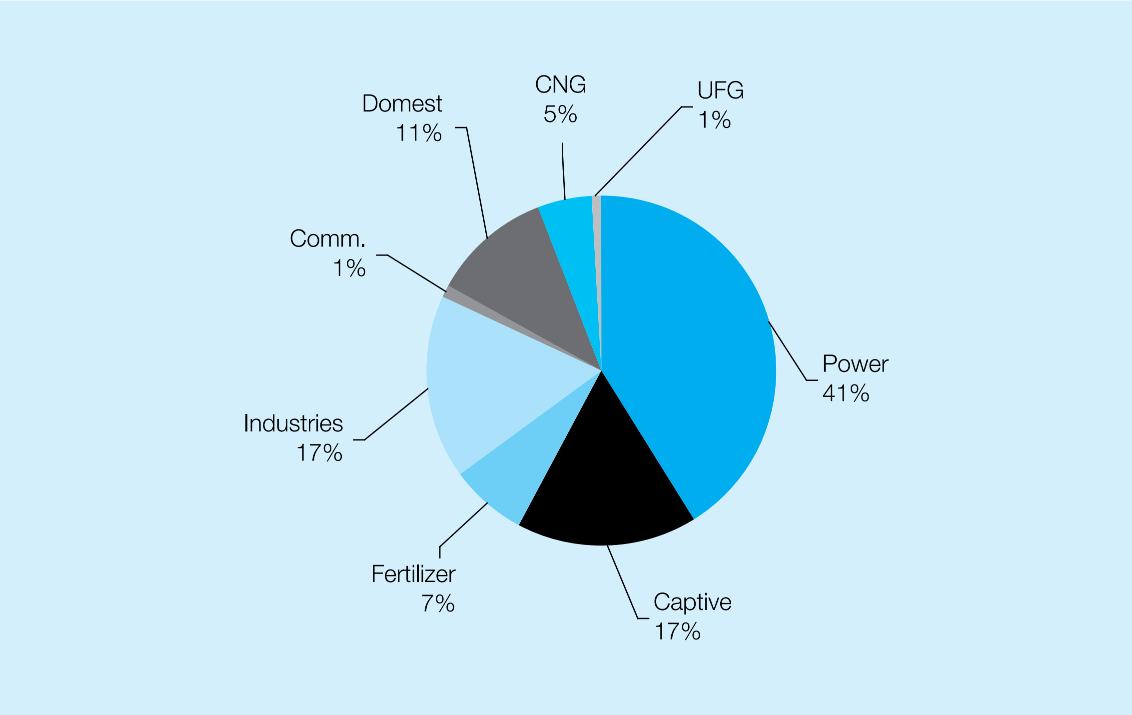
It seemed to the policy planners and decision makers that energy and power are synonymous. Therefore, development of power sub-sector would be sufficient to ensure energy security of the country. As a consequence, the country has serious power crisis, resulting due to shortage of primary energy

Status of Natural Gas

Current Consumption of Natural Gas

Indigenous natural gas is the major source of commercial energy; it provides more than 67 percent of total commercial energy demand. There are 25 discovered gas fields, of which 17 gas fields are in production. Total amount of gas produced in 2013 was 801 bcf against estimated demand of 1000 bcf. There was shortage of 199 bcf gas (19.9% shortage). Consumption of gas by different categories of consumers were as follows: electricity generation 58% (power 41%, captive power 17%), industry 17%, domestic 11%, fertilizer 7% and CNG (transport) 5%, commercial 1% and unaccounted for 1% (Figure 3).

Figure 3: Consumption of Natural Gas in 2013



Source: Productional Marketing Division, Petrobangla

[Total amount of gas produced in 2013: 801bcf]

Historical data of gas production & consumption for the period from 1991 to 2013 is shown in Table 5 and Figure 4. Government has given priority attention to supply gas for electricity generation. Gas supply to fertilizer plants have been temporarily suspended to provide additional gas to generate power, even then 600MW power plants remained inoperative due to shortage of gas. In this context the government decided to establish new power plants based on imported oil, with provision to use gas (duel fuel) where and when it may be available in future. In July 2009, the government issued an order that no new gas connection will be made until further order and the consumers were advised to use alternative fuels (EMRD/Dev-2/Gas/2009-641 dated 21-07-2009).

Table 5: Production & Consumption of Natural Gas by Different Categories of Consumers (1991-2013)

Unit: billion cubic feet

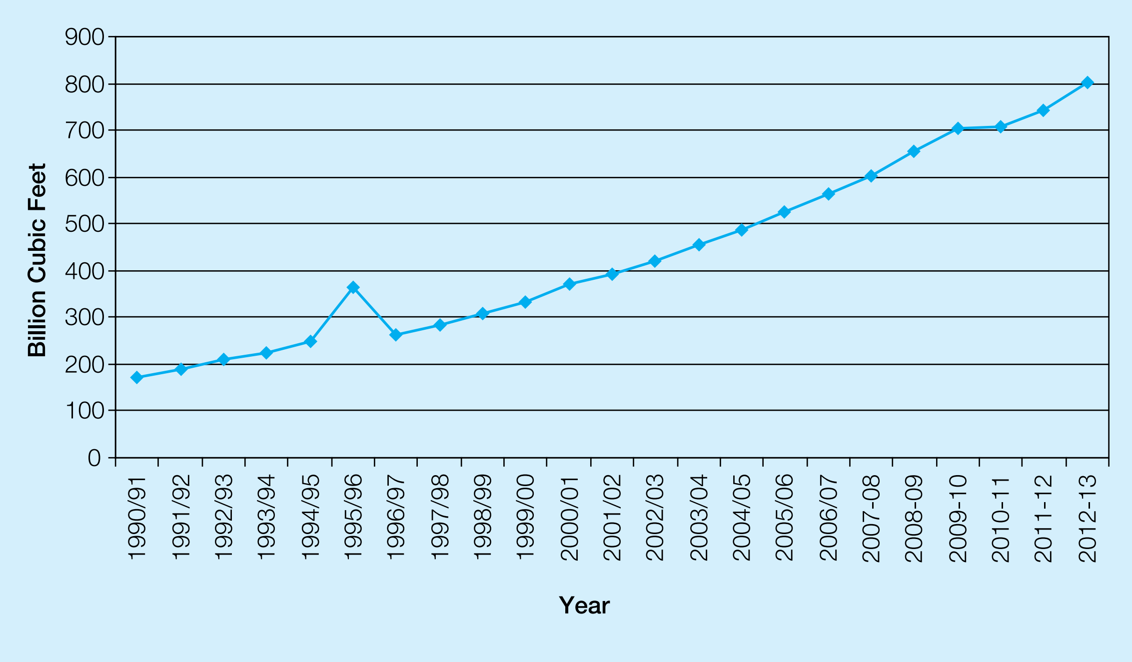
Year	Prodn.	Power	Captive	Fertiliz	Indus.	TeaInd	Bricks	Comm.	Domes.	CNG	UFG	Total Use
1	2	3	4	5	6	7	8	9	10	11	12	13
1990/91	172.84	82.6		54.2	13.2	0.7	0	2.9	10.5	0	8.74	164.10
1991/92	188.48	88.1		61.6	13.4	0.7	0.2	2.9	11.6	0	9.98	178.50
1992/93	210.98	93.3		69.2	15.2	0.7	0.2	2.4	13.5	0	16.48	194.50
1993/94	223.76	97.3		74.5	20.26	0.7	1.1	2.87	15.4	0	11.63	212.13
1994/95	247.38	107.4		80.5	24.24	0.6	1.1	2.88	18.86	0	11.80	235.58
1995/96	365.51	110.9		90.98	27.31	0.72	0.99	3	20.71	0	110.90	254.61
1996/97	260.99	110.82		77.83	28.62	0.71	0.48	4.49	22.84	0	15.20	245.79
1997/98	282.02	123.447	0	79.991	32.105	0.743	0.392	3.453	25.221	0	16.67	265.35
1998/99	307.48	140.837	0	82.73	35.778	0.71	0.347	3.652	27.183	0	16.24	291.24
1999/00	332.35	149.255	0	84.894	41.372	0.671	0.35	3.836	29.676	0	22.30	310.05
2000/01	372.16	175.204	0	88.464	48.096	0.632	0.437	4.066	31.872	0	23.39	348.77
2001/02	391.53	185.956	21.6	78.824	35.938	0.726	0.53	4.25	36.762	0	26.94	364.59
2002/03	421.16	186.249	26.182	95.903	41.753	0.743	0.524	4.515	44.828	0.003	20.46	400.70

Year	Prodn.	Power	Captive	Fertiliz	Indus.	TeaInd	Bricks	Comm.	Domes.	CNG	UFG	Total Use
2003/04	454.59	199.41	31.925	92.803	46.367	0.818	0.19	4.795	49.256	1.937	27.09	427.50
2004/05	486.75	211.023	37.793	93.986	51.417	0.798	0	4.862	52.669	3.633	30.57	456.18
2005/06	526.72	224.394	48.862	89.086	63.261	0.756	0	5.208	56.747	6.828	31.58	495.14
2006/07	562.21	221.139	62.512	93.472	77.479	0.75	0	5.662	63.25	11.995	25.95	536.26
2007-08	600.86	234.283	80.226	78.667	92.191	0.705	0	6.596	69.023	22.816	16.35	584.51
2008-09	653.7	256.843	95.008	74.832	104.595	0.596	0	7.488	73.389	31.207	9.74	643.96
2009-10	703.6	283.146	112.61	64.719	118.811	0.804	0	8.1192	82.687	39.331	-6.63	710.23
2010-11	708.9	273.8	121.2	62.8	121.5	0.8	0	8.5	87.4	38.5	-5.60	714.5
2011-12	743.57	304.3	123.56	58.39	128.45	0.76	0	8.55	89.15	38.55	-8.14	751.71
2012-13	800.5	328.1	133.3	59.9	135.1	0.8	0	8.7	89.7	38.6	6.30	794.2
2012-13 (%)	100.00	40.99	16.65	7.48	16.88	0.10	0.00	1.09	11.21	4.82	0.79	99.21

Source: Production and Marketing Division, Petrobangla

IUCN_Gas Reserve-2013.xls [Sheet 2]

Figure 4: Production of Natural Gas [1991-2013]



Reserves and Production of Natural Gas

Summary of recoverable reserves of natural gas, cumulative production (up to June 30, 2013) and remaining reserves of gas (on July 01, 2013) is shown in Table 6.

Table 6: Summary of 2P Reserve and Production (As of June 2013)

Gas in BCF

Sl No.	Operator	Field	2P GIIP (in BCF)	2P Recoverable (in BCF)	Cum. Gas Production (in BCF)	Gas Production in 2013 (in BCF)	Remaining Reserve (in BCF)
1	2	3	4	5	6	7	8
1	BAPEX	Begumganj	47.0	33.0	0.0	0.0	33.0
2	BAPEX	Shahbazpur	415.0	261.0	8.3	2.6	252.7
3	BAPEX	Semutang	654.0	318.0	5.8	3.2	312.2
4	BAPEX	Fenchuganj	483.0	329.0	92.7	14.0	236.3
5	BAPEX	Saldanadi	393.0	275.0	74.8	5.9	200.2
6	BAPEX	Srikail*	230.0	161.0	2.5	2.5	158.5

Sl No.	Operator	Field	2P GIIP (in BCF)	2P Recoverable (in BCF)	Cum. Gas Production (in BCF)	Gas Production in 2013 (in BCF)	Remaining Reserve (in BCF)
7	BAPEX	Sundalpur*	62.2	50.2	4.4	3.5	45.8
A.	**BAPEX**	**(Sub-total)**	**2284.2**	**1427.2**	**188.5**	**31.8**	**1238.7**
8	BGFCL	Meghna	122.0	101.0	46.2	3.6	54.8
9	BGFCL	Narshingdi	405.0	345.0	143.8	10.9	201.2
10	BGFCL	Kamta	72.0	50.0	21.1	0.0	28.9
11	BGFCL	Habiganj	3981.0	2787.0	1980.2	83.1	806.8
12	BGFCL	Bakhrabad	1825.0	1387.0	739.8	11.2	647.2
13	BGFCL	Titas	9039.0	7582.0	3615.7	165.1	3966.3
B.	**BGFCL**	**(Sub-total)**	**15444.0**	**12252.0**	**6546.8**	**274.0**	**5705.2**
14	Santos/ Cairn	Sangu	976.0	771.0	489.2	5.9	281.8
C	**Santos/ Cairn**	**(Sub-total)**	**976.0**	**771.0**	**489.2**	5.9	**281.8**
15	Chevron	Bibiyana	5321.0	4532.0	1417.3	286.3	3114.7
16	Chevron	Moulavi Bazar	630.0	494.0	212.7	31.4	281.3
17	Chevron	Jalalabad	1346.0	1128.0	771.5	83.6	356.5
D.	**Chevron**	**(Sub-total)**	**7297.0**	**6154.0**	**2401.5**	**401.3**	**3752.5**
18	Niko	Feni	185.0	130.0	63.0	0.0	67.0
E.	**Niko**	**(Sub-total)**	**185.0**	**130.0**	**63.0**	**0.0**	**67.0**
19	SGFL	Kailas Tila	3463.0	2880.0	587.7	31.3	2292.3
20	SGFL	Sylhet	580.0	408.0	196.1	3.4	211.9
21	SGFL	Rashidpur	3887.0	3134.0	518.5	17.2	2615.5
22	SGFL	Chatak	677.0	474.0	25.8	0.0	448.2
23	SGFL	Beani Bazar	225.0	137.0	75.2	4.3	61.8
F.	**SGFL**	**(Sub-total)**	**8832.0**	**7033.0**	**1403.3**	**56.2**	**5629.7**
24	Tullow	Bangura	730.0	621.0	226.3	32.3	394.7
G.	**Tullow**	**(Sub-total)**	**730.0**	**621.0**	**226.3**	32.3	**394.7**
25		Kutubdia	65.0	46.0	0.0	0.0	46.0

Sl No.	Operator	Field	2P GIIP (in BCF)	2P Recoverable (in BCF)	Cum. Gas Production (in BCF)	Gas Production in 2013 (in BCF)	Remaining Reserve (in BCF)
H.		**(Sub-total)**	**65.0**	**46.0**	**0.0**	**0.0**	**46.0**
Sub-total	National	(A+B+F)	26560.2	20712.2	8138.6	362.0	12573.6
Sub-total	IOC	**(C+D+E+G+H)**	9253.0	7722.0	3180.0	439.4	4542.0
Total	**(National+IOC)**		**35813.2**	**28434.2**	**11318.6**	**801.4**	**17115.6**

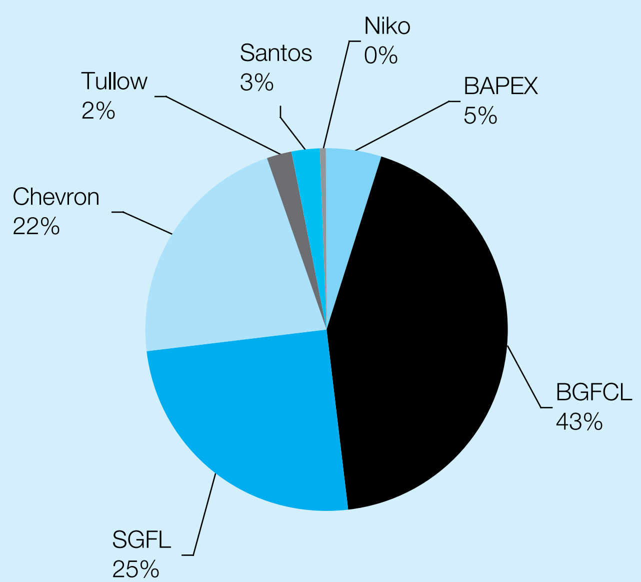
*Preliminary reserve estimated by BAPEX

Source: Hydrocarbon Unit, Energy & Mineral Resources Division

IUCN_Gas Reserve-2013.xls [Sheet 1]

It may be observed from Figure 5 that the total 2P recoverable reserve was 28.40tcf and its distribution between the three national gas production companies (BAPEX, BGFCL & SGFL) and four international oil companies (Cairn, Chevron, Niko & Tullow) were 73 percent and 27 percent respectively.

Figure 5: 2P Recoverable Reserve of Natural Gas According to Operators

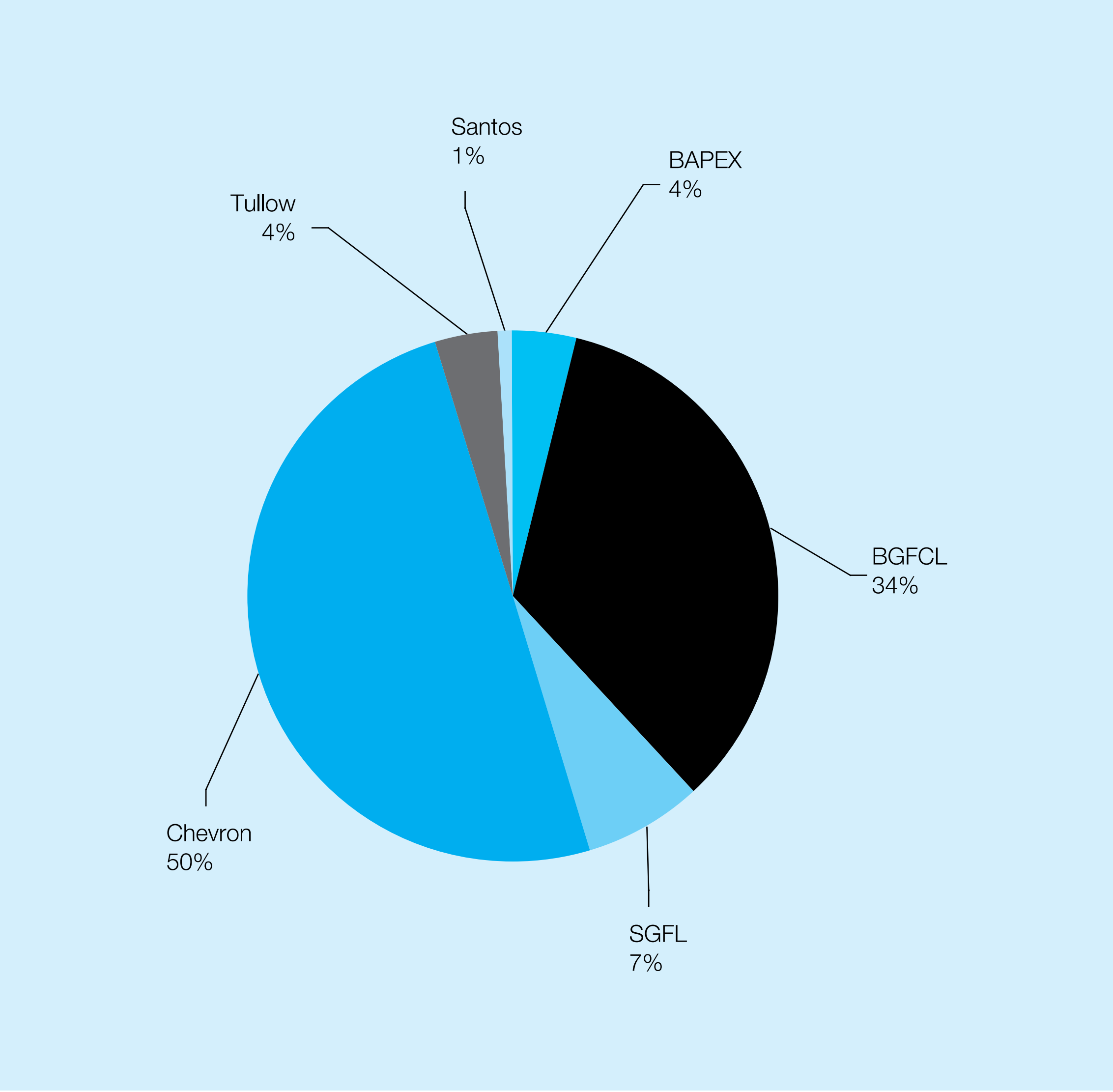


Source: Hydrocarbon Unit, Energy & Mineral Resources Division

[Total 2P Recoverable Reserve: 28.40tcf]

Up to June 30, 2013 cumulative production of total gas was 11.26tcf and its distribution between three national gas companies (NGCs) and four IOCs were 73 percent and 27 percent respectively as shown in Figure 6.

Figure 6: Cumulative Production of Natural Gas according to Operators

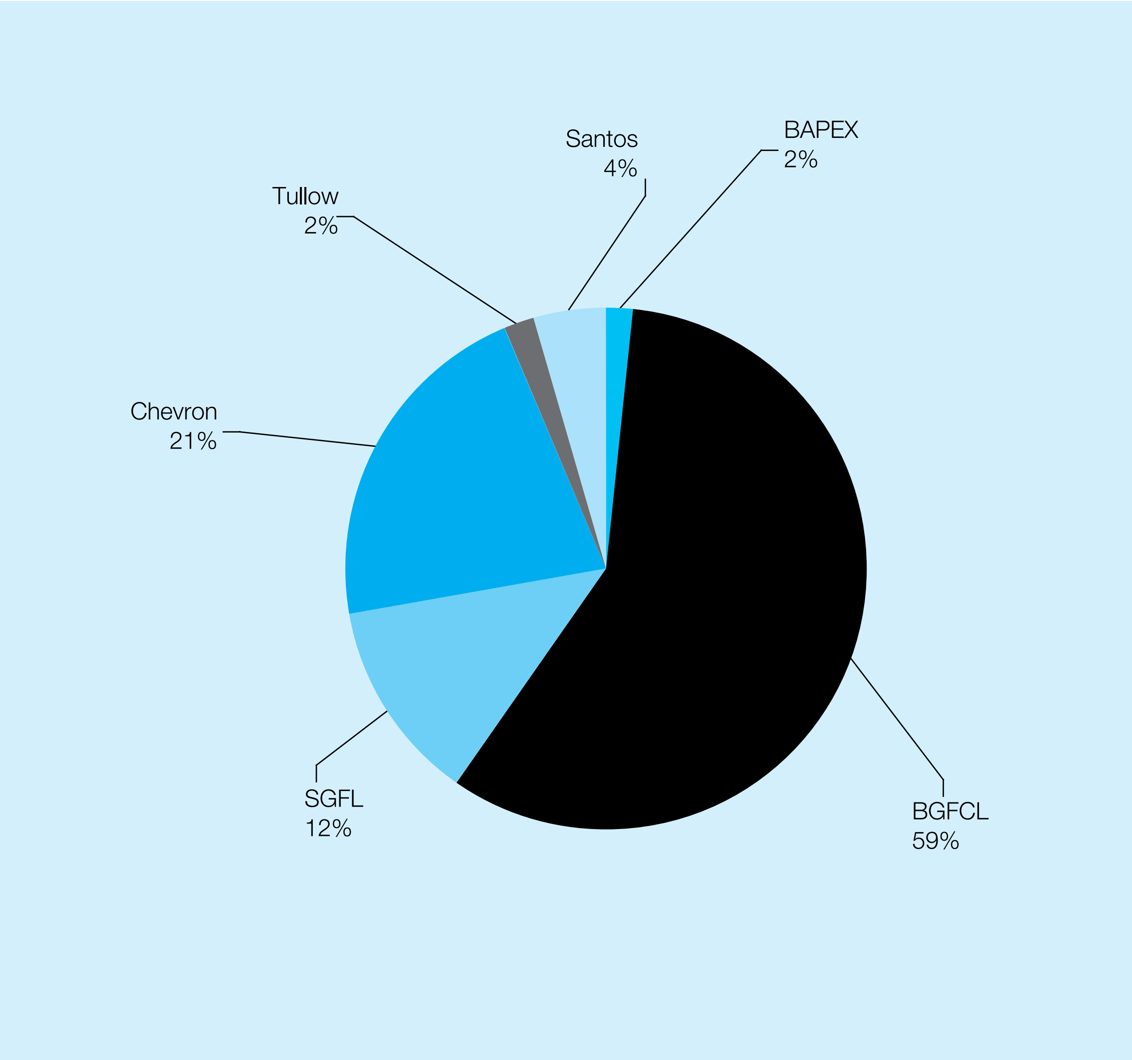


Source: Hydrocarbon Unit, Energy & Mineral Resources Division

[Cumulative Gas Production Up to June 30 2013: 11.26tcf]

Prior to 1996, 100 percent gas was produced by NGCs, since then the share of IOCs gas has been increasing gradually. In 2013, NGCs (BAPEX, BGFCL & SGFL) and IOCs (Cairn, Chevron, Niko & Tallow) supplied 45 percent and 55 percent of total gas (801BCF) as shown in Figure 7. It is envisaged that in future NGCs' share of natural gas will gradually decrease.

Figure 7: Production of Gas According to Operators



Source: Hydrocarbon Unit, Energy & Mineral Resources Division

[Total Gas Production in 2013: 801bcf]

Status of Coal

High quality bituminous coal fields were discovered at Boropukuria, Dighipara, Phulbari, Jamalganj and Khalashpir in the north-western part of the country. The total reserve is around 2797 million tonnes and the heat generation capacity is equivalent to about 37tcf of gas. The existing coal reserves of the 5 coal fields of the country are shown in Table 7.

Table 7: Coal Reserves of Five Coal Fields

Location/Exploration Year	Depth (Meter)	Magnitude of mine area (Sq.km)	Actual Reserve (Million ton)
1. Baropukuria, Dinajpur (1985)	119-506	6.88	390
2. Khalashpir, Rangpur (1995)	257-483	12	143(GSB), 685 (Hosaf)
3. Phulbari, Dinajpur (1997)	150-240	30	572
4. Jamalganj, Bogura (1965)	648-1158	16	1050
5. Dighipara, Dinajpur (1995)	327	-	200
Total			2355-2897

Source: Energy and Mineral Resources Division

Of the 5 coal fields, Baropukuria in Dinajpur has begun commercial production since September, 2005 by using underground mining method with designed production capacity of 1million tones per year. Total coal produced during 2005-2013 was 5.55 million tonnes and coal produced in 2013 was 0.95 million tonne. The nearby Baropukuria power plant of capacity 250 MW uses about 80 percent of locally produced coal. Although Bangladesh has substantial deposit of quality coal, there is a concern about the method of extraction as well as selection of coal mining technology.

In addition to indigenous coal produced from Barapukuria coal mine, about 3- 4 million tonnes of coal is being imported from India annually, via road transport and is used in the brick industries. Due to scarcity of natural gas, in the short-term, the government decided to establish a number of coal-fired power plants based on imported coal.

Hydropower Reserves and Potential

Total hydro power potential of the country was reported as 1500 MkWh/year at Kaptai (1000MkWh/year). Matamuhury (300MkWh/year) and Sangu (200MkWh/year) (GOB 1996). In 2013, total generation capacity of 5 hydropower units installed at Kaptai was 230MW and electricity generated was 893.9 MkWh. Depending upon rainfall, yearly electricity generation capacity of hydro plants varies between 700 MkWh to 1000 MkWh. Total electricity generated in 2010 was 36,482MkWh, of which the share of hydro power (primary electricity) was only 2.5 percent.

It was reported that a feasibility study was undertaken in 1998 to establish additional hydropower units (Nos. 6 & 7) at Kaptai with generation capacity of 100MW. There is potential to install 170MW hydropower plant at the Sangu and the Matamuhury rivers in the Chittagong Hill

Tracts (The Daily Amadershomoy, 21 January, 2010). It was also reported that the government has sought assistance from the USA to assess the possibility of constructing a second dam, six kilometers downstream of existing Kaptai dam to generate hydropower (Energy & Power, 1 February, 2010). In Chittagong Hill Tracts local population are already conscious about the negative impacts of existing hydropower plants at Kaptai.

Status of Renewable Energy Development Program

Institute of Fuel Research and Development (IFRD), Local Government Engineering Department (LGED), Bangladesh Power Development Board (BPDB), Rural Electrification Board (REB), Bangladesh Agricultural University (BAU), Bangladesh University of Engineering and Technology (BUET), Dhaka University (DU) are involved in research, development and demonstration of different renewable energy technologies (e.g. improved cooking stoves, solar PV, biogas etc.) during last 30 years. Due to the absence of an agency dedicated for the promotion of renewable energy technologies, large-scale diffusion of renewable energy technologies has not taken place in the country.

Since 2003, Infrastructure Development Company Ltd. (IDCOL), a public sector company has undertaken systematic approach for the diffusion of solar photovoltaic technology and biogas technology through 46 partner organizations (mostly NGOs)[15]. Up to November 2013, IDCOL installed a total of 2.7 million solar home systems and more than 20,000 biogas plants. IDCOL's solar energy program is one of the fastest growing renewable energy programs in the world. IDCOL has set target to finance 6 million SHSs by the end of year 2016. Among the partner organizations, Grameen Shakti[16] played the leading role in dissemination of solar home systems.

Biomass-fuel Resources

In Bangladesh, three major types of biomass fuel resources are in use: wood fuels, agricultural residues and animal dung. Wood fuels are obtained from different type of forests and tree resources grown in rural areas. The first national tree and forest resources assessment (NFA) of Bangladesh was carried out during 2005-2007 by Bangladesh Forest Department (BFD), Bangladesh Space Research and Remote Sensing Organization (SPARRSO) and Forestry Department of FAO, Rome. The initiative for the assessment originated from the signing of the Rio-Convention in 1992, which stated that timely, reliable and accurate information on forest and forest eco-system is essential for public understanding and informed decision making. It was suggested that the NFA be carried out periodically with five years cycle. Comparison of gross volumes as per Village Forest Inventory 1981 with average gross volume estimated by NFA in 2005-2006 indicate increase of volume varying between 13 percent (in Rajshahi Division) and 333 percent (in Barisal Division). Increase in volume of tree resources of village forest took place probably due to implementation of community forest projects in rural areas starting since 1981 (Khan et al 2004, Atrell, D. et al (editors) 2007, Ahmad 2011).

Agricultural residues and animal dung contribute a substantial portion of biomass fuel in Bangladesh. A part of the total agricultural residues available during harvesting of crops and a part of total animal dung produced by animal resources are used as fuel. Availability of these resources (agricultural residues, animal dung) as fuel depends on local situation and socio-economic condition of the owners (GOB 1987). Data on current consumption of biomass fuels and their future demand are not available.

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[15] www.idcol.org

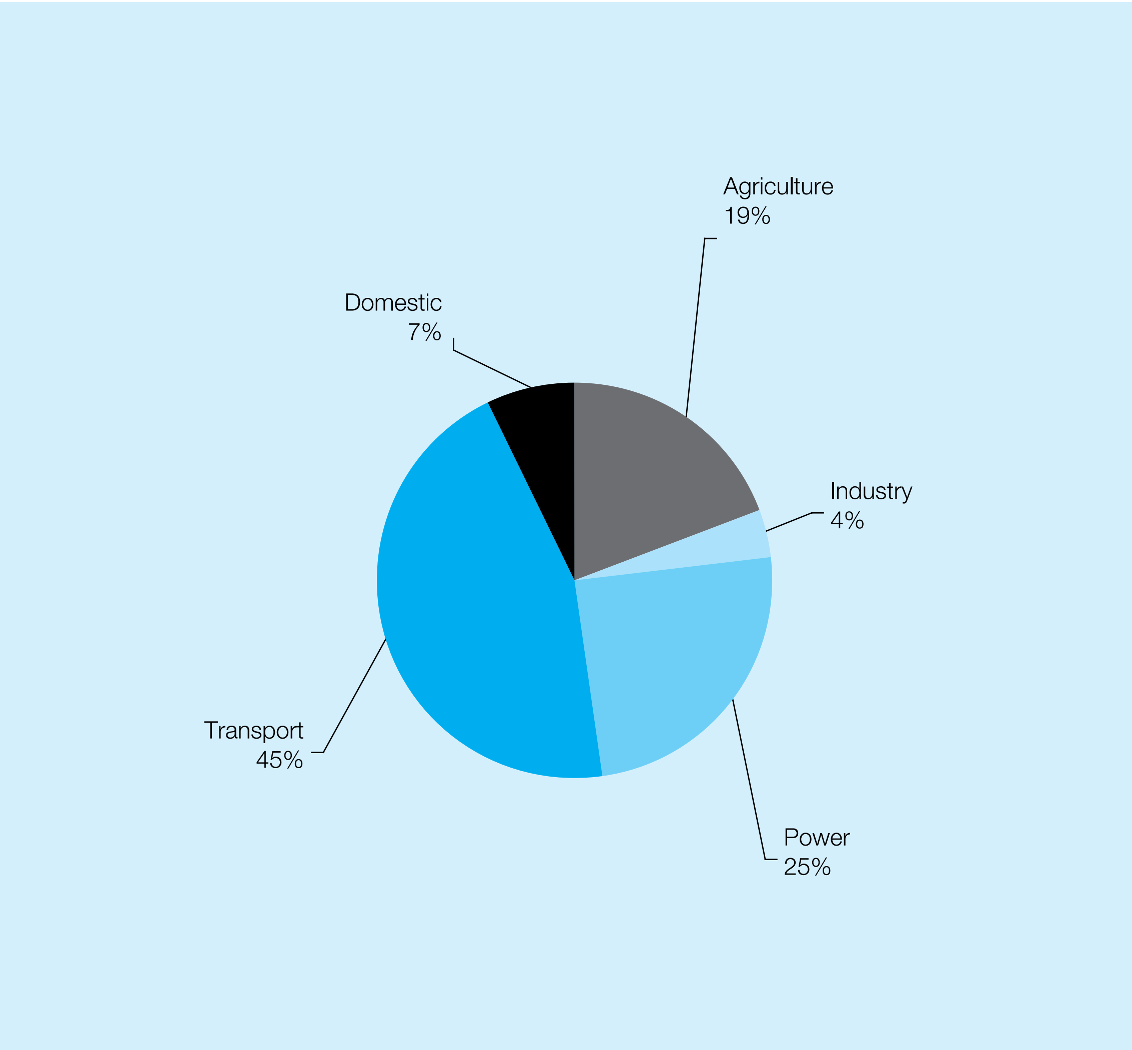
[16] www.gshakti.org

Status of Imported Petroleum Fuels

Consumption of Petroleum Fuels

Total consumption of petroleum fuels in 2013 was 5.09 million tonnes and about 98 percent was met from imported sources. Distribution of different categories of consumers of petroleum fuels is shown in Figure 8. Of the total petroleum fuels consumed in 2013, 45 percent and 25 percent were used in transport and power sector respectively.

Figure 8: Consumption of Petroleum Fuels According to Different Categories of Consumers



Source: Bangladesh Petroleum Corporation (BPC)

[Total Petroleum Fuels Consumption in 2013: 5.09 Million Tonne]

The consumption of petroleum fuels by different categories of consumers for the period from 2007-2013 is shown in Table 8. It may be observed that during 2011-2012 and 2012-2013, the shares of petroleum fuels for power generation were 22.5 percent and 24.8 percent respectively. Increased used of petroleum fuels was due to operation of liquid fuel based power plants to ease power crises.

Table 8: Consumption of Petroleum Products According to Sectors [2006-07 to 2012-13]

[Quantity In Million Tonnes]

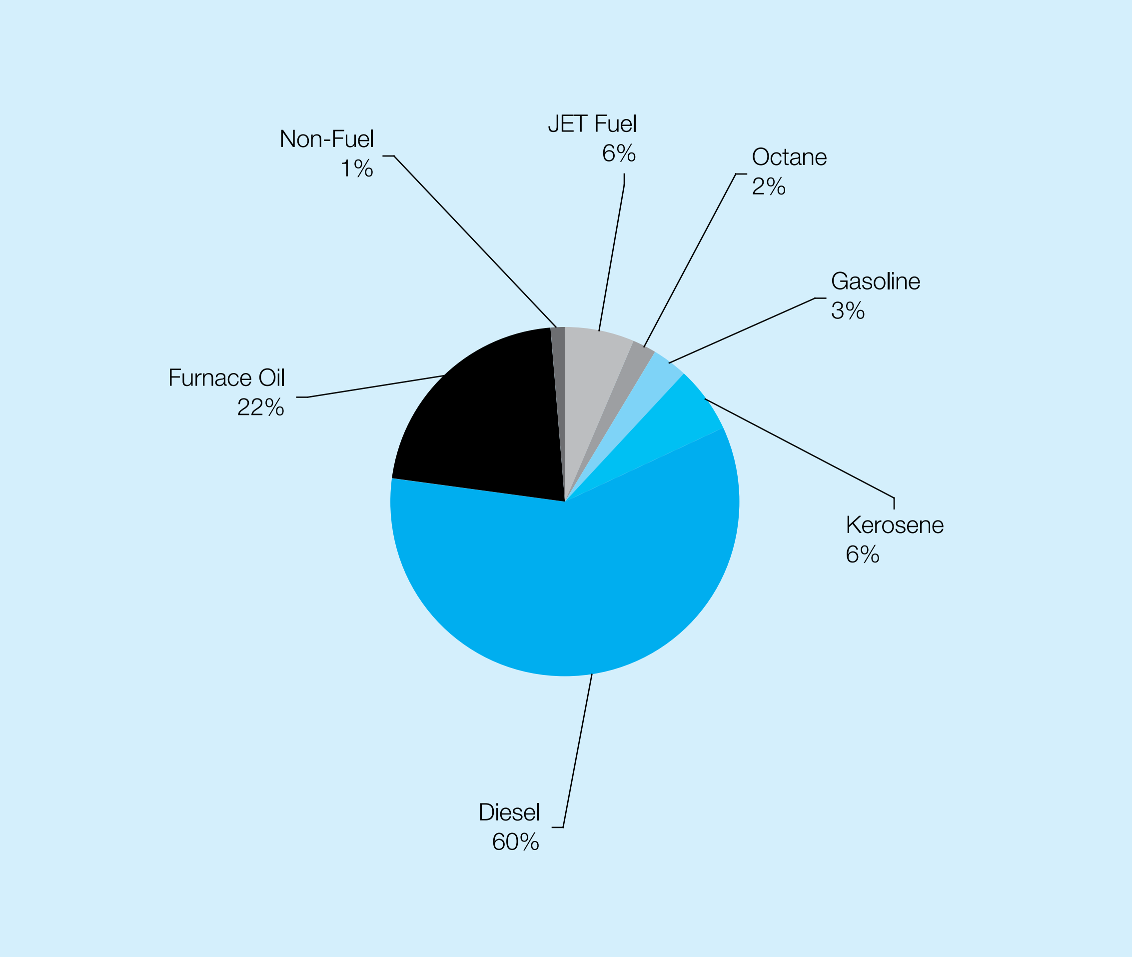
Year	Agri	Agri-(%)	Indus	Indus (%)	Power	Power (%)	Trans	Trans (%)	Domes	Domes (%)	Total	Total (%)
2006-07	0.72	20.23	0.15	4.07	0.25	7.10	1.94	54.24	0.51	14.36	3.57	100
2007-08	0.70	19.38	0.15	4.23	0.26	7.29	2.04	56.26	0.47	12.84	3.63	100
2008-09	0.80	23.92	0.12	3.76	0.25	7.66	1.77	53.11	0.38	11.55	3.33	100
2009-10	0.91	24.21	0.18	4.73	0.22	5.76	2.03	53.96	0.43	11.34	3.76	100
2010-11	1.00	20.63	0.29	6.04	0.93	19.14	2.18	44.86	0.45	9.33	4.87	100
2011-12	1.09	20.94	0.23	4.43	1.17	22.47	2.29	44.00	0.42	8.15	5.21	100
2012-13	0.98	19.36	0.19	3.72	1.26	24.80	2.29	44.99	0.36	7.13	5.09	100

Source: Bangladesh Petroleum Corporation (BPC) [www.bpc.gov.bd]

IUCN_Gas Reserve-2013.xls [Sheet 2]

Consumption of petroleum products in 2013 is shown as follows: diesel-60 percent, kerosene-6 percent, jet fuel-6 percent, furnace oil-22 percent, gasoline-3 percent, octane-2 percent, others (non-fuel)-1 percent (Figure 9).

Figure 9: Consumption of Different Type of Petroleum Fuels in 2013



Source: Bangladesh Petroleum Corporation (BPC)

[Total Petroleum Consumption in 2013: 5.09 million tonne]

Consumption of petroleum products during last 10 years is shown in Table 9. In 2011 and 2012 consumptions of petroleum fuels increased by 29.6 percent and 7.1 percent in comparison to the consumption of 2010 and 2011, respectively, whereas the consumption of petroleum fuels in 2013, decreased by 2.44 percent in comparison to 2012. Variation of total consumptions was due to the variation of use of petroleum fuels in power generation.

Table 9: Consumption of Petroleum Products during Last Ten Years

[Quantity In Million Tonne]

Products	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
JET A-1	0.227	0.254	0.238	0.226	0.277	0.254	0.287	0.336	0.312	0.318
HOBC	0.146	0.142	0.126	0.095	0.090	0.078	0.086	0.097	0.107	0.111
MS	0.151	0.144	0.153	0.130	0.125	0.115	0.127	0.141	0.159	0.170
SKO	0.694	0.544	0.499	0.462	0.405	0.343	0.377	0.397	0.358	0.315
HSD	2.004	2.265	2.299	2.294	2.334	2.301	2.568	3.239	3.240	2.965
LDO	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.001
JBO	0.019	0.017	0.020	0.016	0.018	0.016	0.019	0.023	0.026	0.026
FOHS	0.309	0.310	0.333	0.256	0.290	0.164	0.194	0.545	0.884	1.076
LUBE	0.015	0.016	0.017	0.016	0.017	0.015	0.016	0.018	0.018	0.016
SBP	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MTT	0.007	0.007	0.006	0.007	0.006	0.004	0.006	0.007	0.008	0.010
LPG	0.023	0.021	0.022	0.017	0.015	0.011	0.017	0.021	0.021	0.020
BITUMEN	0.060	0.046	0.065	0.052	0.048	0.025	0.060	0.041	0.080	0.058
TOTAL	3.657	3.768	3.782	3.574	3.626	3.327	3.757	4.868	5.214	5.086
INC/(DEC)	0.258	0.111	0.014	-0.208	0.052	-0.300	0.431	1.111	0.346	-0.127
%		3.02	0.37	-5.50	1.46	-8.26	12.94	29.56	7.10	-2.44

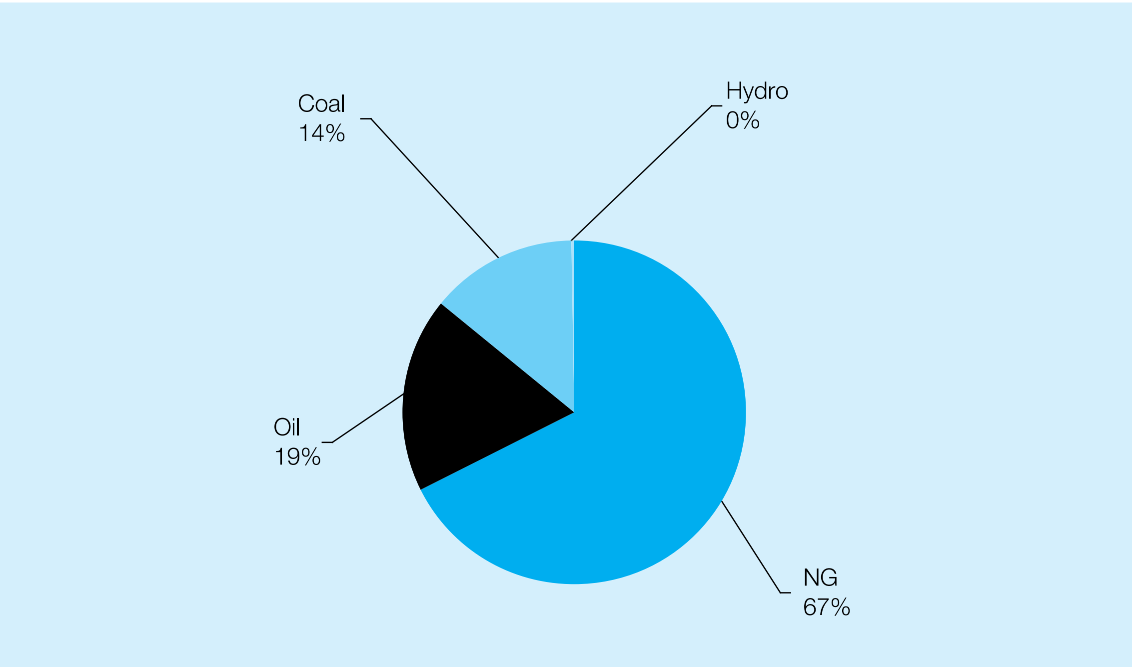
Source: Bangladesh Petroleum Corporation (BPC) [www.bpc.gov.bd]
(IUCN_Gas Reserve-2013.xls [Sheet 2]

Total Primary Energy Consumption

Total Primary Commercial Energy Consumption

Total primary commercial energy consumption of Bangladesh in 2013 was 27.51MTOE. Distribution of different type of commercial energy sources were as follows: natural gas 67 percent, oil 19 percent, and coal 14 percent (Figure 10). Import cost of 4.92 million tonne petroleum products & fuel in 2013 was Tk. 3,48,916.00 million.

Figure 10: Consumption of Different Type of Primary Commercial Fuels



Source: Bangladesh Power Development Board

[Total Primary Commercial Energy Consumption in 2013: 27.51MTOE]

Total Primary Energy Consumption

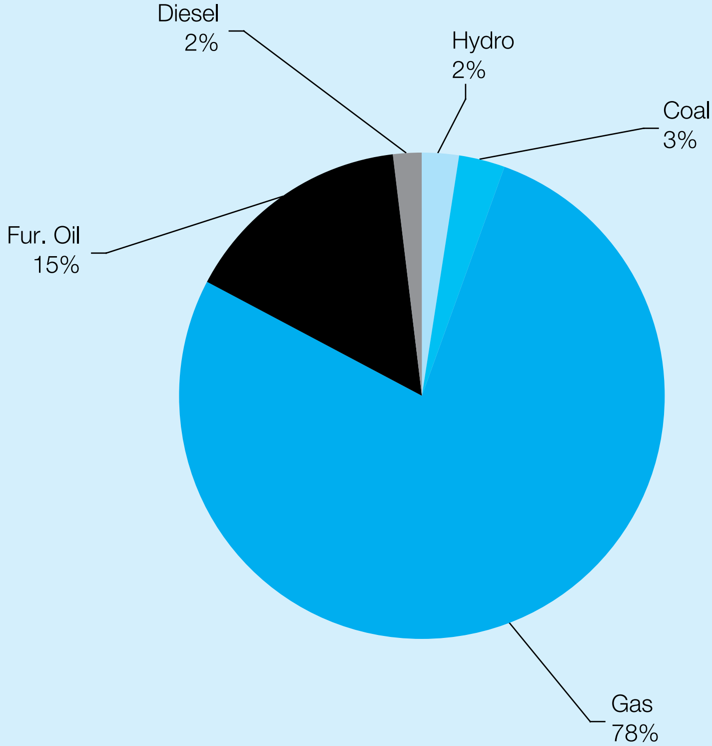
In Bangladesh a substantial quantity of traditional biomass fuels (e.g. wood fuels, agricultural residues, animal dung etc.) are used to meet rural households cooking and rural industries needs. Data on supply and consumption of traditional biomass fuels are not available.

Status of Power Sector

Existing Situation

Total electricity generated in 2013 was 36482MkWh. Distribution of primary energy used for power generation was natural gas 78 percent, coal 3 percent, furnace oil 15 percent, hydro 2 percent and diesel 2 percent (Figure11). The shares of indigenous (hydro 2%, coal 3%, gas 78%) and imported (furnace oil 15%, diesel 2%) primary energy for power generation were 83 percent and 17 percent respectively.

Figure 11: Distribution of Primary Energy used for Power Generation

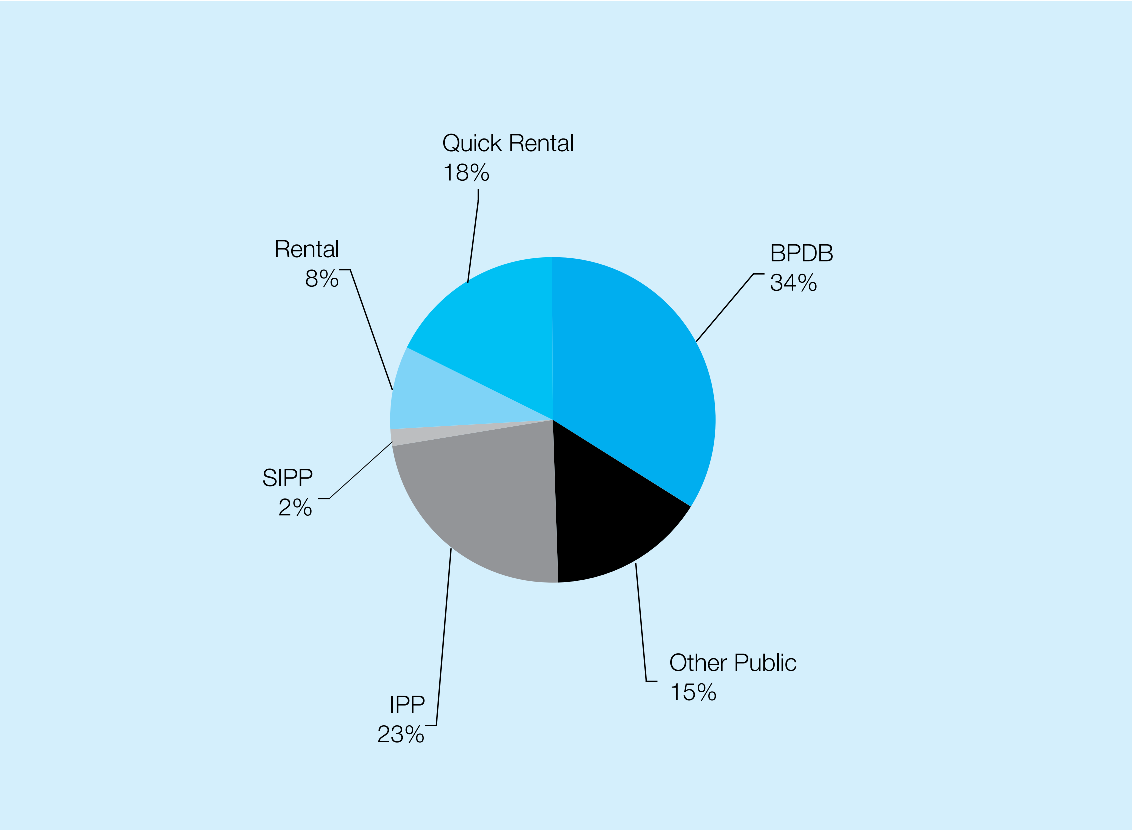


Source: Bangladesh Power Development Board

[Total Electricity Generated in 2013: 36482MkWh]

Initially Bangladesh Power Development Board (BPDB) was responsible for total generation of electricity. With power sector reforms, gradually different public sector entities other than BPDB and private sector entities started getting involved in power generation. Of the total power generation in 2013 (36482MkWh), shares of public sector organizations (BPDB 34% & Other Public Sector 15%) and private sector organizations (IPP IPP 23%, SIPP 2%, Rental 8%, Quick Rental 18%) were 49 percent and 51 percent respectively (Figure 12).

Figure 12: Share of Power Generation by Public Sector and Private Sector Organizations



Source: Bangladesh Power Development Board

[Total Electricity Generated in 2013: 36482MkWh]

Energy Crises

There is no quantitative analysis about the magnitude of energy crises (shortage) and their impact on economy. However, it is of common knowledge that during 2005-2011 the country has suffered from different type of energy crises, which means that supplied energy could not meet demands. Qualitative observations on energy crises are presented below.

It was reported that the State Minister, Ministry of Power Energy and Mineral Resources wrote a letter to all the 345 Members of Parliament (MPs) seeking their cooperation in creating public awareness regarding gas and electricity crises (The Daily Prothom-Alo, 01-04-2011).

Natural Gas Crises

Energy and Mineral Resources Division (EMRD) issued an order that until such time the daily production of natural gas rises to 2200mmcf, except those customers who already were committed, no further new gas connection would be made. In order to reduce dependence on gas, use of alternative fuels should be considered for power generation and for industrial use (EMRD/Deb-2/Gas-9/2009-641 dated 21-07-2009).

Petrobangla decided to initiate gas rationing to the industries from January 27, 2010 by staggering weekly holidays in different industrial zones (The Daily Samakal, 22-01-2010). Supply of CNG to automobiles has since then been restricted during evening peak hours (5 pm to 11 pm). In some areas households cooking with natural gas was forced to switch over to LPG and/or kerosene for cooking due to shortage of natural gas.

Government decided to close the following fertilizer industries: CUFL, KAFCO, ZFCL, GUFCL, PUFF from 02-04-2010 till the end of irrigation season. It was estimated that such decision would save 246mmcfd natural gas, which could be used to generate 500MW electricity (The Daily Star, 02-04-2010).

Because of sudden decrease of gas supply from the Sangu gas field, gas shortage in Chittagong area became very acute. The local gas distribution company (the then BGSL) wrote to the industrial customers located in its franchise area (mostly in Chittagong industrial area) to arrange alternate fuels in place of natural gas (The Daily Prothom-Alo, 02-04-2010).

With the increase of gas supply EMRD decided to resume gas connections to the consumers from 20 June, 2013.

Electricity Crises

It is reported that in 2012, average daily load shedding was 500-800MW (6.6-10.6 percent peak demand), against the peak demand of 7518MW. Industrial consumers are reported to have met their electricity need by installing captive power plants with extra investment and operated them with natural gas or imported petroleum fuels.

Holiday staggering program for industrial zones reported to have saved 150MW demand. Shutting down of shopping-centers and markets at 8pm, reduced a demand of 350MW at the peak hours. Government distributed 15 million energy efficient Compact Florescent Lamps (CFL) to 4.5 million consumers free of cost, which would have further reduced the demand by 150-160MW of electricity

Government decided to ensure uninterrupted electricity supply for irrigation, daily from 11pm to 5am. It required about 1600MW electricity to operate 260,000 electricity operated pumps. Concerned electricity utilities were instructed to maintain uninterrupted supply of electricity for irrigation by load shedding in urban centers. Government also instructed BPC to ensure timely supply of diesel for operating 1.4 million diesel-operated pumps (The Daily Prothom-Alo, 14-01-2010). In addition to assured supply of energy for irrigation, Ministry of Agriculture decided to give Tk. 50,000 million subsidy for agriculture sector under the revised budget of FY 2009-2010 (The Daily Star, 22-01-2010).

In order to combat electricity shortage during peak hour (6pm to 11pm), BERC issued an order that except hospitals, hotels and restaurants, air conditioners should not be used and temperature should not be set below 25^0C. It was reported that through enactment of the order 200-500MW of electricity could be saved (The Daily Prothom-Alo, 01-04-2010).

Holiday staggering program for industrial zones reported to have saved 150MW demand. Shutting down of shopping-centers and markets at 8pm, reduced a demand of 350MW at the peak hours. Government distributed 15 million energy efficient Compact Florescent Lamps (CFL) to 4.5 million consumers free of cost, which would have further reduced the demand by 150-160MW of electricity. Government also planned to distribute an additional 17.5 million CFL bulbs to the consumers. Status of per capita electricity generation and load shedding during 2009-2012 are shown in Table 10. Type of primary energy used for power generation during 2009-2013 is shown in Table 11. Because of shortage of gas supply, the share of imported liquid fuels (furnace oil & diesel) has been increasing in recent years.

Table 10: Status of Electricity Generation and Load Shedding

Particulars	2009 (June)	2010 (April)	2011(April)	2012 (April)
Installed Generation Capacity (MW)	5464	5873	6658	8625
De-rated Capacity (MW)	4942	5376	6208	8005
Generation (MW)	3500-4000	3700-4300	4000-4600	5000-5800
Maximum Generation (MW)	4130	4406	4699	6066
Peak Demand (MW)	4600	5800	6500	7518
Access to Electricity (% Population)	47	47	49	53
Per Capita Generation (kWh)	183	220	236	265
Load-Shedding (MW)	1000-1300	1200-1500	1000-1200	500-800

Source: Power Division

IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Table 11: Primary Energy used for Power Generation

Type of Fuels	Percent				
	2009	2010	2011	2012	2013
Hydro	1.56	3.39	4.00	3.00	2.00
Coal	3.88	3.77	2.00	2.00	3.00
Gas	88.84	88.29	83.00	78.00	78.00
Furnace Oil	3.76	2.81	5.00	11.00	15.00
Diesel	1.97	1.75	6.00	6.00	2.00
Total	100.00	100.00	100.00	100.00	100.00

Source: Power Division

IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

In order to control the severity of electricity crisis, as per decision of the government (Power Division) all new electricity connections were stopped from 25th March, 2010. Power Division issued an order on 07-11-2010 to resume limited new connections subject to fulfillment of certain conditions including installation of solar panels to meet certain portion of electricity needs for lighting and fan. All the distribution utilities were instructed to report the progress of implementation of the decision on weekly basis (Table 12). Status of installation of solar home system within different power distribution utilities up to November 2013 is shown in Table 13.

With the increase of electricity generation capacity through involvement of the private sector organizations, the Power Division resumed new connections to the consumers from February 17, 2012.

Table 12: Recommended Capacity of Solar Panels by Categories of Consumers and Estimated Price in Bangladesh

Consumer Category	Connected load(kW)	Estimated Light & Fan Load (kW)	Capacity of Solar Panel (Wp)	Estimated Cost of SHS with Battery (Tk)	Estimated Cost of SHS without Battery (Tk)
1	2	3	4	5	6
Domestic	3		90	36,000.00	27,000.00
	5		150	60,000.00	45,000.00
	7.5		225	90,000.00	67,500.00
	10		300	120,000.00	90,000.00
Industry & Commercial	10	1.5	105	42,000.00	31,500.00
	25	3.75	262.5	105,000.00	78,750.00
	50	7.5	525	210,000.00	157,500.00
	60	9	900	360,000.00	270,000.00
	80	12	1200	480,000.00	360,000.00
	100	15	1500	600,000.00	450,000.00
Readymade Garments Industries	20	5	250	100,000.00	75,000.00
	40	10	500	200,000.00	150,000.00
	60	15	750	300,000.00	225,000.00
	80	20	1000	400,000.00	300,000.00
	100	25	1250	500,000.00	375,000.00

Source: Power Cell

Notes: SHS-Solar Home System Price in 2010

Table 13: Status of Installation of Solar Home System within Different Power Distribution Utilities upto November, 2013.

Name of the Distribution Company	No. of Units	Capacity (kW)
Bangladesh Power Development Board	1750	1247.01
Dhaka Power Distribution Company	1760	1183.67
Dhaka Electricity Supply Company	5272	5544
West Zone Power Distribution Company	704	77.13
Rural Electrification Board	13262	1322.71
Total	22748	9374.52

Source: Power Cell
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Impacts of Energy Crises

There is lack of systematic study to assess the impacts and cost of energy crises on national economy. It is reported that hundreds of newly constructed flats could not be handed over to owners due to lack of electricity and natural gas connections. Industrial production in existing industries was affected due to shortage and irregular supply of energy. Newly established industries could not start operation due to non-availability of electricity and natural gas. As a consequence their liabilities with banks kept on increasing due to non-payment of borrowed capital and interest. There is a need to undertake a study to assess the impacts of energy and power crises on economy.

Energy Tariffs

Fixation of energy tariff on economic rationale is a major policy instrument for sustainable operation of energy utilities and overall development of the energy sector. Although it has been stated in various policy documents that tariff of different types of energy would be fixed on economic rationale, but was never practiced due to socio-political reasons. The situation has been addressed by giving subsidy to the utilities.

Government enacted Bangladesh Energy Regulatory Commission Act 2003 and empowered the commission to fix consumer level tariffs (downstream tariffs) of oil, gas and electricity. Since 2008, BERC has been trying to play active roles in fixing tariffs of petroleum fuels, natural gas and electricity through public hearing. In reality, BERC fixes tariffs in close consultation with the government. As a result, the energy utilities suffer financial losses. In some cases, losses are adjusted through government subsidy.

Tariffs of Natural Gas

There are two major components of natural gas tariffs: ***(a) upstream tariff*** (up to the level of production of natural gas) commonly known as wellhead price of natural gas; and ***(b) downstream tariff*** of natural gas (consisting of transmission & distribution costs and government taxes). In Bangladesh there is no upstream regulator to fix the tariffs of wellhead price of natural gas. Wellhead price of natural gas produced by the International Oil Companies (IOCs) are fixed under respective Production Sharing Contracts (PSCs). Wellhead price of natural gas produced by the IOCs from different fields are: Shangu US$ 2.68 per mcf; Jalalabad US$ 2.73 per mcf; Bibiyana US$ 2.74 per mcf; Maulavibazar US$ 2.68 per mcf and Bangura US$ 2.33 per mcf. Petrobangla receives its share of natural gas at no-cost (free), as the owner of resources[17]. Effective wellhead price of natural gas depends on the proportion of the free gas. If it is considered that Petrobangla's share of free gas is 50 percent of gas produced by the IOCs during the total life cycle of the fields; then effective wellhead price of natural gas would be half of the price mentioned in the PSCs. Consumer level tariffs of natural gas fixed by BERC on August 01, 2009 are shown in Table 14.

Table 14: Natural Gas Tariff Effective from August 01, 2009 (as per BERC order 2009/8)

Consumer Category	Tariff in 2005 (Tk./mcf)	Tariff in 2009 (Tk/mcf)	Tariff in 2005 (Tk./cm)	Tariff in 2009 (Tk./cm)	Percent Increase
1	2	3	4	5	6
1. Power (PDB, IPP)	73.91	79.82	2.61	2.82	8.00
2. Fertilizer	63.41	72.92	2.24	2.58	15.00
3. Captive Power	105.59	118.26	3.73	4.18	12.00
4. Industries	148.13	165.91	5.23	5.86	12.00
5. Tea Garden	148.13	165.91	5.23	5.86	12.00
6. Commercial	233.12	268.09	8.23	9.47	15.00
7. Domestic with meter	130.00	146.25	4.59	5.16	12.50
Domestic (single burner) per month	350.00	400.00	350.00	400.00	14.29
Domestic (double burner) per month	400.00	450.00	400.00	450.00	12.50
			3.50(av.)	4.29(av.)	11.22 (av.)

Source: BERC
Note: 1cm=35.3147cf

Government maintains lower tariff of gas for fertilizer (Tk. 2.58/cm) to provide incentive for agricultural production. Similarly lower tariff for power (Tk. 2.82/cm) generation is maintained to provide cheaper electricity to a larger section of population. Considering CNG as substitute of petroleum fuels, government fixed the tariff of CNG as Tk. 16.75/cm on 18 April, 2008. Subsequently BERC increased the tariff separately from Tk.16.75/cm to Tk. 25.00/cm on 12 May, 2011 and to Tk. 30.00/cm on 19 September, 2011.

Tariffs of Petroleum Fuels

Bangladesh imports two different types of petroleum products, namely crude oil for refining at the local refinery and refined petroleum products. Quantity and value of imported products for the period

[17] Petrobangla's shares of free gas vary from contract to contract and for the same contract it varies with the life-cycle of production wells.

from 2004 to 2013 are shown in Table 15. Bangladesh Petroleum Corporation (BPC) is responsible for import, processing and marketing of consumer products. BERC is mandated to fix the retail price of petroleum products on economic rationale. Retail price of petroleum oil since 2002 is shown in Table 16. Financial performance of BPC and its contribution to government exchequer in the form of duties and taxes are shown in Table 17. It may be observed that BPC continuously suffered loss during 2002 to 2013.

Table 15: Quantity and Value of Imported Petroleum Products [2004-2013]

Year	Crude Oil			Refined Products			Total Value (Tk Million)
	Quantity (Million Tonne)	Price (US$/bbl)	Value (Tk. Million)	Quantity (Million tonne)	Price (US$/ bbl)	Value (Tk. Million)	
2003-04	1.25	33.41	18484.30	2.27	39.32	40341.90	58826.20
2004-05	1.06	45.85	22619.80	2.74	56.96	73135.50	95755.30
2005-06	1.25	59.04	37506.90	2.39	75.92	94183.00	131689.90
2006-07	1.21	63.59	39850.20	2.54	78.31	104713.30	144563.50
2007-08	1.04	95.70	50936.90	2.28	119.07	143729.80	194666.70
2008-09	0.86	76.87	34314.00	2.54	83.04	110292.50	144606.50
2009-10	1.14	75.66	47015.40	2.64	86.17	120802.10	167817.50
2010-11	1.41	93.13	70370.00	3.49	113.69	214474.40	284844.40
2011-12	1.08	112.95	70535.10	4.10	128.30	309834.20	380369.30
2012-13	1.29	109.22	85367.00	3.64	127.70	263549.20	348916.20

Source: BPC (http://www.bpc.gov.bd/contactus.php?id=13)
IUCN_Gas Reserve-2013.xls [Sheet 3]

Table 16: Tariff of Petroleum Fuels

Effective Date	Product (Taka/Liter)					
	Motor Sprit (Gasoline)	HOBC (Octane)	SKO (Kerosene)	HSD (Diesel)	Furnace Oil	LPG
1 July, 02	28	30	17	17	9	275
6 Jan, 03	33	35	17	20	10	335
23 Dec, 04	33	35	23	23	10	450
25 May, 05	35	35	25	25	10	450

Effective Date	Product (Taka/Liter)					
	Motor Sprit (Gasoline)	HOBC (Octane)	SKO (Kerosene)	HSD (Diesel)	Furnace Oil	LPG
20 July, 05	36	38	25	25	10	450
4 Sept, 05	42	45	30	30	14	475
1 Jan, 06	42	45	30	30	14	475
9 June, 06	56	58	33	33	14	475
26 June, 06	56	58	33	33	20	500
2 April, 07	65	67	40	40	20	600
1 July, 08	87	90	55	55	30	1000
27 Oct, 08	78	80	48	48	30	1000
22 Dec, 08	74	77	46	46	30	1000
13 Jan, 09	74	77	44	44	30	1000
1 March, 09	74	77	44	44	26	850
1 June, 09	74	77	44	44	26	700
25 Jan, 11	74	77	44	44	35	700
6 May, 11	76	79	46	46	42	700
19 Sept, 11	81	84	51	51	50	700
11 Nov, 11	86	89	56	56	55	700
30 Dec, 11	91	94	61	61	60	700
4 Jan, 13	96	99	68	68	60	700

Source: Compiled by Author 2013
IUCN_Gas Reserve-2013.xls [Sheet 3]

Table 17: Financial Performance of Bangladesh Petroleum Corporation [2002-2013]

(In Taka Million)

Financial Year	Profit(+)/ Loss (-)	Contribution to Exchequer
2001-2002	-7801.60	30330.00
2002-2003	-76.10	27660.00
2003-2004	-9589.30	30872.70
2004-2005	-23178.80	24589.50
2005-2006	-33377.80	26202.60

Financial Year	Profit(+)/ Loss (-)	Contribution to Exchequer
2006-2007	-23146.30	27565.50
2007-2008	-70503.00	30036.10
2008-2009	-10226.30	19089.90
2009-2010	-25712.20	23242.50
2010-2011	-97999.10	35085.00
2011-12 (Provisional)	-105517.40	46916.30
2012-13 (Provisional)	-53687.00	50223.10
Total	-460814.90	371813.20

Source: BPC
IUCN_Gas Reserve-2013.xls [Sheet 3]

Tariffs of Bulk Electricity

BPDB bears its own cost of production for electricity. It also purchases electricity as a single buyer from IPPs, RPCL, Rental Power Plants, EGCB and Ashugonj Power Station Company Limited. BPDB is selling electricity to the bulk consumers [BPDB(D), DPDC, DESCO, WZPDCL and REB] for subsequent selling to the retail consumers by different electricity distribution utilities. It may be noted that BPDB(D) also acts as a distribution utility within the areas designated by the government. Bulk tariff increase since 2008 is shown in Table 18. The difference between the average cost of supply approved by BERC and average bulk-supply-tariff (BST) is the subsidy received by BPDB. Subsidies adjusted against different functional accounts are shown in Table 19.

Table 18: Increase of Bulk Electricity Tariff Since 2008

(Tariff in Taka/kWh)

<table>
<tr><th rowspan="3">Distribution Utilities</th><th colspan="7">Effective Date</th></tr>
<tr><th>1 Oct, 08</th><th>1 Feb, 11</th><th>1 Aug, 11</th><th>1 Dec, 11</th><th>1 Feb, 12</th><th>1 Mar, 12</th><th>1 Sep, 12</th></tr>
<tr><th>BERC Order 2008/1 (29 Sept, 08)</th><th>BERC Order 2011/2 (8 Feb, 11) [BST Effective for Stage-1]</th><th>BERC Order 2011/2 (8 Feb, 11) [BST Effective for Stage-2]</th><th>BERC Order 2011/7 (24 Nov, 11) [BST Effective for Stage-1]</th><th>BERC Order 2011/7 (24 Nov, 11) [BST Effective for Stage-2]</th><th>BERC Order 2012/8 (29 Mar, 12)</th><th>BERC Order 2012/10 22 Sept, 12)</th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>BPDB-132KV</td><td>2.415</td><td>2.758</td><td>2.941</td><td>3.565</td><td>4.205</td><td>4.530</td><td>5.325</td></tr>
<tr><td>BPDB-33KV</td><td>2.445</td><td>2.671</td><td>2.849</td><td>3.425</td><td>3.985</td><td>4.255</td><td>4.978</td></tr>
<tr><td>DPDC-132KV</td><td>2.415</td><td>2.758</td><td>2.941</td><td>3.565</td><td>4.205</td><td>4.530</td><td>5.325</td></tr>
<tr><td>DESCO-33KV</td><td>2.445</td><td>2.783</td><td>2.968</td><td>3.605</td><td>4.245</td><td>4.570</td><td>5.405</td></tr>
</table>

Distribution Utilities	Effective Date						
	1 Oct, 08	1 Feb, 11	1 Aug, 11	1 Dec, 11	1 Feb, 12	1 Mar, 12	1 Sep, 12
	BERC Order 2008/1 (29 Sept, 08)	BERC Order 2011/2 (8 Feb, 11) [BST Effective for Stage-1]	BERC Order 2011/2 (8 Feb, 11) [BST Effective for Stage-2]	BERC Order 2011/7 (24 Nov, 11) [BST Effective for Stage-1]	BERC Order 2011/7 (24 Nov, 11) [BST Effective for Stage-2]	BERC Order 2012/8 (29 Mar, 12)	BERC Order 2012/10 22 Sept, 12)
WZPDCL-33KV	2.445	2.642	2.818	3.155	3.475	3.740	4.430
REB-33KV	2.309	2.475	2.640	2.915	3.175	3.423	4.033
Average Bulk Supply Tariff	2.37	2.63	2.80	3.27	3.74	4.02	4.70
Average Cost of Supply Approved by BERC	2.37	2.92		5.22	5.22	5.50	5.70

Source: BERC
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Table 19: Subsidy/Loan Received from Government [2007 to 2012]

(Taka Million)

Year	IPP	Rental IPP	Quick Rental IPP	Total
2006-07	3000			3000
2007-08	6000			6000
2008-09	6000	4067.3		10067.3
2009-10	6000	3937.6		9937.6
2010-11	9712.3	13268.2	17019.5	40000
2011-12	5520.1	12083.2	45963.6	63566.9
Total	36232.4	33356.3	62983.1	132571.8

Source: BPDB
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Tariffs of Retail Electricity

Retail electricity tariffs for different categories of consumers approved by BERC for the four distribution utilities (BPDB, DESCO, DPDC, WZPDCO & REB) are shown in Table 20 -24. It may be noted that minimum electricity tariff for domestic consumers of the three urban electricity utilities (BPDB, DESCO, DPDC) were fixed as Tk. 100/month, where-as for the rural utility (REB) the minimum tariff was fixed as Tk. 65/month.

Table 20: Retail Electricity Tariff of BPDB (Effective from September 01, 2012)

Consumer Category	Range	Rate/kWh	Charges		
			Demand	Service	Minimum
1	2	3	4	5	6
Domestic Category-A	000-75 kWh 76-200 kWh 201-300 kWh 301-400 kWh 401-600 kWh Above 600 kWh	Tk. 3.33 Tk. 4.73 Tk. 4.83 Tk. 4.93 Tk. 7.98 Tk. 9.38	Tk. 12.00 Per kW sanctioned load	Tk. 6.00 Per month for single phase & Tk 27.00 per month for 3-phase	Tk. 100 Per month
Agricultural Pumping Category – B	Flat	Tk. 2.51	Tk. 35.00 Per kW Per month (for sanctioned load above 30 kW)	1 Phase Tk. 5.00 3 Phase Tk.25.00 per month	Tk. 125.00 Per H. P. (per month during season)
Small Industry Category-C	Flat Peak Off peak	Tk. 6.95 Tk. 8.47 Tk. 5.96	Tk. 37.00 Per kW per month sanctioned load (above 40kW)	Tk. 63.00 per month	Not applicable
Non-Residential Category-D		Tk. 4.53	Tk. 10 Per KW of sanctioned load	1Phase Tk. 5.00 3 PhaseTk.25.00	Tk. 100
Commercial Category-E	Flat Peak Off peak	Tk. 9.00 Tk. 11.85 Tk. 7.22	Tk. 22.00 Per kW Per month (for sanctioned load above 40 kW)	Tk. 6.00 Per month for single phase & Tk 27.00 per for 3-phase	Tk. 125 Per KW of sanctioned load per month
Medium Voltage 11 kV General Category-F	Flat Peak Off Peak	Tk. 6.81 Tk. 9.33 Tk. 5.96	Tk. 42.00 Per kW of sanctioned load per month	Tk. 355.00 per month	Tk. 80.00 Per KW sanctioned load but not less than Tk. 8000.00 per month
Extra High Voltage 132 KV General Category- G-2	Flat Peak Off Peak	Tk. 6.16 Tk. 8.67 Tk. 5.57	Tk. 37.00 Per kW of sanctioned load.	Not Applicable	Tk. 60.00 Per KW of connected load
High Voltage 33 kV General Category-H	Flat Peak Off Peak	Tk. 6.48 Tk. 9.14 Tk. 5.87	Tk. 37.00 Per kW of sanctioned load per month	Tk. 410.00 Per month	Tk. 80.00 Per KW of connected load
Street Lights & Pump Category-J		Tk. 6.48	Tk. 37 Per kW sanctioned load	Tk. 205.00	Not Applicable

Source: BERC

Table 21: Retail Electricity Tariff of DESCO (Effective from September 01, 2012)

Consumer Category	Range	Rate/kWh	Charges		
			Demand	Service	Minimum
1	2	3	4	5	6
Domestic Category-A	000-75 kWh 76-200 kWh 201-300 kWh 301-400 kWh 401-600 kWh Above 600 kWh	Tk. 3.33 Tk. 4.73 Tk. 4.83 Tk. 4.93 Tk. 7.98 Tk. 9.38	Tk. 12.00 Per kW sanctioned load	Tk. 6.00 Per month for single phase & Tk 27.00 per month for 3-phase	Tk. 100 Per month
Agricultural Pumping Category – B	Flat	Tk. 2.51	Tk. 35.00 Per kW Per month (for sanctioned load above 30 kW)	1 Phase Tk. 5.00 3 Phase Tk.25.00 per month	Tk. 125.00 Per H. P. (per month during season)
Small Industry Category-C	Flat Peak Off peak	Tk. 6.95 Tk. 8.47 Tk. 5.96	Tk. 37.00 Per kW per month sanctioned load (above 40kW)	Tk. 63.00 per month	Not applicable
Non-Residential Category-D		Tk. 4.53	Tk. 10 Per KW of sanctioned load	1Phase Tk. 5.00 3 PhaseTk.25.00	Tk. 100
Commercial Category-E	Flat Peak Off peak	Tk. 9.00 Tk. 11.85 Tk. 7.22	Tk. 22.00 Per kW Per month (for sanctioned load above 40 kW)	Tk. 6.00 Per month for single phase & Tk 27.00 per for 3-phase	Tk. 125 Per KW of sanctioned load per month
Medium Voltage 11 kV General Category-F	Flat Peak Off Peak	Tk. 6.81 Tk. 9.33 Tk. 5.96	Tk. 42.00 Per kW of sanctioned load per month	Tk. 355.00 per month	Tk. 80.00 Per KW sanctioned load but not less than Tk. 8000.00 per month
High Voltage 33 kV General Category-H	Flat Peak Off Peak	Tk. 6.48 Tk. 9.14 Tk. 5.87	Tk. 37.00 Per kW of sanctioned load per month	Tk. 410.00 Per month	Tk. 80.00 Per KW of connected load
Street Lights & Pump Category-J		Tk. 6.48	Tk. 37 Per kW sanctioned load	Tk. 205.00	Not Applicable

Source: BERC

Table 22: Electricity Tariff of DPDC (Effective from September 01, 2012)

Consumer Category	Range	Rate/kWh	Charges		
			Demand	Service	Minimum
1	2	3	4	5	6
Domestic Category-A	000-75 kWh 76-200 kWh 201-300 kWh 301-400 kWh 401-600 kWh Above 600 kWh	Tk. 3.33 Tk. 4.73 Tk. 4.83 Tk. 4.93 Tk. 7.98 Tk. 9.38	Tk. 12.00 Per kW sanctioned load	Tk. 6.00 Per month for single phase & Tk 27.00 per month for 3-phase	Tk. 100 Per month
Agricultural Pumping Category – B	Flat	Tk. 2.51	Tk. 35.00 Per kW Per month (for sanctioned load above 30 kW)	1 Phase Tk. 5.00 3 Phase Tk.25.00 per month	Tk. 125.00 Per H. P. (per month during season)
Small Industry Category-C	Flat Peak Off peak	Tk. 6.95 Tk. 8.47 Tk. 5.96	Tk. 37.00 Per kW per month sanctioned load (above 40kW)	Tk. 63.00 per month	Not applicable
Non-Residential Category-D		Tk. 4.53	Tk. 10 Per KW of sanctioned load	1Phase Tk. 5.00 3 PhaseTk.25.00	Tk. 100
Commercial Category-E	Flat Peak Off peak	Tk. 9.00 Tk. 11.85 Tk. 7.22	Tk. 22.00 Per kW Per month (for sanctioned load above 40 kW)	Tk. 6.00 Per month for single phase & Tk 27.00 per for 3- phase	Tk. 125 Per KW of sanctioned load per month
Medium Voltage 11 kV General Category-F	Flat Peak Off Peak	Tk. 6.81 Tk. 9.33 Tk. 5.96	Tk. 42.00 Per kW of sanctioned load per month	Tk. 355.00 per month	Tk. 80.00 Per KW sanctioned load but not less than Tk. 8000.00 per month
Extra High Voltage 132 KV General Category-G-2	Flat Peak Off Peak	Tk. 6.16 Tk. 8.67 Tk. 5.57	Tk. 37.00 Per kW of sanctioned load.	Not Applicable	Tk. 60.00 Per KW of connected load
High Voltage 33 kV General Category-H	Flat Peak Off Peak	Tk. 6.48 Tk. 9.14 Tk. 5.87	Tk. 37.00 Per kW of sanctioned load per month	Tk. 410.00 Per month	Tk. 80.00 Per KW of connected load
Street Lights & Pump Category-J		Tk. 6.48	Tk. 37 Per kW sanctioned load	Tk. 205.00	Not Applicable

Source: BERC

Table 23: Retail Electricity Tariff of West Zone Power Distribution Company Ltd. (WZPDCO) (Effective from September 01, 2012)

Consumer Category	Range	Rate/kWh	Charges		
			Demand	Service	Minimum
1	2	3	4	5	6
Domestic Category-A	000-75 kWh 76-200 kWh 201-300 kWh 301-400 kWh 401-600 kWh Above 600 kWh	Tk. 3.33 Tk. 4.73 Tk. 4.83 Tk. 4.93 Tk. 7.98 Tk. 9.38	Tk. 12.00 Per kW sanctioned load	Tk. 6.00 Per month for single phase & Tk 27.00 per month for 3-phase	Tk. 100 Per month
Agricultural Pumping Category – B	Flat	Tk. 2.51	Tk. 35.00 Per kW Per month (for sanctioned load above 30 kW)	1 Phase Tk. 5.00 3 Phase Tk.25.00 per month	Tk. 125.00 Per H. P. (per month during season)
Small Industry Category-C	Flat Peak Off peak	Tk. 6.95 Tk. 8.47 Tk. 5.96	Tk. 37.00 Per kW per month sanctioned load (above 40kW)	Tk. 63.00 per month	Not applicable
Non-Residential Category-D		Tk. 4.53	Tk. 10 Per KW of sanctioned load	1Phase Tk. 5.00 3 PhaseTk.25.00	Tk. 100
Commercial Category-E	Flat Peak Off peak	Tk. 9.00 Tk. 11.85 Tk. 7.22	Tk. 22.00 Per kW Per month (for sanctioned load above 40 kW)	Tk. 6.00 Per month for single phase & Tk 27.00 per for 3-phase	Tk. 125 Per KW of sanctioned load per month
Medium Voltage 11 kV General Category-F	Flat Peak Off Peak	Tk. 6.81 Tk. 9.33 Tk. 5.96	Tk. 42.00 Per kW of sanctioned load per month	Tk. 355.00 per month	Tk. 80.00 Per KW sanctioned load but not less than Tk. 8000.00 per month
High Voltage 33 kV General Category-H	Flat Peak Off Peak	Tk. 6.48 Tk. 9.14 Tk. 5.87	Tk. 37.00 Per kW of sanctioned load per month	Tk. 410.00 Per month	Tk. 80.00 Per KW of connected load
Street Lights & Pump Category-J		Tk. 6.48	Tk. 37 Per kW sanctioned load	Tk. 205.00	Not Applicable

Source: BERC

Table 24: Electricity Tariff of Rural Electrification Board (REB) (Effective from September 01, 2012)

Consumer Category	Range	Rate/kWh	Charges		
			Demand	Service	Minimum
1	2	3	4	5	6
Domestic	000-75 kWh 76-200 kWh 201-300 kWh 301-400 kWh 401-600 kWh Above 600 kWh	Tk. 3.36-3.87 Tk. 4.05-4.63 Tk. 4.18-4.79 Tk. 6.88-7.30 Tk. 7.18-7.62 Tk. 9.38	Tk. 12.00 Per kW sanctioned load	Tk. 6.00 Per month for single phase	Tk. 65 Per month
Commercial	Flat Peak Off peak	Tk. 9.00 Tk. 11.85 Tk. 7.22	Tk. 22.00 per kW	Tk. 6.00 Per month for single phase & Tk 27.00 per month for 3-phase	Tk. 75.00-100.00 Per kWh & Tk 130.00 per kWh for 3-phase
Charitable Organization		Tk. 4.45-4.54	Tk. 15.00 per kW	Tk. 5.00	Tk. 120.00-125.00
Irrigation		Tk. 3.39-3.39	-	-	-
General Industry	Flat Peak Off peak	Tk. 6.95 Tk. 8.47 Tk. 5.96	Tk. 12.00 Per kW up to 25 kW. Tk. 37.00 Per kW above 25 kW	Tk. 65.00 per month	Tk. 45/kW
Large Industry	Flat Peak Off peak	Tk. 6.81 Tk. 9.33 Tk. 5.96	Tk. 43.00 Per kW or 70% of connected load whichever is higher	Tk. 360.00	Tk. 55/kVA
High Voltage 33 kV General Category-H	Flat Peak Off Peak	Tk. 6.48 Tk. 9.14 Tk. 5.87	Tk. 37.00 Per kW of sanctioned load per month	Tk. 410.00 Per month	Tk. 80.00 Per KW of connected load
Street Lights & Pump		Tk. 6.48	Not Applicable	Not Applicable	Tk. 250

Source: BERC

Subsidy in Energy Sector

Traditionally energy tariffs have never been fixed on economic rationale. As a consequence government has been maintaining the supply of energy through subsidy. Financial allocations including subsidy for Energy & Mineral Resources Division (EMRD) are shown in Table 25. It may be noted that in 2011-12, 92 percent of total allocation made for EMRD was on account of subsidy, as a result only 8 percent of total allocation could be invested for development projects.

Table 25: Resource Allocation in Energy Sector

(in million TK.)

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13
Development Budget of EMRD	2410.00	13680.00	10550.00	7760.00	16140.00
Subsidy	15000.00	9000.00	40000.00	90000.00	62000.00
Total Government Expenditure	17410.00	22680.00	50550.00	97760.00	78140.00
Subsidy as a % of Gov. Exp.	86.16	39.68	79.13	92.06	79.34

Source: Ministry of Finance, 2012

IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Financial allocations including subsidy for Power Division are shown in Table 26. It may be noted that in different years allocation for Power Division was much higher in comparison to EMRD. Since 2010-11, more than 44 percent of total allocation made for Power Division was on account of subsidy.

Table 26: Allocation of Resources in Power Sector

(in million TK.)

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13
Development Budget of Power Div.	23083.00	21022.00	59819.00	71858.00	81510.00
Subsidy	10070.00	9940.00	42000.00	60000.00	64000.00
Total Government Expenditure	33153.00	30962.00	101819.00	131858.00	145510.00
Subsidy as a % of Gov. Exp.	30.37	32.10	41.25	45.50	43.98

Source: Ministry of Finance, 2012

IUCN_Gas Reserve-2013.xls [Sheet: Electricity)

In future, the country will have to depend more on the import of different types of fuels (e.g. oil, coal, LNG etc.) and electricity. There is a need to undertake a study to suggest strategies to introduce rational tariffs for all types of energy delivered to the consumers (oil, natural gas, coal, electricity) in order to reduce financial burden for subsidy.

Future Energy Scenarios

No comprehensive analysis on future energy demands and supply options is available. There is a need to undertake a systematic study to make projections for future energy demand and possible supply scenarios.

Future scenarios of energy as reported in different government publications are presented below.

Projected Demands of Natural Gas

Sector- wise gas demand projection for the period from 2010-11 to 2015-16 is shown in Table 27. It may be noted that during 2011-2013 due to shortfall of supply, unmet demand of gas increased from 18.14 percent in 2010-2011 to 25.18 percent in 2012-13.

Table 27: Projected Gas Demand (2011-2016)

(bcf-billion cubic feet)

Categories of Consumers	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Power	300.50	324.50	350.50	378.50	415.80	443.70
Captive power	142.60	164.00	188.60	216.90	238.60	264.50
Sub-Total Power	443.10	488.50	539.10	595.40	654.40	708.20
Fertilizer	94.00	94.00	94.00	94.00	94.00	94.00
Industry	160.70	184.80	214.40	246.50	271.10	301.00
Household (Domestic)	99.50	111.40	124.80	139.80	153.80	167.80
CNG for transport	44.70	51.40	56.50	113.00	124.30	152.50
Others	30.80	31.90	32.70	33.70	37.40	38.90
Total natural gas demand	872.80	962.00	1061.50	1222.40	1335.00	1462.40
Actual natural gas consumption	714.50	751.71	794.20			
Deficit	158.30	210.29	267.30			
Deficit as % of Demand	18.14	21.86	25.18			

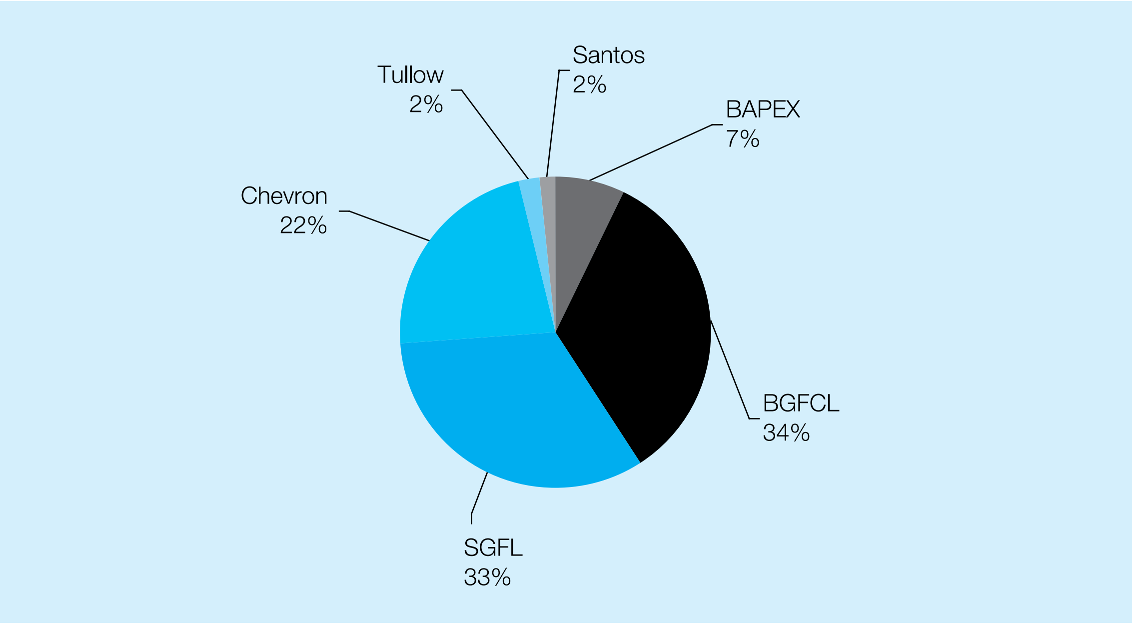
Source: Energy & Mineral Resources Division (EMRD)
IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

The government undertook the following strategies to mitigate the problem of natural gas shortage.

- Adoption of time based action plan for discovering new gas fields
- Make BAPEX more effective in exploring oil and gas
- Speedy processing of tenders and signing agreements for offshore blocks
- Approval for importing liquefied natural gas by private sector as an alternative to natural gas and building necessary infrastructure
- Reduce the supply of natural gas to those sectors where alternative energy can be used and encourage them for using alternative energy
- Finalizing National Energy Policy and Coal policy to create opportunity for using energy from multiple sources
- Increasing financial capacity of BAPEX by forming Gas Development Fund
- Ensuring proper pricing of gas to conserve energy and improve the financial operations of the gas sector
- Maximizing domestic production of diesel, kerosene, motor spirit (MS) and High Octane Blending Component (HOBC) through fractionation of condensate in the country.

On July 01, 2013 the NGCs had 74 percent of net remaining reserve of gas while the IOCs had 26 percent (Figure 13). It may be noted that three national gas companies have been playing an important role in supplying natural gas to meet commercial energy need of the country.

Figure 13: Distribution of Remaining Reserve of Natural Gas according to Operators



Source: Hydrocarbon Unit, Energy Mineral Resources Division

[Total Remaining Reserve of Natural Gas on July 01, 2013: 17116bcf]

Natural Gas Reserves and Resources

Petrobangla USGS study on natural gas resources carried out in 2001 suggested that there is 32TCF undiscovered gas resources with 50% probability. A review of the study reported (Jamaluddin 2010) that out of 32TCF gas resources only 0.2TCF gas reserve was confirmed. In 2008, government initiated the bidding process for exploration of hydrocarbon in offshore areas. Because of maritime dispute with Myanmar and India, it was not possible to implement the bidding process in total offshore area. A PSC for two blocks (DS:08 & DS:11) was signed with Conocco-Phillips in 2011 in a part of undisputed area. After the resolution of the maritime boundary dispute with Myanmar at International Tribunal for the Law of the Sea (ITLOS) on 14 March 2012, a bidding round for offshore area was announced in December 2012. Three PSCs are in the process of signing with three IOCs for four offshore blocks: ONGC Videsh Ltd., for Blocks SS: 04 & SS:09, Conocco-Phillips Asia Pacific New Venture for Blocks SS:07 and Santos Sangu Field Ltd. for Block SS:11.

Development of Coal

In order to solve the energy problems, the Government has been considering to take the following measures for development of coal (GOB 2011a, GOB 2012).

- Finalize Coal Policy immediately
- Formulate coal extraction plan consistent with social and environmental safeguards and country's demand
- Build up mass awareness regarding the method of extraction, especially, for the open pit coal mines among the local population
- Obtain public opinion of the locality and ensure rehabilitation of the affected people of the area where open pit mining is found to be economically profitable
- Develop strategies for the import of coal.

Coal development experience of Bangladesh is only of 20 years. Barapukuria coal mining project was implemented by a Chinese company on turn-key basis. After the completion of underground mine in 2005, commercial coal mining was carried out by another Chinese consortium under a Management, Production and Maintenance contract. A British consulting company has been providing overall in house advisory services to Petrobangla and BCMCL since 1991. It indicates that the country's technological capability in coal mining is weak.

The country has substantial quantity (2355-2897 million tonne) of bituminous coal to meet future commercial energy need. The Power System Master Plan 2010 stressed the need for increasing use of coal in future years. The Government of Bangladesh may consider the following observations and suggestions for the development of local coal.

- o It is not legally obligatory to have an approved Coal Policy for the development of Coal Mines. The Mines & Mineral Resources Act 1992 and The Mines & Mineral Rules 2012 are the legal framework for the development of all the mines (Including Coal Mines).
- o Government should decide about the assignment contract of the Phulbari Coal Development Project as per Mining Act (1992) and Mining Rules (2012). Expert committee report on Phulbari Coal Development Project submitted to government (EMRD) in September 2006 may be given due consideration in this respect.

- o Because of serious negative environmental impacts, development of coal should not be allowed under private sector. A State-owned Mining Corporation (Khanibangla) should be established for overall supervision and sustainable development of all the minerals including coal. Khanibangla should act as the apex body of existing two mining companies (BCMCL, MGMCL) and develop all coal basins and mines.
- o Following the experiences of development of hydrocarbon (oil & gas) under Production Sharing Contract (PSC), in future development of coal mines should also be considered under PSC.
- o Hydro-geological (100-150m aquifer over the coal seams), geological (very thick coal seams located below aquifer), spatial (all the four coal basins are located within smaller area), socio-economic (high population density[18] and three cropped area) & environmental conditions of the coal zone are very complex for open cut coal mining. Experiences of open cut mining of other countries cannot be transferred to Bangladesh.
- o Because of special characteristics of coal zone it is necessary to undertake a pilot study for open cut coal mining at northern part (shallow depth) of Barapukuria Coal Mine under the supervision of BCMCL under PSC. If the result of pilot study found satisfactory, open cut mining may be adopted on commercial basis for other coal basins.
- o It is necessary to enact law for reclamation of mined lands similar to the USA[19].
- o Considering the scarcity of lands in and around the coal basins, it is necessary to enact Law for return of reclaimed land to original owners at no cost.
- o It should be mandatory to establish mine-mouth power plants for use of coal. Extraction of coal should be synchronized with due attention to local demand of coal, to avoid export.
- o Office of the Chief Inspector of Mines should be established as per mining rules to oversee the safety aspects of the two existing mines (BCMCL, MGMCL) and mines to be developed in future.
- o Bureau of Mineral Development (BMD) should be strengthened to carryout its existing functional responsibilities effectively and BMD should be assigned to oversee the reclamation of mined lands as per the proposed reclamation law. In the USA, Office of Surface Mining was established to supervise the implementation of SMCRA.
- o Department of Environment (DOE) should approve Standard Guidelines for carrying out EIA for coal mining, storage, transport and power generation.
- o DOE should be strengthened to monitor and evaluate the performance of mining operations and an office of DOE should be established in the mining zone with laboratory facilities.
- o A Coal Master Plan should be prepared for the development and use of coal (local and imported).

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[18] About 1100 person/sq.km

[19] Surface Mining Control and Reclamation Act (SMCRA), 1977

Coal India Ltd. (CIL), India[20] is the largest coal mining enterprise in the world, having long experience and technological capabilities in design, development and management of different types of coal mines. Government (EMRD) may consider establishing a long-term agreement with the Ministry of Coal, Government of India for development of coal resources of Bangladesh.

Prospect of Hydropower Development

Considering the problem of dislocation of human settlements due to inundation, there is very limited prospect to implement further hydropower project(s) in the Chittagong Hill Tracts. It may be possible to install some mini-hydro and micro-hydro power generation units in selected locations without causing inundations. But their contributions in meeting total electricity need of the country will be very limited. Bangladesh may initiate to undertake joint feasibility study with India for the development of hydropower resources in Bhutan, India and Nepal.

Potential for Development of Electricity from Renewable Energy

The Government of Bangladesh has planned to produce 500MW electricity from renewable energy by 2016, of which 160MW social sector project will be implemented by public sector and 340MW commercial sector project will be implemented by the private sector (Table 28). Total estimated cost of the project is US$ 2.76 billion.

Table 28: 500MW Solar Program

Type of Project	MW
Health Center	50
Remote Educational Institutions	40
Union e-Centers	7
Religious Establishment	12
Remote Rail Way Stations	10
Government & Semi-government Offices	41
Sub-total: Social Sector Projects	**160**
Irrigation	150
Mini-grid	25
Park	135
Residential & Commercial Buildings	10
Industrial Buildings	20
Sub-total: Commercial Sector Projects	**340**
Total Social & Commercial Solar Projects	**500**

Source: Power Division (2013)

IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

[20] www.coalindia.in

Development of Other Renewable Energy Resources

It is planned that electricity would be generated from other renewable energy resources as follows: (i) biomass: 45MW, (ii) wind power: 200MW, (iii) biogas: 45MW, and (iv) others: 15MW.

Development of Biomass Fuel Resources

Similar to other developing countries, biomass fuels play an important role in Bangladesh in meeting total primary energy need of the country. Reliable data on consumption/demand of biomass fuels in different end-use sectors (e.g. cooking, industries) and their composition (e.g. wood fuels, agriculture residues, animal dung) with reference to different supply sources are not available. Based on experiences of other countries it is observed that with the increase of per capita income, the proportion of biomass fuels in meeting total energy demand decreases. In other words, per capita consumption of commercial energy increases due to substitution. As a result, it is a challenging task to undertake development programs for sustainable supply of biomass fuels.

In a recent publication, it is reported that biomass fuels meet 68 percent (in author's opinion it may be about 40 percent) of total primary energy consumption, and over 90 percent of households cooking energy need[21]. There is potential to save biomass fuel and reduce indoor air pollution through dissemination of improved cook stoves. Up to 2013, different organizations introduced about 1 million improved cook stoves. The government has initiated Bangladesh Country Action Plan (CAP) for clean cook stoves in 2013. The target of CAP is to disseminate improved cook stoves to over 30 million households by 2030.

Import of Liquefied Natural Gas

To meet the current shortage of natural gas as well as to meet future energy demand, the Government took initiatives to import 500mmcfd LNG. A memorandum of understanding (MOU) was signed with Qatar to import LNG. A site has been selected for installation of a floating LNG storage station at Moheshkhali of Cox's Bazar. The construction of about 95 km long pipeline from Moheshkhali to Anwara for LNG transmission is in progress. Following actions will be taken to mitigate the intensity of gas shortage by LNG import:

- Allow private sector opportunities to import LNG
- Construction of at least two terminals with auxiliary infrastructure and the capacity of receiving 500 MMCFD liquid gas from ships
- Involving private sector in the plan for importing and installation of LNG terminals.

Future Strategies for the Development of Primary Energy Resources

It is mentioned in the policy document that the following steps will be taken for the development of Primary Energy Resources (GOB 2011a).

- Ensuring adequate investment in the energy sector.
- Developing and sustaining skilled professionals with knowledge on various sources of energy.
- Determining rational price for ensuring sustainable development of energy sector.
- Fixing maritime boundary with India for further exploration in offshore blocks.
- Expediting onshore bidding process.

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[21] Country Action Plan for Clean Cook Stoves, November 2013

- Reducing the tendency of international oil Companies for quick withdrawal of invested money under Production Sharing Contract (PSC).
- Finalizing Coal Policy for coal development.
- Expediting import of LNG.
- Providing incentives for establishing solar panel producing industry.
- Providing incentives for setting up of Bio-digester Plant.
- Providing financial support to generate electricity from wind power.

Future Electricity Demand

Government has decided to provide electricity to all by 2021 and Power Sector Master Plan (PSMP) 2010 was approved in 2011. Projected power generation capacity up to 2016 is shown in Table 29. Power generation capacities in subsequent years have been projected as follows: 2015: 13300MW, 2020: 22500MW, 2025: 30000MW and 2030: 39000MW.

Table 29: Projected Power Demand and Supply During 2012-2016

Particulars	2012	2013	2014	2015	2016
Maximum Demand (MW)	7518.00	8349.00	9268.00	10283.00	11405.00
Increase in Capacity in Public Sector (MW)	632.00	1467.00	1660.00	1410.00	750.00
Increase in Capacity in Private Sector (MW)	1354.00	1372.00	1637.00	772.00	1600.00
Import (MW)		500.00			
Increase Capacity (MW)	1986.00	3339.00	3297.00	2182.00	2350.00
Capacity Retired (MW)	40.00	344.00	950.00	462.00	632.00
Generation Capacity (MW)	9559.00	12554.00	901.00	16621.00	18339.00
Net Generation Capacity (MW)	9177.00	12052.00	14305.00	15956.00	17605.00
Reliable Capacity (MW)	7158.00	9521.00	11444.00	12765.00	14084.00
Deficit(-)/Surplus (MW)	-360.00	1172.00	2176.00	2482.00	2679.00
Deficit(-)/Surplus (%)	-4.79	14.04	23.48	24.14	23.49

Source: Power Division

IUCN_Gas Reserve-2013.xls [Sheet: Electricity]

Electricity Import

Import of Electricity from India

Bangladesh and India signed a Memorandum of Understanding (MoU) on January 11, 2010 to enhance cooperation in the power sector. The areas emphasised in the MoU are electricity generation, transmission, increase in energy efficiency, development of different sources of renewable energy, installation of regional gridline, delivery of consultancy services, human resources development, exchange of electricity and joint venture in power sector.

According to the bilateral decisions taken at the Prime Ministers' level meeting between India and Bangladesh, the Government has established 'Regional Grid Interconnection' by installing 400 KV transmission line and HVDC (High Voltage Direct Current) Power sub-station to import 500MW of electricity from India. In the meantime, the Indian Government made a commitment to supply 250MW of electricity at lower price from their 'Unallocated Resource' and Bangladesh can import rest 250 MW of electricity from Indian's 'Power Pool'[22]. Import of electricity from India started from 5 October, 2013. In addition a joint study has been undertaken for grid interconnections (i) between Tripura, India & Comilla, Bangladesh and (ii) Asam, India & Bibiyana, Bangladesh.

Joint Venture Electricity Generation with India

A second MoU has been signed on August 30, 2010 between Bangladesh Power Development Board (BPDB) and Indian National Thermal Power Company (NTPC) to install a power station. An initiative has been taken to install an imported coal-based power station with installed capacity of 1320 MW electricity. For this purpose, 2300 acres of land is acquired close to the Mongla Sea Port and a feasibility study has been undertaken. The proposed power station will be equally owned by both the BPDB and NTPC. Despite public protests in Bangladesh against establishing the coal fired power plant 14 kilometer from the Sundarbans, the Prime Ministers of Bangladesh and India Jointly unveiled the foundation plaque of the power plant at Rampal, Bagerhat through a video conference (Prime Minister of Bangladesh was at Kushtia and Prime Minister of India at New Delhi) [http://www.thedailystar.net/beta2/news/pm-to-unveil-foundation-plaque-today/]. It was reported that generation of electricity from this plant would start in 2016.

Import of Electricity from India, Bhutan & Nepal

With reference to the data of SARIE study presented in Table 30 it is highlighted in the Sixth Five Year Plan document "Energy trade including electricity trade with neighbors has tremendous potential for unlocking Bangladesh's long-term energy constraints in a cost effective manner. South Asia's North-East sub region has tremendous un-tapped hydro power potential. Through proper grid connectivity and transmission lines the scope for power trade to relieve Bangladesh energy constraints is tremendous" (GOB 2011b).

[22] The Prime Ministers of Bangladesh and India open the transmission line on 5th October, 2013.

Table 30: Hydropower Potential in North-East South Asian Countries

Country	SARIE Study			Present Study		
	Hydropower Potential (MW)	Installed Cap.(MW)	Utilization (%)	Hydropower Potential (MW)	Installed Cap*.	Utilization (%)
1	2	3	4	5	6	7
Bangladesh	1897.0	230.0	12.1	380.0	230.0	60.5
India	148701.0	25587.0	17.2	148701.0	46353.0	31.2
North-East India				58971.0	3992.0	6.8
Bhutan	30000.0	432.0	1.4	30000.0	1488.0	5.0
Nepal	42130.0	527.0	1.3	42000.0	628.0	1.5
Total	222728.0	26776.0	12.0	221081.0	48699.0	22.0

Sources: South Asia Regional Initiative for Energy, USAID (Quoted in GOB 2011b)
Notes for Present Study: Bangladesh estimated by Author, India & North-East India data for May 2010 [TERI 2010, Bhutan and India data for 2009] Data for 2009 (Obaidullah 2010)

Hydropower potential of Bangladesh (1897MW) quoted by the SARI Study seems to be an over estimation. On the basis of observations made by the present study, total estimated hydropower potential of Bangladesh in three locations may be 380MW. India's data on installed capacity for hydropower up to May 2010 is reported by present study as 46,353MW. Considering geographical contiguity it is more appropriate to mention that hydropower potential and installed capacity of North-East India which are 58971MW and 3992 MW, respectively, than India's total hydro power potential of 148701MW and installed capacity of 46353MW, respectively.

"Energy trade including electricity trade with neighbors has tremendous potential for unlocking Bangladesh's long-term energy constraints in a cost effective manner. South Asia's North-East sub region has tremendous un-tapped hydro power potential. Through proper grid connectivity and transmission lines the scope for power trade to relieve Bangladesh energy constraints is tremendous" (GOB 2011b)

Prospects of increased electricity import from India need to be assessed on case by case basis. India decided to develop in October, 2011 to develop 1500MW hydro power project at Tipaimukh, Manipur. But there was no discussion about the possibility of power exchange from Tipaimukh Project. India already made agreements to develop and import electricity from Bhutan and Nepal. Total capacity of installed power plant in India on August, 2013 was 227356MW; even then there was some shortage of electricity. India planned to install additional 90,000MW during the 12th Plan (2012-2017) (TERI 2010). In this context it may be difficult for Bangladesh to import electricity from Bhutan and Nepal.

Import of Electricity from Myanmar

An MoU was signed between the governments of Bangladesh and Myanmar, for import of 500MW from a hydro power plant located at Lemro river in Rakhain state. It is expected that by 2018 the proposed 500MW of electricity would be imported through successful regional cooperation (GOB 2011a).

Nuclear Energy

Attaching highest priority to the development of power sector, the Government has taken an initiative to implement the Rooppur Nuclear Power Project (RNPP), as a project of national importance. At present, actions are underway on assessing the design parameter of nuclear power plant site and carrying out geophysical, geological, geotechnical and morphological study to install nuclear establishments under the project titled 'Accomplishment of Essential Activities to Implement Rooppur Nuclear Power Plant'. Various challenges envisaged in establishing nuclear power plant have been identified as follows (GOB 2011a).

- Making necessary provision for financing.
- Ensuring safety and security.
- Building up trained and efficient manpower to run and maintain the nuclear plant.
- Building up awareness among general people regarding the risk and prevention of nuclear power plants.

In May 2009, the government signed a memorandum of understanding (MOU) with Russia to establish a nuclear power plant. Bangladesh and Russia signed a nuclear power deal on 02-11-2011 at Dhaka for building two generators of 1000MW capacity. Considering the experiences of Fukushima, Japan nuclear power accident in March, 2011, it was assured that adequate safety features would be incorporated in designing the nuclear plant. The Prime Minister laid the foundation stone of the Rooppur Nuclear Power Project at Ishwardi, Pabna on 2nd October, 2013. Project would be implemented by Rosatom. The first and the second phase of the project of installing 1000MW would be completed by 2017 and 2021 respectively [http://www.thedailystar.net/beta2/news/quest-for-nuke-energy-begins/].

Financial Allocation in Energy Sector

The energy sector, especially power, faces substantial development challenges. In recognition of the fact that energy has become a binding constraint on the acceleration of GDP growth, the Government places highest priority in allocating resources to this sector. Nevertheless, the investment needs are just too large to be met through the Government's own resources. Accordingly, a key financing strategy

is to mobilize as much financing through PPP arrangements as possible. The Government is also attracting direct foreign investment and domestic enterprises to invest in the energy sector. The policy framework for private participation is already in place. Further efforts would be made to strengthen this policy as needed in order to ensure adequate flow of private investment in energy sector.
Financial allocation for the development of energy sector in the Sixth Plan in current price is shown in Table 31.

Table 31: Financial Allocation for the Development of Energy Sector in Sixth Plan (2011-2015)

(Million Tk. In Current Price)

Particulars	FY11	FY12	FY13	FY14	FY15
Power Division	49950.0	70690.0	85570.0	108980.0	134580.0
Percent	82.2	82.4	83.3	84.4	85.5
EMR Division	10800.0	15130.0	17170.0	20120.0	22890.0
Percent	17.8	17.6	16.7	15.6	14.5
Total	60750.0	85820.0	102740.0	129100.0	157470.0
Percent	100.0	100.0	100.0	100.0	100.0

Source: Sixth Fiver Year Plan, Part 2 (GOB 2011b)

Energy Import to Ensure Energy Security

It is envisaged that in future the country's dependence on imported energy will increase to ensure energy security. Various actions to be considered are presented below.

Capacity Development

Various policies approved in the past by the government for the development of energy sector are neither reviewed nor updated on a regular basis. Moreover, implementation status of different master plans of the energy sector and sub-sectors are not monitored and revised for sustainable development of energy sector. It would be very costly to ensure energy security through energy import (e.g. petroleum, coal, LNG, electricity etc.). In Bangladesh there is no permanent institution to study alternative options and prepare long-term energy strategy including imported energy resources. The government may consider establishing the National Energy Institute (NEI), on permanent basis to overcome the institutional gap. The major functions of the institute should be to advice/assist the government on energy policy and formulate long-term energy strategy. It should also be assigned to organize training programs to develop capacity for planning, development and management of the energy sector on a sustainable basis.

Import of Different Types of Commercial Energy Resources

Bangladesh has modest reserves of extractable commercial energy resources (coal & natural gas); in future the country will have to be increasingly dependent on imported commercial energy resources. In addition to increasing import of petroleum fuels, the government has already decided to import LNG from Qatar, establish imported coal based power plant, import of 500MW electricity from India through grid connection and installation of 2000MW nuclear power plant. Attaining energy security through import of energy from the nearest neighbor (India) might appear to be cheaper and convenient compared to energy import from distant countries, provided India has sufficient energy and willing to export specific type of energy as per requirement at competitive price. Most important aspect for energy import is its tariff and the cost of transportation. Bangladesh should initiate a study to identify appropriate types and quantities of energy to import under different time horizons. In this respect various projects identified by the SAARC Regional Energy Trade Study (SRETS) may be given due consideration.

Status of Water Sharing and Energy Trade Agreements with India

Bangladesh and India are the closest neighbors for centuries. Except the South side, Bangladesh is surrounded by India in the East, North and West sides. Cooperation between two neighbors varied over the years due to the changes of political regimes. Both the countries are founder members of the SAARC, established in 1985 with the objective of regional cooperation. In recent years various attempts have been made to develop regional cooperation in many different areas of economy including water and energy. It would be mutually beneficial to maintain meaningful cooperation between the two neighboring countries. In this respect, establishment of the European Coal and Steel Community (ECSC) and its subsequent transformation to the European Union (EU) may be considered role model to follow. It took more than sixty years to transform six-member ECSC to 27-member European Union.

Bangladesh and India share the waters of 54 common rivers flowing through both the countries. So far agreement was made for sharing the water of the river Ganges. Both the countries made serious efforts to sign water-sharing agreements for the Teesta river. Due to some technical reasons the signing of long-waited agreement was deferred at the last moment during the visit of the Prime minister Dr. Manmohon Singh to Bangladesh on September 06, 2011. Because of economic value of water for different end uses, the West Bengal government might have some justifiable reasons to reassess the terms and conditions of previous draft agreement jointly prepared by the central government of India and Bangladesh.

Most important aspect for energy import is its tariff and the cost of transportation. Bangladesh should initiate a study to identify appropriate types and quantities of energy to import under different time horizons

Favorable topographical condition suggests good prospects to generate hydro electricity from potential energy available from the rivers flowing through mountainous terrains, with and without making dam to store water. When electricity is produced from potential energy of river water without making dam (run of the river) it does not cause much environmental hazard. Negative environmental impacts of large hydropower project with dam are well known. There had always been and will be public protests from the affected people living at the back and the front end of the dam. When the dam is made on the international rivers, public protests take place in all the affected countries. Hydro electricity produced from flowing river is considered more valuable than the electricity produced by burning fossil fuels, because no cost is required for fuel. However, it is necessary to consider total environmental costs of the project. Similar to sharing of water of common rivers, if provision could be made for sharing of electricity produced from waters of common rivers, it could reduce tensions. When India decided to develop 1500MW hydropower project at Tipaimukh, Manipur Bangladesh government decided to send a delegation to India to discuss the related issues. However, there had been no discussion about the possibility of electricity exchange from Tipaimukh Project to Bangladesh.

…various attempts have been made to develop regional cooperation in many different areas of economy including water and energy. It would be mutually beneficial to maintain meaningful cooperation between the two neighboring countries. In this respect, establishment of the European Coal and Steel Community (ECSC) and its subsequent transformation to the European Union (EU) may be considered role model to follow. It took more than sixty years to transform six-member ECSC to 27-member European Union

Petrobangla advertised for hydrocarbon exploration in offshore areas through Model PSC 2008. After the objections raised by India and Myanmar regarding maritime boundary, the Ministry of Foreign Affairs, Bangladesh tried to resolve the issue in International Tribunal. After almost 40 years of intermittent and non-committal talks, Bangladesh and Myanmar appear close to a final settlement of their maritime boundary dispute in the Bay of Bengal. Frustrated with stalled negotiations, Bangladesh submitted the case to the International Tribunal for the Law of the Sea (ITLOS) in 2009. ITLOS gave the Judgment on the maritime boundary line between Bangladesh and Myanmar on 14th March 2012 and it is reported that the Judgment on maritime boundary line between Bangladesh and India may be given in 2014.

Appropriate tariffs of imported energy, duration of contract, time and skill for negotiation would be the deciding parameters for creating win-win situation for both Bangladesh and India to establish bi-lateral energy trade agreements.

Stakeholders of Energy Cooperation between Bangladesh and India

Analysis of on going negotiations between Bangladesh and India indicate that the success of energy cooperation would depend on a large number of stakeholders in India.

- Federal Government of India
- Member of Parliament
- Ministry of Foreign Affairs

- Ministry of Coal (MoC)
- Ministry of Petroleum and Natural Gas (MoPNG)
- Ministry of Power (MoP)
- Ministry of New and Renewable Energy (MNRE)
- Ministry of Environment and Forest
- Ministry of Law
- Courts of Law
- Central Regulatory institutions
- Energy Utilities
- Federal level chambers (private sector)
- State governments of India surrounding Bangladesh
- State level chambers (private sector)
- International investment banks
- Civil societies
- Mass-media

In case of Bangladesh, similar stakeholders also will have important roles to play in establishing and maintaining meaningful relations between the two countries.

Areas for Energy Cooperation between Bangladesh and India

Various areas which may be considered for energy cooperation between Bangladesh and India, are presented below.

- Establishment of Framework agreements for long-term cooperation on energy.
- Sharing of information.
- Sharing of energy database.
- Human Resources Development (HRD).
- Confidence building.
- Identification of appropriate energy infrastructures (e.g. interconnection of electricity grids).
- Mobilization of investment funds for implementation projects.
- Agreements on tariffs of different type of energy at place of delivery.
- Trade of different type of energy resources (e.g. coal, natural gas, oil, electricity etc.).
- Trade of energy technologies (e.g. refineries, power plants, sub-station, pipes etc.).
- Exchange of expert services (e.g. consultancy).
- Trade of technical know-how (e.g. royalty).
- Regulatory harmonization.
- Participation of public sector organizations.
- Participation of private sector organizations.
- Collaborative research and studies.

Priority Areas for Future Research

In order to improve overall performance of the energy sector there is a need to undertake different type of research and studies (e.g. policy research; research-development-demonstration of technologies; adaptation of imported technologies; diffusion of energy technologies etc.) for different sub-sectors of the energy sector on a continuing basis. Due to lack of capabilities and absence of institutions very little research works are undertaken in Bangladesh for development and management of energy. A good number of collaborative projects on energy between Bangladesh and India were identified by recently completed regional energy studies (SAARC Energy Center 2009, SAARC Secretariat 2010, Obaidullah 2010). It is envisaged that the policy planners and decision makers of Bangladesh will give attention to implement those projects.

With reference to the objectives of the present study, in order to strengthen regional cooperation, it would be necessary to undertake research on national topics and joint research topics to be carried out by competent organizations of Bangladesh, and for the latter, in collaboration with similar organizations in India. Various research topics identified by the present study are presented below.

Due to lack of capabilities and absence of institutions very little research works are undertaken in Bangladesh for development and management of energy

National Research Areas

For effective use of research outcomes at the initial stage government of Bangladesh (Ministry of Power, Energy and Mineral Resources) will have to endorse the research topics and initiate the process of implementation.

(i) There is a need to assess status of implementation and effectiveness of the National Energy Policy 1996 and formulate an Integrated National Energy Policy (INEP) including all the sub-sectoral policies such as coal policy, petroleum policy, renewable energy policy, power policy for the approval of the government. It is not justifiable to formulate and independent Coal Policy to decide appropriate strategies for coal development only without paying due attention to the availability of other commercial energy resources.

(ii) There is a need to establish a National Energy Research Institute (NERI) on a permanent basis to accumulate the experiences of different research & studies and also to carryout further research to advise the government on matters related to energy development programs. NERI should also be assigned to organize training programs to develop capacity for planning, development and management of the energy sector on a sustainable basis.

(iii) There is a need to undertake a study to assess/quantify the negative impacts of energy and power crises on economy to avoid events like economic activities of the country have to suffer due to energy and –power crises.

(iv) There is a need to undertake a systematic study. No comprehensive analysis on future energy demands and supply options is available, to make projections for future energy demand and possible supply scenarios on a continuing basis.

(v) Bangladesh should undertake a comprehensive time bound survey of all indigenous energy resources (fossil fuels as well as renewable energy resources) as per the international energy resource measurement standards to assess and take necessary measures for future energy needs.

(vi) In future the country will have to depend more on the import of different type of fuels (e.g. oil, coal, LNG etc.) and electricity. There is a need to undertake a study to suggest strategies to introduce rational tariffs for all types of energy delivered to the consumers (oil, natural gas, coal, electricity).

(vii) Government of Bangladesh may initiate study(ies) to identify appropriate types and quantities of energy to be imported under different time horizons. In this respect various projects identified by the SAARC Regional Energy Trade Study (SRETS) may be given due consideration.

Joint Research Areas

Joint research initiatives may be taken by both the countries on the issues that may of mutual benefit and interest. Such research programs may be participated by one or more organizations of each of the two countries. In Bangladesh, Initially the Ministry of Foreign Affairs and the Ministry of Power, Energy and Mineral Resources will have to decide the framework to initiate the process.

(a) Energy and Mineral Resources Division (EMRD) of Bangladesh may consider in establishing a long-term agreement with the Ministry of Coal, Government of India for sustainable development of coal resources of Bangladesh under the concept of South-South technology cooperation. Barapukuria Coal Mining Company Ltd. (BCMCL) will be benefited if they make a medium to long-term technology transfer agreement with Coal India Ltd., India.

(b) In Bangladesh during dry season, because of low drought, sometimes it becomes difficult to transport liquid fuels to northern districts through river routes. It may be convenient to import fuels from convenient locations of India via road transport. A joint study may be undertaken by BPC and appropriate organization of India to assess the prospects of import of diesel from India via pipeline and/or road transport.

(c) Bangladesh can propose a joint feasibility study with India to assess the prospects of development of hydropower resources in Bhutan, India and Nepal and sharing generated electricity by Bangladesh and India.

(d) There has been a massive protest against the proposed Tipaimukh dam in both countries raising environmental concerns. Recently it was learnt that the Environment Ministry of India did not give clearance, since as many as 78 lacs of trees and 27000 bamboo columns need felling for the Hydropower Project (the Daily Star 9 June 2013). It was further known that the Forest Advisory Committee also rejected the project proposal (the Hindu, 9 August 2013). However, should India decide to proceed with the project, a joint research may be under taken to assess the impacts of the proposed Tipaimukh Hydropower Project on Bangladesh.

(e) Bangladesh and India may undertake a joint study to resolve the issues of maritime boundary to enhance the process of hydrocarbon exploration in offshore locations.

(f) In both the countries women play important roles in managing energy usage in domestic sector. A joint study may be undertaken to assess gender sensitivity of energy policies and programs.

(g) In both the countries there are many programs to mitigate poverty. Energy is a key input for the survival of the poor and also to generate employment. A joint study may be undertaken to identify pro-poor energy policies and programs.

(h) Coastal areas of Bangladesh and India are becoming more vulnerable to natural calamities due to effects of climate change. Government of Bangladesh established few thousands cyclone shelters in coastal zone for sheltering people during cyclones. Solar PV systems were installed to light the shelters. A joint study may be undertaken to disseminate Solar Home Systems for individual households to meet lighting need of coastal region.

(i) India achieved notable success in developing wind power. Bangladesh can propose to undertake a joint study to assess the prospects of harnessing wind power to meet energy needs of coastal and other potential regions of Bangladesh. This study may be implemented under the concept of South-South technology cooperation.

(j) Both the countries have long coastlines; a joint study may be undertaken to assess the prospects of harnessing wave power and tidal energy to meet energy needs of coastal regions.

(k) Hilly and Haor regions of both the countries are isolated from power network. A joint study may be undertaken to assess the prospects of dissemination of Solar Home Systems for individual households to meet lighting need of Hilly and Haor regions.

It may be noted that two energy cooperation projects have already been implemented/and under implementation between Bangladesh and India. In future if the policy planners, decision makers and researchers continue their cooperative actions it would make positive contribution in achieving energy security of both the countries.

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