Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software

Shahidul I Khan
BRAC University

Asif Islam
The University of Queensland (UQ)

Alimul Haque Khan
University of Saskatchewan

Global Journal of Researches in Engineering
Volume 11 Issue 1 Version 1.0 February 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
ISSN: 0975-5861

Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software

By Shahidul I. Khan, Asif Islam, Alimul Haque Khan
Bangladesh University of Engineering & Technology, Energypac Engineering Ltd., International Islamic University of Chittagong

Abstract- This paper represents the first application of Long-Range Energy Alternative Planning (LEAP) software in energy forecasting of gas sector in Bangladesh. LEAP is used to take government decisions in many developed countries. In this work, at first the data on amount of gas consumption in different sectors of Bangladesh have been collected from year 1993 up-to year 2007. Then using 'Linear' and 'Exponential' time series wizard, gas consumption of these sectors has been forecasted up-to year 2020. Comparison between the results of forecasted data using aforementioned two time-series wizards have been discussed. The most acceptable forecasting model and why it wasn't used in this work have also been discussed thoroughly.

Keywords: Energy Forecast, Exponential Forecast, Linear Forecast, Logistic Forecast, Long Range Energy Alternative Planning (LEAP)

Classification: GJRE-J FOR Classification: 850103

ENERGY FORECASTING OF BANGLADESH IN GAS SECTOR USING LEAP SOFTWARE

Strictly as per the compliance and regulations of:

Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software

Shahidul I. Khan[1], Asif Islam[2], Alimul Haque Khan[3]

Abstract - This paper represents the first application of Long-Range Energy Alternative Planning (LEAP) software in energy forecasting of gas sector in Bangladesh. LEAP is used to take government decisions in many developed countries. In this work, at first the data on amount of gas consumption in different sectors of Bangladesh have been collected from year 1993 up-to year 2007. Then using 'Linear' and 'Exponential' time series wizard, gas consumption of these sectors has been forecasted up-to year 2020. Comparison between the results of forecasted data using aforementioned two time-series wizards have been discussed. The most acceptable forecasting model and why it wasn't used in this work have also been discussed thoroughly.

Keyword: Energy Forecast, Exponential Forecast, Linear Forecast, Logistic Forecast, Long Range Energy Alternative Planning (LEAP)

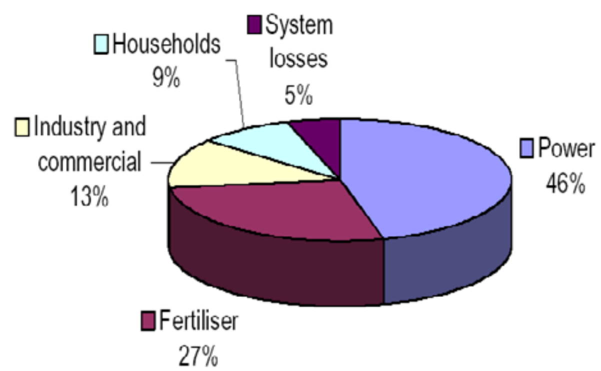

Figure 1: Gas Consumption in Bangladesh in 1998[2]

I. Introduction

LEAP – Long-range Energy Alternative Planning is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute (SEI). LEAP has been adopted by hundreds of organizations in more than 150 countries worldwide. Its users include government agencies, academics, non-governmental organizations, consulting companies and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications. The United Nations recently announced that more than 85 countries have chosen to use LEAP as part of their commitment to report to the U.N. Framework Convention on Climate Change (UNFCCC) [1].

II. Gas Sector of Bangladesh

Energy consumption in Bangladesh constitutes only 0.1 per cent of total world energy consumption. Consumption of commercial energy makes up about half of total energy consumption, somewhat less than other South Asian countries, but its absolute level is very low even in comparison with the low South Asian standard. The two most important energy intensive sectors are transport and industry, accounting for around 50% and 43% of total commercial energy use in the country.

Before the discovery of significant quantities of natural gas, energy supply depended on limited domestic hydroelectricity and coal or fuel-driven power generation based on imports. Gas is currently the only indigenous non-renewable energy resource in the country that is produced and consumed in significant quantities [3]. Gas production is concentrated in the hands of four suppliers: two of them are international oil companies and two are national companies. The International Oil Companies (IOC) produce a quarter of total production – Shell produces 16% of the total while Unocal accounts for the remaining 9%. The rest is produced by two Petrobangla firms. Total production has on average increased by 7.1% per year during the last decade and daily production is 900 million cubic feet. Arrangements with international oil companies are regulated through production sharing agreements. The IOCs cover all the costs of exploration and production.

About[1] - Bangladesh University of Engineering & Technology (BUET)
About[2] - Energypac Engineering Ltd.
E-Mail- asif038@gmail.com
About[3] - International Islamic University of Chittagong (IIUC)
E-Mail- alimul_buet@yahoo.com

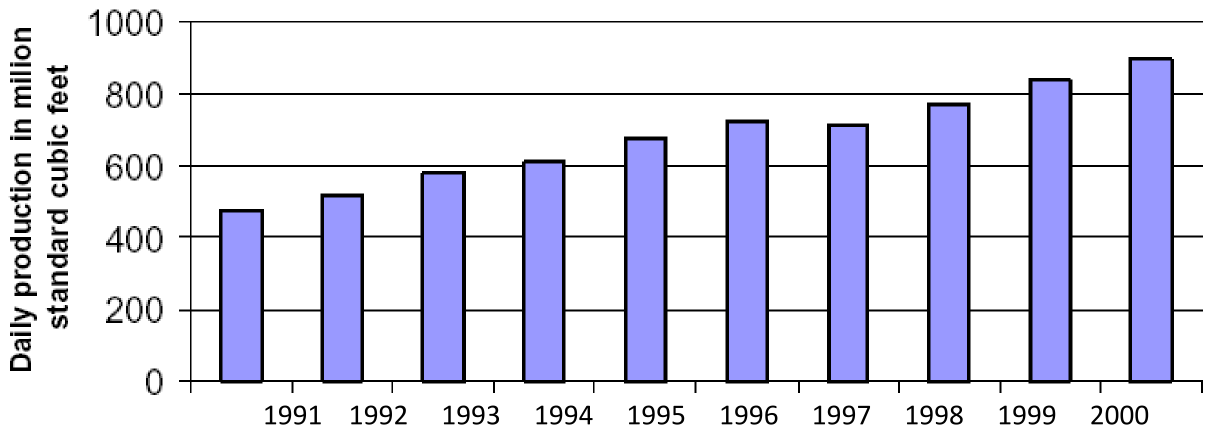

Figure 2: Yearly Gas Production in Bangladesh [2]

III. ENERGY FORECASTING

A state energy forecast is a measurement and estimate of historic, current and projected patterns of energy supply and demand within a state. The baseline or Business As Usual (BAU) forecast illustrates what state energy use will look like in the absence of additional policies beyond what is already planned.

There are six steps involved in creating a baseline forecast:

1. Define objectives and constraints of the forecast.
2. Compile historical energy consumption and generation data into a baseline profile.
3. Choose method to forecast the energy baseline.
4. Develop or review assumptions.
5. Apply the method.
6. Evaluate forecast output

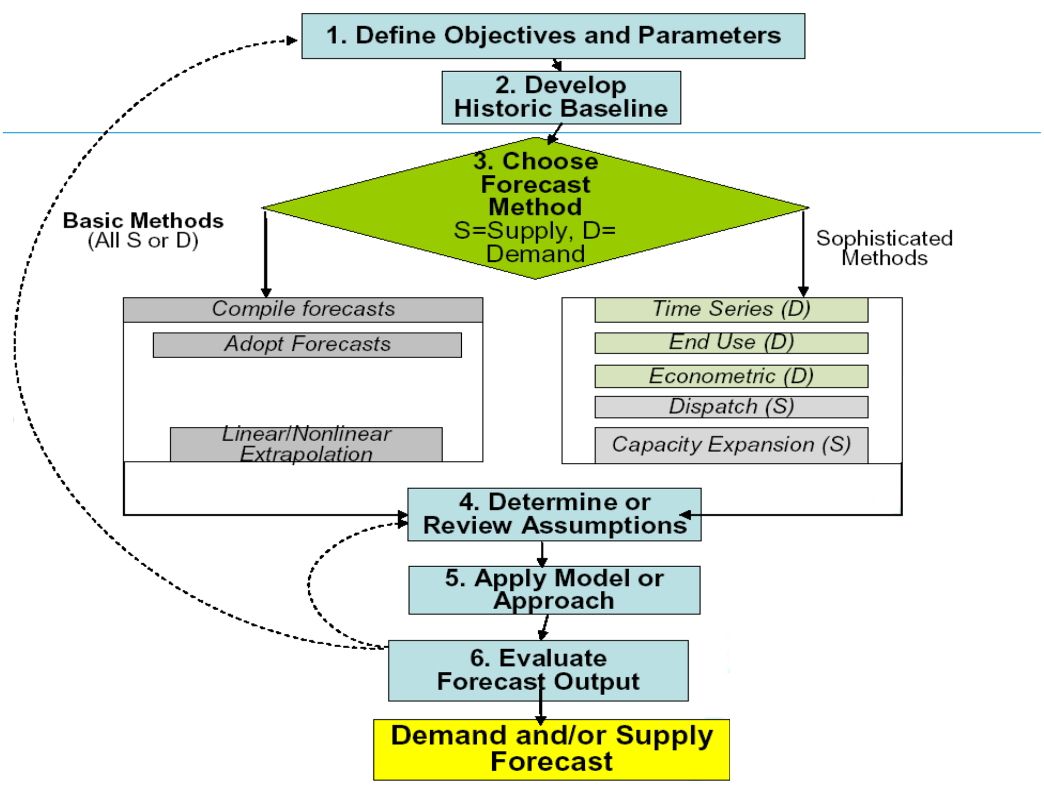

Figure 3: Flowchart Showing Steps to Forecast Energy [4]

IV. Background of LEAP

LEAP was created in 1980 for the Beijer Institute's Kenya Fuel wood Project, to provide a flexible tool for long-range integrated energy planning. It was designed by Paul Raskin, President of Energy Systems Research Group (ESRG was renamed Tellus Institute in 1990). LEAP provided a platform for structuring data, creating energy balances, projecting demand and supply scenarios, and evaluating alternative policies, the same basic goals as the current version of LEAP. Major funding was provided by Swedish SIDA, German GTZ, the Government of the Netherlands (DGIS), and US-AID [1]. The spread of the Internet in the mid-1990s allowed for much wider dissemination of LEAP. In 1991, the first major LEAP based study in an OECD country was conducted by Tellus, America's Energy Choices: An analysis of the potential for energy efficiency and renewable in the USA. In 1992, the first global energy study using LEAP was published by SEI-Boston, Towards a Fossil Free Energy. Meanwhile, studies continued throughout the developing world, including a World Bank sponsored project to integrate LEAP with an emission dispersion model for studying air quality in Beijing. By 2003, with the number of LEAP users approaching 500 with most in the developing world, a new project was launched to upgrade the support provided to these users and to foster a community among Southern energy analysts working on sustainability issues. With support from DGIS, a new web-based community called COMMEND was created, with the number of participating LEAP users growing to over 1500 in more than 130 countries by early 2006 [1].

V. LEAP Calculation Flows

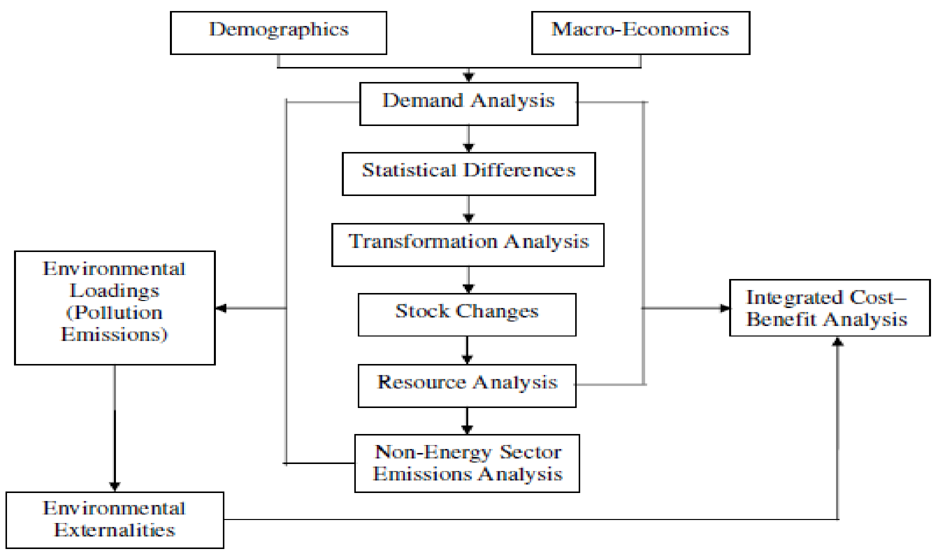

Figure 4: Flowchart Showing Data Calculation Flow in LEAP

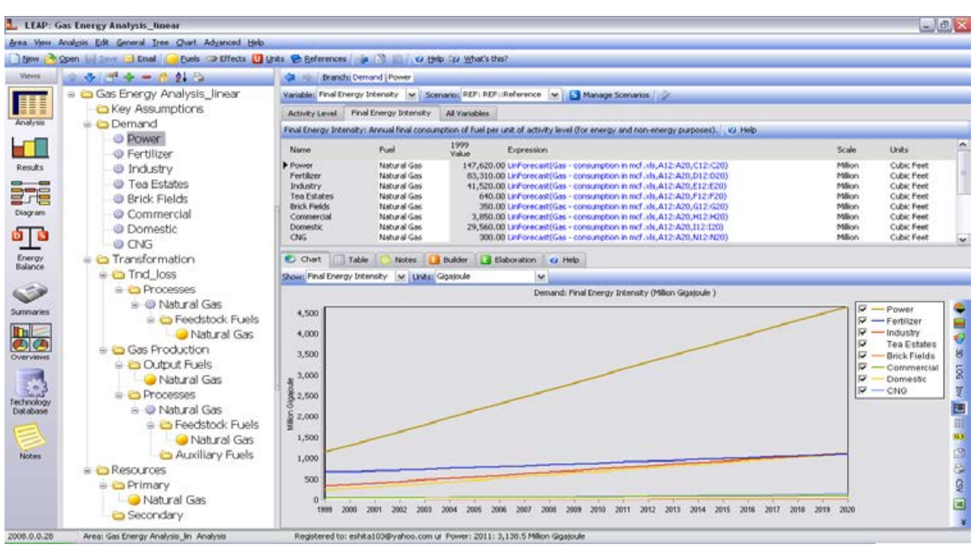

Figure 5: Analysis View of LEAP

Global Journal of Researches in Engineering Volume XI Issue I Version I February 2011

VI. Data Requirement

For Energy Planning & Mitigation Assessment, six types of data are required [11] as input to LEAP. These are:

1) Demographic Data
2) Economic Data
3) General Energy Data
4) Demand Data
5) Transformation Data
6) Fuels Data

VII. Time-Series Wizard

There are six types of Time-Series [11] Wizard available for energy forecasting in LEAP. These are:

1) Interpolation
2) Step-Function
3) Linear Forecasting
4) Exponential Forecasting
5) Logistic Forecasting
6) Smooth-Curve

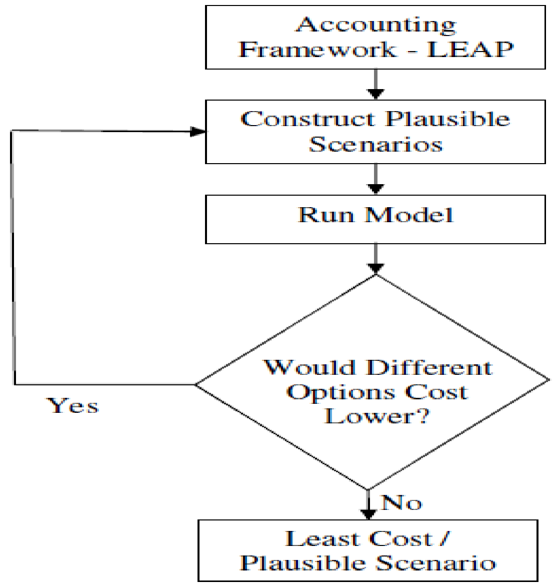

Figure 6: General Accounting Framework of LEAP

VIII. Accumulated Data

Sector-wise consumption of natural gas [5]-[10], [12]-[15] in BCF (Billion Cubic Feet)

Year	Power	Fertilizer	Industry	Tea Estates	Brick Fields	Commercial	Domestic	CNG
1993	97.3	74.5	20.26	0.70	0	2.87	15.4	0
1994	102.4	80.5	24.24	0.60	0	2.88	18.86	0
1995	110.9	90.98	27.31	0.72	0.99	3.00	20.71	0
1996	110.82	77.83	28.62	0.71	0.48	4.49	22.84	0
1997	123.55	80.07	32.32	0.74	0.39	4.61	24.89	0
1998	140.82	82.71	35.79	0.71	0.35	4.71	27.02	0
1999	147.62	83.31	41.52	0.64	0.35	3.85	29.56	0
2000	175.27	88.43	47.99	0.65	0.44	4.06	31.85	0
2001	190.03	78.78	53.56	0.72	0.53	4.25	36.74	0
2002	190.54	95.89	63.76	0.74	0.52	4.56	44.8	0.23
2003	199.4	92.8	46.59	0.82	0.12	4.83	49.22	1.94
2004	210.67	94.14	51.63	0.84	0	5.1	52.37	3.55
2005	233.6	98.91	68.98	0.8	0.1	5.5	59.45	4.5
2006	247.8	98.91	79.99	0.1	0.1	5.8	65.41	5.2
2007	268.3	107.3	86	4.5	0.1	6.3	72	5.6

IX. Analysis of Result

1. *Linear Forecast*

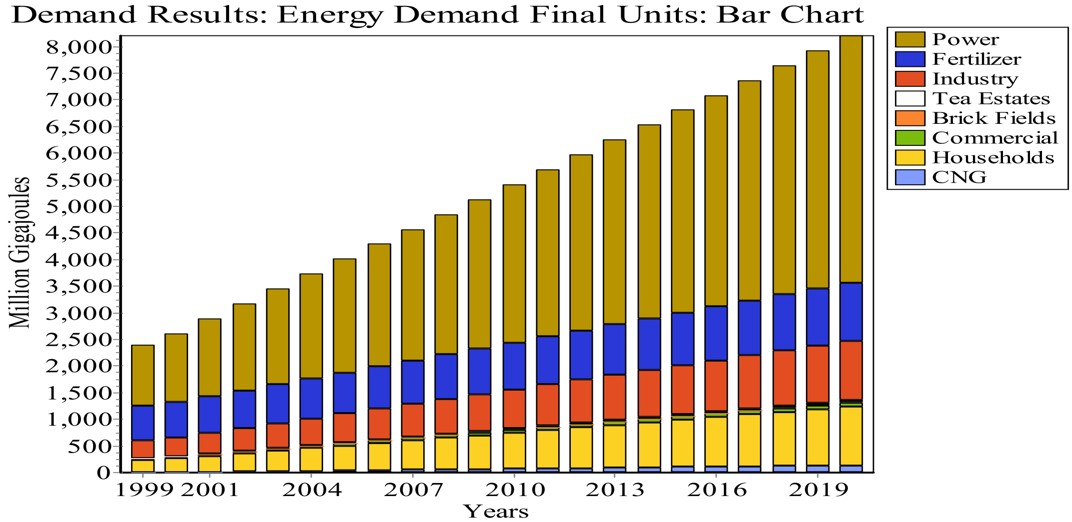

Figure 7: Demand Analysis (Linear Forecast)

Result in Tabular form (2010 - 2020)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Power	2,971	3,138	3,306	3,473	3,640	3,807	3,974	4,142	4,309	4,476	4,643
Fertilizer	879	900	922	943	965	987	1,008	1,030	1,051	1,073	1,094
Industry	735	773	811	849	887	925.5	964	1,002	1,040	1,078	1,116
Tea Estates	21	23	25	27	29	30.5	32	34	36	39	40
Brick Fields	4	4.1	4.2	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
Commercial	55	57	59.5	62	64	67	69	71	734	76	78
Households	678	720	762	804	846	888	930	972	1,014	1,056	1,098
CNG	64	71	77	84	90	97	103	110	116	123	130
Total Demand (Gigajoule)	5,407	5,687	5,966	6,246	6,526	6,806	7,085	7,365	7,645	7,925	8,204
Total Demand (Bcf)	676	711	746	781	816	851	886	921	956	991	1026

2. *Exponential Forecast*

As can be seen from the records, all forecasting procedures follows exponential pattern. Even the data collected for this work, also follows exponential trends and gives better forecasted approximation of data up to 2008 if exponential increment of energy demand is assumed. But the use of exponential trend results in an abrupt situation. The demand is so high which cannot be fulfilled by the generation. Particularly the demand in the CNG sector becomes the next to the demand of the power sector by the year 2020and much greater by the year 2030, which is definitely unacceptable. That's why linear approximation is a better choice.

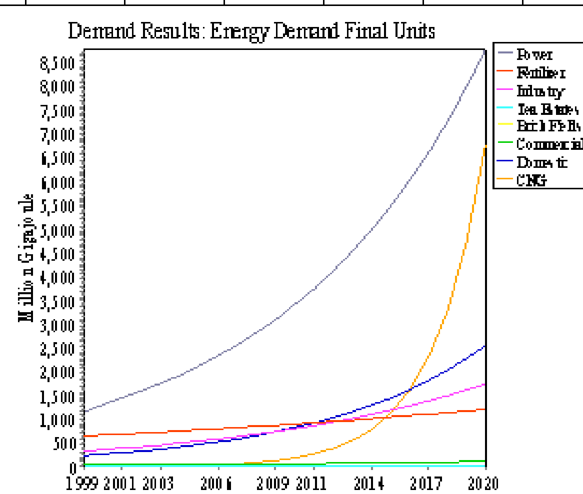

Figure 8: Demand Analysis (Exponential Forecast)

Linear vs. Exponential forecast (Year 2010)

Sectors	Linear Approximation (Giga joules)	Exponential approximation (Giga joules)
Power	4643.2	8755.8
Fertilizer	1094.5	1201.6
Industry	1115.9	1743.6
Tea Estates	39.6	11.6
Brick Fields	4.9	4.8
Commercial	78.3	107.2
Households	1098.5	2547.5
CNG	129.6	21140.2
Total	8204.5	35512.3

X. Conclusion

Among the six patterns in time-series wizard – Interpolation, Step Function, Smooth Curve, Linear Forecast, Exponential Forecast and Logistic Forecast; Logistic Forecast is the best way to achieve more accurate energy forecasting. But in case of the energy forecasting in a third world country like Bangladesh, the demand function of different economic parameters, which is the key factor of logistic forecasting, is unavailable. Rather the economic situation leaps and bounds due to unstable political scenario. That's why linear forecasting has been used in energy modeling of Bangladesh. But in stable political situation with demand functions into account, precise approximation can be made following the aforementioned guidelines.

XI. Acknowledgement

The authors would like to acknowledge Charlie Heaps (LEAP Developer and COMMEND Manager) for the software support. They are also grateful to Dr. Nurul Islam (Professor, Institute of Appropriate Technology, BUET), Dr. Jubair Bin Alam (Professor, Department of Civil Engineering, BUET), Masum Al Beruni (Chairman, WAPDA) & Dr. Ijaz Hossain (Professor, Head of Department of Chemical Engineering, BUET) for their consistent data and information source.

References Références Referencias

1. http://www.energycommunity.orgAnnual report of Petrobangla
2. 2007K.A.S. Murshid and Arne Wiig, "A Review of Development Trends in the Energy Sector of Bangladesh" Chr. Michelson Institute-Development Studies and Human Rights, Report R 2001:3
3. Denise Mulholland, "State Energy Forecasting - An Overview of Methods" USEPA, June19, 2008
4. Bangladesh Economic Review, 2007
5. Annual Report of Bangladesh Power Development Board (BPDB), 2007
6. www.reportlinker.com/d011002798/Tea-sector-in-Bangladesh.html?v=4
7. Report on Census of Manufacturing Industries (CMI)
8. Monthly Report of Rupantarita Prakritik Gas Company Ltd. (RPGCL), Number-34, March, 2009
9. Statistical Yearbook of Bangladesh, 2007
10. LEAP Training Exercises – Stockholm Environment Institute, January 2008
11. Annual Report of Bangladesh Bureau of Statistics, 2007
12. Statistical Pocketbook of Bangladesh
13. Agricultural Yearbook, 2007
14. http://energy.ihs.com/News/published-articles/articles/bangladesh-natural-gas-perspective.htm