Electricity Crisis and Load Management in Bangladesh

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Abstract: Bangladesh is a densely populated country. Only a small part of her area is electrified which cover around 18% of total population. The people who are in the electrified area are suffering from severe load shedding. A systematic load management procedure related to demand side may improve the situation is the research problem. The major objectives serve by the research are to analyze contemporary electricity status with a view to drawing inference about demand supply gap and extracting benefits from load management. Data supplied by the Bangladesh Power Development Board, World Bank and outcome of survey are analyzed with some simple statistical tools to test the hypothesis. Analysis discloses that with properly managed uses of electricity with load switch and rotation week-end can improve the concurrent condition of electricity. Moreover, introducing smart distribution system, reducing system loss, shifting load to off-peak, large scale use of prepaid mete, observing energy week and using energy efficient home and office appliance are recommended to improve load through demand side management. Some other recommendations such as introducing alternative energy, public private partnership and using renewable energy development and producing energy locally are made for load management from the supply side.

Keywords: load management; electricity; load switch; energy crisis

1. Introduction

Bangladesh is a country endowed with huge natural resources. There are lots of sources of energy from the nature. Electricity is a type of converted energy from another form of energy. According to Global Energy Network Institute (n.d.), Bangladesh has small reserves of oil and coal, but potentially very large natural gas resources. Commercial energy consumption is around 71% natural gas, with the remainder almost entirely oil (plus limited amounts of hydropower and coal). Only around 18% of the population (25% in urban areas and 10% in rural areas) has

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access to electricity, and per capita commercial energy consumption is among the lowest in the world. The rest of the total population in Bangladesh is still in the dark. Bangladesh's per capita electricity generation of 182 kWh p.a. is still among the lowest in the world. (Power, 2012) A large number of populations of Bangladesh are still leading their life in the dark. Over 80% of people depend on traditional energy sources such as firewood, cow dung and agricultural residues for their energy needs. (WEC, 2001) In the year 2008, the amount of electricity production of Bangladesh was 34957000000 (table 2). At the present production level of electricity, only proper management of its distribution and load may assure better consumer satisfaction through reduced load shedding. The main research problem of this paper is to manage the supply side of electricity as a tool for crisis management.

Electricity crisis means actual demand is higher than the actual supply. Officially the country's present power demand is about 5202 MW (table 1) and shortage 265MW (table 1) per day on an average. Load management is a program which reduces the demand of electricity at any specific time period. The prime objective of Load management system is "Manage the Peak". It is important for reduce cost factor of energy and run our less efficient power plant to meet high energy demand. By considering that demand for energy during peak is alarmingly increasing day by day. Due to this there is a significant gap between demand and supply of electricity and occur load shedding. Load management is a strong weapon to beat this peak. So it is a challenge for Govt. and power generation authority for ensuring adequate, reliable and quality power. Load management for electricity is a crying need to develop the sector in a sustainable manner. Only it can provide more benefit to our citizens and environment.

2. Rationale of the Study

This paper has done a bit of such work that an honest endeavors to find out the present status of electricity condition and importance of load management system in our power sector. A few studies are found on load management. Perhaps Bangladesh Load management to confront crisis by Khondkar A. Saleque and Managing Energy Crisis in Bangladesh by Sayed Javed Ahmad attempted to analyze the phenomenon of load management system in Bangladesh. Though electricity sue plays a vital role in the economic development of a country, enough research is not found thereon. Ferguson (2000) analyzed that correlation between electricity use and economic development in over 100 countries and found a strong correlation between the concerned variables for the global as a whole. Even no research or literature has been found to exist indicating the relationship between load management and demand and supply of electricity in the context of Bangladesh. The study paves the way for further research into electricity sector.

Further researcher pursues more exhaustive and in depth research studies in this area. This is what the authors of the present study strongly feel. According to BPDB, Annual Report (2009) the total number of consumers at the end of FY 2009 was 19,22,361 compared to 17, 83,295 at the end of FY 2008. This was about 7.80% increase over FY 2008.

3. Objectives of the Study

This research aims at exploring the electricity situation and improving the situation through load management system. Its specific objectives are:

1. to focus on the present status of electricity.
2. to identify the trend of demand-supply gap of electricity in Bangladesh.
3. to trace out the relationship between load management and demand and supply of electricity.
4. to show how can sound load management lead to improvement of electricity situation
5. to find out ways to solve the crisis in the electricity sector.

4. Scope and the Method of the Study

It is undoubted true that the scope of the study is very limited because it is very difficult and expensive to collect data from the Bangladesh Power Development Board (BPDB) office all over the Bangladesh. The country's per capita energy consumption in 1997 was about 77 Kgoe, and it was much below the world average of 1474 Kgoe (ADB, 2001). For this reason, we are able to collect data from some selected BPDB office in Chittagong. In spite of these apparent theoretical limitations, the relationship between demand and supply and load management of electricity are tried to disclose in our country.

The study is mainly based on secondary data. Information relevant to electricity crisis and load management in Bangladesh context has been gathered on perusal of research studies and available literature. Most of the data collected from Annual Report published by Bangladesh Power Development Board (BPDB), Rural Electrification Board and World Bank. Some data used in this study have been taken from various published articles, research papers and periodical magazines. These different web sites have been used as another source of information as well. All the data gathered there from have been analyzed with simple statistical tools to draw inference about the research hypothesis.

5. Key Concepts

5.1. Load Management

Load management is the process of balancing the supply of electricity on the network with the electrical load by adjusting or controlling the load. "Load management is the peak performers for peak performance" Mainly electricity peak hour occurs from 5pm at 11 pm. In this period, customer consumes more electricity in different purpose. So the generated electricity can't able to satisfy the electricity demand .Due to this create shortage of electricity which lead to load shedding. In this year 2009, load shedding was imposed on 351 days which varied up to 30.49% of maximum demand (BPDB Annual Report-2009). Load management is a means of controlling the amount of electricity being used at any one time when peak demand periods of electricity occur.

5.2. Electricity Crisis

Electricity is a vital part of functioning as a society. Human civilization is advancing tremendously from the diversified use of electricity. Its crisis occurs when the generation of electricity is less than the demand. Electricity crisis has become a common affair of our daily life which is called load shedding. It creates problems of far-reaching consequences in the economic and social development of the country.

6. Status of Electricity in Bangladesh

Electricity sector in Bangladesh is now in a sickbed. People are suffering a lot of due to load management in every alternative hour. Reliable and efficient electricity is now a "Golden deer" to residential and commercial users. It is true that no noticeable as achieved during the last all most 39 years after our liberation. Bangladesh took this time to reach a power generation capacity of 3800MW-4000MW. People are hearing day to day new energy generation plant is coming but yet there are no strategic plans to effectively deliver huge amount of new generation electricity to consumers.

Bangladesh fails to make any visible progress on installation of nuclear power plants since signing of a protocol deal with Russia on October 21, 2009 on cooperation for peaceful use of nuclear energy. At present over 80% Bangladesh's power plant are run by natural gas and the remaining 20% by hydro, coal and liquid fuel. But recently a panic situation was observed among gas sector. It is unfortunate that as a nation we have not been able to resolve this problem even after thirty eight years of our independence. Governments come and go and this issue remains a struggling issue. The country faces the gas shortage of 300 million cubic feet per day. Three fertilizer plants and Raujan power plant, Sikalbaha 56

MW gas turbine and 60MW thermal power plant cannot be run in full capacity for want of gas.

It is true that Bangladesh is in the grips of a massive energy crisis but we must not forget that in a developing low income economy this is not an unusual phenomenon. On the positive side, a number of small, medium and large scale power generation plants were established and some of them successfully operated.

An inter-country electricity grid would be established to import electricity from India at an investment of Tk.11 billion. Bangladesh would initially import around 250MW of electricity. To ensure adequate power supply Government organization continuously pursuing the reform program for the last few years such as removing all barriers for implementation of the new generation plant, renewable energy development, Energy Efficiency Measures.

The demand of electricity is not fixed. Higher purchasing power drives an economic entity to the consumption of superior commodities. Therefore the demand is expected to increase with the growth of the economy (Cleveland; Kaufmann & Stern, 2000). It varies over time and based on people's activity. For modeling the demand in the in the domestic sector, several characteristics of the household such as the size of the location, geographical location of the household, age of the household members etc. also need to be considered (Baker, Blundell & Micklewright, 1993). So, a credible and realistic demand forecast is necessary for any country for the sake of stable and healthy economy. There are several factors directly contributing to the change of electrical energy demand over time. Such as: economic factors, technological factors, environmental factors and demographic factors.

Economic factors - Income and price are the two main factors that driving the electricity demand. When income increase that leads to higher purchasing power. Higher purchasing power drives to consumption of superior commodities.

Environmental factors - Electricity demand is dependent upon temperature, humidity and wind speed. Climate Change often plays a significant role in the economies of energy. Energy demand is dependant on weather variation (Considine, 2000).

Technological factors - By using modern newer technologies in the production may influence energy demand. So, technology is another important factor regarding the variation of electricity demand.

7. Load Management in Bangladesh

Load management can make the electricity demand-supply trade off. Properly managed use of electricity can eradicate the sufferings of load shedding. The cost of load shedding is not only physical sufferings but also financial. Because of shortage in power supply, countrywide financial operations are hampered. Load management is a technique that can be able to spread evenly the surplus of off-peak period for peak period use. Load management can be implemented either weekly basis or day basis.

7.1. Load Management by Week-round equal electricity distribution

Load management is a technique to reduce the load shedding minimum. Load shedding is the fulfill demand due shortage of supply. According to Table 3, demand for electricity on Friday is only 5,100 MW which is topped on Wednesday and Thursday at 5,300MW. Furthermore, if load shedding is considered, table 3 again depicts that on two Fridays' load shedding are 0 MW and 98 MW respectively. But in other days of the week suffer load shedding for larger MW of electricity. In 7-day week, the demand for electricity is not equal. During weekends the consumption of electricity is slow down than that of other days of the week. On the weekend all Governments and autonomous organization remain closed. Moreover, a good number of private offices including bank and educational institutions remain closed. As a result, the shortage of electricity is reduced at the end of any week which is displayed in table 3. If the rotational holiday policy can be introduced, electricity shortage may be reduced to some extent as the figure 2 depicts. Excess load shedding from Monday to Thursday during the week can be plateau over the week through rotational weekend policy for different institutions including Government organization, Financial Institutions, Educational Institutions, Shopping mall and Factories etc.

7.2. Load Management by Load Switch

The daily electrical load is not even throughout the day. It varies from time to time. Figure 4 depicts that, at 6.00 pm electricity load starts to increase and it reaches at the peak at 9.00 pm. From table 1, of the total users of electricity, around 77.78% is domestic users; 1.31% is agricultural uses; 2.03% is small industrial users and 17.37% is small commercial users. The rest is the other users including 0.13% of large and Industrial and Commercial users. Domestic load can me managed with planned uses. Some appliance can be kept switch off in the peak period. Air conditioners, woven, coffee heater, washing machine etc. should keep off during peak hours of the day. Load switch is a device that will keep some specific device switch off for a pre specified period of time. This device helps to adopt the planned use of electricity and easily speared out limited electricity throughout the day evenly to ensure balance consumption.

8. Hypothesis of the Study

The hypothesis of the study is set as an improvement of electricity management is obtainable in terms of lower shortage from the proper load management even only demand side. The amount of electricity saved from proper management and efficiency in supply can reduce the shortage of electricity to a great extent.

9. Analysis and Findings

Data are analyzed and sorted out for inferring some conclusion and recommendation about the research problem. According to Temple (2002), the coverage of energy sector in Bangladesh is limited, service quality is low, theft of power and gas is rampant, and utilities are bankrupt and live on state subsidy.

9.1. Daily Load Management

Day wise average maximum electricity generation is 4938 MW (table 1) against the daily average demand of 5202 MW (table 1). The shortage is on an average 265 MW (table 1) which includes system loss. If it is assumed that the supply side is constant, electricity situation could be improved by managing load of electricity. Scattering daily peak among the off-peak, load shedding and shortage can be reduced. Some office and household appliance can be kept switch off during peak. From the survey on five hundred and fifty people, it reveals that 38.76% electricity (table 4) is consumed by households. Industry consumes 41.23% (table 4) and agriculture uses 7.55% (table 4). Of the household's consumption, lighting, fans & A/C and refrigeration consume 40%, 27% and 22% respectively (table 4). Industrial uses consist of motor, lighting and other uses which could be minimized to some extent during peak. Agricultural uses electricity widely for irrigation and rice husking as the survey reveals. Peak hour electricity demand can avoid agricultural consumptions. Begin strategic about electricity use, people can save 2.92% electricity that can be scattered while peak demand arises. Another way of handling dialing peak is to use load switch as the figure 2 reveals. Use of this switch can reduce electricity consumptions by some households and official appliances.

9.2. Weekly Load Management

From the analysis of data another fact is disclosed from figure 1. A Friday to Friday load shedding diagram depicts that the amount of weekend load shedding is negligible. This is because of no industrial consumption and no public and other consumption which is around 44% (table 4) of total daily electricity consumption. Using rotational holidays may be an effective to scatter other day's load shedding to the weekend. As the arrow in figure 1 indicates, maximum load shedding of

around 500MW and minimum 0 MW load shedding will be adjusted at straight on an average throughout the week.

9.3. Test of Hypothesis

The table 5 from the output listing of SPSS (Statistical Package for Social Sciences) contains the t-value (9.736) and the 2-tail p-value (0.00). The 95% confidence interval of 95.03373 to 150.54962 is also shown in the table 5. Since the p-value of 0.00 is less than 0.05 the difference between the mean is significant. In other words, using load management has reduced the electricity shortage.

10. Recommendations

A. Smart Distribution System

According to BPDB Annual Report (2009), the total length of distribution lines of 33 KV is 3,763 km, 11 KV is 9,449 km. and 0.4 kV is 15,965 km. i.e. Total distribution lines are about 29,177 km at the end of FY 2009. Efficient distribution line and its proper maintenance can reduce system loss to a good extent. Moreover, illegal use of electricity should be stopped. The smart distribution system can reduce the system loss to a great extent. According to Khan S. I. & Islam A. (2012), the concept of smart grid refers to a “Digital Upgrade” of distribution and long distance transmission grids to optimize current operations by reducing the losses, as well as open up new markets for alternative energy production.

B. Reducing System Loss

System loss is slicing a good quantity of electricity both in production and distribution line. The system loss is increasing day by day. It is estimated that the total transmission and distribution losses in Bangladesh amount to one-third of total generation, the value of which is equal to US$247 million per year (Alam et al., 2004). Proper concentration and some corrective measure are very emerging for improvement of the supply side of electricity. Reduction in system loss is the only supply side management for load management in a state fixed electricity generation plant. According to the BPDB annual Report (2009), Distribution loss in BPDB's own distribution zones has decreased to 13.57 % from 14.43% in FY 2009. In addition, taking some initiatives, this distribution loss may be decreased to some more extent.

C. Alternative Energy

Alternative energy sources such as solar energy, wind energy and nuclear energy are a permanent solution to the load management problem. According to the World Bank funded market survey, there is an existing market size of 0.5 million households for Solar Home System (SHS) on a free-for-service basis in the off grid

area of Bangladesh. This assessment is based on current expenditure levels on fuel for lighting and battery charging being substituted by SHS (World Bank, 1998). Moreover at present the national grid is serving only 50% of the nearly 10,000 rural markets and commercial centers in the country which are excellent market for centralized solar photovoltaic plants (World Bank, 2000).

D. Shifting Load to Off-peak

The maximum amount of load shedding occurs during evening peak period. Proper load management and using the load management switch which can automatically control power supply to some special device like Air Conditioner, TV, Excess lighting in households, shopping mall and industries can reduce load shedding.

E. Large Scale Use of Prepaid Meter

Prepaid meter can implement budgetary control on the electricity bill of households and commercial use. To keep control over expenditure, people may feel interested in using the prepaid meter. Moreover, the use of the meter will be helpful to limit the consumption of electricity use. It can ensure reduction of system loss and can save few MW of electricity in the national grid. From the consumer's perspective, prepayment systems may result in a better understanding of how much energy is being consumed, inducing more control of energy use and budget management (Tewari & Shah, 2003)

F. Public Private Partnership (PPP)

In the power sector, the role of the Bangladesh government should be limited only to electrical regulations, electrical safety, consumer protection, monopoly prevention, nuclear energy development; support for oil, gas and coal exploration required to meet the energy needs of Bangladesh. The policies created should be those which encourage local technical innovations by private enterprises, growth of local expertise and electrical industries, support for the free market economy and increase in employment opportunities in electrical power industries in Bangladesh. (Ahmed, 2009)

G. Energy week

Celebration of energy week can play a vital role in load management. Most of households and official users are not conscious about savings of electricity from proper utilization. A nice percentage of electricity losses is achieved due to unconscious use. A switched on fan or light or AC room without a man can some a good quantity of electricity. It can serve the crisis moment of electricity during the peak. To make the mass people conscious about proper utilization of electricity and saving therefrom with a bit care some program like observing 'energy week' may be an effective tool.

H. Renewable Energy Development

Some alternative energy sources have to be explored. Limited supply of natural gas which is largely being used for electricity production is limited in supply. Moreover, production of electricity in hydroelectric plant is hampered due to less water flow and some unsettled issues between Bangladesh and India for sharing water of important rivers lay between the countries. BPDB has taken a number of steps in the development of Renewable Energy and implementation of Energy Efficiency Measures. Under the Hill Tracts Electrification Project BPDB has implemented three solar projects in the Hill Tracts area. Some wind based and atomic electricity plants may be established as an alternative energy sources.

I. Energy Efficient Home and Office Appliance

Using energy efficient office and household appliance can save a good amount of electricity during peak. There is some energy efficient office equipment widely available in the market. Use of these appliances can play a role in load management during the peak. Electronic appliances with energy star level are being used in many developed countries as a mechanism of load management. ENERGY STAR-labeled office equipment is widely available. It can provide dramatic energy savings—as much as 90% savings for some products (Energy Savers, 2012).

J. Local Energy Production

A considerable quantity of electricity is lost during transmission. If the distribution distance could be minimized by local production setup, transmission loss may be avoided to a good extent. In 1998, Bangladesh also adopted a Small Power Generation Policy to encourage development of small local generations' projects of up to 10 MW in capacity in undeserved areas (Alam et al., 2004).

11. Concluding Remarks

With the present level of electricity production Bangladesh may improve her electricity situation using the proper load management system. There some widely used mechanism for management load of electricity during. Some require huge investment and technical know-how which are not feasible to apply in developing countries like Bangladesh. As the supply side is not improvable over night, concentration goes to demand side for improving electricity crisis. Some artificial crisis is manageable with proper tools that even do not require huge investment. The research discusses about these mechanisms. This research is helpful and contributory one for policy making about electricity in Bangladesh. But it cannot be staid this is an absolute in aspect. There some other area that can be a good field for further research. Especially public private partnership in the energy sector is a very important area for researchers where one can contribute.

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Annexes

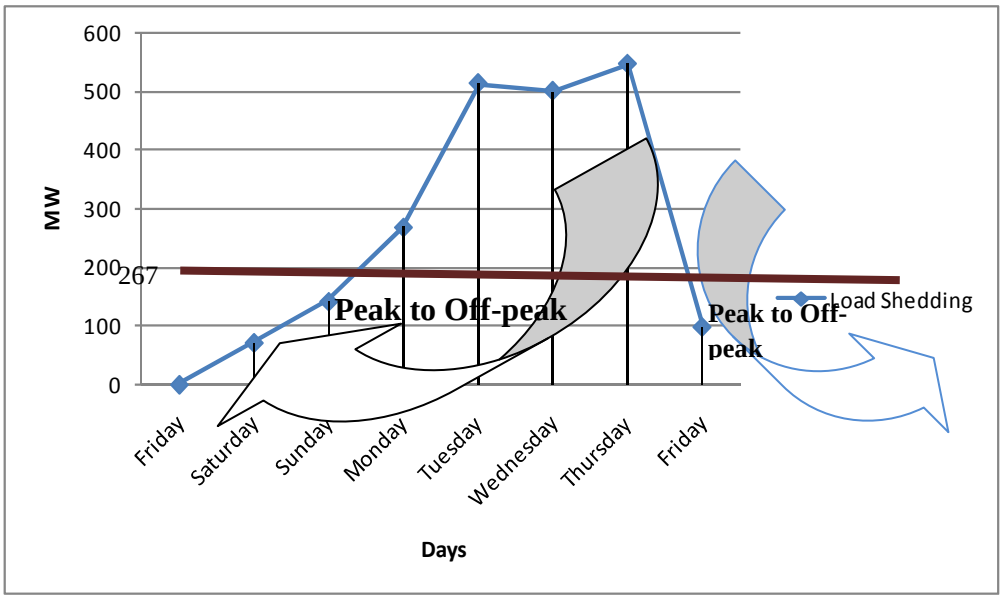

Figure 1. Week-round Load

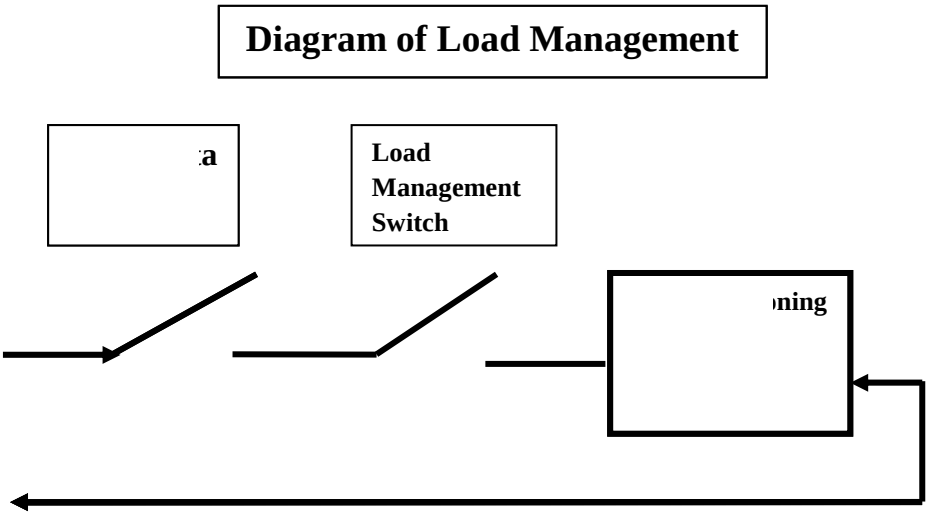

Figure 2. Block Diagram of How a load Management Switch Works

Source: Load Management in Apex, North Carolina)

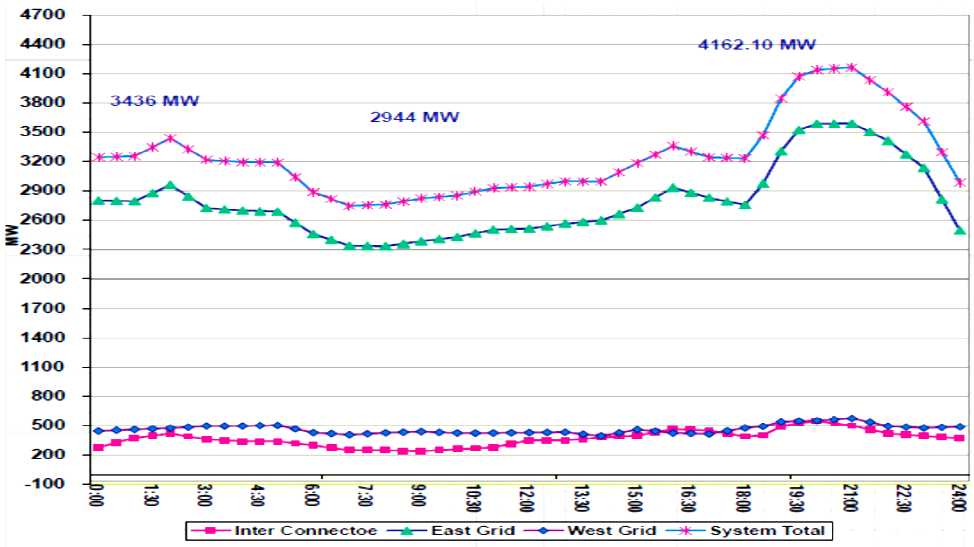

Figure 3. Daily Load Curve

Table 1. Day-wise Electricity Generation, Demand, Load Shedding, Shortage (MW)

Column Number		1	2	3	4=(2+3)	5	6	7	8	9	10	11	12	13
Date	Days	Minimum Generation (at 4:00)	Maximum Generation (Probable)	Shortage	Maximum Demand (Probable)	Load Shedding	System Loss	Evening Peak Deamand	Evening Peak Generation	Day Peak Generation	Maximum Generation	Total Generation (MKWH)	Shoratge after load management	Savings for load management
31/1/2012	Tuesday	3027	4998	202	5200	190	12	5200	4933.5	4068	4933.5	94.35	57.94	144.06
1/2/2012	Wednesday	3027	4927	273	5200	251	22	5100	4908	4374	4908	96.27	129.69	143.31
2/2/2012	Thursday	3111	4934	266	5200	242	24	5150	4923	4330	4923	95.85	122.25	143.75
3/2/2012	Friday	3012	5166	(66)	5100	0	---	4916	4916	3787	4916	88.22	-209.55	143.55
4/2/2012	Saturday	2889	5047	78	5125	71	7	5100	4947	3996	4947	92.33	-66.45	144.45
5/2/2012	Sunday	2965	4947	153	5100	141	12	5100	4936	4010	4936	90.72	8.87	144.13
6/2/2012	Monday	2921	4910	290	5200	267	23	5200	4869	4340	4869	94.55	147.83	142.17
7/2/2012	Tuesday	3119	4690	560	5250	512	48	5250	4738	4202	4738	94.29	421.65	138.35
8/2/2012	Wednesday	3063	4757	543	5300	499	44	5300	4858	4231	4858	95.17	401.15	141.85
9/2/2012	Thursday	3165	4700	600	5300	545	55	5300	4804	4136	4804	94.54	459.72	140.28
10/2/2012	Friday	3165	5091	109	5200	98	11	5064.5	5064.5	3982	5064.5	90.20	-38.88	147.88
11/2/2012	Saturday	2940	5084	166	5250	149	17	5200	5089	4208	5089	92.89	17.40	148.60
Average		3034	4938	265	5202	247	25	5157	4916	4139	4916	93	121	144

Table 2. Electricity Statistics from World Bank

Categories	Domestic		Agriculture		Industrials								Others		Total	
Year	Domestic	Domestic Users in %	Agriculture	Agricultural Users in %	Small Industries	Small Industrial Users in %	Small Commercial	Small Commercial Users in %	Large Inds. & Com.	Large Inds & Com. Users in %	Sub Total of Industrial Users	Sub Total of Industrial users in %	OTHERS	Other Users in %	Total	Growth of Users Percentage
1989-90	815,059	69.39	10,705	0.91	47,454	4.04	281,818	23.99	2,975	0.25	332247	28.29	16,463	1.40	1,174,572	1.99
1990-91	853,959	69.77	12,828	1.05	48,479	3.96	287,498	23.49	3,251	0.27	339228	27.72	17,851	1.46	1,223,964	4.21
1991-92	606,627	67.18	11,675	1.29	35,943	3.98	231,450	25.63	1,294	0.14	268687	29.75	15,914	1.76	903,001	(26.22)
1992-93	649,173	68.15	16,670	1.75	36,969	3.88	230,096	24.15	1,375	0.14	268440	28.18	18,228	1.91	952,609	5.49
1993-94	708,118	69.03	17,854	1.74	38,395	3.74	237,922	23.19	1,437	0.14	277754	27.08	22,025	2.15	1,025,849	7.69
1994-95	750,273	69.75	17,974	1.67	39,702	3.69	245,234	22.80	1,486	0.14	286422	26.63	20,967	1.95	1,075,734	4.86
1995-96	811,370	70.15	19,807	1.71	41,313	3.57	260,167	22.49	1,514	0.13	302994	26.20	22,403	1.94	1,156,672	7.52
1996-97	858,354	70.93	17,878	1.48	42,248	3.49	267,197	22.08	1,595	0.13	311040	25.70	22,762	1.88	1,210,132	4.62
1997-98	923,117	71.36	18,387	1.42	43,856	3.39	283,032	21.88	1,714	0.13	328602	25.40	23,459	1.81	1,293,663	6.90
1998-99	963,319	72.06	17,142	1.28	43,742	3.27	287,636	21.52	1,748	0.13	333126	24.92	23,185	1.73	1,336,870	3.34
1999-00	1,043,977	72.86	17,872	1.25	44,793	3.13	299,896	20.93	1,801	0.13	346490	24.18	24,380	1.70	1,432,817	7.18
2000-01	1,134,074	73.51	18,293	1.19	45,816	2.97	316,629	20.53	1,890	0.12	364335	23.62	25,850	1.68	1,542,650	7.67
2001-02	1,221,324	74.26	17,215	1.05	46,068	2.80	331,224	20.14	1,999	0.12	379291	23.06	26,827	1.63	1,644,755	6.62
2002-03	1,270,727	75.17	15,084	0.89	44,432	2.63	331,997	19.64	2,038	0.12	378467	22.39	26,075	1.54	1,690,451	2.78
2003-04	1,359,724	75.75	14,284	0.80	44,018	2.45	347,635	19.37	2,183	0.12	393836	21.94	27,016	1.51	1,794,958	6.18
2004-05	1,114,679	76.38	12,484	0.86	34,472	2.36	273,957	18.77	1,867	0.13	310296	21.26	21,767	1.49	1,459,324	(18.70)
2005-06	1,165,265	76.72	14,911	0.98	34,574	2.28	280,079	18.44	2,010	0.13	316663	20.85	21,954	1.45	1,518,891	4.08
2006-07	1,272,144	77.17	17,693	1.07	35,561	2.16	297,213	18.03	2,163	0.13	334937	20.32	23,539	1.43	1,648,411	8.53
2007-08	1,385,424	77.69	21,191	1.19	37,065	2.08	312,041	17.50	2,299	0.13	351405	19.71	25,177	1.41	1,783,295	8.18
2008-09	1,495,195	77.78	25,175	1.31	39,114	2.03	333,818	17.37	2,534	0.13	375466	19.53	26,427	1.37	1,922,361	7.80

Table 3. Number of Consumers (Category wise)

Consumer Category	Consumption	Consumption Pattern (MW)		In %	Savings from Load Managemen
i) Households	38.76%	Lighting	759.81	40%	37.9905
	(1899.52 MW)	Fans & A/Cs	512.87	27%	25.6435
		Refrigeration	417.9	22%	10.4475
		Others	208.95	11%	20.895
ii) Agriculture	7.55%	Pumps	147.94	40%	14.794
	(369.85 MW)	Rice Husking	184.93	50%	18.493
		Lighting	36.99	10%	1.8495
iii) Industry	41.23%	Motors	1414.15	70%	
	(2020.21 MW)	Lighting	161.62	8%	4.0405
		Others	444.45	22%	
iv) CELL	9.44%	Lighting	300.87	65%	7.52175
	(462.88 MW)	Others	162.01	35%	
vi) Public and others	3.02%	Lighting	59.02	40%	1.4755
	(147.54 MW)	Water Pump	44.26	30%	
		Others	44.26	30%	
Total	4900	Total	4900		143.15075
Savings from load management in percentage					2.92%

* Source: Work out

Table 4: Composition of Electrical Demand by Different Sectors

Details		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Shortage before load management - Shortage after load management	122.79167	43.68787	12.61160	95.03372	150.54962	9.736	11	.000

Table 5. Paired Samples Test

Indicator Name	1999	2000	2001	2002	2003	2004	2005	2006	2007
Electricity production from coal sources (kWh)	0	0	0	0	0	0	58000000	343000000	275000000
Electricity production from coal sources (% of total)	0	0	0	0	0	0	0.218818381	1.147963453	0.878987407
Electricity production from oil, gas and coal sources (% of total)	94.23529412	94.0016486	94.29047838	94.28877578	94.28774351	95.0332199	95.1218592	95.35125004	95.55072556
Electricity production from hydroelectric sources (kWh)	833000000	946000000	993000000	1066000000	1126000000	1226000000	1293000000	1389000000	1392000000
Electricity production from hydroelectric sources (% of total)	5.764705882	5.998351404	5.709521619	5.711224216	5.712256494	4.9667801	4.878140798	4.648749958	4.449274436
Electric power transmission and distribution losses (kWh)	2286000000	2417000000	2413000000	2372000000	2271000000	2038000000	1966000000	1778000000	1602000000
Electric power transmission and distribution losses (% of output)	15.8200692	15.32559762	13.87419503	12.70827752	11.52090097	8.256360395	7.417188561	5.950667693	5.120501183
Electricity production from natural gas sources (kWh)	12278000000	13797000000	15227000000	16341000000	17257000000	22011000000	23629000000	26507000000	27976000000
Electricity production from natural gas sources (% of total)	84.96885813	87.48335553	87.55174793	87.54888829	87.54565747	89.17112299	89.14585377	88.71448174	89.42018794
Electricity production from oil sources (kWh)	1339000000	1028000000	1172000000	1258000000	1329000000	1447000000	1526000000	1640000000	1643000000
Electricity production from oil sources (% of total)	9.266435986	6.51829307	6.738730451	6.73988749	6.742086039	5.862096905	5.757187052	5.488804846	5.251550214
Electricity production (kWh)	14450000000	15771000000	17392000000	18665000000	19712000000	24684000000	26506000000	29879000000	31286000000
GDP per unit of energy use (PPP $ per kg of oil equivalent)	5.832800976	5.988118461	5.932468398	6.131268154	6.305249491	6.634668991	6.856861646	7.100507036	7.454695721
GDP per unit of energy use (constant 2005 PPP $ per kg of oil equivalent)	6.722865962	6.755718931	6.54456089	6.655745107	6.700194693	6.855912622	6.856861646	6.8768359	7.013592933
Electric power consumption (kWh)	12164000000	13354000000	14979000000	16293000000	17441000000	22646000000	24540000000	28101000000	29684000000
Electric power consumption (kWh per capita)	95.61777466	103.0462657	113.5249326	121.3482793	127.7590715	163.3516875	174.5526902	197.4029427	206.200742