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Towards Power to All: A Case Study on Misuse of Power in Lucknow, India

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Abstract: Nowadays, power crisis term is very common to make us realize that we have deficit amount of electrical energy. On the other hand, 'misuse of power' and 'electricity theft' are also being heard by everyone. Various articles have been published dealing with electricity theft and how to minimize it. 'Misuse of power' is either not in focus or has less priority. To give a clear picture of the present scenario regarding the misuse of power, a thorough study is needed. In this paper, an attempt has been made through a case study to analyze how much power is misused showing the real facts and figures about the current distribution sector of lighting in Lucknow, the capital of Uttar Pradesh (a state in India) and to find out the proper initiatives which might be taken for making the present situation better.

Keywords: Case study, misuse of power, over lighting, power crisis, people in dark.

1. Introduction

An easy way to satisfy increasing demand for more electricity would be to build new energy generating plants. The costs of these plants are huge in terms of financial commitments and adverse effects on the environment. Increasing demands for energy places a huge burden on the electricity supply grid. Therefore, it makes sense to implement steps to manage these demands for more energy. The smart thing to do is to reduce consumption - this ensures an adequate supply of cheap energy for the future. Reducing demand and consumption can reduce the stress on the generation and T&D systems at a fractional cost compared to the investment required to increase capacity. Energy management schemes could be formulated that would educate the consumer public on efficient ways in which energy could be consumed. Having an effective energy management program costs much less than building a new energy generating plant.

Demand side management provides a range of technical, organisational and behavioural solutions to cut or decrease electricity consumption and demand [1]. In view to this, various demand side management initiatives and policy measures relevant to the Indian energy scenario are discussed [2]. Sonavane *et al.* (2008) discussed one of the successful demand side management measures that were implemented by the state utility of Maharashtra in India [3]. Moreover, the electrical load management techniques on the supply side and demand side have been reviewed [4]. The scope and benefits of energy efficiency for the developing world is discussed [5]. The benefits of shift in the focus from supply augmentation to demand management through a case study of replacement of inefficient devices with efficient ones for residential lighting has been investigated analytically [6].

India is a developing country where backbone of the development is electrical power. With a long term vision of shining and electrically developed India, several mega projects are under development and many are proposed in the country. Most of mega projects are scheduled for 2012-2017. Some were proposed in 2007-2012. In all of these plans and proposals, we have missed one important aspect *i.e.* 'present'. This 'present' surrounds not only the current status but the near future also. To compromise with the present is not a genuine solution to the power crisis. In Uttar Pradesh, a high populated state of India, the power crisis is on its peak. The rural and urban populations of Uttar Pradesh are 131,658,339 and 34,539,582 respectively [7-8]. It is observed that most of the population reside in 97,942 villages [9], and thus, an average population of a village is 1,344 in Uttar Pradesh.

Even with the scarcity of electricity supply in Uttar Pradesh, some cities have almost 22-24 hrs uninterrupted supply and most other cities with 20-22 hrs supply. Lucknow, the capital of Uttar Pradesh, is supplied continuously. For taking the steps to properly manage the power in Uttar Pradesh, real time data from the present distribution system is required and for this Lucknow city was selected for this case study.

2. Misuse of Power

At a time when the entire state is reeling under power crisis, it can easily be seen lights ON during the day hours and over lighting at night in various places in Lucknow as shown in Figures 1-2.

Figure 1. Images showing lights ON during day hours.

Figure 2. Image showing over lighting at night.

Tariff policy in Uttar Pradesh does not motivate stopping the wastage of electricity. Data provided by the Central Electricity Authority, New Delhi, India [10], as Table 1 shows, there is no criterion for operating timings for the users. If the rate of electricity is the same at all times, the user will use electricity in the necessary hours and in unnecessary hours as well. Moreover, at present there are a large number of hoardings in Lucknow. These are using electrical illumination much more than necessary as seen in Figure 3. The hoarding lights are switched ON in the evening and remains ON until morning.

Figure 3. A big sized hoarding with a large number of illumination lamps.

Table 1. Tariffs effective from 10-05-2007 in urban areas [10].

Domestic 1 kW (100 kWh/month)	249.00 paise per kWh
Domestic 4 kW (400 kWh/month)	359.00 paise per kWh
Domestic 10 kW (1000 kWh/month)	359.00 paise per kWh
Commercial 2 kW (300 kWh/month)	452.33 paise per kWh
Commercial 10 kW (1500 kWh/month)	452.33 paise per kWh
Commercial 30 kW (4500 kWh/month)	452.33 paise per kWh
Commercial 50 kW (7500 kWh/month)	452.33 paise per kWh

3. Experimental

The methodology in this case study has the following steps:

- Surveying
- Sampling
- Interview questions
- Data collection
- Analysis
- Conclusions
- Recommendations

The survey data were obtained in March, 2010. For the municipal case, Gomati Nagar, and for the commercial lighting case, Hazratganj were choosen as sample places in Lucknow. Some interview questions to the local residents and the shop keepers were asked regarding time schedules of street lights and shining hoardings. Other related data were also gathered. Drawing on the data from the interviews, some simple but vital calculations were made to analyze the present scenario.

The various distances provided in the data are approximate distances. The operating hours provided here are obtained from the timing of operation of lights in March and are sufficient to analyze the present conditions of distribution. Furthermore, the winter operating hours will be more than that of summer. Illumination level is here on the basis of normal eye view under such poles/ hoardings or between the poles.

The classification of small, medium and big sized hoardings are made based on the number of lamps used per hoarding. Hoardings, in which the lamps used are ranged from one to two, are considered as small sized hoardings. Hoardings, in which the lamps used are more than two but not more than eight, are considered as medium sized hoardings. Hoarding, in which the lamps used are more than eight, are considered as big sized hoardings. The municipal and commercial sector data obtained from the survey are summarized in Table 2.

Table 2. Municipal and commercial sector data obtained from the survey (Present scenario).

Place	Gomti Nagar			Hazratganj		
Survey Point →	Roads		Over Bridge	Hoardings		
	(1)	(2)		Big Size	Medium Size	Small Size
Type of Lamps	Mercury	High Pressure Sodium Lamp	Mercury	Mercury	Mercury	Mercury
No. of Lamps	12	10	36	24	8	2
Wattage (Each)	400 W	250 W	400 W	400 W	400 W	400 W
Road Length	100 m.	100 m.	100 m.	—	—	—
No. of Hoardings	—	—	—	1	3	10
Illumination Level	High	Sufficiently High	Very High	Sufficiently High	Very High	Very High
Operating Hours	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs
Energy Consumed	576.00 kWh/day/km	300.00 kWh/day/km	1728.00 kWh/day/km	115.20 kWh/day	115.20 kWh/day	96.00 kWh/day
Average Energy Consumption	438.00 kWh/day/km		1728.00 kWh/day/km	23.31 kWh/day/hoarding		

Table 3. Municipal and commercial sector data after change in operating hours.

Place	Gomti Nagar			Hazratganj		
Survey Point →	Roads		Over Bridge	Hoardings		
	(1)	(2)		Big Size	Medium Size	Small Size
Type of Lamps	Mercury	High Pressure Sodium Lamp	Mercury	Mercury	Mercury	Mercury
No. of Lamps	12	10	36	24	8	2
Wattage (Each)	400 W	250 W	400 W	400 W	400 W	400 W
Road Length	100 m.	100 m.	100 m.	—	—	—
No. of Hoardings	—	—	—	1	3	10
Recommended Operating Hours	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	**1830 – 2230 hrs**	**1830 – 2230 hrs**	**1830 – 2230 hrs**
Energy Consumed	576.00 kWh/day/km	300.00 kWh/day/km	1728.00 kWh/day/km	**38.40 kWh/day**	**38.40 kWh/day**	**32.00 kWh/day**
Average Energy Consumption	438.00 kWh/day/km		1728.00 kWh/day/km	**7.77 kWh/day/hoarding**		

4. Case Study

The study was done for the following cases:
(1) Impact of change in operating hours
(2) Impact of lamp replacements
(3) Overall impact

Case 1: Impact of Change in Operating Hours

In this case, if the operating hours of the commercial hoardings in the survey data of Table 2 are changed then the impact of change in operating hours can be estimated, as summarized in Table 3.

Case 2: Impact of Lamp Replacements

Due to the availability of a variety of lamps in the market, we have numerous choices. Based on the study over a few lamps provided [11], it can be observed that induction lamps might be a good substitute for conventional lamps and the modern source of light used in lighting at public and commercial places should be induction lamps instead of other lamp.

The recommendation of the induction lamp with decreased wattage is done by performance comparison of induction lamp with other light sources. Less wattage does not necessarily imply less illumination. One can find in various data sheets of various manufacturers of light sources that luminous flux in induction lamps with low wattage is more than that of other light sources with higher wattage. In this way, the safety issue during foggy winter nights if wattage is decreased, as recommended in the paper, becomes irrelevant as for these duration the luminous flux available would be more than what is available with the current lighting system on roads and over bridges.

In this case, if all lamps in the survey data of Table 2 are replaced by induction lamps, then the impact of lamp replacement can be estimated as summarized in Table 4.

Case 3: Overall Impact

In this case, we are considering the combined effects of all things *i.e.* lamps are replaced with induction lamps along with the change in operating hours of the commercial hoardings. The overall impact can be estimated as summarized in Table 5.

5. Results and Discussion

The only way any country can meet its energy requirements is by increasing generation or reducing demand. Increasing generation requires huge amounts of money and takes time. There are many things we can do to use less energy and use it more wisely. These things involve energy conservation and energy efficiency, referred to as energy management. The immediate strategy is to reduce the demand and one way this can be achieved is through controlling unnecessary consumption of electricity by the commercial sector and through the use of energy efficient appliances, such as the energy saving lamps. The major results after the study and the analysis are listed as follows:

Table 4. Municipal and commercial sector data after replacement of all lamps by induction lamps.

Place	Gomti Nagar			Hazratganj		
Survey Point →	Roads		Over Bridge	Hoardings		
	(1)	(2)		Big Size	Medium Size	Small Size
Type of Lamps (After Replacement)	**Induction**	**Induction**	**Induction**	**Induction**	**Induction**	**Induction**
No. of Lamps	12	10	36	24	8	2
Wattage (Each)	**200 W**	**135 W**	**200 W**	**200 W**	**200 W**	**200 W**
Road Length	100 m.	100 m.	100 m.	—	—	—
No. of Hoardings	—	—	—	1	3	10
Operating Hours	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 2230 hrs	1830 – 0630 hrs	1830 – 0630 hrs
Energy Consumed	**288.00 kWh/day/km**	**162.00 kWh/day/km**	**864.00 kWh/day/km**	**57.60 kWh/day**	**57.60 kWh/day**	**48.00 kWh/day**
Average Energy Consumption	**225.00 kWh/day/km**		**864.00 kWh/day/km**	**11.66 kWh/day/hoarding**		

Table 5. Municipal and commercial sector data considering the combined effect of all things *i.e.* lamps are replaced with induction lamps along with change in operating hours of the commercial hoardings.

Place	Gomti Nagar			Hazratganj		
Survey Point →	Roads		Over Bridge	Hoardings		
	(1)	(2)		Big Size	Medium Size	Small Size
Type of Lamps (After Replacement)	**Induction**	**Induction**	**Induction**	**Induction**	**Induction**	**Induction**
No. of Lamps	12	10	36	24	8	2
Wattage (Each)	**200 W**	**135 W**	**200 W**	**200 W**	**200 W**	**200 W**
Road Length	100 m.	100 m.	100 m.	—	—	—
No. of Hoardings	—	—	—	1	3	10
Recommended Operating Hours	1830 – 0630 hrs	1830 – 0630 hrs	1830 – 0630 hrs	**1830 – 2230 hrs**	**1830 – 2230 hrs**	**1830 – 2230 hrs**
Energy Consumed	**288.00 kWh/day/km**	**162.00 kWh/day/km**	**864.00 kWh/day/km**	**19.20 kWh/day**	**19.20 kWh/day**	**16.00 kWh/day**
Average Energy Consumption	**225.00 kWh/day/km**		**864.00 kWh/day/km**	**3.89 kWh/day/hoarding**		

(i). After changes in operating hours (case-1) in a proper manner, as recommended in Table 3, a total of **66.67%** electrical energy can be saved per year from commercial hoardings, as illustrated in Figure 4. The tariff policy in the commercial sector is not as per the operating timings *i.e.* day, evening and late night. It is recommended that late night operating costs of electricity per unit should be increased.

(ii). If all the lamps are replaced by induction lamps (case-2), a total of **49.98%** electrical energy can be saved per year from commercial hoardings, as illustrated in Figure 4. On the other hand, a total of **48.63%** and **50.0%** electrical energy can be saved per year from road lights and over bridge lights respectively, as illustrated in Figures 5–6. It is recommended that at the time of maintenance or new installation, the use of induction lamps should be encouraged.

(iii). If we combine all of these major alternatives, a vast amount of electrical energy *i.e.* **83.31%** per year from commercial hoardings; **48.63%** per year from road lights and **50.0%** per year from over bridge lights can be saved. This fact is illustrated in Figures 4–6. It is recommended that these alternatives must be implemented as a step towards the better present.

(iv). In the survey, it was found that the number of lamps installed per hoarding is more than enough as spotted in Figure 3. It is recommended that there should be a proper criterion regarding the number of lamps installation based on the size of the hoarding.

The above results obtained in this case study cannot be ignored. According to Central Electricity Authority's (CEA) general review report of 2008, the annual per capita electricity consumption for Uttar Pradesh is 340 kWh. It is estimated that about **2%, 17%** and **69%** residents of a single village in Uttar Pradesh with an average population of 1,344 persons can be benefited by the electrical energy saved per year from per commercial hoarding, per km road lights and per km over bridge lights respectively in Lucknow city implementing all the major alternatives (using case-3).

6. Conclusions

Energy efficiency can be used to reduce existing demand and to decrease demand growth, particularly in areas experiencing rapid demand growth due to new construction. The results of this case study show that implementing all the recommendations, a total of about **88%** residents in a single village in Uttar Pradesh with an average population of 1,344 persons can be benefitted from the electrical energy saved from different sectors in Lucknow per year. This in turn forms a shining ray of hope and will definitely be a step towards a better present, helping in the dream of a shining India to become true very soon. Government should make the rules regarding operating hours of commercial hoardings and/or increase late night tariffs for commercial consumers in order to control the unnecessary consumption of electricity by them. Government should also implement other suggested alternatives *viz.* replacements of existing lamps by induction lamps so as to manage total available power in such a way that it can be delivered to all.

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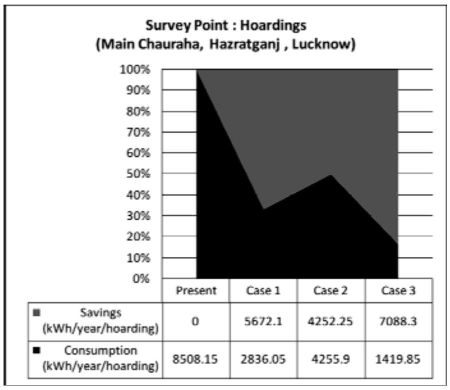

Figure 4. Annual energy consumption and savings for all cases from commercial hoardings.

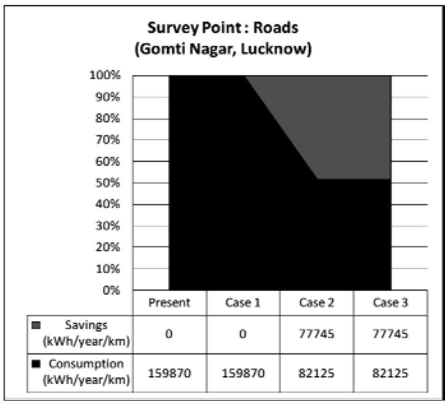

Figure 5. Annual energy consumption and savings for all cases from road lights.

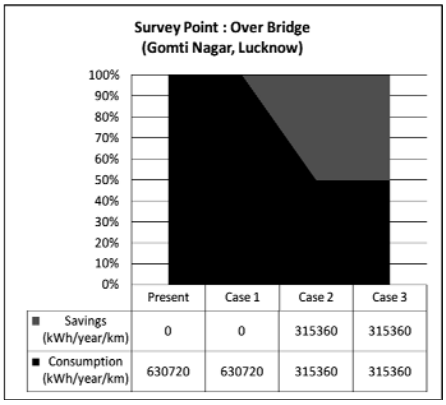

Figure 6. Annual energy consumption and savings for all cases from over bridge lights.

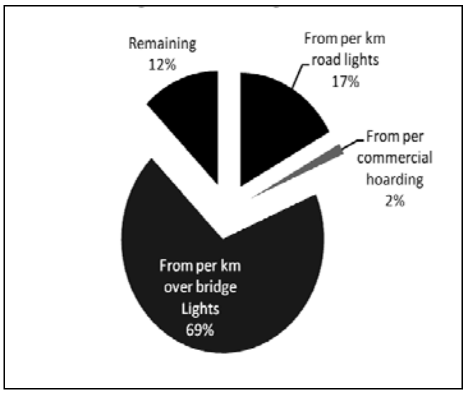

Figure 7. Percentage of the residents in a village in Uttar Pradesh benefited from saved electrical energy in Lucknow.

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