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Energy Auditing: A Walk through Survey of Library Building of Institute to Reduce the Lighting Cost

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Abstract: This paper presents simple walk though energy audit for the lighting load of library section of educational institution. Lighting is a major load in case of educational institution particularly in library section. Lighting is an area which provides a major scope for achieving energy efficiency at the design stage by using the modern energy efficient lamps. Innovation and continuous improvements in lighting design has given big energy saving options. Implementation of energy audit can reduce the wastage of energy and gives good practice of energy conservation. In this paper library loads have been surveyed tabulate, energy saving measures is analyzed involves the replacement of low efficient lighting by high efficient lighting. The outcome of evaluation namely annual consumption reduction, greenhouse gas reduction and payback period is presented.

Key words: Energy audit, lighting, payback period, energy conservation.

I. INTRODUCTION

In modern era day to day activities of human being is depends on electricity. Conservation of electrical energy is the need of the hour. Electricity demand is increasing day by day. India ranks fourth in the world in total installed power capacity [1]. All India installed capacity in MW of power stations is 272687.17 as on April 2015 [2]. The detailed break up share of different types of generating stations is mentioned below-

Thermal power plant – 189497.78MW, Hydro power plant – 41632.43MW, Nuclear power plant – 5780.00MW and Renewable energy sources – 35776.96MW; Total – 272687.17MW [2].

The electric energy generation is a measure of economical progress of the country and the economical development of the country depends on per capita consumption of energy. Table1. Shows the per capita consumption of different countries; all economically developed countries per capita consumption of electrical energy is high. Even though India ranks fourth in the world for power generation, because of population per capita consumption of energy is less. Graph shown in figure 1, indicates the growth of per capita consumption of India from year 2005-06 to 2013-14, it has increased from 631.4kWH to 957kWH [3]. At present only 78.7% of Indian population is access to electricity [7]. To become developed country per capita consumption of energy needs to be increased, this requires increasing the generation capacity. To establish the new power plants to increase the power supply needs more time.

India is facing over 25000-30000 MW, power shortage daily due to breakdown, repair and maintenance work of the power plant [4]. Until generation over comes this shortage of power supply, India needs to focus on energy conservation. Energy conservation means reduction in energy consumption without making sacrifice of quantity or quality.

A successful energy management program begins with energy conservation; it will lead to adequate rating of equipments, using high efficiency equipments and change of habits which cause enormous wastage of energy [5, 6].

Table.1; Per Capita Consumption of Developed Countries

Country	Kwh
United Arab Emirates	15,131.10
United States	12,185.94
Australia	9,485.68
Switzerland	7,315.01
Russia	7,285.73
Germany	7,191.65
France	6,986.22
Saudi Arabia	6,980.92
Japan	6,763.79
European Union	5,938.20
China	3,925.67
Brazil	2,249.12
India	**957.00**
World	2,850.33

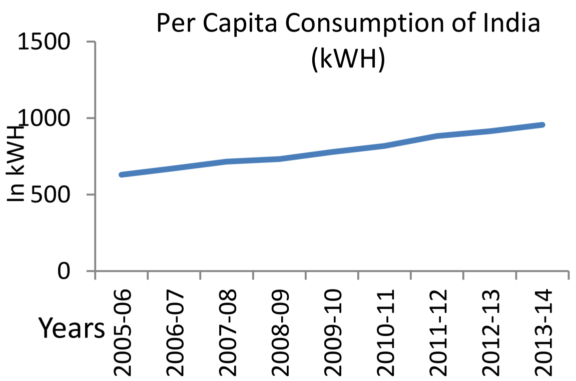

Figure 1; Per Capita Consumption of India

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II. ENERGY CONSERVATION AND AUDIT

As per the Energy Conservation Act 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption". Implementation of recommended measures can help to achieve significant reduction in the energy consumption levels [8]. Studies and survey have shown 35 – 40% of the load in big cities is lighting load.CFL, LED and electronic ballast in tube light will save 25 – 30% of power with estimated 673.3 million tube lights in India by the year 2016, a saving of 15watts per tube light will mean 1000MW of load and saving of 45 million units a day @ 4hours of usages a day [9].

III. TYPES OF ENERGY AUDIT

The term energy audit is commonly used to describe a broad spectrum of energy studies ranging from a quick walk-through of a facility to identify major problem areas to a comprehensive analysis of the implications of alternative energy efficiency measures sufficient to satisfy the financial criteria of investors.

- **Benchmarking**: Benchmarking mainly consists of comparing the measured consumption with reference consumption of other similar loads or generated by simulation tools to identify excessive or unacceptable running costs.

- **Walk-through audit:** The preliminary audit (alternatively called a simple audit, screening audit or walk-through audit) is the simplest and quickest type of audit. It involves minimal interviews with site-operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the operation and to identify any glaring areas of energy waste or inefficiency.

- **Detailed/General energy audit:** The general audit (alternatively called a mini-audit, site energy audit or detailed energy audit or complete site energy audit) expands on the preliminary audit described above by collecting more detailed information about facility operation and by performing a more detailed evaluation of energy conservation measures. This level of analysis can involve advanced on-site measurements and sophisticated computer based simulation tools to evaluate precisely the selected energy retrofits.

- **Investment-Grade audit:** In most corporate settings, upgrades to a facility's energy infrastructure must compete for capital funding with non-energy-related investments. Both energy and non-energy investments are rated on a single set of financial criteria that enerally stress the expected return on investment [10, 11].

IV. ENERGY SAVINGS ON LIGHTING SYSTEM

Possibility of energy conservation is more in educational building due to the fact that huge numbers of people are involved. Lighting load is where most of the energy is wasted than consumption. In library building lighting load consumes more than 40% of the total electrical energy consumption. Remaining loads are fans, computers, water cooler and air conditioner. In walk through survey it is observed that most of fluorescence tubes light of 36 Watts are having choke coil/ electronic ballast, these needs to be replaced by LED tube light of 18Watt capacity. Following table 2 gives comparison between Fluorescence tube light and LED T8 tube light and reason for replacement [12, 13].

Lamp selection must be based on several factors, such us: efficiency (ratio between light output and electric power input -lumens per watt), color temperature, color rendering index, life and lumen maintenance, availability and cost [14]. Lives of different luminaries are shown in the figure 2 [15]. It is observed that life of LED tube light is more than fluorescent tube and power consumption is also less for same lumen output.

The objective of this paper is to study the energy consumption due to lighting loads in a library building of the KLS Gogte Institute of Technology, Belgaum, India and reduce the consumption without affecting the outputs. The institute library building is considered here because of the uncontrolled and unpredictable usage of light in different sections. An audit activity in general order includes:

- Identification of all types of lighting loads.
- Evaluation of the condition of the systems.
- Analysis of impact of improvement to those systems.
- Preparation of energy audit report.

Economical analysis is done after energy audit work using all the data gathered.

Following table 3 gives the details of the walk through survey to identify the number of fluorescent tube lights in different section of library building of Gogte Institute of Technology, Belgaum, India. A count of lighting is done after proper identification and calculation about the replacement of the light as it should not affect consumers need. Even though library section is open for the students 24x7 but actual hours of usage in different section are mentioned in the table. Energy calculation is made assuming 30 days in the month. Gogte Institute of Technology is having HT connection from Hubli Electricity Supply Company for its electrical energy supply, a tariff of Rs. 8.00 as per electricity bill / month is considered for the calculation of the yearly energy consumption bill.

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Table 2: Comparison between Fluorescent Tube-light and LED

Fluorescence tube-light	LED T8 tube-light
• Fluorescent Tube light is a gas discharge lamp, which contains gases like Mercury. It produces short wave ultraviolet light that gets transformed into visible light, the inside of the tube has a phosphor lining (coating).	• Light Emitting Diode (LED) is a semiconductor diode. In forward biased condition the electrons recombine with holes, and then it release some energy in the form of photon (visible light).
• More amount of electrical energy converted into heat and small amount is converted into light compared to LED tube light.	• The electrical energy is converted into 80% light energy; remaining 20% get converted into heat energy.
• Harmful chemical (like mercury) are used.	• No harmful chemical used
• 36 watts fluorescent lamp, light output is 2000 lumens, so system efficacy is 55 lm/ watt. Rated life is 5,000 hrs. Tube light efficiency comes down with time.	• Power consumption is 18 watts, System Efficacy 123 lumens/watt, so total light output (Luminous Flux) is 2000 lumens. Life span (50,000 hours) is very high for led lights over other lights.
• Fluorescent lights it runs using electronic ballast (called solid state ballast) which consume above 12 watts power. Dimming is not available for this ballast.	• Power consumption is very low. And no need to use electronic ballast because it runs by constant current and voltage. Dimming also available for the LED lights.
• Beam Angle is very important in every lighting technology. For Fluorescent lamp Beam angle is 360 degree. We can calculate the beam spread only for 270 degree, 90 degree beam angle is wasted • Beam Spread = 48.6 (Recommended height is 10 ft)	• Led lights are available with variety of Beam Angle, Beam Angle is 120 degree for our LED Tube Light, we can calculate beam spread for 120 degree • Beam Spread = 21.6 (Recommended height is 10 ft)
• It will emit the yellowish white color. It has a low Color temperature and Color Rendering Index (Color Tempreature-4100 Kelvin, CRI-80)	• It can emit the cool white color in the spectrum of 380-740 nm. For Humans also the visible spectrum is 380-740 nm.

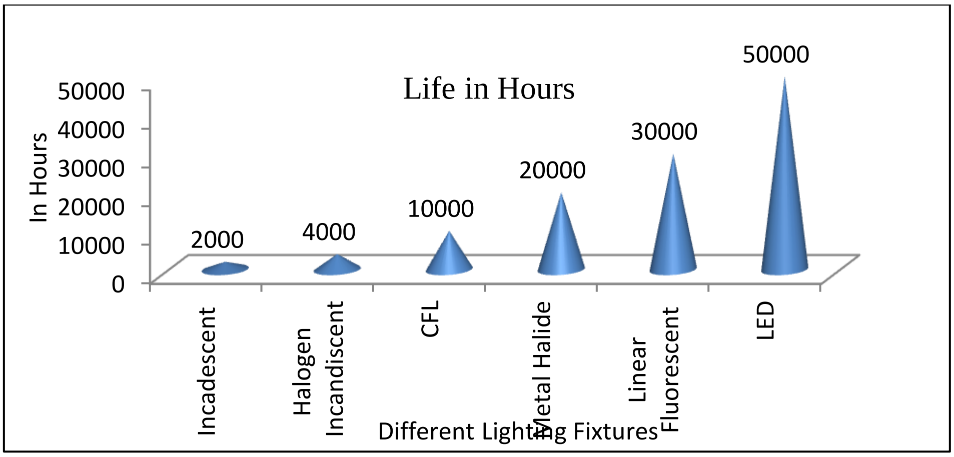

Figure 2; Comparison of life of different lighting fixtures

Venue detail	No. of tubes	Wattage of tube light	Hours of usage	Energy Consumption per day in kWH	Energy Consumption per Month in kWH	Energy Consumption per year in kWH	Electricity Bill paid per year@ Rs. 8/- in Rs.
Reading Hall no.	27	36	15	14.58	437.4	5248.8	41,990.40
Entrance lobby	21	36	12	9.072	272.16	3265.92	26,127.36
Librarian Room	4	36	7	1.008	30.24	362.88	2,903.04
A-Partition	7	36	14	3.528	105.84	1270.08	10,160.64
PG Section n stack room	17	36	4	2.448	73.44	881.28	7,050.24
Stock room	24	36	5	4.32	129.6	1555.2	12,441.60
Sore room	3	36	4	0.432	12.96	155.52	1,244.16
Reference section	12	36	4	1.728	51.84	622.08	4,976.64
Journal section	12	36	4	1.728	51.84	622.08	4,976.64
Digital library	6	36	10	2.16	64.8	777.6	6,220.80
	133					14761.44	118,091.52

Table 3; Walk-through Survey Details of Existing Lighting Fixtures

Venue detail	No. of LED T8 tubes	Wattage of LED tube light	Hours of usage	Energy Consumption per day in kWH	Energy Consumption per Month in kWH	Energy Consumption per year in kWH	Electricity Bill paid per year@ Rs. 8/- in Rs.
Reading Hall no.	27	18	15	7.29	218.7	2624.4	20,995.20
Entrance lobby	21	18	12	4.536	136.08	1632.96	13,063.68
Librarian Room	4	18	7	0.504	15.12	181.44	1,451.52
A-Partition	7	18	14	1.764	52.92	635.04	5,080.32
PG Section n stack room	17	18	4	1.224	36.72	440.64	3,525.12
Stock room	24	18	5	2.16	64.8	777.6	6,220.80
Sore room	3	18	4	0.216	6.48	77.76	622.08
Reference section	12	18	4	0.864	25.92	311.04	2,488.32
Journal section	12	18	4	0.864	25.92	311.04	2,488.32
Digital library	6	18	10	1.08	32.4	388.8	3,110.40
	133					7380.72	59,045.76

Table 4; Proposed LED Lighting Scheme with Tariff Calculation for Year

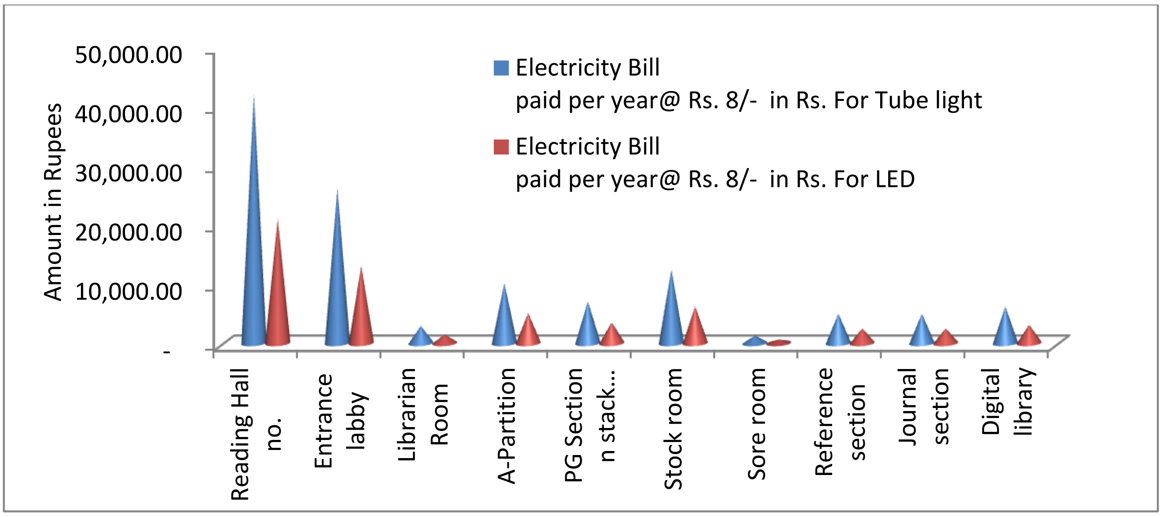

Figure 3; Tariff Wise Comparison

Fluorescent tubes in the different sections of the library are replaced by the T8 LED tube of 18 watts, then energy consumption and tariff per year at the rate of Rs. 8.00 is shown in the table 4. Figure 3 shows the comparison of tariffs before and after replacement of fluorescent tube lights with LED tube lights.

The initial investment in replacing the existing fluorescent tube lights with LED tube lights at the rate of Rs. 900.00 per tube (Approximate competitive price assumed) is 133 x 900= Rs. 119700.00. Net saving in the electricity bill per year is Rs. 118,091.52 – Rs.59, 045.76 = Rs. 59,045.76. Payback period for investment is 119700.00/59045.76 = 2.02 years. This implies that the break even occurs at 2.02 years and LED tube lights start to payback after 2.02 years.

V. RECOMMENDATIONS

- As initial investment cost for LED tube light is more, fluorescent tube lights can be replaced with LED tube lights in a phase manner (can be replaced one by one when tube light gets damaged).
- Consider purchasing of ENERGY STAR-qualified fixtures. They are available in many styles; distribute light more efficiently and evenly than standard fixtures, and some offer convenient features such as dimming.
- Keep curtains or shades open to use day lighting instead of turning on lights. Also, decorate with lighter colors that reflect daylight.
- Practice of turning off the light when not required.
- Better arrangement for the day light can be made. CO_2 emission is reduced when tube lights are replaced. Every kWH of energy saved, 0.9389 Kg of carbon dioxide emission is reduced. In above case units saved per year is 7380 kWH (approx), this is equals to 6922 Kg of reduction of CO2 emission to atmosphere every year [16].

VI. CONCLUSION

The above discussion shows that replacement of fluorescent tube lights with LED T8 tube lights will reduce the energy consumption drastically. Saving energy will help reduce carbon footprint on earth and help green cover of our planet. Detailed study of illumination level required in different sections of library considering day light usage will further reduces the number of luminaries with proper wiring design.

Energy audit in all the sectors with few or moderate changes in existing system will reduce the power demand of the country. The government can decide strict polices to initiate energy audit in domestic and institute sectors where the lighting load is major one. This will make great change in economical status.

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