# ENERGY AUDIT: A CASE STUDY TO REDUCE LIGHTING COST

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***ABSTRACT***

***This paper presents a physically based model and formulation for industrial load management. Lighting is an essential service in all the industries. The power consumption by the industrial lighting varies between 2 to 10% of the total power depending on the type of industry. Innovation and continuous improvement in the field of lighting, has given rise to tremendous energy saving opportunities in this area. Lighting is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy efficient lamps, luminaries and gears, apart from good operational practices. It provides merely to indicate some of the options that energy auditor can consider when performing an analysis of an industry. Energy conservation and exploration of new energy avenues are the well accepted solution to fulfill the growing industrial demand in future. Implementation of energy audit can improve the plant efficiency and thereby reducing the energy wastages.***

**Introduction**

Availability of power has a crucial rule in economic development of the country .In today's world energy is very precious india ranks fifth in the world in total energy.All india installed capacity of electric power generating stations under various electrical utilities was 185.5GW on November 2011[1].The detail break up share of different type of generating stations is follows :

Hydro power plants – 37367.4 GW[8]

Thermal power plant – 115649.48 GW [8]

Nuclear power plant -4.8 GW[7]

Renewable Energy source-22.4GW [10]

The country's annual electricity generation capacity has increased in last 20 years by about 120 GW, from about 66 GW in 1991 to over 100 GW in 2001, to over185 GW in 2011. Over 2010–11, India's industrial demand accounted for 35% of electrical power requirement, domestic household use accounted for 28%, agriculture ,21% commercial,9% lighting and other miscellaneous applications accounted for the rest. Energy consumption without making any 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 equipment and change of habits which causes enormous wastages of energy.

## Energy Audit

An energy audit is an inspection ,survey and analysis is of energy flow for energy conservation in an industry process to reduce the amount of energy input into the system without negatively affecting the output .Energy audit is testing and analysis of how the enterprises and other organizations use energy.According to national energy conservation laws and regulations for energy consumption, investigation and energy audit management .[14]

Audit activities in general order include:

investigation and energy audit management [14] Audit activities in general order include:

- Identification of all energy systems
- Evaluation of conditions of the systems
- Analysis of impact of improvement to those systems
- Preparation of energy audit report.

The analysis which includes the economic analysis is done after the audit work using all the data gathered. Studies and researchers have shown that energy auditing and conservation can save India Rs.1800 crore per year as there is a big potential for saving energy in industrial sector .In terms of electricity, these saving are equivalent to installation of 5250MW.

**(a) Preliminary Energy Audit**

The preliminary energy audit alternatively called a simple audit screening audit or walk through audit, is the simplest and quickest type of audit. It is carried out in a limited span of times and it focuses on major energy supplies and demands. It aims at taking steps which are necessary for implementation of energy conservation program in an establishment. It involves activities related to collection, classification, presentation and analysis of available data in arising at the most appropriate steps to be taken in establishing energy conservation. It involves collection of necessary data, minimal interviews with site operating personnel, a brief review of facility utility bills and other operating data and identifies glaring areas of energy waste or inefficiency.

Typically, only major problems area will be uncovered during this type of audit, corrective measures are briefly described and quick estimates of implementation cost, potential operating cost savings and simple payback periods are provided. This level of detail, while not sufficient for searching a final decision on implementing proposed measures, is adequate to prioritize energy efficiency projects and determine the need for more detailed audit.

**(b) General Energy Audit**

The general energy audit is also called a mini audit or site energy audit or complete site energy audit. It expands on the preliminary audit by collecting more detailed information about facility operation and performing a more detailed evaluation of energy conservation measures identified. Utility bills are collected for a 12 to 36 months period to allow the auditor to evaluate the facility energy/demand rate structure and energy usage profiles. Additional metering of specific energy consuming systems is often performed to supplement utility data. In depth interviews with facility operating personnel are conducted to provide a better understanding of major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand. This type of audit will be able to identify all energy conservation measures appropriate for the facility given its operating parameters. A detailed financial analysis is performed for each measures based on detailed implementation cost estimates, site specific operating cost savings and the customer's investment criteria. Sufficient detail is provided to justify project implementation.

**(c) Detailed Energy Audit**

Detailed energy audit is also called comprehensive audit or investment grader audit. It expands on the general energy audit. It covers estimation of energy input for different processes, collection of past data on production levels and specific energy consumption. It is a comprehensive energy audit action plan to be followed effectively by the industry.

It provides a dynamic model of energy use characteristics of both the existing facility and all energy conservation measures identified. The building model is calibrated against actual utility data to provide a realistic baseline against which to compute operating savings for proposed measures.

Extensive attention is given to understanding not only the operating characteristics of all energy consuming systems, but
also situations that cause load profile variations on both an annual and daily basis. Existing utility data is supplemented with sub metering of major energy consuming systems and monitoring of system operating characteristics.

Thus, the scope of this audit is to formulate a detailed plan on the basis of quantitative and control evaluation, to evolve detailed engineering for options to reduce total energy costs, consumption for the product manufactured. It should be at 8 to 10 percent savings, detailed audit study shall be completed in a period of three weeks from the date of commencement. After which, preparation of energy audit reports shall be completed in a period of three weeks. The major system that are encountered in industries with regard to which energy audit is to be carried out are: Boilers, furnaces, air conditioning systems, refrigeration or cold room etc., power generation and distribution systems, compressed air generation systems, pumping systems and electric motor driven systems.

## ENERGY SAVING ON LIGHTING SYSTEMS

Lighting energy consumption of the whole factory is limited to the 1700 of the total electrical energy consumption. During the factory audit several places are identified as the places where the savings are easily guaranteed. A count on lighting is needed to be done, after identifying the proper locations. As a rule of thumb, the followings are the common methods of energy saving on the lighting systems.[2]

Halogens (spot lights) are replaced with infra read Coating halogens.

Incandescent lamps are replaced with compact Fluorescent lamps (CFL).

Halogens (flood type) are replaced with metal halides.

Replacement of the magnetic ballast from electronic Ballast.

## ENERGY CONSUMPTION

The sanctioned load of mill is 30430.64 KW and Also one DG set of 1250 KVA is installed for emergency purposes, when PSEB supply fails. The mill gets supply from PSEB at 66 KV.

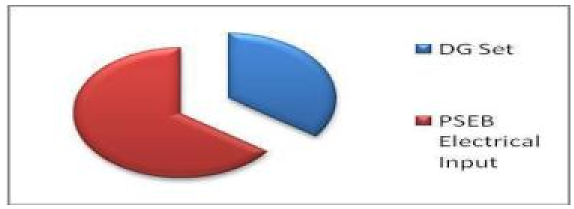



**Fig 1 – Comparison of Consumption of Power between Tubes with copper chokes and Fluorescent Tubes with electronics Chokes.**

## A CASE STUDY: LIGHTING

### I) Observations and Analysis

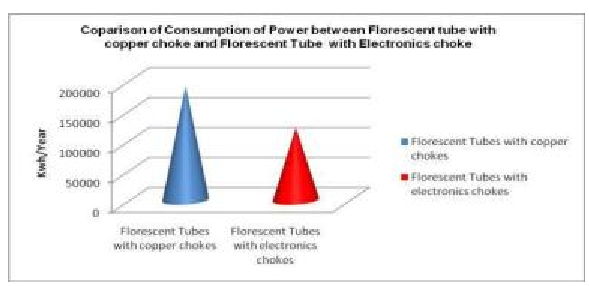
In this the Observations and Analysis of halogen Lamps, florescent tubes and mercury vapors lamps has been done.

### 1 .Fluorescent Tubes

Two sets of florescent tubes consisting of 36 watt tubes were considered. The results are shown in annexure 3. Consumption of Power of tube & choke = 56+52.7 2 = 54.5 Watt/tube

Consumption of Electrical Power:

**Fig 1 – Comparison of Consumption of Power between Fluorescent Tube with copper chokes and Fluorescent Tube with electronics chokes**



By processed tube & electronics chokes [12] = 34.5 watt/tube
Difference = 20 watt
Total no. of tubes and chokes = 357
Saving = $\frac{357x20}{1000}$ = 7.14 KW

Saving in unit, if working hrs. and days are assumed to be 10 and 350 respectively.

= 7.14 X 10 X 350
= 24990KWH

Cost of electricity @ Rs. 5.56/unit = Rs. 1, 38,944/-

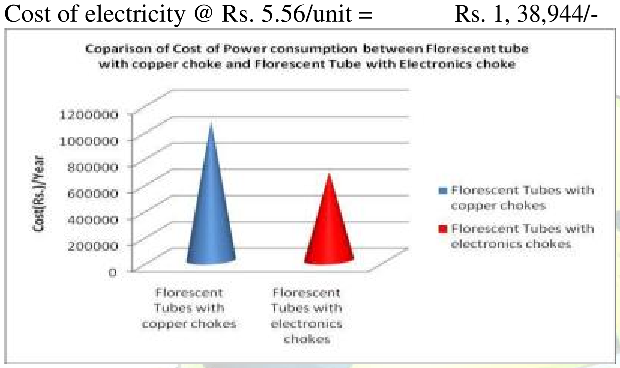



**Fig 2 – Comparison of cost of Power Consumption between Florescent Tubes with copper chokes and Fluorescent Tubes with electronics chokes.**

Price difference between two sets
= App. Rs. 260
Cost involved for replacing all the existing tubes and chokes
= 357x260
= Rs. 92,820/-
Payback period = $\frac{92,820 \times 12}{1\ 38,944}$
= 8months

**2. Halogen Lamps**

There are total 40 halogen lamps in the mill. Each is of 1000 watt rating. Halogen lamps are inefficient as compared to discharge lamps like metal halide lamps.[7] Saving on this account will be:
Total no. of halogen lamps of 1000 W = 40
Total power consumption = 40x1000

= 40,000 W
= 40 KW
Power consumption by metal halide lamps = 40x400 = 16 KW

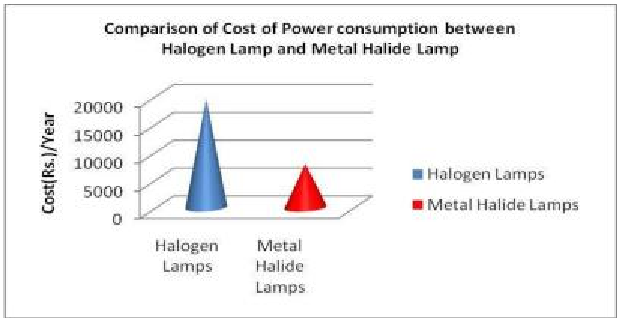



**Fig 3 – Comparison of Consumption of Power between halogen lamps and metal halide lamp.**

Saving = 24KW
Saving in units if working hrs and Days are assumed to be 10 and 350 resp. = 24x10x350
= 84000 KWH
Saving in Rupees @ Rs. 5.56/unit = Rs. 5.56x84000
= Rs. 4, 67,040

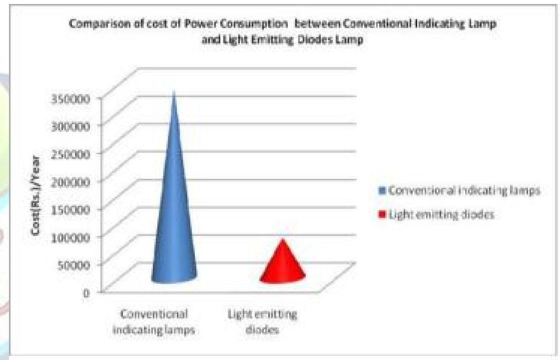



**Fig 4 – Comparison of cost of Power Consumption between halogen lamps and metal halide lamp**

Price difference between two types =
Rs. 4000

Cost involved in replacement
= Rs. 4000x40
= Rs. 160000/-

Payback period = $\frac{160000x12}{4,67,040}$

= 4 months

**3. Indicating Lamps**

Conventional indicating lamps consume about 5-10 watts and their life is about one year. Light emitting diodes (LED) consume 1.5 watts only and have a life of 5-6 years.[4] There are around 280 light emitting diodes and 400 conventional indicating lamps. If remaining conventional indicating lamps installed in mill are also replaced by LED's it will result in energy conservation. Saving per year will be as follow:
Power consumed by conventional lamps = 7 watt
Power consumed by LED = 1.5 watt
Difference in power consumption = 5.5 watt

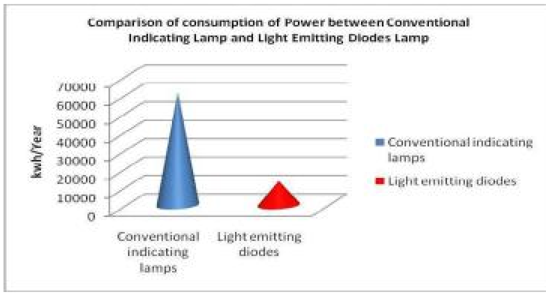



**Fig 5 – Comparison of Consumption of Power between Conventional indicating lamps and Light emitting diodes.**

Saving in power per year by assuming the indicating lamps remain on for all 24 hrs and days

$$= \frac{24x365x400x5.5}{1000}$$

= 19270 KWH

Amount savable @ 5.56per unit

= 5.56x19270=Rs. 107152/-

## II) CONCLUSION

A famous quote **"**Energy saved is Energy generated**".** This shows that apart from increasing the generation capacity at higher cost, one must go for the energy audit to save the electricity at much lower cost. Because the demand for electricity is continuously growing and it is putting stress on the power utilities to increase the capacity to meet the load demand. With this aim the authors have undertaken a case study of an industrial unit because industries are the major power consumers. The data provided in this paper shows that how we can save electric energy by incorporating some changes in the installation and making it energy efficient. The government should make it mandatory for every industrial house in the country for energy audit.

## RECOMMENDATIONS

The conventional electromagnetic tubes and chokes should be replaced with electronic chokes in a phased manner. They can be replaced one by one when they get damaged. Halogen and mercury vapour lamps should be replaced by metal halide lamps. The indicating lamps can also be replaced in a phased manner when existing lamps get damaged. The tubes not required during day time should be switched off and better arrangements for use of natural daylight should be made.

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