

# Energy Audit, Conservation and Management

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**Abstract**— Day-to-day energy demand is increasing rapidly leading to need of energy conservation. Energy Audit is the best option for conservation of energy. Energy Audit is the analysis of total energy consumption at particular organization. It helps to reduce consumption of energy without affecting output. Also, it is the best approach trying to match demand and supply. Indirectly, it also helps to maintain the environmental balance. So In this paper, we are trying to focus on some Parameters which contribute in Energy Conservation and Management such as Optimization of lighting devices and also use DIALUX software for lighting design, optimize AC temperature. Lastly we want to focus on Thermal imaging for analyzing heat loss in a room.

**Keywords:** Energy Audit, Optimization, Lighting, Air Conditioner, Thermal Imaging

## I. INTRODUCTION

As per the reports and standard guidelines of illumination referred, we analyzed that there is need to optimize the lighting using energy efficient lighting and proper illumination designs. Energy Audit is done in different steps leading to energy conservation. This review is based on the literature referred from different case studies, government publications, Energy Audit Reports, National Lighting Code 2010 and Research papers. As per the survey, IR (Indian Railway) is the single largest organizations with highest electricity consumption in India, So it is identified as a Designated Consumer (DC). It consumes 2.4% of India's Total Consumption [1].

## II. NEED OF ENERGY AUDIT AND CONSERVATION

Energy Audit help to know detail information about the use of energy and fuel in any organization, and also help to identify the areas causing energy waste, finally leads to finding scope for improvement in energy utilizing sources. It gives preventive measures for maintenance. Energy audit help to focus on energy cost variation, monitoring of energy consumption, reliability and availability of energy supply etc. It helps to reduce energy consumption, also lowering operation cost. It also provide improved effective way to use energy in the organization without affecting the output and leads to achieve environmental sustainability by reducing greenhouse gas emission and also minimize air pollution caused by acid rain and smog.

## III. STEPS INVOLVED IN ENERGY AUDIT

Energy Audit involves following steps:

1. Pre Audit Phase
  - Load Data Collection and calculation ,Collection of electric bill
2. Targeted Energy Audit Phase
  - Analyzing energy use pattern(load pattern), Study of Electric Bill

## 3. Post Audit Phase

- Steps for minimizing energy consumption, reducing electric bills without affecting output, making report with above recommendation.

### A. Optimization of Lighting Devices

Efficiency of lighting devices depends on lighting design which involves different factors such as room length, breadth and width. This will help to minimize lighting load by adjusting room index while building construction. 3 Layered lighting design is as follows:

1. Ambient (for normal room lighting)
2. Task (for ex. Study)
3. Accent (such as lighting artwork or focus spot)

We can also use AutoCAD software for making wiring diagram and DIALUX software for proper lighting design [2]. To achieve proper illumination as per National Lighting Code 2010 at working place, we can reduce the mounting height of lamp but it may cause non-uniformity of light in room. So the solution to this, the room can divided into virtual rooms which will help to organize the lighting as per requirement i.e. low lighting zone and high lighting zone.

If the ceiling of the room is so high, then false ceiling can be used to mount the lamps or mount them on surface of wall with proper tilt angle measurement(in between 45° and 65°)[2]. This two tilt angles of lamp will help to maintain the uniformity of light.

### B. Recommended Values of Illumination [3]:

Areas	Illumination (Average Lux)
Laboratories	300
Office Rooms	150
Libraries	300
Reading Rooms	150 to 300
Auditorium	
Hall	70
Foyer	70
Stage Area	300
Lecture Rooms (Including Demonstrating areas)	300

Canteen	150
Entrances, Corridors and Stairs	100
Parking Areas	20
Reception and Waiting Room	150

Formula to Manually Calculate Wattage and Lux for a room [4]:

$$\begin{aligned} \text{Amount of Wattage Required} \\ &= \text{Room Length} * \text{Width} * \text{Height} \\ \text{Lux} &= \text{Total Lumens} \div \text{Area in Square Meters} \end{aligned}$$

#### C. Optimization of Air Conditioner

As per the increasing demand of Air Conditioners, they are contributing in increased electricity demand. As per the papers referred, Electricity consumed by inverter type Air Conditioner is 33% less than non-inverter type air conditioner [5]. Also, total cost saving for life cycle is huge for 5 star compared to 3 star. So there is need to use efficient Air Conditioners for energy saving.

If two speed compressors is used in a system, then 49% more better Energy Efficiency Ratio Can be attained compared to system using a cylinder unloaded compressor [5]. This is because of less frictional losses at half speed in case of two-speed compressor leads to decrease in power input requirements. Also set temperature at 24°C helps to save energy, also providing human comfort zone [10] in terms of temperature and humidity. As per Bureau of Energy Efficiency, 1 degree Celsius increase in temperature help to save 6% of energy leading to energy conservation.

#### D. Use of Thermal Camera for Energy Auditing:

Heat Loss is also one of the important parameter affecting the energy efficiency of devices and indirectly increasing energy consumption. Thermal Camera can be used to find out heat loss in building envelope. It can be done two ways: i) Active Thermography ii) Passive Thermography [8]. In active thermography, external energy source is necessary to create thermal contrast by increasing the temperature. In passive thermography, naturally surface or parts which are going to inspect are at higher or lower temperature compared to surrounding. Thermography is required to be performed when the difference in air temperature is minimum 10°C amongst internal temperature and external temperature. Also wind speed should be less than 5m/s. The wall or surface should not be directly exposed to sunlight while executing and before execution about 8h to 12h. Qualitative thermography is used for walk through audit for collecting information. It involves Building envelope for insulation detection, air leakage detection, heat loss areas moisture and water detection, etc. Quantitative thermography is used for detailed study of thermal anomalies to calculate the heat loss. It involves Building envelope for thermal defects along with calculation of U-value [6]. This will help to quantify the heat loss [9]. The best insulating material have U-value close to zero.

#### IV. CONCLUSION

The paper gives basis idea for performing energy audit in traditional as well as new ways such as thermography. Also it focused on maintaining the proper lux value in workspace as per the requirement; it will help to save unnecessary electricity consumption. There is need to use Air conditioner at 24°C set temperature. Also 5 star inverter air conditioner help to save huge amount of energy. 49% more better EER can be calculated using two speed compressor. Thermography is new approach of calculation heat loss which is also contributing in increased energy demand. U-Value calculation will help to identify heat loss through building envelope.

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