International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Basics of Energy and Lighting Audit

Mainak Mukherjee[1], Surajit Mondal[2]

[1, 2]University of Petroleum and Energy Studies, M. Tech Energy Systems, Department of Electrical, Power and Energy, Dehradun, India

Abstract: ***Energy audit is a technique developed to eradicate unnecessary usage of energy, control and also streamline processes leading to energy efficiency. Energy audit and its impact on a daily basis is precarious and hence should be prioritized. Energy Conservation over the years has been a key in terms of saving excessive bills and building up unnecessary usage. Since the world is not completely energy efficient yet, it should be a forefront process to ensure optimum usage and saving wherever possible. In this paper we shall discuss in brief about energy audit, techniques and tools that are used and would also highlight a case from a lighting audit. Since India's strive for complete energizing is yet on the verge of completion, need for saving unused energy and also recovering waste energy can be beneficial in developing an energy content environment.***

Keywords: Basics of energy Audit, Audit Tools, Audit Process, Audit analysis, lighting audit

1. Introduction

Energy audit's foremost intention is to verify and find faults in energy systems. Saving bills through minimum usage and procuring devices to formulate energy flow are decisive in terms of mitigating excess cost in various domains of domestic, industrial and so on. Utility bills can be saved up to 15-20% of the current bills if auditing is implemented on a regular basis. Energy auditing is done in various ways which shall be briefed later down the page, where the thrust lies in effective energy management and conservation. The word Auditing seems a negative word as it implies scrutiny. Auditing hence can also be termed as energy survey or energy analysis which necessarily removes the negativity of the word audit and gives a significant result which is consumer oriented.

Energy audit evaluates efficiency of all processes that uses energy. Auditing starts by allocating areas of energy sources, then it is quantified into discrete functions followed by efficiency analysis and finally by substantiating energy saving and cost saving opportunities.

2. Components in an Energy Audit

Energy auditing is a vast process and hence requires a lot of components to come together at the same time. Depending upon the auditing procedure processes had to be defined in a conventional way. The audit process initiates by identifying the facility's operations its previous records and utility bills. These data are then used to assess and help in selecting a technique for approach.

3. Energy Audit Tools/ Instruments

Tools and Instruments that are widely used for auditing are

1. ***Tape Measures*:**A tape measure or measuring tape is a flexible ruler. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.
2. ***Light meter* :** A light meter is a device used to measure the amount of light.They provides a quick result in showing the adequate light level at that particular area.Few considerations while using lightmeter are height , proportionality, daylight, shadows, orientation , accuracy.
3. ***Thermometers***: Various thermometers are required which offers wider range of variety and simplicity in carrying out process.Temperature is a key attribute as this enhances an auditor to determine efficiencies identify waste heat recovery scopes . Nowadays electronic thermometers with interchangeable probes are being used. Infrared thermometers and thermographic equipment are also widely used.
4. ***Infrared Cameras***: Though expensive yet very essential in carrying out audit. They are used to find overheated electrical wires , connections , neutral , circuit breakers, transformers , motors and various electrical equipments.They are also used in finding out wet insulation , missing insulation , cols spots and roof leaks.
5. ***Voltmeter*:** A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.
6. ***Combustion Analyzer***: Emissions monitoring can be done accurately with analyzer in a product line of industrial portable emissions analyzers designed for emissions monitoring. Portable analyzers measuring O_2, CO, NO_x (NO + NO_2), SO_2, H_2S, CO_2, and C_xH_y hydrocarbons provide emissions monitoring for boilers, engines, burners, and other combustion equipment.
7. ***Air Flow Measurement device*:** Air flow measurement from heating , air conditioning , and various such sources of air flow are used. Few devices are velometer, anemometer, airflow hood are few such devices.
8. ***Blower Door Attachment*:** A blower door is a machine used to measure the airtightness of buildings. It can also be used to measure airflow between building zones, to test ductwork airtightness and to help physically locate air leakage sites in the building envelope
9. ***Smoke generator***: Also called air current testers, smoke generators can be used either in conjunction with a

blower door or independently to visually indicate sources of leaks or air infiltration. They are an excellent client education tool.

10. ***Clamp on Ammeter***: Digital clamp-on ammeter. Measures AC/DC current up to 400 amps with 3.0 percent (VAC) accuracy without breaking the circuit. Also measures AC/DC voltage, resistance, frequency, capacitance, continuity and diode.
11. ***Safety Equipment*** : Auditing becomes pretty tough owing to the various conditions one is subjected to hence safety glasses , hearing protectors, electrical insulated gloves , breathing mask , safety shoes are few of the standard safety equipment that are necessary.
12. ***Miniature data loggers***: a data logger is any device that can be used to store data. This includes many data acquisition devices such as plug-in boards or serial communication systems which use a computer as a real time data recording system. The advantage of data loggers is that they can operate independently of a computer, unlike many other types of data acquisition devices. Data loggers are available in various shapes and sizes

4. Safety Considerations

1) *Hearing*: Usage of foam inert plugs when around loud machinery can reduce sound levels upto 30 decibels
2) *Respiratory*: wearing of full face respirator mask with proper filtration. Using activated carbon cartridges in low concentrated noxious gas environments, and changing on a regular basis.
3) *Electrical*: Avoiding live currents .switching off of circuits on equipment.

5. Audit Process

Initially an audit visit information is secured in which details like energy and utility bills, processes and current status is identified. In accordance with this audit equipment are finalized.

First Meet: An introductory visit can be made by meeting the facility manager or supervisor and discuss out the purpose of audit. If possible managers from various departments can be familiarized with the audit process and also point out the possible energy conservation technique.

Audit Sessions: Obtaining adequate and appropriate information is crucial for audit as it will yield in giving ways to trap losses and save bills. Few steps during an initial visit

1. Meeting facility manager or plant manager for information on running data and past record
2. Finance officers can provide with various bills like electricity, fuel and water.
3. Interacting with floor supervisor and operators to understand conditions
4. Maintenance supervisor is always a key to retrieve information from.
5. An auditor must record down the important contacts for further record

5.1 Walk through Audit

A walk through audit is extremely necessary to get the initial feel and to recognize the prospective areas. This will help the auditor and the audit team to see the major operational equipment General information can be obtained and hence would yield to data acquisition

5.2 Detailed Audit: Post walk through a detailed audit is extremely crucial to actually decide upon the factors involved in energy losses and potential areas for focusing.

5.3 Important Parameters to look for:

a) ***Lighting*:** A detailed inventory for lighting is required to be obtained. Data pertaining to number of lights and fixtures wattage, hours of operation. A lighting record should be maintained to. Using a light meter auditors should measure out the lux levels at various points as suitable.
b) ***HVAC Equipment*:** HVAC equipment should be stocked taked. With the use of prepared data sheets size, model numbers,age, electrical specification, hours of operation are to be noted. The equipment is to be monitored to determine the condition of condenser coils, evaporators, air filters, and insulation on refrigeration lines.
c) ***Electric Motors*:** All motors present in the industry to be taken into consideration. Audit data sheet highlighting motor size, age, duration of work,specifications. Other important factors like power factor voltage levels, current are to be noted. Rewinding of motor is a common feature in industries, comparing the cost and performance of a rewound motor to a new motor are few areas of concern.
d) ***Water Heaters*:** Relevant details like type, size, model number, and working duration are noted. Temperature of hot water should be noted.
e) ***Waste Heat Sources*:** Majorly all industries have waste heat sources giving an opportunity to reuse that heat. Various waste heat sources are air conditioners, air compressors, heaters and boilers, ovens, furnace and so on. The main condition is temperature that determines the amount of heat that can recovered.
f) ***Peak Load Equipment*:**Peak load equipment would generally mean the electrically powered machines that are either used intermittently or at a stretch. Peak load should be adjudged surveying a load pattern and hence should be advisable to operate at intervals keeping in mind the time for maximum usage.

5.4 Post Audit Analysis:

Data obtained should be examined, organized and reviewed for authentication. Missing data should be obtained from facility manager in case of discrepancy. There should be a proper channeling of the obtained value and conditions and should yield a proper result. Cost effectiveness should be shouldered in mind as one of the major criteria is to cut down expenses due to losses.

6. Case Study on Lighting Audit at University Energy Lab

Lighting: Lighting doesn't account to great percentage of total industrial usage in audits, yet lighting comprises a huge energy usage and cost. Lighting inventory should be

prepared during audit. Make, specifications, duration of usage are important in preparing audit report. Lights generally left switched on results in energy loss. Now with the use of energy management systems, timers, occupancy sensors are useful in turning off lights when not required. A facilities lighting arrangement are the areas to look out for. Energy saving techniques and to adhere to a better luminance re-orientation can also be proposed.

The aim is to find out the luminancelevels in Energy lab in the university

The various apparatus used are lux meter, measuring tape, work planes in the form of floor, work table, experiment desk, measuring staff.

The main purpose of photometry is to measure visible radiation in a way that will correspond to human eye perception. The intensity of illumination is measured by a lux meter.

The light sensitive cell should be in a horizontal plane at the work plane or 760mm above the floor. No shadows must fall across the light cell. To determine the reflectance factor of a surface the incident light delivered to the surface should be measured by holding the meter cell up on the surface. Illuminance in Lab: Good light quality and appropriate illuminance are a necessary requirement for safe work.

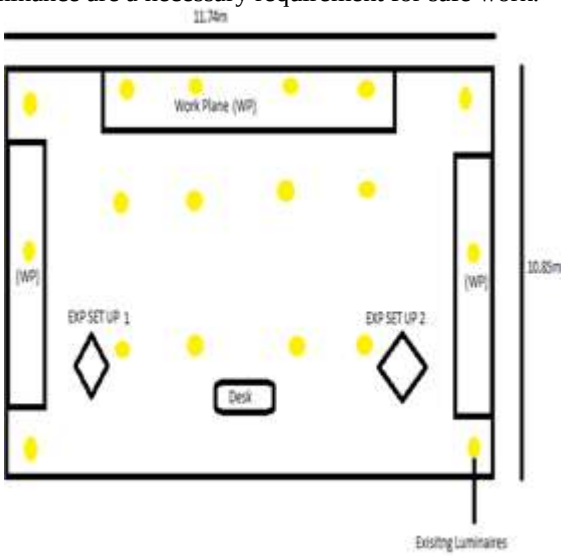

Figure 1

Calculations for existing conditions;
Area of floor = 11.74m x 10.85m = 127.37 sq.m
Mounting Height = 4.1m
No of Fixtures present = 18
Wattage of fixtures = 18Watts
Light O/P = 18 x 18 = 324
Room Index = (Length x Breadth)/Mounting height (Length + Breadth)
= (11.74 x 10.85) / 4.1 (11.74 + 10.85)
= 1.37
Taking wall reflectance to be 70% for light colored wall, ceiling reflectance to be 30%, and cavity ratio to be 0.8.
Coefficient of utilization = 0.91
LLF (Light Loss Factor) = 0.8
Illuminance level = 40.1 lumens / m sq
No. of Luminaires = (Area x Illuminance Level)/ CUF x LLF x Light O/P
= (127.37 x 40.1)/ 0.8 x 0.8 x 324
= 24.6 ~ 25 fixtures
Recommended Number of fixtures are 25.

7. Conclusion

Energy audit being a part of effective energy conservation technique is a methodical method and is technologically advanced procedure. The various instruments used for auditing and measurement devices are technically enhanced and is portable in various uses. The prior intention for usage is easiness in use and mobility as an auditor has to travel all around in pursuit of data collection. The case sample case study of the lab showcases how number of luminaires can be increased in order to enhance illuminance.

References

[1] Bureau of Energy Efficiency ,India
[2] Lighting Survey & Audit- John L. Fetters
[3] International Journal of Government Auditing