

Energy Auditing

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Abstract: Utilization of energy in a pertinent manner is the complex criteria for power system engineers. In this context, energy auditing is one of the primary tasks to be performed in the accomplishment of an effective energy control program. An energy audit consists of a detailed study of a facility that consumes energy, economic considerations for utilization of the energy, and finally a recommended program for changes in operating practices or energy consuming equipment that will cost-effectively save money on energy bills. Also it plays a prominent role in reducing green-house gas emissions that contribute to climate change that manages energy usage at peak load efficiency. Real life applications of energy audit, regarding lighting loads in the institutions are considered as case studies.

Keywords: Energy auditing, Lighting loads, Power factor, Save money, Utility bills

I. Introduction

Saving money on energy bills is alluring aspect to business holders, industries, and even individuals. Very low cost operational changes can often save 10-20% on utility bills of a customer or an industry. In many cases, these energy cost control programs also result in both reduced energy consumption and reduced emissions of environmental pollutants [1]. An energy audit is defined as an inspection, survey and analysis of energy flow for energy conservation in an industry and suggesting a process to reduce the amount of energy input into the system without negatively affecting the output [2]. Auditors analyze the monthly bills, and inspect all of the appliances in any home, organization or institution.

1.1 Goals of Energy Auditing

Generally goals of energy audit vary for different kinds of energy. The overall goals of energy auditing can be simplified as following:

- Study of variation and improvement in power factor and load factors.
- Clearly identifying the various types and costs of energy use.
- Reduction in utility bills.
- Also to understand how energy is possibly wasted.
- Identify and analyze more cost-effective ways of consuming energy [3].

The real power which is consumed by loads is mainly depend on power factor. Similarly improper employment of loads results in the wastage of energy hence a suggestive proposals are made to overcome the wastage.

1.2 Types of Energy Audits

1.2.1 Walk-Through-Audit

The walk-through audit, as its name implies, it is a visual inspection of the energy using systems. It is the cheapest audit but can yield a preliminary estimate of savings potential and provide a list of low cost savings opportunities through improvements in operational and maintenance practices [4].

1.2.2 Standard Audit

The standard audit examines energy uses and losses through a more detailed review and analysis of equipment, systems, and operational characteristics. This analysis may also include some on-site measurement, testing and some energy saving calculations are used to analyze efficiencies, costs savings based on improvements and changes made to each system.

1.2.3 Simulation Audit

This audit will include more detail of energy use and comprehensive evaluation of energy use patterns. It is accomplished through the use of computer simulation software. The auditor will develop a computer simulation of building systems that will account for weather, other variables and predict year-round energy use.

The auditor's goal is to build a base for comparison that is consistent with the actual energy consumption of the facility.

1.3 Basic audit systems

Areas of audit implementation vary from utility to utility. General systems to be audited are as follows:

1. Building Envelope
2. HVAC System
3. Electrical Supply System
4. Lighting
5. Boiler and Steam System
6. Hot Water System (domestic)
7. Compressed Air System
8. Motors inventory
9. Special Purpose Process Equipment

II. Implementation of Energy Auditing

Implementation of audit falls into various pivotal steps with legitimate care. The following are those steps [5]

Step 1: The particulars about facility size, floor plan, construction features, wall and roof material, insulation levels, door and window sizes and construction are to be noted with proper specifications.

Step 2: The working hours of a facility are obtained by justifying the following questions:

- How many shifts does the facility run?
- Is there only a single shift? Two? Three?

Step 3: Determine the pattern of building use to show annual needs for heating, cooling and lighting.

Step 4: Compile an equipment inventory. Get equipment list for facility and review it before conducting audit.

Step 5: Conduct a room-by-room lighting inventory

- Light fixtures
- Lamp types, size and numbers
- Levels of illumination
- Uses of task lighting

Step 6: Collect the data regarding the utility bills, and the cost of the electric energy consumed per unit, number of different motor load inventory in practice etc

Step 7: Cost base analysis is made and specific changes are proposed to gain cost-based benefits.

Step 8: Finally an action plan is created where certain changes are selected for implementation and then actual process of saving energy begins.

III. Case Study

For better understanding about the energy auditing in daily life, consider the following case studies conducted in Sree Vidyanikethan Educational Trust.

3.1 Case Study 1

The lighting loads of the entire college campus are found to be 1815(in number)[6].

Table 1: Information regarding case study in college campus

Parameter	Fluorescent lamps	LED's
Life time of each lamp	20000	50000
Approximate cost	Rs. 400	Rs.1250
Utilization of each lamp	8 hrs/ day	8 hrs/ day
Wattage of each lamp	32W	16.5W
Total Power Consumed	58.08kW	29.945kW
Total Power consumed per day	464.640units	239.58units
Unit cost	Rs. 6 approx	Rs.6 approx
Cost of total power consumed by lamp/day	Rs. 2875.4	Rs. 1437.5
Power saved/day	28.14kW	
Total power consumed/year for 300 days	1,39,392 Units	71874 Units
Total power Saved	67518Units	
Money saved per year	Rs. 4,05,108 .00	

3.2 Case Study 2

The lighting loads of the entire school campus are found to be 1346(in number)[6].

Table 2: Information regarding boarding campus case study

Parameter	Fluorescent lamps	LED's
Life time of each lamp	20000	50000
Approximate cost	Rs. 400	Rs.1250
Utilization of each lamp	8 hrs/ day	8 hrs/ day
Wattage of each lamp	32W	16.5W
Total Power Consumed	43.072kW	22.209kW
Total Power consumed per day	344.576units	177.672units
Unit cost	Rs. 6 approx	Rs.6 approx
Cost of total power consumed by lamp/day	Rs. 2067	Rs. 1066
Power saved/day	166.904kW	
Total power consumed/year for 300 days	103372.8 Units	53301.6 Units
Total power Saved	50071.2Units	
Money saved per year	Rs. 3,00,427 .00	

Model Calculations (Case Study)

Total power consumed by fluorescent lamps = 1815×32
 $= 58.08 \text{ kW}$

Total number of units consumed per day = 58.08×8
 $= 464.64 \text{ units}$

Total power consumed by LED lamps = 1815×16.5
 $= 299.47 \text{ kW}$

Total number of units consumed per day = 239.58 units

Saved units per day = 225.06 units

Saved units per annum/300 (working days) = 67518 units

Total money saved per annum = 67518×6
 $= \text{Rs. } 405108.00$

3.3 Recommended energy conservation measures

- Required number of lighting loads must be selected as per the brightness of the location.
- Usage of automatic sensing system which prevents the unnecessary switching on of different kinds of lighting loads.

IV. 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. Energy audit is an effective tool in identifying energy problems. By means of energy auditing the high power consuming equipments are identified and the sources of power loss can be detected. It identifies the poor quality equipment or the old equipment which causes energy losses. These problems can be limited by energy auditing and by means of this the energy bill can be reduced. By performing the cost-base analysis the energy consumption is analyzed effectively. Lighting loads in the institutions are considered as case studies and it's reports before and after conducting energy audit are presented.

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