

Electrical Energy Audit-An Overview

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Abstract—An energy audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some technologies that already exist provide the most hopeful prospects for the future. In this paper, the importance of energy auditing and process of energy auditing are presented in detail.

Keywords— Energy audit, Energy management, Supply side management (SSM), Demand side management (DSM).

I. INTRODUCTION

Energy crisis is one of major problem in surviving world where demand of energy is increasing rapidly. Energy is prime focus due to rapid growth and development of technology. Proper utilization of Energy is one of the major aspects of any developing country. Today the need of energy has increased greatly in order to meet the demand of ever increasing consumption of it. This energy crisis problem will be solved through Energy conservation and use of energy efficient equipment. Energy is the basic necessity for the economic development of a country. Many functions necessary to present day living grind to halt when the supply of energy stops. It is practically impossible to estimate the actual magnitude of the part that energy has played in the building up of present day civilization. The availability of huge amount of Energy in the modern times has resulted in shorter working day, higher agricultural and industrial production, a healthier and more balanced diet and better transportation facilities.

A. Electrical Energy

Electrical energy is energy that is caused by moving electric charges. Since the electric charges are moving, this is a form of kinetic energy. The faster the electric charges are moving the more electrical energy they carry. Electrical energy is basically generated the same way regardless of the starting form of energy

Electrical energy is superior to all other forms of energy due to the following reasons:

- **Convenient form.** Electrical energy is a very convenient form of energy. It can be easily converted into other forms of energy. For example, if we want to convert electrical energy into heat. The only thing to be done is to pass electrical current through a wire of high resistance (e.g. A heater similarly), Electrical

energy can be converted into light (e.g. electric bulb), mechanical energy (e.g. Electric motors) etc.

- **Easy control.** The electrically operated machines have simple and convenient starting. Control and operation. For instance, an electric motor can be started or stopped by turning on or off a switch. Similarly With simple arrangements. The speed of electric motors can be easily varied over the desired range.
- **Greater flexibility.** One important reason for preferring electrical energy is the flexibility that it offers. It can be easily transported from one place to another with the help of conductors.
- **Cheapness.** Electrical energy is much cheaper than other forms of energy. Thus it is overall economical to use this form of energy for domestic, commercial and industrial purposes.
- **Cleanliness.** Electrical energy is not associated with smoke. Fumes or poisonous gases. Therefore its use ensures cleanliness and healthy conditions.

B. Definition

➤ Energy Auditing

The word Audit can be defined as methodological examination and review or an examination with an intent to verify. Historically audits have only concentrated on determination of the financial of conditions of the organization or business. However, it is wholly appropriate, in an era in which energy become a major cost factor in almost all the walks of the life. In fact, in much industrial process, energy and profit are so closely related that financial audits and energy audits are close akin. Basically the term "Energy Audit" is to denote an in-depth study of a facility.

- To determine how and where energy is being used or converted from one form to another.
- To identify opportunities to reduce energy usage.
- To evaluate the economics and technical practicability or implementing these reduction.
- To formulate prioritized recommendations for implementing process, Improvement to save energy.

➤ *Energy Efficiency Improvements*

Energy efficiency improvements result in reductions in the energy consumed by a given Energy service or level of activity. These reductions are not necessarily associated with technical changes since they can also result from better organization and management or improved economic efficiency.

➤ *Energy Monitoring*

Energy monitoring involves the regular recording of energy consumption and cost, and of the principal variables, such as outside temperature and occupancy, which affect them. It allows essential information on energy performance to be provided at the right time and in a useful form to those responsible for its control.

➤ *Energy Management*

Energy management must balance justifiable energy demand with appropriate energy supply. The process couples energy awareness, energy conservation, and energy efficiency with the use of primary renewable energy resources.

It can be classified as

- Supply Side Management (SSM)
- Demand Side Management (DSM)

➤ *Supply side Management*

A theory of economics that reduces the investment and in turn will benefit the entire society. Elements of supply side management

- Renewable energy source
- Efficient boiler & Generator
- Cogeneration energy system
- Captive generation
- Distributed Generation

➤ *Demand side Management*

DSM consists of the planning, implementing, and monitoring activities of electric utilities which are designed to encourage consumers to modify their level and pattern of electricity usage. Elements of DSM are

- Incorporation of customer load
- Modification as alternatives or addition to traditional recourse planning
- Intervention by utility on the “customer side of the meter” to change magnitude or shape of customer loads
- Broad range of alternatives for reducing, adding or changing load

DSM Programs fall into two categories, energy conservation and load management.

Energy conservation encourages consumers to use energy more efficiently, resulting in reduced energy consumption without sacrificing comfort, convenience or productivity. Load management shifts electricity loads from one period to another but rarely reduces electricity consumption. Load survey data is necessary to evaluate demand side management techniques. Demand side management can be defined as those activities oriented towards influencing consumers use of electricity in ways that produce the desired changes in load shape. DSM refers to co-operative activities between the utility and the consumers to implement options to modify consumer loads with resulting benefits to the consumers & utility.

The concept of DSM in power systems involves both the suppliers and the consumers, for optimal utilization of available resources. It imposes a supplier consumer relationship that produces mutually beneficial results. From suppliers point of view the DSM includes those suppliers' activities that are designed to influence consumer use of electricity and achieve a desirable system load shape. To achieve these objectives supplier can offer suitable incentives to the consumer such as different tariff incentive for maintaining high power factor, incentive for reduced use of electricity during system peak period, Incentive for use of energy efficient equipment's & rebates for use of non-conventional energy equipment's. For consumer's point of view, the DSM includes those activities that are implemented by the consumer such as increasing the off-peak use of electricity, better utilization of available power, rescheduling of loads, & reducing unnecessary use of electricity etc.

C. Type of Energy Audit

The type of Energy Audit to be performed depends on

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types

- Preliminary Audit
- Detailed Audit

1. Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to

- Establish energy consumption in the organization.
- Estimate the scope for saving Bureau of Energy Efficiency.
- Identify the most likely (and the easiest areas for attention.
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'

- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data

2. Detailed energy auditing Methodology

Detailed energy auditing is carried out in following phases:

❖ Pre-audit phase

- Plan and organize
- Conduct brief awareness program with all individual heads and persons connected.
- To collect data from energy consuming centers.
- To identify any additional metering required.

❖ Audit Phase

- Historic data analysis
- Measurement: Motor survey, lightning and other equipment survey with portable instrument for collecting more and accurate data.
- Power monitoring
- Energy loss/waste analysis **Post Audit Phase**
- Reporting and presentation to the management
- Implementation and follow up
- Periodic review

D. Methodology Adapted

Flow Chart

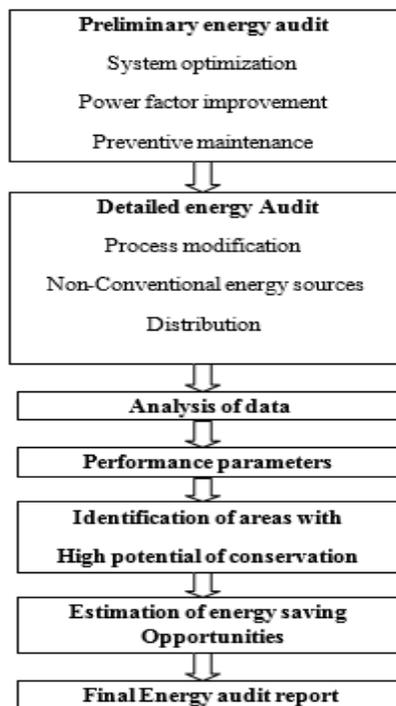


Fig 1: Flow Chart representing energy audit process

The methodology adapted for this audit was a three step process comprising of

1. *Data Collection* – In preliminary data collection phase, exhaustive data collection was made using different Methods such as observation, interviewing key persons, and measurements.

Following steps were taken for data collection

- Visited each department, center, laboratories, library, canteen, auditorium and other entities of the Institution.
- Information about the general electrical appliances was collected by observation and interviewing.
- Obtained Site drawing of available building lay-out and Electricity distribution.
- Collection of Electricity bill from the in-charge personnel.
- The power consumption of appliances was measured using power analyzer in some cases (such as fans) While in other cases, rated power was used (CFL for example).
- Information collected on redundant / non-operational energy systems.
- The details of usage of the appliances were collected by interviewing key persons e.g. Electrician, caretaker (in case of departments) etc.
- Approximations and generalizations were done at places with lack of information.

2. Data Analysis

The analysis of data is done in following way

- Evaluation of collected data department wise analysis, block wise analysis and location wise analysis.
- Reasons for the Variance between connected load and actual consumption was evaluated.
- The database prepared was further studied and the results have been graphically represented.
- This helped to identify the areas with maximum energy saving potential.

3. Recommendation

Following were the steps involved in this process

- The capital cost involved in replacing an appliance and/or process was estimated.
- The energy saving by the move was calculated in terms of price of energy per year.
- These two costs were compared to calculate the capital cost recovery time which is defined as the

total time by which the saving in energy bill balances the capital cost involved.

- If capital cost recovery time is less than the product life, the move can be supported.

E. Advantages of Energy Audit

The identification and implementation of recommendations for energy efficiency improvements arising from an Energy Audit can deliver different inter-related benefits to site operators, viz.

- Setting of energy efficiency targets.
- Financial benefits in terms of reduced costs or increased profits.
- Operational benefits including improved productivity, comfort and safety, and security of energy supply.
- Environmental benefits such as sustainability, conservation of resources and emissions savings including greenhouse gas reductions. Environmental benefits are often realized through compliance with environmental legislation or regulatory requirements for instance.
- The proposed introduction of an energy tax by late 2004 should provide additional motivation to improve energy efficiency.
- Electricity market deregulation and the increased deployment of renewable energy conversion systems have improved accessibility to sustainable energy supplies.

F. Suggestions and Measures

- *Minimizing Repair Works in Fans*

During data collection, the repaired fans have been found to be consuming very high power as compared to the rated power. Fans repaired once and twice were consuming 16W and 43W more than the average consumption of new fans respectively. Thus, effort should be made to minimize the repairing of fans and also repair work should be supervised properly.

- *Proper Insulation*

Good quality insulation must be maintained in the air conditioned rooms by keeping all doors and windows closed properly so as to prevent cool air go out and hot air come in.

- *Curtains*

Always keep curtains on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.

- *Maintenance*

Proper maintenance and cleaning of ACs is required at regular intervals to make it work at highest efficiency. Any dirt in filter may reduce efficiency of ACs very significantly.

- *Operating*

The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room.

II. CONCLUSIONS

Energy audit is an effective tool in identifying and perusing a comprehensive energy management program. A careful audit of any type will give the organization a plan with which it can effectively manage the organization energy system at minimum energy cost. In this paper, a detailed study has been made to reduce the electrical energy consumption. It highlights the amount of energy savings that can be obtained thereby energy crisis can be reduced considerably.

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