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An Engineering Approach to Energy Auditing

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Abstract

Buildings in the World are consuming nearly about 50% and have become responsible for primary cause of greenhouse emissions. Present standards and energy efficiency programs in the several countries have succeeded in improving the energy performance of existing buildings. However, energy systems currently utilized in buildings are still can be improved to appreciable levels. Even with current technologies, there is significant potential to improve energy efficiency cost-effectively for both new and existing buildings. In addition to improvements in energy systems, proper usage of energy in terms of proper capacity and elimination of wastage of energy are also essential. Energy audits are the means of metric to quantify energy. The standard audit provides energy analysis of the energy systems. To perform an energy audit, several tasks are typically carried out depending on the type of audit and the size and function of the audited building. Some of the tasks may have to be repeated, reduced in scope, or even eliminated based on the findings of other tasks. Therefore, the execution of an energy audit is often not a linear process and is rather iterative. However, a general procedure can be outlined for most buildings. This paper is aimed at giving general procedure, measure and methods of energy auditing.

Keywords: Greenhouse, Auditing, iterative, metrics

1. INTRODUCTION

An Energy Audit is an investigation of all facets of an organization's historical and current energy use with the objective of identifying and quantifying areas of energy wastage within the organization. An Energy Audit establishes the baseline for any improvements in an organization's energy use. It provides a comprehensive and systematic method for targeting cost effective efficiency gains. Energy audit is an effective tool in defining and pursuing comprehensive energy management programmers. It has positive approach aiming at continuous improvement in energy utilization in contrast to financial audit which stresses to maintain regularity. Energy audit provides answer to the question – what to do, where to start, at what cost and for what benefits. Energy audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating and maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment, instrumentations and technology.

1.1 Phases of Energy Audit

There are generally three phases to an Energy Audit are as below,

1. Investigation Phase
2. Monitoring Phase
3. Analysis & Reporting Phase

Investigation Phase

This phase encompasses obtaining all relevant data concerning:

- Historical energy consumption for the past 1 to 2 years
- Tariffs and related energy supply contracts
- Floor areas, staff numbers, production levels
- Occupancy hours
- Industry energy use/cost benchmark levels
- Sub electrical and gas metering equipment
- After-hours air conditioning usage
- Mechanical plant configuration (e.g. chiller plant rated cooling capacity, pump and fan motor kW ratings and efficiency), as-installed drawings, electrical single line drawings, and operational & maintenance manuals
- Lighting configuration (i.e. lamp number & fitting type, Wattage, ballast type), condition and controls
- Compressed air system (if present) including rating, presence of air leaks, hours of usage
- Steam and hot water boilers
- Building Management Systems and control strategies
- Building envelope, shading, orientation, insulation levels
- Energy management process and policy information

Monitoring Phase

This phase involves obtaining detailed information pertaining to the overall site as well as the major energy use categories. The operation of key plant and equipment is inspected, and measurement of a range of parameters, is undertaken where appropriate, including:

- Electrical & gas load profiles
- Internal temperature/humidity
- Ventilation rate
- Light levels
- Boiler flue combustion analysis.

Feedback is also obtained from maintenance staff on issues concerning building and plant operation and maintenance which could well be impacting on energy efficiency as well as occupant comfort.

Analysis and Reporting Phase

This phase involves:

- Determination of overall energy efficiency of complex; for example MJ/m2 per annum for office buildings, MJ or $/occupied room night per annum for hotels, MJ or $/bottle per annum for winery industry.
- Determination of the greenhouse emission index and ABGR energy star rating for office buildings
- Life cycle cost analysis of various energy saving measures
- Tariff analysis
- Peak demand management including evaluation of power factor correction

2. AUDIT PROCEDURE

An energy audit consists of 5 main steps that can be performed at the auditor's office or at the organization's facilities*:*

Data collection: the auditor starts collecting some preliminary information on the energy consumption of the facilities and some technical details such as process diagrams, drawings and equipment inventory - usually provided by the organization.
Field work: at least one on-site visit is required, with the aim of gathering all the information needed for the study depending on the defined scope. This information includes collecting details of the energy consuming equipment such as brand, model, power and hours of operation. Some interviews with staff will also be required. Depending on the type of energy audit, some metering devices will be used.
Analysis of energy consumption and performance of energy accounting: all the operations of the organization must be analyzed, as well as the equipment consuming higher energy. The processes which have higher energy consumption must be identified in order to determine the potential for reducing it and to define the energy saving measures to improve global energy-performance.

All information collected is used to evaluate the different uses of energy within the process and to establish a breakdown of the energy consumed. This energy accounting is also called *Energy Balance*.
Analysis and development of energy saving measures: once all the data collected has been analyzed, energy saving measures can be identified. The information collected and analyzed enables the auditor to detect energy saving measures to reduce energy consumption. Energy and cost savings of these measures will be assessed, together with investment needed and payback.
Energy audit report: following the energy audit, an energy audit report must be issued, which should include at least the following information:
Technical scope: this point includes facilities, services and included areas and level of depth in the analysis and detail required.
Methodology: this point includes the analysis of the state of art of the facilities (energy inputs, technologies and services), measurement results and energy balance.
Suggested energy saving measures: this point includes a description of each energy saving measure, including potential energy savings, economic savings, investment needed and payback.

CONCLUSION

This point includes the recommended measures, total energy savings, total economic savings, total investment and payback.

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