

## A FUNDAMENTAL OVERVIEW ON ENERGY AUDIT

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**Abstract:** - For the developing country like India, the energy generated make a decision on the economic development of the country. Being the fifth major power generator and the fourth principal power consumer in the world, energy demand and insufficiency rules the country. Energy demand in our country is rising exponentially. Energy conservation can be the paramount solution for the increasing energy demand. Energy audit is the best solution for the energy conservation where the system is well investigated and a report stating the probable changes in the system with no negative output is appraised. Energy audit is an inspection, survey and investigation of energy flows in a building, in a process or a system with the intention of realizing the energy dynamics of the system under analysis. In each industry, there is conservation and utilization of electrical energy. However every so often, it is not probable to utilize electrical energy in an appropriate manner. So, energy audit is an aid to utilize electrical energy very competently and in appropriate way. This paper presents a basic review on energy audit and few new concepts like demand response, demand side management, zero energy building and green building are also been discussed in the paper.

**Key Words:** - Energy Audit, Energy Conservation, Demand Response, Zero Energy Building, Green building, LEED.

### I. INTRODUCTION

Energy is one of the main inputs for the economic growth of any country. In case of developing countries, the energy segment presumes a significant importance in view of the forever increasing energy needs necessitating massive investments to meet them. For minimizing energy cost and increasing efficiency, we use the energy conservation, management and audit. The goal of energy management is to attain and maintain best possible energy utilization, all over the institution as to reduce the energy cost without disturbing production and quality. The energy audit is nothing but cyclic inspection of energy system to make certain that energy is being utilized appropriately and efficiently as far as possible. Energy audit is an aid to a systematic method for decision making in the vicinity of energy management. It attempts to stabilize the total energy inputs with its utilization, and serves to recognize all the energy flows in a facility. Presently, electrical energy is being produced with the help of conventional as well as non-conventional energy sources. However, on load side, energy demand is increasing exponentially. Energy conservation could protect the current reserve of energy from the ethnicity of wasting the energy. In the presented paper energy audit has been focused to review the state of energy utilization. The methodology of energy audit is the measurement of energy performance with respect to production factor. Energy dominion of the country could be guaranteed through the efficient practice of energy audit which would decide the path to set increasing energy efficiency of all resources critical with respect to both environment and economy of the country. Energy auditing is an obligation for the energy sovereignty of any country. This paper is presented in five sections including introduction. Section II presents the necessity of energy audit, its goals and types of energy audit methods. Section III gives the methodology of energy audit. Demand response and Zero-Energy Building and green building are explained in section IV and finally section V gives the conclusion.

### II. NECESSITY OF ENERGY AUDIT

In every industry, the three top operating expenditures are frequently found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the expenditure or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and hence, energy management function comprises a tactical area for cost reduction. Energy Audit will facilitate to understand more about the ways energy and fuel are utilizes in any industry, and assists in recognizing the areas where waste can occur and where there is scope for improvement. The Energy Audit gives a positive direction to the energy cost minimization, preventive maintenance and quality control programs which are major factors for production and utility activities. Such an audit programme will assist to keep focus on discrepancies which take place in the energy costs, availability and reliability of supply of energy, make a decision on suitable energy mix, discover energy conservation technologies, retrofit for energy conservation equipment etc. In common, Energy Audit is the

translation of conservation schemes into realities, by providing technically realistic solutions with economic and other institutional considerations within a specific time frame. The prime objective of Energy Audit is to establish methods to minimize energy consumption per unit of product output or to reduce operating expenditures. Energy Audit presents a "bench-mark" for managing energy in the organization and also offers the base for planning a more effectual utilization of energy all over the organization.

**2.1 Goals of energy audit:** - major goals of energy audit are,

- 1) To reduce wastage of electrical energy of a particular building and site.
- 2) To find actual energy consumption of building.
- 3) To improve efficiency of electrical supply system of the relevant site.
- 4) To improve performance of supply system of the building.
- 5) To reduces cost of the system.

**2.2 TYPES OF ENERGY AUDIT:** - The type of Energy Audit to be carried out depends on,

- 1) Function and type of industry
- 2) Depth to which final audit is needed,
- 3) Potential and magnitude of cost reduction desired.

Hence, energy audit can be classified into the following two types:-

- i) Preliminary energy Audit
- ii) Detailed energy Audit

**2.2.1 PRELIMINARY ENERGY AUDIT:** - Preliminary energy audit is a kind of audit where the analysis of energy utilized in organization according to requirement of energy is carried out. A Preliminary Energy Audit is fundamentally a data collecting process which aspires to develop an understanding of how energy is utilized in an Industry and organize a background for detailed energy audit accomplishment. In an Preliminary auditing process the prime obligation is to collect data from important persons like, manager and owner of the organization about the schematic design of the industry production process, production program and capacity, production of the year, using raw material, monthly and annual fuel consumption data by an interview. Preliminary energy audit is fairly a quick process to:

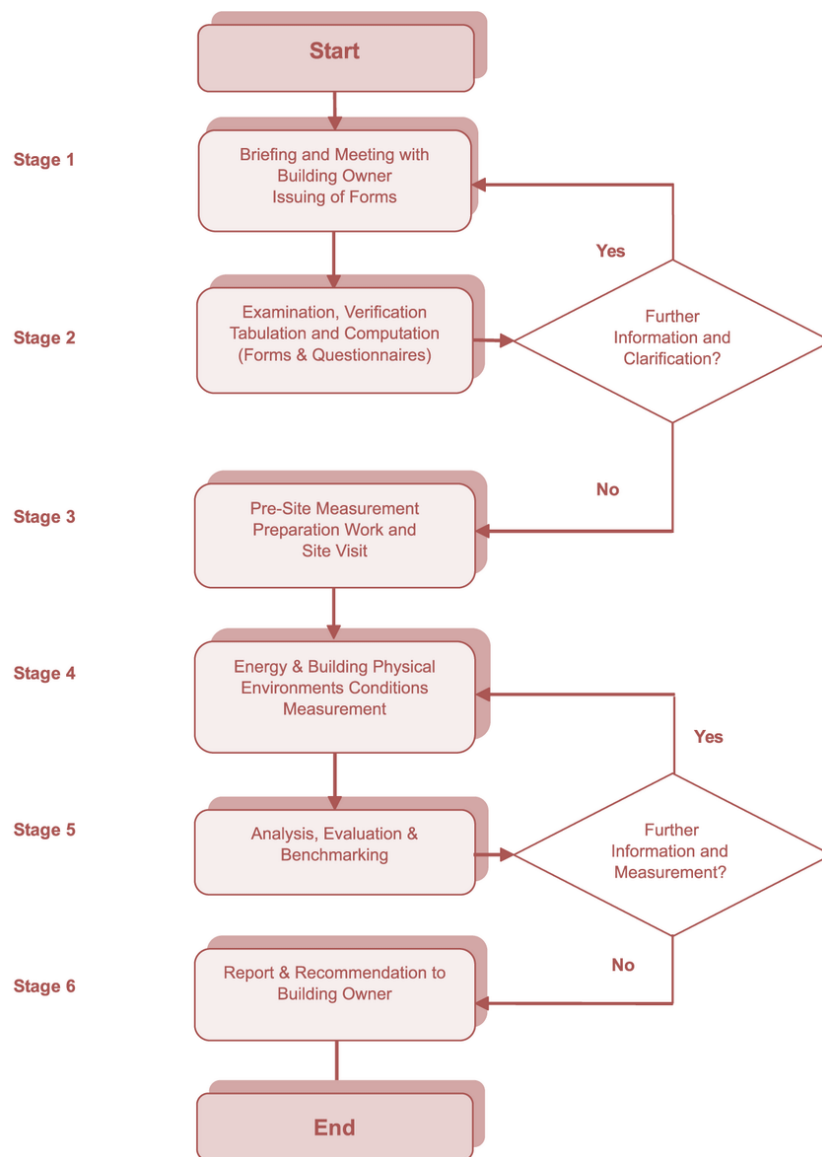
- set up energy consumption in the organization
- Estimate the extent for saving
- recognize the most likely (and the easiest) areas for attention
- recognize immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit utilizes accessible or easily obtained data

**2.2.2 DETAILED ENERGY AUDIT:** - A complete audit gives a detailed energy project execution plan for a facility, because it assesses all major energy utilizing systems. This kind of audit gives the most precise estimate of energy savings and cost. It considers the interactive consequences of all projects, accounts for the energy utilization of all major equipment, and comprises detailed energy cost saving calculations and project cost. A detailed energy audit intends at setting up actual energy performance of preferred end-users and processes based on recognized energy conservation opportunities during the

preliminary audit. Detailed energy audit is the long term investigation process comprising of all kinds of data like production processing, equipment’s efficiency and performance, consumption of energy and economic and financial evaluation of energy performance improvement measures includes cost-benefit analysis. The audit outcomes have to be summarized in a report, collectively with an action plan containing the priorities for the accomplishment of performance enhancement project. In a comprehensive audit, one of the major elements is the energy balance. This is based on a catalog of energy using systems, assumptions of present operating circumstances and calculations of energy utilization. This estimated utilization is then compared to utility bill charges. Detailed energy auditing is performed in three phases: Phase I-Pre audit phase, Phase II-Audit phase and Phase III- Post Audit phase.

### III. ENERGY AUDITING METHODOLOGY

Figure1 shows the flow chart of Energy Audit methodology.



**Figure1. Flowchart of Energy Audit methodology**

Auditing in Industries means the verification of the efficiency of the production according to the consumption of energy, this follows the following steps:-

- 1) Preparation and planning
- 2) Data collection and review
- 3) Plant surveys and system measurements
- 4) Observation and review of operating Practices
- 5) Data documentation and analysis
- 6) Reporting of the results and recommendation

### **3.1 METHODOLOGY FOR DETAILED ENERGY AUDIT**

#### **Phase I -Pre Audit Phase Activities,**

A prearranged method to accomplish an energy audit is essential for efficient working. A preliminary study of the site should always be carried out, as the planning of the procedures essential for an audit is most important.

Initial Site Visit and Preparation required for Detailed Auditing: - An initial site visit may take one day and provides the Energy Auditor/Engineer an occasion to meet the personnel concerned, to familiarize him with the site and to appraise the procedures essential to complete the energy audit. During the initial site visit the Energy Auditor/Engineer should carry out the following actions: -

- Discuss with the site's senior management about the aims of the energy audit.
- Discuss economic guidelines related with the recommendations of the audit.
- Analyze the major energy consumption data with the related personnel.
- get site drawings where available - building layout, steam distribution, compressed air distribution, electricity distribution etc.
- Tour the site accompanied by engineering/production.

#### **The main purposes of this visit are**

- To decide the Energy Audit team
- To recognize the main energy consuming areas/plant items to be surveyed during the audit.
- To make out any existing instrumentation/ additional metering required.
- To make a conclusion whether any additional meters have to be installed prior to the audit e.g. kWh, steam, oil or gas meters.
- To identify the instrumentation required for the execution of the audit.
- To plan according to time frame.
- To gather macro data on plant energy resources, major energy consuming centers
- To create awareness through meetings/ programmes

## Phase II- Detailed Energy Audit Activities

Depending on the nature and convolution of the site, a comprehensive audit can take from several weeks to several months to complete. Detailed studies to establish, and investigate, energy and material balances for specific plant departments or items of process equipment are conducted. Whenever possible, verification of plant operations are conducted over extended periods of time, at nights and at weekends as well as during normal daytime working hours, to make sure that nothing is ignored. The audit report will comprise a description of energy inputs and product outputs by major department or by major processing function, and will assess the efficiency of every step of the manufacturing process. Means of enhancing these efficiencies will be planned and at last a preliminary assessment of the cost of the improvements will be made to signify the expected payback on any capital investment required. The audit report should conclude with specific recommendations for detailed engineering studies and feasibility analyses, which must then be performed to rationalize the execution of those conservation measures that need investments

## IV. DEMAND RESPONSE

Demand response offers a prospect for consumers to play a major role in the operation of the electric grid by reducing or shifting their electricity utilization during peak hours in response to time-based rates or other forms of financial incentives. Demand response programs are being utilized by some electric system planners and operators as resource options for balancing supply and demand. Such programs can reduce the price of electricity in wholesale markets, and in turn, lead to reduce the retail rates. Approaches of engaging customers in demand response efforts include presenting time-based rates such as time-of use pricing, critical peak pricing, variable peak pricing, real time pricing, and critical peak rebates. It also comprises direct load control programs which provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills.

**4.1. CORRELATION AMONG ENERGY EFFICIENCY AND DEMAND RESPONSE:** - Demand response and energy efficiency both affect customer end-use of energy. We could not find published research on the issue of how demand-response programs affect energy use during off-peak periods and overall building/facility energy use and energy efficiency. There is some most anecdotal evidence that proposes certain kinds of technologies capable of enabling demand response during peak demand periods can also realize energy and demand savings in off-peak periods.

**4.2. DEMAND SIDE MANAGEMENT (DSM):** - Demand Side management is the progression of managing energy consumption to optimize accessible and planned resources for power generation. DSM integrates all activities that influence customer utilization of electricity and results in the reduction of the electricity demand, which are mutually useful to the customers and the utility. Electrical energy cannot be stored economically or in large quantities. Hence, supply and demand has to be balanced concurrently. To make sure sustenance of supply, the total capacity of electricity generation must be larger than the maximum demand. During the precedent years, the demand for electricity is increasing every year. The economic cost and environmental impact to build new power plants to satisfy the rising demand will be very expensive. Demand Side Management (DSM) techniques provide multiplicity of measures to lower energy consumption, which leads to more manageable demand.

**4.3. ZERO ENERGY BUILDING:-** A zero-energy building, also known as net-zero energy building (NZEB), or net zero building, is a building with zero net energy consumption, meaning the total amount of energy utilized by the building on an annual basis is roughly equal to the amount of renewable energy produced on the site. These buildings accordingly contribute less overall greenhouse gas to the atmosphere than similar non-ZNE buildings. They do consume nonrenewable energy and produce greenhouse gases, but at other times reduce energy consumption and greenhouse gas production elsewhere by the same amount while consuming renewable energy. A similar concept approved and implemented by the European Union and other agreeing countries is nearly Zero Energy Building (nZEB), with the goal of having all buildings in the region under nZEB standards by 2020. Most zero net energy buildings get half or more of their energy from the grid, and return the same amount at other times. Buildings that produce a surplus of energy over the year may be called "energy-plus buildings" and buildings that consume slightly more energy than they produce are called "near-zero energy buildings" or "ultra-low energy houses".

**4.4 GREEN BUILDING:** - Green building or sustainable design is the practice of enhancing the efficiency with which buildings and their sites utilize energy, water and materials, and dipping brunt on human health and the environment for the whole life cycle of a building. a few of the general green building practices comprise; utilization of sustainable building

materials like recycled glass and steel, as well as renewable materials like bamboo and rubber, installing energy-efficient windows and doors by means of lower volatile organic compounds (VOC) paints and stains. Green buildings presents us a incredible prospect to save energy, decrease waste, reduction on green house gas emissions, conserve natural resources; all whilst enhancing water and air quality. Green building as well present their inhabitants better health and productivity and are moreover cost proficient to operate. The most significant advantage of green building is that it absolutely influences our climate and on the whole eco system by reducing water use and energy sources that contaminate our environment for instance coal and carbon dioxide discharged in to the atmosphere.

**4.4.1 Advantages of green building:** - The advantages of a green building are,

- 1) Energy efficiency
- 2) Water efficiency
- 3) Material efficiency
- 4) Superior health
- 5) Enhanced indoor environment quality
- 6) Low maintenance and operation cost
- 7) Improved environment
- 8) Decreases strain on local resources.

**4.4.2 Disadvantage of green building:** - The disadvantages of green building are,

- 1) Initial building cost is high.
- 2) Green construction materials are not constantly readily accessible as conventional materials.

**4.4.3 LEED (Leadership in Energy and Environment Design):-** It is an internationally recognized green building certification system, providing third party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most; Energy savings, water efficiency, carbon dioxide emission reduction, improved indoor environment quality and stewardship of resources and sensitivity to their impacts. There are four level of LEED certification as mentioned below,

- Certified (40-49 Points)
- Silver (50-59 Points)
- Gold (60-79 Points)
- Platinum (80+ Points)

## V. CONCLUSION

The primary objective of energy management is to produce goods and offer services with the minimum cost and minimum environmental hazards. We can accomplish this objective by employing energy audit in the associated institution or utility. This Paper represents the fundamental information about industrial energy audit with few new concepts like zero energy building, green building. Energy audit is just the transitional between energy management and load side energy demand. Presently, energy consumption is considerably increasing. So, we have to find out the possible ways for reducing this extreme energy consumption. Energy audit is the remedy which reduces unwarranted energy consumption.

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