

# Industrial Energy Audit

Paras N. Patravale <sup>1</sup>, Shubham S. Tardekar <sup>2</sup>, Nihal Y. Dhole <sup>3</sup>, Sujit S. Morbale <sup>4</sup>

Mr. R. G. Datar <sup>5</sup>

<sup>1234</sup> Students, Electrical Engineering,  
Sanjay Ghodawat Institute, Kolhapur, Maharashtra.

<sup>5</sup> Professor, Dept. of Electrical Engineering,  
Sanjay Ghodawat Institute, Kolhapur, Maharashtra.

\*\*\*

**Abstract** - An energy audit is an inspection, survey and analysis of energy flows in building, process or system with the objective of understanding the energy dynamics of the system under study. In every industry, there is an conservation and use of electrical energy. But sometimes, it is not possible to use electrical energy in proper manner. So, energy audit is a tool to make use of electrical energy very efficiently and in proper way. This paper gives an review on energy flow of industry, total energy demand, total consumption of industry according to energy demand. This paper represents detailed energy audit of textile industry & solutions for energy savings. During the study, it is seen that the most of the connected load is 3-Phase Induction Motor and 1-Phase Induction Motor. During the energy audit, new concepts arises like green building, zero energy building, energy efficient building.

**Key Words:** Energy Audit, Green Building, Demand Response, Zero Energy Building

## 1. INTRODUCTION

Energy is one of the major inputs for the economic development purpose for any country. In the case of developing countries, the energy sector assumes a critical importance in view of the ever increasing energy needs requiring huge investments to meet them. For reducing cost and increasing efficiency, then use energy conservation, management and audit. The objective of energy management is to achieve and maintain optimum energy utilization, throughout the organization as to minimize energy cost without disturbing production and quality.

The energy audit is nothing but periodic examination of energy system to ensure that energy is being used properly and efficiently as possible. Energy audit is an key to a systematic approach for decision making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. Now a days, everyone is going to produce the electrical energy with the help of conventional as well as non-conventional energy sources but actually on load side, energy demand is increasing. Energy conservation could protect the present reserve of energy from the culture of wasting. In this paper energy audit has been focused to assess the state of energy usage.

The methodology of energy audit is the measurement of energy performance with respect to production factor.

The technical survey for the energy audit to monitor the consumption in industry, domestic area, hospital and power plant has been studied. All attempts are taken to the total energy input correlating with production for the mentioned fields. As a result of the study the areas where the energy is wastefully used and the improvements are felt, are identified and corrective measures are recommended so that the overall field efficiency could be improved. Energy sovereignty of the country could be ensured through the effective practice of energy audit which would determine the way to set increasing energy efficiency of all resources crucial with respect to both environment and economy of the country. Energy auditing is a must for the energy sovereignty of our country.

## 1.1 NEED OF ENERGY AUDIT

In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and helps in identifying the areas where waste can occurs and where scope for improvement exists. The Energy Audit would gives an positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are main for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.

In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a " bench-

mark" for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Goals of energy audit :-

- To reduce wastage of electrical energy of that particular building and site .
- To obtain actual energy consumption of building .
- To improve efficiency of electrical supply system of the relevant site.
- To improve performance of supply system of the building.
- To reduces cost of the system .

## 1.2 TYPES 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.

- i) Preliminary Audit
- ii) Detailed Audit

### 1.2.1 PRELIMINARY AUDIT

Preliminary energy audit is nothing but the one of the type of energy audit. It is type of audit where the study of energy used in organization according to need of energy. A Preliminary Energy Audit is essentially a data gathering exercise which aims to develop an understanding of how energy is used in an Industry and prepare a background for detailed energy audit implementation.

In an Preliminary auditing process the first requirement is to gather data from key peoples like manager and owner of the factory about the schematic design of the factory 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 a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- 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

### 1.2.2 DETAILED ENERGY AUDIT

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

A detailed energy audit aims at establishing actual energy performance of selected end-users and processes. Based on identified of energy conservation opportunities during the preliminary audit. DEA is the long term inspecting process consisting of all types 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 results have to be summarized in a report, together with an action plan containing the priorities for the implementation of performance improvement project.

In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges. Detailed energy auditing is carried out in three phases: Phase I, II and III.

- Phase I - Pre Audit Phase
- Phase II - Audit Phase
- Phase III - Post Audit Phase

## 2. METHODOLOGY

Auditing in Industries means the checking of the efficiency of the production according to the consumption of energy, this is following some steps.

- Preparation and planning
- Data collection and review
- Plant surveys and system measurements
- Observation and review of operating
- Practices
- Data documentation and analysis
- Reporting of the results and recommendations

## 2.1 METHODOLOGY FOR DETAILED ENERGY AUDIT

- **Phase I -Pre Audit Phase Activities**

A structured methodology to carry out an energy audit is necessary for efficient working. An initial study of the site should always be carried out, as the planning of the procedures necessary for an audit is most important.

### Initial Site Visit and Preparation Required for Detailed Auditing :-

An initial site visit may take one day and gives the Energy Auditor/Engineer an opportunity to meet the personnel concerned, to familiarize him with the site and to assess the procedures necessary to carry out 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 the aims of the energy audit.
- Discuss economic guidelines associated with the recommendations of the audit.
- Analyse the major energy consumption data with the relevant personnel.
- Obtain site drawings where available - building layout, steam distribution, compressed air distribution, electricity distribution etc.
- Tour the site accompanied by engineering/production

### The main aims of this visit are: -

- To finalise Energy Audit team
- To identify the main energy consuming areas/plant items to be surveyed during the audit.
- To identify any existing instrumentation/ additional metering required.
- To decide whether any meters will have to be installed prior to the audit eg. kWh, steam, oil or gas meters.
- To identify the instrumentation required for carrying out the audit.
- To plan with time frame
- To collect macro data on plant energy resources, major energy consuming centers
- To create awareness through meetings/ programme

- **Phase II- Detailed Energy Audit Activities**

Depending on the nature and complexity 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 carried out. Whenever possible, checks of plant operations are carried out over extended periods of time, at nights and at weekends as well as during normal daytime working hours, to ensure that nothing is overlooked.

The audit report will include a description of energy inputs and product outputs by major department or by major processing function, and will evaluate the efficiency of each step of the manufacturing process. Means of improving these efficiencies will be listed, and at least a preliminary assessment of the cost of the improvements will be made to indicate the expected payback on any capital investment needed. The audit report should conclude with specific recommendations for detailed engineering studies and feasibility analyses, which must then be performed to justify the implementation of those conservation measures that require investments.



Fig -1: Flowchart for detailed energy audit

## 3. DEMAND RESPONSE

Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives. Demand response programs are being used by some electric system planners and operators as resource options for balancing supply and demand.

Such programs can lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates. Methods of engaging customers in demand response efforts include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing, and critical peak rebates. It also includes 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.

### 3.1. RELATIONSHIP BETWEEN ENERGY EFFICIENCY AND DEMAND RESPONSE

Demand response and energy efficiency both affect customer end-use of energy. How exactly these primary objectives relate to each other was a primary focus of our research and analysis. Unfortunately, we found that there is almost no 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 mostly anecdotal evidence that suggests certain types of technologies capable of enabling demand response during peak demand periods can also realize energy and demand savings in off-peak periods. We were not able to determine the extent that customers are using these technologies actively as a means of achieving broader energy savings because this simply has not been a research focus within the industry.

### 3.2. DEMAND SIDE MANAGEMENT

Demand Side management is the process of managing energy consumption to optimize available and planned resources for power generation. DSM incorporates all activities that influence customer use of electricity and results in the reduction of the electricity demand, which are mutually beneficial to the customers and the utility.

Electrical energy can't be stored cheaply or in great quantities. Therefore supply and demand has to be balanced simultaneously. To ensure sustenance of supply, the total capacity of electricity generation must be larger than the maximum demand. During the past years, the demand for electricity is rising 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 variety of measures to reduce energy consumption, which leads to more manageable demand.

### 3.3. ZERO ENERGY BUILDING

A zero-energy building, also known as a zero net energy (ZNE) building, net-zero energy building (NZEB), or net zero building, is a building with zero net energy

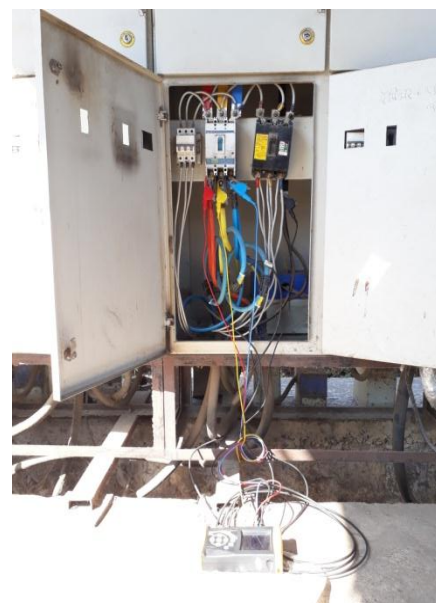
consumption, meaning the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site, or in other definitions by renewable energy sources elsewhere.

These buildings consequently contribute less overall greenhouse gas to the atmosphere than similar non-ZNE buildings. They do at times consume non-renewable energy and produce greenhouse gases, but at other times reduce energy consumption and greenhouse gas production elsewhere by the same amount. 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.

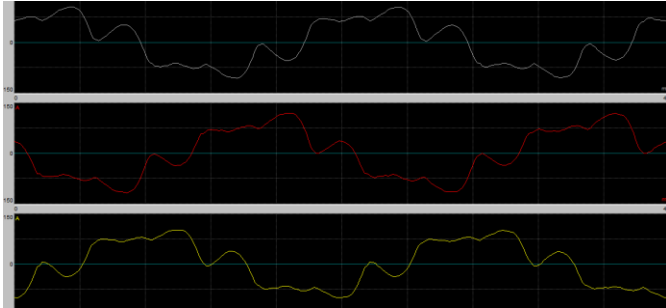
Most zero net energy buildings get half or more of their energy from the grid, and return the same amount at other times. Buildings that produce a surplus of energy over the year may be called "energy-plus buildings" and buildings that consume slightly more energy than they produce are called "near-zero energy buildings" or "ultra-low energy houses".

## 4. REVIEW OF DETAILED ENERGY AUDIT

During the energy audit, we found important data regarding to current industry. This graphical vies shows the analysis of the system of the current industry. With the help of this graphs , we can study easily the system which is installed in the current industry. We had done an detailed energy audit in the industry using power analyzer , digital multimeter, tachometer, lux meter etc.

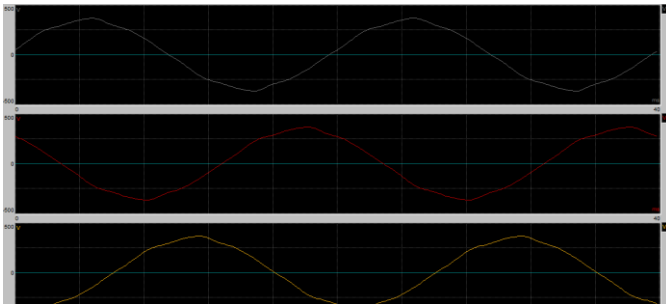


**Fig -2:** Power analyzer connected to LT Connection



**Graph -1:** Current Waveform

Graph -1 shows the graphical representation of the current waveform of the LT connection where the power analyzer has been connected. We can see that there are harmonics present in the current waveform. The graph- 2 shows the voltage waveform of the LT connection in which three phases are in phase with each other. The Fig- 3 shows the THD (Total Harmonic Distortion).



**Graph -2:** Voltage Waveform



**Fig -3:** THD (Total Harmonic Distortion)

## 5. CONCLUSION

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. We can achieve this goal by using energy audit in the related organization or utility. We had done the detailed energy audit in the industry. Here we come with some new ideas which are studied during this energy audit. This paper represents the basic information about industrial energy audit with some new concepts like zero energy building, green building.

During the energy audit, we come to know that harmonics are the main reason for increasing the load side demand which is very complex for the energy system of the related industry.

Energy audit is nothing but the intermediate between energy management and load side energy demand. Now a days, energy consumption is going to take its peak value. So, we have to find out the optional ways for reducing that excessive energy consumption. Energy audit is the remedy which reduces excessive energy consumption.

## REFERENCES

- Saurabh Kumar Rajput, Omveer Singh, "Energy Audit in textile industry : a study with ring frame motor"
- Abhishek Arya, Jyoti, Arunchalam P., Bhuvneshwari N., Awnish kumar , "Review on Industrial Audit and Energy Saving Recommendation in Aluminium Industry"
- Mr. P.S. Magdum, Mr. S.R. Lokhande, Mr. P.M. Mhaskar, Mr. I.D. Pharne, "A case study : Energy audit at commercial and educational building"
- Alan Meier, Thomas Olofsson, Roberto Lamberts, "What is an Energy Efficient Building ?"
- Mr. Raturaj A. Mohite, Mrs. S.N. Chaphekar, "Energy Monitoring by Energy Audit and Supply Side Management"
- M. Singh and J. Gupta, "Efficiency of Rewound Induction Motors in a Textile Plant: An Analysis," International Journal of Electronics Engineering, vol. 3, no. 2, pp. 185- 187, 2011.
- C.Palanichamy, C.Nadarajan, P.Naveen, Natarajan sundar babu, and Dhanalakshmi ; "Budget constrained energy conservation - An experience with a Textile Industry,"