

### 3. ENERGY MANAGEMENT AND AUDIT

#### 3.1 Definition & Objectives of Energy Management

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect.

The term energy management means many things to many people. One definition of energy management is:

*"The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions"*

(Cape Hart, Turner and Kennedy, Guide to Energy Management Fairmont press inc. 1997)

Another comprehensive definition is

"The strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems"

The objective of Energy Management is to achieve and maintain optimum energy procurement and utilisation, throughout the organization and:

- To minimise energy costs / waste without affecting production & quality
- To minimise environmental effects.

#### 3.2 Energy Audit: Types And Methodology

Energy Audit is the 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. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme.

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, mon-

itoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

#### **3.2.1 Need for 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 help in identifying the areas where waste can occur and where scope for improvement exists.

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital 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" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

#### **3.2.2 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.

- i) Preliminary Audit
- ii) Detailed Audit

#### **3.2.3 Preliminary Energy Audit Methodology**

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

#### **3.2.4 Detailed Energy Audit Methodology**

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.

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

#### **A Guide for Conducting Energy Audit at a Glance**

Industry-to-industry, the methodology of Energy Audits needs to be flexible.

A comprehensive ten-step methodology for conduct of Energy Audit at field level is presented below. Energy Manager and Energy Auditor may follow these steps to start with and add/change as per their needs and industry types.

**Ten Steps Methodology for Detailed Energy Audit**

Step No	PLAN OF ACTION	PURPOSE / RESULTS
	<u>Phase I –Pre Audit Phase</u>	
Step 1	<ul style="list-style-type: none"> <li>Plan and organise</li> <li>Walk through Audit</li> <li>Informal Interview with Energy Manager, Production / Plant Manager</li> </ul>	<ul style="list-style-type: none"> <li>Resource planning, Establish/organize a Energy audit team</li> <li>Organize Instruments &amp; time frame</li> <li>Macro Data collection (suitable to type of industry.)</li> <li>Familiarization of process/plant activities</li> <li>First hand observation &amp; Assessment of current level operation and practices</li> </ul>
Step 2	<ul style="list-style-type: none"> <li>Conduct of brief meeting / awareness programme with all divisional heads and persons concerned (2-3 hrs.)</li> </ul>	<ul style="list-style-type: none"> <li>Building up cooperation</li> <li>Issue questionnaire for each department</li> <li>Orientation, awareness creation</li> </ul>
	<u>Phase II –Audit Phase</u>	
Step 3	<ul style="list-style-type: none"> <li>Primary data gathering, Process Flow Diagram, &amp; Energy Utility Diagram</li> </ul>	<ul style="list-style-type: none"> <li>Historic data analysis, Baseline data collection</li> <li>Prepare process flow charts</li> <li>All service utilities system diagram (Example: Single line power distribution diagram, water, compressed air &amp; steam distribution.</li> <li>Design, operating data and schedule of operation</li> <li>Annual Energy Bill and energy consumption pattern (Refer manual, log sheet, name plate, interview)</li> </ul>
Step 4	<ul style="list-style-type: none"> <li>Conduct survey and monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Measurements : Motor survey, Insulation, and Lighting survey with portable instruments for collection of more and accurate data. Confirm and compare operating data with design data.</li> </ul>
Step 5	<ul style="list-style-type: none"> <li>Conduct of detailed trials /experiments for selected energy guzzlers</li> </ul>	<ul style="list-style-type: none"> <li>Trials/Experiments: <ul style="list-style-type: none"> <li>24 hours power monitoring (MD, PF, kWh etc.).</li> <li>Load variations trends in pumps, fan compressors etc.</li> </ul> </li> </ul>

		<ul style="list-style-type: none"> <li>- Boiler/Efficiency trials for (4 – 8 hours)</li> <li>- Furnace Efficiency trials Equipments Performance experiments etc</li> </ul>
Step6	<ul style="list-style-type: none"> <li>• Analysis of energy use</li> </ul>	<ul style="list-style-type: none"> <li>• Energy and Material balance &amp; energy loss/waste analysis</li> </ul>
Step 7	<ul style="list-style-type: none"> <li>• Identification and development of Energy Conservation (ENCON) opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Identification &amp; Consolidation ENCON measures</li> <li>• Conceive, develop, and refine ideas</li> <li>• Review the previous ideas suggested by unit personal</li> <li>• Review the previous ideas suggested by energy audit if any</li> <li>• Use brainstorming and value analysis techniques</li> <li>• Contact vendors for new/efficient technology</li> </ul>
Step 8	<ul style="list-style-type: none"> <li>• Cost benefit analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Assess technical feasibility, economic viability and prioritization of ENCON options for implementation</li> <li>• Select the most promising projects</li> <li>• Prioritise by low, medium, long term measures</li> </ul>
Step9	<ul style="list-style-type: none"> <li>• Reporting &amp; Presentation to the Top Management</li> </ul>	<ul style="list-style-type: none"> <li>• Documentation, Report Presentation to the top Management.</li> </ul>
Step10	<p><u>Phase III –Post Audit phase</u></p> <ul style="list-style-type: none"> <li>• Implementation and Follow-up</li> </ul>	<p>Assist and Implement ENCON recommendation measures and Monitor the performance</p> <ul style="list-style-type: none"> <li>• Action plan, Schedule for implementation</li> <li>• Follow-up and periodic review</li> </ul>

### **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 pay-back 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.

**The information to be collected during the detailed audit includes: -**

1. Energy consumption by type of energy, by department, by major items of process equipment, by end-use
2. Material balance data (raw materials, intermediate and final products, recycled materials, use of scrap or waste products, production of by-products for re-use in other industries, etc.)
3. Energy cost and tariff data
4. Process and material flow diagrams
5. Generation and distribution of site services (eg.compressed air, steam).
6. Sources of energy supply (e.g. electricity from the grid or self-generation)
7. Potential for fuel substitution, process modifications, and the use of co-generation systems (combined heat and power generation).
8. Energy Management procedures and energy awareness training programs within the establishment.

Existing baseline information and reports are useful to get consumption pattern, production cost and productivity levels in terms of product per raw material inputs. The audit team should collect the following baseline data:

- Technology, processes used and equipment details
- Capacity utilisation
- Amount & type of input materials used
- Water consumption
- Fuel Consumption
- Electrical energy consumption
- Steam consumption
- Other inputs such as compressed air, cooling water etc
- Quantity & type of wastes generated
- Percentage rejection / reprocessing
- Efficiencies / yield

**DATA COLLECTION HINTS**

It is important to plan additional data gathering carefully. Here are some basic tips to avoid wasting time and effort:

- measurement systems should be easy to use and provide the information to the accuracy that is needed, not the accuracy that is technically possible
- measurement equipment can be inexpensive (flow rates using a bucket and stopwatch)
- the quality of the data must be such that the correct conclusions are drawn (what grade of product is on, is the production normal etc)
- define how frequent data collection should be to account for process variations.
- measurement exercises over abnormal workload periods (such as startup and shutdowns)
- design values can be taken where measurements are difficult (cooling water through heat exchanger)

***DO NOT ESTIMATE WHEN YOU CAN CALCULATE  
DO NOT CALCULATE WHEN YOU CAN MEASURE***