

✚ Lesson 3: energy audit

1. Defining energy audit:

Energy such as electricity, oil, coal and natural gas is being consumed in all facilities for its operations. If energy is not efficiently used and managed, it will increase operational and maintenance costs besides polluting the environment.

Energy audit is defined as the verification, monitoring 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.

An energy audit is an investigation of all facets of a facility's historical and current energy use with an objective of identifying and quantifying areas of energy wastage in its activities. The outcome is the identification of viable and cost effective energy saving measures to reduce energy consumption per unit of product output thereby lowering the operating costs.

Energy audit is an inspection, survey and analysis of energy flows for energy conservation to reduce the amount of energy input into the system without negatively affecting the output. The energy audit is the key for decision-making in the area of energy management. It helps any organization to analyse its energy use and discover areas where energy use can be reduced and waste can occur, plan and practice feasible energy conservation methods that will enhance their energy efficiency, serve to identify all the energy streams in a facility, quantify energy usage, in an attempt to balance the total energy input with its use.

Energy audit refers to the inspecting, examining and analysing on the physical and the financial activities processes of enterprises and other high energy-using units according to relevant state regulations and standards of energy-saving. Energy utilization units or its competent authorities or entrusted specialist agencies conduct energy audit. Energy audit is a kind of scientific management method of energy. Its main content is objectively inspecting on the energy efficiency, energy consumption level and the economic benefit of the energy unit and proposing the energy-saving measures for energy-using units by means of statistical analysis, inspection testing, and diagnostic evaluation.

2. Scope of energy audit:

Typically, the scope of an energy audit includes an examination of the following areas:

- Energy conversions in equipment such as boilers, furnaces, transformers, pumps, fans, compressors etc.
- Energy distribution (electricity, steam, condensate, compressed air, water etc.)
- Energy utilization efficiency of equipment
- Production planning, operation, maintenance and housekeeping
- Management aspects (information flow, data collection and analysis, feedback, achievements, training of employees, motivation etc.)

Other related areas such as water audit and conservation, waste minimization studies are sometimes included as part of an energy audit.

3. Energy audit team:

The energy audit team may comprise:

- Works Manager (Team Leader)
- Material Manager
- Electrical or Electronics Engineer
- Mechanical Engineer
- Civil Engineer
- Accountant

- Technician bearing knowledge of electrical/ electronic/ mechanical Engineering and Computer awareness.

👉 **Note:**

Questions should be asked by an energy auditor:

- What function does this system serve?
- How does this system serve its function?
- What is the energy consumption of this system?
- What are the indications that this system is working properly?
- If this system is not working, how can it be restored to good working conditions?
- How can the energy cost of this system be reduced?

4. Benefits of energy audit:

Many benefits can be achieved through energy audit. Some of these benefits are:

- Reduction in specific energy consumption and environmental pollution.
- Reduction in operating costs (approximately 20–30%) by systematic analysis.
- Improves the overall performance of the total system and the profitability and productivity.
- Slower depletion of natural resources and narrowing demand supply gap.
- Averts equipment failure.

👉 **Clear it up:**

Energy audit is needed because we need measurable energy use, in energy management we know energy accounting, which is an activity to record and link between energy use and costs incurred. In addition, to monitor energy use on a time scale. Implementing an energy audit can increase management's knowledge about the amount of energy and costs incurred, so that it will improve environmental performance. Energy audit is an important activity in the context of implementing energy conservation, and the purpose of an energy audit is to find out historical data on energy use and look for opportunities to save energy consumption for improving environmental performance.

5. Types of energy audit:

The type of Energy audit to be performed depends on various factors:

- Type of industry.
- Type of Fuel/energy is being used.
- Depth to which final audit is needed.
- Function are performed in the industry.
- Investment and time availability.
- Potential and magnitude of cost reduction desired.

Most of energy Audit falls into the three categories:

- Walk through: It involves going round the plant and identifying visible losses and negligence in operation and maintenance. Its require one or three days for energy audit.
- Mini audit: It involves collection of basic data, drawings, blue prints etc along with visual classifications. It requires one to three month for energy audit depending upon size of the plant.
- Maxi audit: It involves preparation of total energy balance sheet, drawing energy flow charts etc.

Energy audit is classified broadly into two types: preliminary energy audit and detailed energy audit.

☞ **Preliminary energy audit:**

Simplest and quickest type of audit and conducted in a limited span of time. It involves minimal interviews with site-operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and to identify any glaring areas of energy waste or inefficiency. It focuses on major energy supplies and demands of the industry. The scope of this audit is to highlight energy costs and to identify wastages in major equipment processes it sets priorities for optimizing energy consumption. This type of energy audit checks energy use and energy management in factories. Preliminary energy audit is conducted to:

- Gather records for the last 12 month of the establishment's energy bills and the corresponding financial statements.
- Relate energy consumption to profitability of the establishment, such as energy cost to profit ratio, energy cost to revenue ratio, to establish the importance of energy in its operation.
- Familiarize on how these energy bills are computed to determine the composition of the charges.
- List all energy consuming equipment with detail of size, percent loading during the period, and hours of operation during the period.
- Identify major energy consuming equipment.
- Inspect the major energy consuming equipment in the order of priority.
- Identify energy conservation opportunities (ECOs) by determining what condition may be modified/ corrected to reduce the energy input to the equipment.
- What are the expected results in modifying / correcting these conditions?
- What are the steps necessary to modify / correct these conditions?
- What is the cost involved?
- Perform a cost benefit analysis on the ECOs.
- List priorities depending on the net return expected from the proposed investment.
- Write and describe these priorities in to an energy audit report.
- Prepare a presentation of the energy audit report for the management.
- Present the energy audit report to the management for approval.
- Organize the implementation of the energy conservation programme.
- Implement no cost energy conservation measure (ECMs).

☞ **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. 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. This type is conducted to:

- Prepare detailed audit and engineering study on approved energy conservation measures requiring additional investment.
- Review cost benefit analysis based on the updated figures.
- Revise energy conservation programme as required.
- Work out the payback period.
- Secure management approval and funding.
- Organize the implementation of the revised energy conservation programme.
- Implement the energy conservation programme.
- Monitor and analyse the progress of the energy conservation measures.
- Report the progress of the energy conservation measure to management and determinate result to all concern.

Preliminary energy audit	Detailed energy audit
Short time frame, say few days to one week.	Longer time frame, say 15–30 days.
Uses readily available data for quick analysis and results are general.	Uses operating data, detailed observations, measurements, energy and mass balance to assess energy performance.
Focus on common opportunities for energy efficiency.	More specific recommendations for energy improvements covering all areas.
Economic analysis is mostly limited to calculation of simple payback period.	Economic analysis may include internal rate of return, net present value, life cycle cost, as well as simple payback period.
Broad recommendations.	Detailed energy audit accounts for and evaluates all major energy using equipment and systems and provides specific recommendations with comprehensive implementation plan.

A detailed energy audit is composed of three phases clarified in the following table:

Step N°	Plan of action	Purpose/ Results
Step 1	<ul style="list-style-type: none"> ▪ Plan and organise ▪ Walk through Audit ▪ Informal Interview with Energy Manager, Production / Plant Manager 	<ul style="list-style-type: none"> ▪ Resource planning, Establish/organize a Energy audit team ▪ Organize Instruments & time frame ▪ Macro Data collection (suitable to type of industry.) ▪ Familiarization of process/plant activities ▪ First hand observation & Assessment of current level operation and practices
Step 2	<ul style="list-style-type: none"> ▪ Conduct of brief meeting / awareness programme with all divisional heads and persons concerned (2-3 hrs.) 	<ul style="list-style-type: none"> ▪ Building up cooperation ▪ Issue questionnaire for each department ▪ Orientation, awareness creation
Step 3	<p>Phase II-Audit Phase</p> <ul style="list-style-type: none"> ▪ Primary data gathering.. Process Flow Diagram, & Energy Utility Diagram 	<ul style="list-style-type: none"> ▪ Historic data analysis, Baseline data collection ▪ Prepare process flow charts ▪ All service utilities system diagram (Example: Single line power distribution diagram, water, compressed air & steam distribution. ▪ Design, operating data and schedule of operation ▪ Annual Energy Bill and energy consumption pattern (Refer manual, log sheet, name plate. interview)
Step 4	<ul style="list-style-type: none"> ▪ Conduct monitoring and survey 	<ul style="list-style-type: none"> ▪ 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.
Step 5	<ul style="list-style-type: none"> ▪ Conduct of detailed trials /experiments for selected energy guzzlers 	<p>Trials/Experiments:</p> <ul style="list-style-type: none"> ▪ 24 hours power monitoring (MD, PF, kWh etc).

		<ul style="list-style-type: none"> ▪ Load variations trends in pumps, fan compressors etc. ▪ Boiler/Efficiency trials for (4 hours) ▪ Furnace Efficiency trials Equipments Performance experiments etc.
Step 6	<ul style="list-style-type: none"> ▪ Analysis of energy use 	<ul style="list-style-type: none"> ▪ Energy and Material balance & energy loss/waste analysis.
Step 7	<ul style="list-style-type: none"> ▪ Identification and development of Energy Conservation (ENCON) opportunities 	<ul style="list-style-type: none"> ▪ Identification & Consolidation ENCON measures. ▪ Conceive, develop, and refine ideas. ▪ Review the previous ideas suggested by unit personal. ▪ Review the previous ideas suggested by energy audit if any ▪ Use brainstorming and value analysis techniques. ▪ Contact vendors for new/efficient technologies.
Step 8	<ul style="list-style-type: none"> ▪ Cost benefit analysis 	<ul style="list-style-type: none"> ▪ Assess technical feasibility, economic viability and prioritization of ENCON options for implementation. ▪ Select the most promising projects ▪ Prioritise by low, medium, long term measures
Step 9	<ul style="list-style-type: none"> ▪ Reporting & Presentation to the Top Management. 	<ul style="list-style-type: none"> ▪ Documentation, Report Presentation to the top Management.
Step 10	<p>Phase III-Post Audit phase</p> <ul style="list-style-type: none"> ▪ Implementation and Follow-up 	<ul style="list-style-type: none"> ▪ Assist and Implement ENCON recommendation measures and Monitor the performance ✓ Action plan, Schedule for implementation ✓ Follow-up and periodic review

👉 **To sum up:**

Basic components of an energy audit:

The audit process starts by collecting information about a facility's operation and past record of utility bills. These data are then analysed to get a picture of how the facility uses -and possibly wastes- energy, as well as to help the auditor learn what areas to examine to reduce energy costs. Specific changes -called energy conservation opportunities (ECOs)- are identified and evaluated to determine their benefits and their cost-effectiveness. These ECOs are assessed in terms of their costs and benefits, and an economic comparison is made to rank the various ECOs. Finally, an action plan is created where certain ECOs are selected for implementation, and the actual process of saving energy and saving money begins.

