

GOVERNMENT COLLEGE OF ENGINEERING, KALAHANDI



DEPARTMENT OF ELECTRICAL ENGINEERING

**Lecture notes on Electrical Energy Conservation
and Auditing**
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5th Semester

Electrical Energy Conservation and Auditing

Module I:

(12 Hours)

Electrical energy conservation: Energy economics- discount rate, payback period, internal rate of return, net present value, and life cycle cost. Energy generation, energy distribution, energy usage by processes, technical and economic evaluation, understanding energy costs, classification of energy conservation measures, plant energy performance, benchmarking and energy performance, matching energy usage to requirement, maximizing energy system efficiency, optimizing the input energy requirements, fuel and energy substitution, and energy balancing.

EB billing- HT and LT supply, transformers, electric motors- motor efficiency computation, energy efficient motors, pumps, fans, blowers, compressed air systems, refrigeration and air conditioning systems, cooling towers, electric heaters (space and liquid), DG-sets, illuminating devices, power factor improvement, and harmonics.

Module II:

(12 Hours)

Electrical energy audit: Energy consumption pattern and scenario of any region; Energy auditing: Need, types, methodology and approaches; Preliminary energy audit methodology (initial site visit and preparation required for detailed auditing, detailed energy audit activities, information and data collection, process flow diagram and process steps); Procedure and techniques: Data gathering, evaluation of saving opportunities, and energy audit reporting; and Energy audit instruments.

Module III:

(06 Hours)

Illumination: Illumination, luminous flux, lumen, luminous intensity, candela power, brightness, glare, types of lighting (incandescent, CFL, and LED), requirements of lux for various purposes, determine the method of lighting, select the lighting equipments, and calculate the lighting parameters.

Text Books:

- [1] Callaghn, P. W." Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
- [2] Dryden. I. G. C., " The Efficient Use of Energy", Butterworths, London, 1982.
- [3] Energy Economics -A. V. Desai (Wiley Eastern).
- [4] Handbook of Energy Efficiency - CRC Press

Reference Books:

- [1] Energy Technology, OP Gupta, Khanna Book Publishing
- [2] Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.
- [3] Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006.

Phase advancer is used to improve the pf of Induction motor - the stator winding of induction motor takes lagging current which is 90° out of phase with voltage. So, pf of induction motor is lower. If the Ampere turns are excited by external AC source then there would be no effect of exciting current on stator winding, so that the pf of induction motor will be improved by suppressing or eliminating the lagging current of induction motor.

Q Explain details the types & methodology of energy auditing system.

Energy Audit :-

An energy audit is an inspection, analysis & survey of energy flows in a building, system or process.

To determine how much energy a building uses & identify ways to reduce energy consumption.

Need of Energy Auditing :-

- ① Reduce energy consumption per unit of product.
- ② To lower operating costs.
- ③ Three top operating expenses are labor, energy, materials.
- ④ Possibility in cost reduction & "Benchmark" for managing energy in the organization.

Types of energy auditing

① Preliminary energy audit

② Detailed energy audit

- Pre Audit
- Phase Audit
- Post Audit

① Preliminary energy audit? —

- Establish energy consumption in the organization
- Estimate scope for saving
- Identify the most likely (areas)
- Identify immediate improvements
- Set a 'reference point'
- Easily obtained data
- Identify areas for detailed study / measurement

② Detailed energy audit? —

It is also known as a diagnostic energy audit.

This type of audit is completed by a professional auditor who monitors, analyzes & verifies energy use to establish problem areas & ways to implement energy efficiency improvements.

Methodology of Energy Audit :-

- ① methodology means way of achieving or doing something.
- ② The methodology term is generally used in case of detailed energy audit.

Detailed energy audit is done in three phases?

Phase I

Phase II

Phase III

Pre Audit phase

Actual Audit phase

Post Audit phase

Pre-Audit phase :-

work done by Auditor / Engineer.

- ① Analysis / Study of site whose audit has to be done. This will be useful for future planning.
- ② Draw drawing of site.
- ③ Discuss with the supervisor / ^{manager} Engineer of site that what is the aim of energy audit.
- ④ Discuss about guidelines & financial strength.
- ⑤ Collect details of all related data about major energy consumptions.
- ⑥ Ask the supervisor about what tools, instruments, equipments are in use at the site. Also what are the different operations, process performed of the site.

Main Aim :-

- ① To finalise energy team.
- ② To prepare plan for audit.
- ③ To identify main focusing areas where there is need of detailed energy audit.

④ To decide which auditing tools & instrument will be used.

Actual Audit phase ? —

Detailed energy audit depends on site/plant Industry.

- ① Study of primary data.
- ② Study of process flow diagram, energy utility diagram.
- ③ Conduct various experiments to know about the machines & processes performed at the site.
- ④ Collect information about energy production, energy usage & energy waste.
- ⑤ Development of Energy conservation opportunities by specialised techniques such as ENCON.
- ⑥ Prepare audit report & present it to upper management in proper format.

Post Audit phase ? —

Assist & Implement ENCON recommendation measures & monitor the performance.

→ Periodically review the performance of all the system.
Manage to control the efficiency if performance tends to reduce.

Energy Management :-

It is the study of identifying monitoring and optimizing energy performance on a regular, within a site or building.

Objective :-

- (1) Identify energy saving opportunities.
- (2) Conserve consumption
- (3) Reduce carbon emission.

Q why cooling tower is used in energy conservation system?

Cooling tower is used in energy conservation system because they :-

- (i) Improve efficiency
- (ii) Increase cooling capacity
- (iii) Reduce maintenance
- (iv) Reduce operating cost

Q Define harmonics of energy system.

A harmonic of a voltage or current waveform is sinusoidal wave whose frequency is an integer multiple of the fundamental frequency.

Need of energy Auditing? -

Energy Audit helps identify ways to reduce energy consumption and costs.

Energy Audits are important? -

→ Identify areas for improvement.

→ Set a benchmark

→ Plan for energy conservation

→ Secure financing

Monitoring

Site visit

Energy Audit Process

Implementing

Planning

Investigating

Initial site visit and preparation required for detailed auditing? -

- (i) An initial site visit may take one day and gives the energy auditor/Engineer an opportunity to meet the person concerned, to familiarize him with the site and to assess the procedures necessary to carry out the energy audit.
- (ii) 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 information to be collected during the detailed audit includes :-

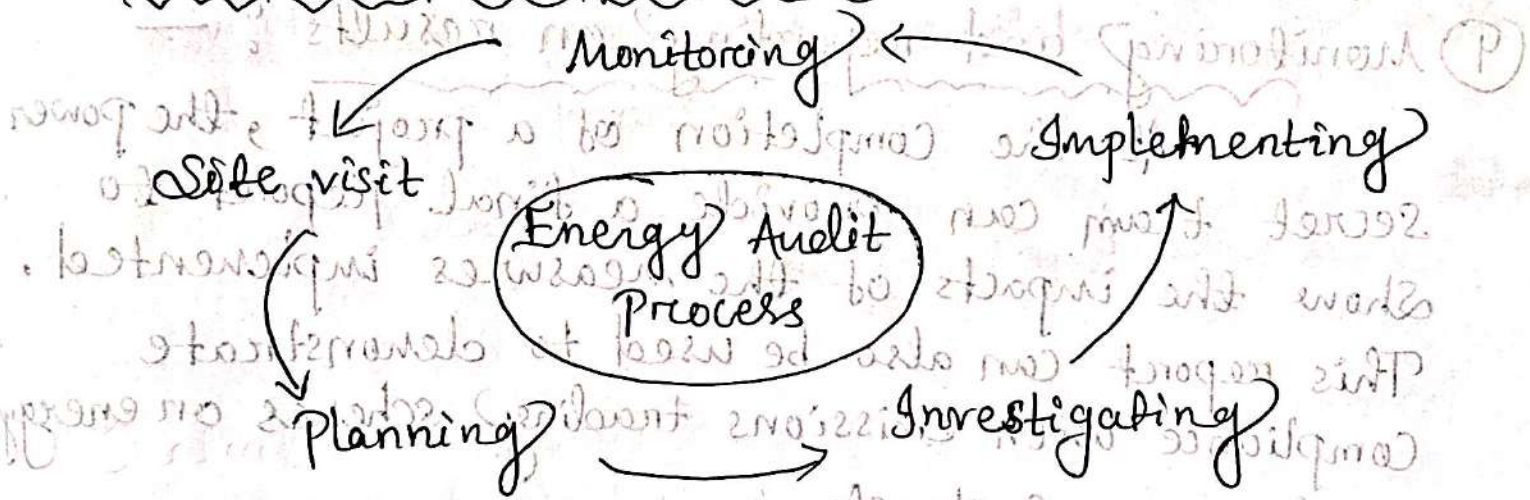
- ① Energy consumption by type of energy, by department, by major items of process equipment, by end-use.
- ② Material balance data.
- ③ Energy cost and tariff data.
- ④ Process and material flow diagrams.
- ⑤ Generation and distribution of site services (e.g. compressed air, steam).
- ⑥ Sources of energy supply (e.g. electricity from the grid or self-generation).
- ⑦ potential for fuel substitution, process modifications and the use of co-generation systems.

⑧ Energy Management procedures and energy awareness training programs within the establishment.

The audit team should collect the following baseline data: -

- ① Technology, Processes used and equipment details
Capacity utilisation
- ② Amount & type of input materials used
- ③ Water consumption
- ④ Fuel consumption
- ⑤ Electrical energy consumption - Steam consumption.

Process flow and process steps: -



① Planning: -

The planning phase of an energy audit is essential for the success of the project. During this phase, auditors will assess the goals and objective of the business and develop a plan to achieve those goals. They will also collect data on the current energy use of the business and create a baseline against which to measure future savings.

② Investigating! — During the investigation phase, auditors will collect data on the energy use of the business and identify potential areas for improvement. Energy audit results will be compared to the average energy use of similar businesses and potential areas for improvement will be highlighted.

③ Implementing the recommendations! — When your report is complete, you will be able to select specific measures to implement. The power secret team can assist with the implementation process if required.

④ Monitoring and reporting on results? — At the completion of a project, the power secret team can provide a final report to show the impacts of the measures implemented. This report can also be used to demonstrate compliance with emissions trading schemes or energy performance contracts.

Data gathering! —

Data gathering takes many forms in different settings. In most organizations, the most relevant and accessible data is the transactional information they possess from interacting with their customers, data about the products they make or sell, and employee data. With data risk management, the

objective is to ensure the data is captured ^{correctly} and classified accurately so that the insights gained later are based on the right data.

Energy Audit Instruments :-

Power meters :- For measuring electrical consumption

Thermographic Cameras :- To identify heat loss in buildings.

Flow meters :- For measuring fluid flow, crucial in industrial settings.

Light meters :- To assess lighting conditions.

Data Loggers :- For continuous data collection and analysis.

Energy management software :- To streamline data analysis and reporting.