

Unit - 5 : Energy Audit of Electrical System

* **Energy Audit** : It is an inspection, investigation, survey & analysis of energy flow in building or system to reduce the amount of energy input to the system.

- It is a survey made by professionals & the client organization together.

- Energy Audit is sometimes called as 'Energy assessment' or 'Energy study'.

• General procedure of energy audit can be summarised in three steps :

① Evaluate : (The present energy consumption)

② Identify : (Energy saving possibilities)

③ Report : (Recommendations & Profitability)

* **Objectives of Energy Audit** :

- Identify the quality & cost of various energy i/p.

- Establish a relation betn Energy consumption & production.

- Set energy saving target at each cost center.

- Implement energy efficiency measures & understand saving.

* **Specific Energy Consumption (SEC)** :

- For any plant, It is important to relate energy use with production.

- The meaning of SEC is to represent how much

energy is used for producing a unit of product,
- Generally, SEC is calculated as a ratio of energy used for producing a product.

$$\text{SEC} = \frac{\text{Amount of Energy used}}{\text{Amount of product}}$$

* Energy Audit Instruments :

- 1) Electric Power Meter
 - 2) Combustion Analyser
 - 3) Fuel Efficiency Monitor
 - 4) Flue Gas Analyzers (Fynitor)
 - 5) Thermometer
 - 6) Airflow measurements
 - 7) Water flow meter
 - 8) Speed Measurement
 - 9) Leak Detectors
 - 10) Lux meters
- } Fuel Gas Analyser

1. Electric Power Meter :

- These are instruments for measuring electrical parameters such as kVA, kW, P.f, Frequency, kVAR, Amp & Vtg. In addition some of these instruments also measures Harmonic.

- These instruments are applied on-line i.e. on running motor, without any need to stop the motor.

2. Combustion Analyzer :

- Latest Combustion analyzers are portable, electronic instruments used for the measurement of Combustion efficiency of boilers, furnaces.
- A basic analyzer supports measurement of ;
 - Flue Gas temperature
 - Combustion Air temperature
 - Oxygen level
 - Carbon monoxide level
- This instruments has in-build chemical cells which helps to measure various gases

3. Fuel Efficiency Monitor :

- Fuel efficiency monitor helps in determining Combustion efficiency.
 Burn of fuel
- This instruments is used to measure oxygen & temperature of the flue gas. Microprocessor calculates Combustion efficiency on receiving calorific values of fuels.

4. Flue Gas Analyzers (Fyniter) :

- A hand bellow pump draws the flue gas sample into the solution inside the fyniter.
- A chemical reaction changes the liquid volume, revealing the amount of gas. A separate fyniter can be used for O_2 & CO_2 measurements.

5. Thermometer :

a) Contact thermometer :

- These are thermocouples which measure for temp. of hot water, hot gases & hot air by inserted probe into the stream.
- For surface temperature, a leaf type probe is used with the same instrument.

b) Infrared Thermometer :

- This is a non-contact type measurement thermometer.
- It gives the temperature readings directly at the display when it is directed towards heat sources.
- This instrument is useful for measuring hot spot in motor, transformer & also in furnace, etc.

6. Airflow Measurements :

- Pitot tube & Manometer is the most versatile instruments for airflow measurement.
- Air velocity in ducts can be measured using a pitot tube & Manometer used for further calculation of flows.

7. Water flow meter :

- This non-contact flow measuring device work on the doppler effect.
- There is a transmitter & receiver, which are placed opposite sides of the pipe. The meter directly gives the flow.
- Water & any other fluid flows can be easily measured with this meter.

8) Speed Measurement :

- Energy auditor requires tachometer, to measure the speed of motor or driven device.
- A simple tachometer is contact type. It is used where direct access is possible.
- It is connected at the end of rotating shaft. It can also be connected against the conveyor belt to determine linear speed.
- Where as Non-contacting type instruments are more sophisticated & safer ones such as stroboscope.

9) Leak Detector :

- Ultrasonic instruments are available which can be used to detect leaks of compressed air & other gases which are normally not possible to detect with human abilities.

10) Lux meter :

- Illumination levels are measured with a lux meter.
- It consists of a photo-cell which senses the light output, converts to electrical impulses which are calibrated as lux.

* Questionnaire for Energy Audit Project :

- The main aim of the questionnaire is to collect the basic data of an organization.
- In questionnaires we can gather the information of the different parts of an organization.
- It will show the present condition of organization's infrastructure & resource consumption.

(A) Details of the organization :

- ① Name of establishment
- ② Add. for communication
- ③ Tel. No.
- ④ Fax. No.
- ⑤ Email ID
- ⑥ Website Add.
- ⑦ Name of the Chief Ex. officer
- ⑧ Mob. No.
- ⑨ E-mail ID
- ⑩ Name of contact Person
- ⑪ Designation of contact person.
- ⑫ Mob. No.
- ⑬ E-mail ID
- ⑭ No. of Employees
- ⑮ No. of shifts.

* Energy flow Diagram (Sankey Diagram) :

- Energy flow diagram of system is a diagram which shows energy distribution of that system from the input to output showing the points of losses.
- It is also known as Sankey diagram.
- With the help of this diagram it can be easily understood of internal distribution of energy to final consumption per energy.
- Consider a simplest example of an incandescent lamp that converts electrical energy into light energy & Heat. A Sankey diagram can be shown this in a simple way.

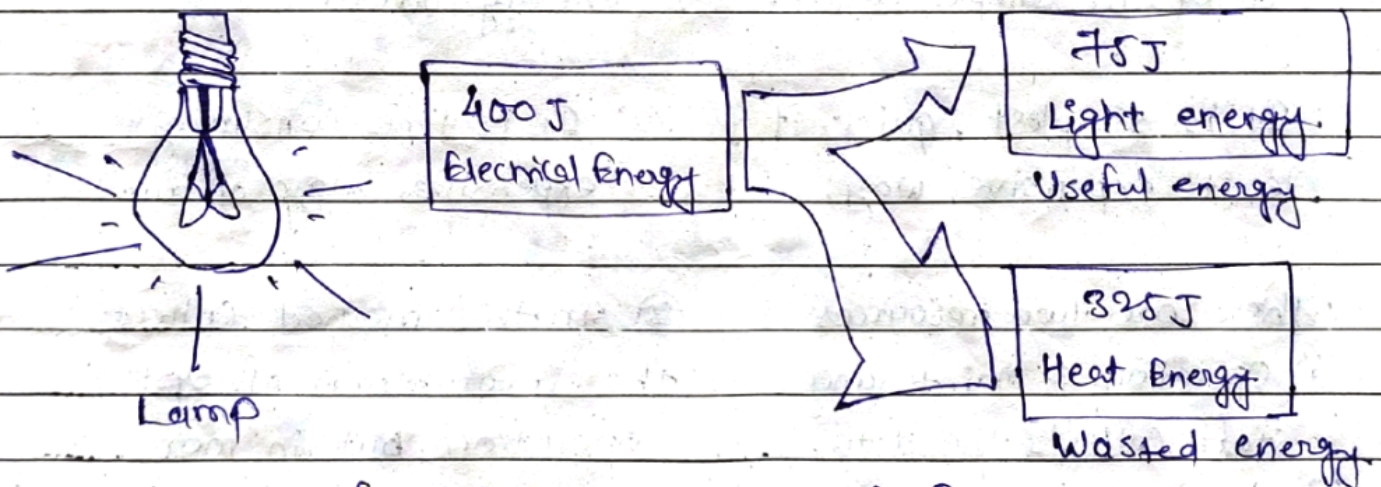


fig. Sankey diagram of Incandescent Lamp

- In this Sankey diagram are a simple & better way to determine, which flows are useful & which flows are waste of energy in the process.
- In this way these diagram are helpful in highlighting major contribution to an overall flows.

* Energy Audit Procedure :

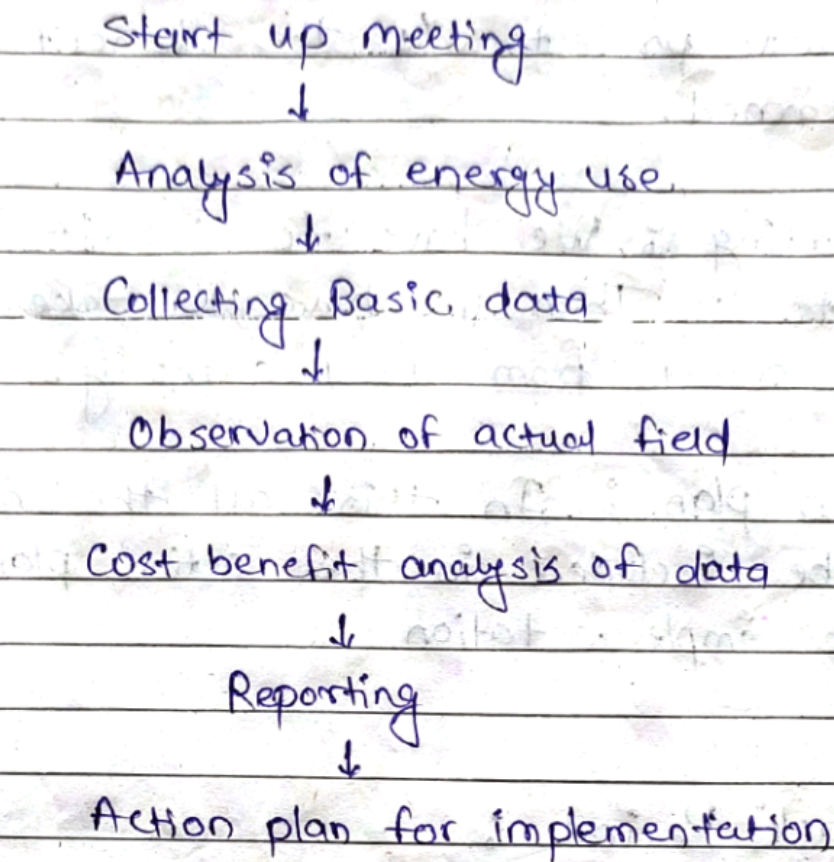
- Basically there are two types of audits by which energy saving potential can be identified.

Types of Energy Audit

- ↳ Walk through audit
- ↳ Detailed audit

Sr.No.	Walk Through Audit	Detailed Audit
①	It is also called as the preliminary audit or screening audit or simple audit.	① It is also called as general audit or site energy audit.
②	It is simplest, quickest & least expensive way.	② It is time consuming & expensive way of audit.
③	There are two resources i) Operation & Maintenance staff collects the data, ii) Serving utility provides this information.	③ In this method collect the information of system operation, but in more detailed form, as compared to simple audit.
④	Basic information of the energy system in the premises is collect as well	④ Auditor collects utility bills of an year to find out tariff structure, etc.
⑤	Only main issues are covered in walk through procedure	⑤ This type of audit focus all the most suitable energy conservation measures for the system.

* Audit Procedure :



A) Start up meeting : Procedure starts with start up meeting, then it continues until implementation of energy saving measures.

B) Analysis of energy used : Identify where energy is used & it shows on which area should be concentrated.

C) Collecting Basic Data : At site load some of the following important points :
① operating hours ② Duty cycle ③ Actual Power consumed

D) Observation of actual field : After collecting data, we start actual field work. It means we have to find out process where energy saving can be done.

E) Cost benefit analysis of the data :

This Analysis is in the terms of carrying out that project v/s the benefit that can be earned.

F) Reporting : We have to submit the detail report. Then we have to take sanction of that report from final authority.

G) Action plan : In this all the measure steps must be included in the action plan for the proper implementation.

• Payback Period :

It is defined as the time required to recover the funds invested in a project called as payback period.

* Procedure of payback Period :

- Payback Period = $\frac{\text{First Cost}}{\text{Annual Saving}}$

- First Cost = Additional cost of purchasing the new energy efficient equipment.

- Annual saving = Existing annual energy cost with old equipment's - new annual energy cost with energy conservation equipment.

* Significance of payback period :

- 1) The most significant advantage of payback method is its simplicity.
- 2) It is easy way to compare several projects & then to choose the project which have shortest payback time.

* Energy Audit Report :

• General Principles for writing Better audit Report :

- 1) Know the reader
- 2) Simple & direct language
- 3) Graphical presentation of the information
- 4) Clear recommendation
- 5) Explanation of assumptions
- 6) Accuracy & consistency
- 7) Clear calculation

1) Know the reader :

- There are many people in the organization those require to read the audit report.
- Report should include executive summary for decision making & technical segment for actual implementation.

2) Simple & direct language :

- Readers may be professional or general trade people.
- The language used must be understandable to all reader & report should be brief & clear.

3) Graphical presentation of the information :

- The report can be made by the use of photos, charts diagrams.
- Many softwares are available to generate graphs & chart which can help.

4) Clear recommendations :

- Recommendations are one of the most important points of the reports.
- Recommendations should not be 'generalized or confusing' to reader. It should be clear & sufficiently detail.

5) Explanation of assumptions :

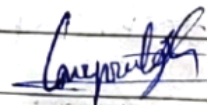
- Assumption made in the calculations should be explained clearly in the report.

6) Accuracy & consistency :

- The calculation has to be accurate. - Accuracy of assumption & calculation may be verified by reader if needed.

7) Clear Calculations :

- Methodology of calculation should be mentioned clearly. It is suggested to include sample accuracy calculation of each kind.



Subject I/C

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