## Meaning of Energy Audit:

Energy audit is an official scientific study of energy consumption of an organisation/process/plant/equipment aimed at reduction of energy consumption and energy costs without affecting productivity and comforts and suggesting the methods for energy saving and reduction in energy cost. Energy audit is carried out in planned, official manner by every energy intensive organisation/plant management.

The energy audit identifies the cost of energy and where and how it is used. It will identify the amount of energy expended in a process with the help of mass and energy balance for each process.

The energy flow diagram is then prepared showing the quantity, form, source and quality (i.e., temperature) of the energy required for various processes. Next step is to make a critical analysis for energy used and energy wasted. This is followed by identification of potential areas for energy saving.

## Objectives of Energy Audit:

The main purpose of energy audit is to establish quickly and reliably, the basic relative costs of the various forms of energy purchased their main use and to identify mam locations where losses, wastages or inefficiency occurs.

In simple language we can say that, energy audit helps to understand more about the ways different energy sources are used in the industry and helps to identify areas where waste can occur and where scope for improvement may be possible. Thus, energy audit is one of the concepts used in the energy management and it involves methodological examination and comprehensive review of energy use in industries.

## Types of Energy Audit: The energy audit can be of following two types:

1. Preliminary audit.
2. Detailed audit.

### 1. Preliminary audit:

Preliminary audit is carried out in the limited time say within 10 days and it highlights the energy cost and wastages in the major equipment's and processes. It also gives the major energy supplies and demanding accounting. The questionnaire containing the industrial details of energy consumption process carried out, energy need to unit product; load data etc. must be completed before the pre-audit visit.

The pre-audit visit is done, by the audit team/audit consultant, in the plant area with the attention focused on the energy inputs, spots of wastage and available energy conservation opportunities. The items for waste recycling opportunities are identified. The data regarding energy inputs and outputs are collected for use during preliminary audit.

**2. Detailed (Comprehensive) Energy Audit:**

Detailed energy audit, also known as comprehensive energy audit includes engineering recommendations and well defined projects with priorities. It account for the total energy utilised in plants. It involves detailed engineering for options to reduce energy consumption and also reduce cost. The duration of such studies is generally from 1 to 10 weeks.

The action plan in divided into short term, medium term and long term actions.

The short term action plan requires no capital investment or least investment to avoid energy wastages and minimising non-essential energy uses and improving the system efficiency through improved maintenance programme.

The medium term action plan requires a little investment to achieve efficiency improvement through modifications of existing equipment's and other operations.

The long term action plan is aimed to achieve economy through latest energy saving techniques and innovations. The capital investments are required to be studied thoroughly while finalising the long term action-plan.

**The comprehensive audit is quite exhaustive, and it is convenient to split it into following sub parts:**

**1. Overall system audit:**

This accounts for energy leakage/loss through the total system to the atmosphere. The energy conservation measures to eliminate such leakages/loss are recommended.

**2. Functional audit:**

It identifies the energy conservation measures in operation and maintenance of each main plant and its subsystems and suggests ECOs is operation and maintenance.

**3. Utility Audit:**

It identifies yearly/monthly/daily consumption of commercial secondary energy (electricity/petroleum products/fuel etc.) and suggests ECOs.

**4. Modernization audit:**

## 3.9 Energy Audit Instruments

The requirement for an energy audit such as identification and quantification of energy necessitates measurements; these measurements require the use of instruments. These instruments must be portable, durable, easy to operate and relatively inexpensive.

The parameters generally monitored during energy audit may include the following:
Basic Electrical Parameters in AC &DC systems - Voltage (V), Current (I), Power factor, Active power (kW), apparent power (demand) (kVA), Reactive power (kVAr), Energy consumption (kWh), Frequency (Hz), Harmonics, etc. Parameters of importance other than electrical such as temperature & heat flow, radiation, air and gas flow, liquid flow, revolutions per minute (RPM), air velocity, noise and vibration, dust concentration, Total Dissolved Solids (TDS), pH, moisture content, relative humidity, flue gas analysis - $CO_2$, $O_2$, CO, SOx, NOx, combustion efficiency etc.

Key Instruments are:`

Electrical Measuring Instruments:
Combustion analyzer:
Fuel Efficiency Monitor:
Fyrite:
Contact thermometer:
Infrared Thermometer:
Pitot Tube and manometer
Water flow meter:
Speed Measurements:
Leak Detectors:
Lux meters:

# IMPORTANCE OF ENERGY CONSERVATION:

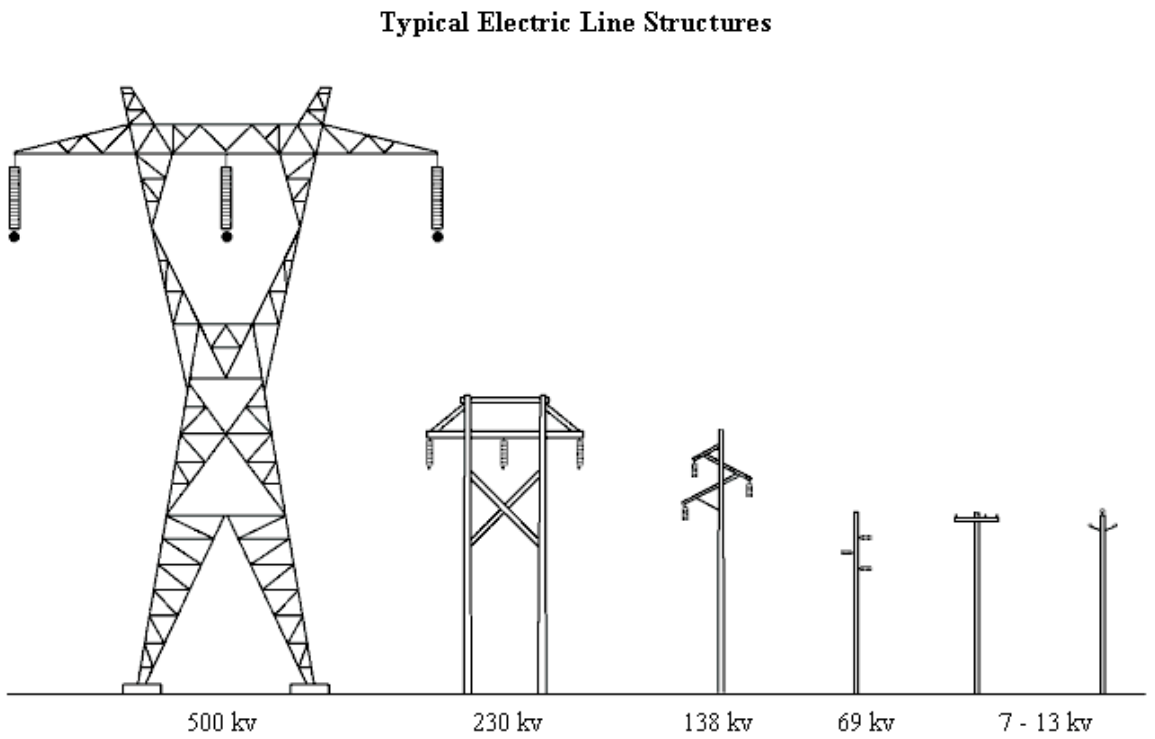
- We use energy faster than it can be produced - Coal, oil and natural gas - the most utilised sources take thousands of years for formation.
- Energy resources are limited - India has approximately 1% of world's energy resources but it has 16% of world population.
- Most of the energy sources we use cannot be reused and renewed - Non renewable energy sources constitute 80% of the fuel use. It is said that our energy resources may last only for another 40 years or so.
- We save the country a lot of money when we save energy - About 75 per cent of our crude oil needs are met from imports which would cost about Rs.1, 50,000 crore a year
- We save our money when we save energy - Imagine your savings if your LPG cylinder comes for an extra week or there is a cut in your electricity bills
- We save our energy when we save energy - When we use fuel wood efficiently, our fuel wood requirements are lower and so is our drudgery for its collection
- Energy saved is energy generated - When we save one unit of energy, it is equivalent to 2 units of energy produced
- Save energy to reduce pollution - Energy production and use account to large proportion of air pollution and more than 83 percent of greenhouse gas emissions.

Advantages of using Light Emitting Diodes (LEDs)

- An ordinary bulb is an extremely energy inefficient form of lighting with just 5% of the electricity input converted to light. Efficient light bulbs like Light-emitting Diode (LEDs) **consumes only one-tenth of energy used by ordinary bulb to** provide the same or better light output. Consumers electricity bill will reduce by about Rs. 160-400 per year with each LED, thus making the cost recovery lesser than a year. This will lead to savings in electricity and lower consumption of fossil fuels thus benefiting the environment.
- Unlike incandescent bulbs, LEDs do not have filament that is heated to create light. These are illuminated by the movement of electrons in a semi conductor material (diode). Since electricity is directly turned into light, LEDs waste less energy as heat.

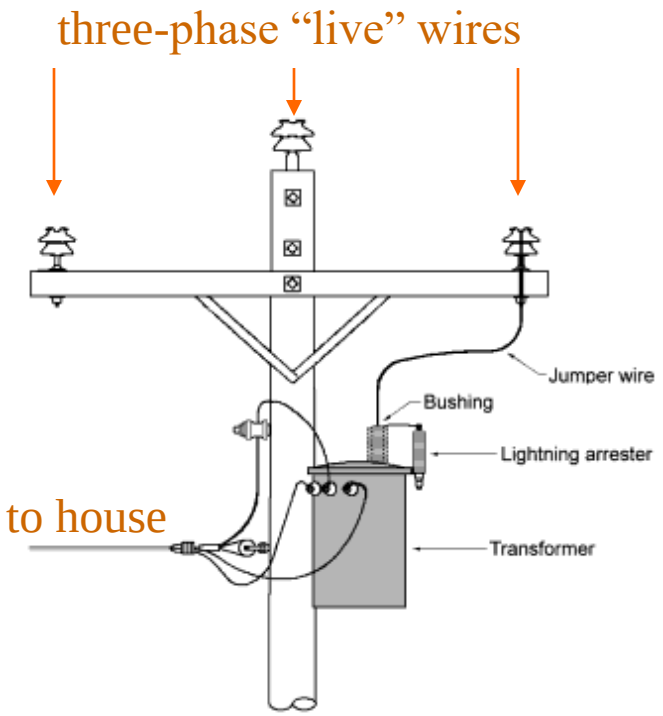
**Lumen intensity of LED vs incandescent bulb -** LEDs have no gases, filaments or any moving parts to fatigue. A 7W LED gives the same and in most cases better lumen intensity and brightness than a 60W Incandescent Lamp. The lumen output of a 60 Watt incandescent bulb is 450 lumens. Whereas, the lumen output of a 7 watt LED bulb is 600 lumens. The proportion of lumens that falls in an area from an LED light source is greater than that of a conventional light source.

# Transmission structures

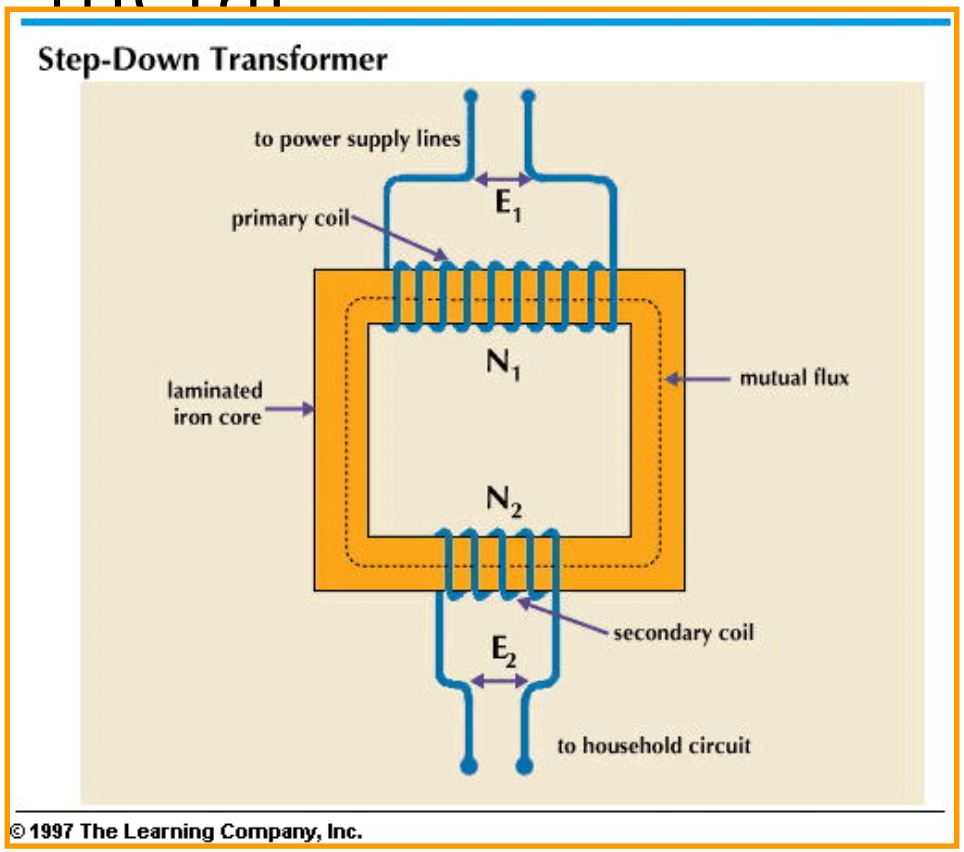



500,000 230,000 138,000 69,000 7–13,000

long-distance → neighborhood



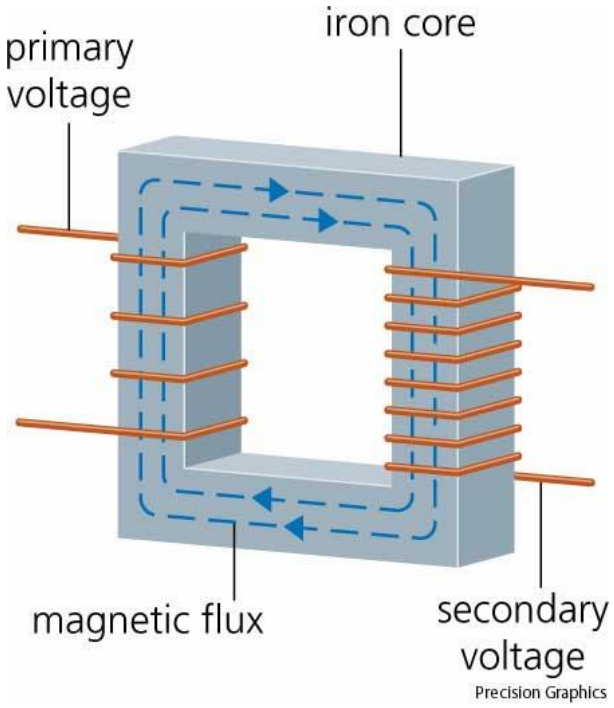
# Transformer is just wire coiled around metal

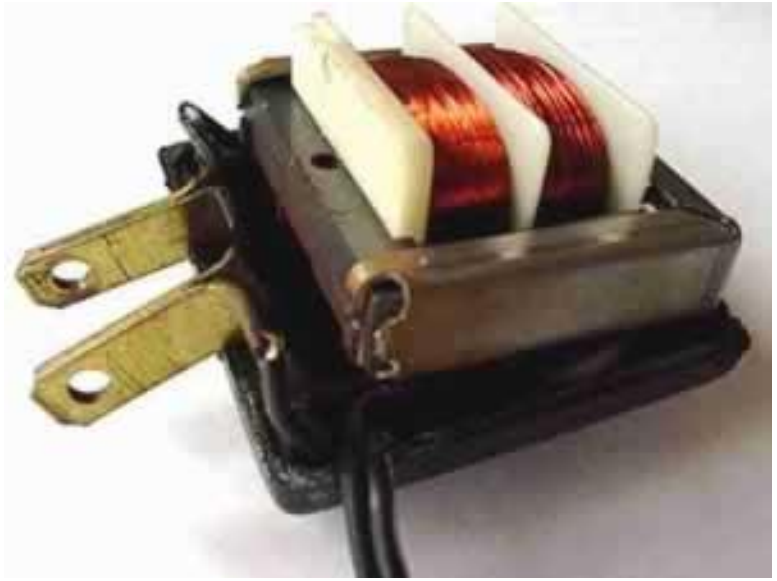



- Magnetic field is generated by current in primary coil
- Iron core channels magnetic field through secondary coil
- Secondary Voltage is $V_2 = (N_2/N_1)\, V_1$
- Secondary Current is $I_2 = (N_1/N_2)\, I_1$
- But Power in = Power out
  - negligible power lost in transformer
- Works only for AC, not DC

*If the primary wires and secondary wires don't actually connect, how does the energy get from the primary circuit to the secondary circuit?!*

# Typical Transformers



transformers usually heavy due to iron core