Energy for sustainable development

- **Access** – ensuring affordable, reliable, and modern energy for all.
- **Efficiency** – promoting technologies and practices that reduce energy waste.
- **Renewables** – shifting towards solar, wind, hydro, and bioenergy to reduce dependence on fossil fuels.
- **Environmental protection** – reducing carbon emissions and pollution linked to energy production and use.
- **Economic growth** – creating green jobs and supporting industries based on clean energy.
- **Social well-being** – improving health, education, and quality of life through sustainable energy access.

Energy Conservation in Industries

Energy Policy

Energy policy is a **document or set of regulations** that include strategies and steps to be taken for energy saving. There are several standards based on which energy policies are made. For example, ISO 50001, a standard made for energy management purposes

- ☐ Making energy policy for efficient use of energy.
- ☐ Setting targets and objectives for policy.
- ☐ Data review for better understanding and decision making of energy use.
- ☐ Results measurement.
- ☐ Reviewing policy
- ☐ Improving policy

Energy Conservation in Industries

Energy Audit

A regular energy audit helps in **finding out the power losses due to different equipment**, also the areas where most of the power is consumed and **what steps are required to be taken in order to reduce power consumption** without affecting the production.

Walkthrough Audit

- It consists of analyzing the **overall area major and minor loads**, type of work performed there, number of staff, shifts, and timings, etc.
- The results through these audits can be like **replacing old CFL lights with led and reducing the number of switches per luminaries** etc.

Detailed Audit

- It includes data collection, bills comparison, losses due to equipment, replacing old equipment with a new one and its payback period calculation.

Energy Conservation in Industries

Renewable Energy

☐ The use of renewable energy is becoming common nowadays as it is a **free source of energy** and has almost **negligible carbon emission**.
☐ These energies are utilized for supplying to load through the combination of power system equipment besides power electronic devices.
☐ The use of renewable energy in industrial facilities can also be a source of **cost-saving and reducing demand on the utility company.**

Efficient Lighting

☐ The use of **electronic ballast** in tube lights instead of using an old electromagnet blast can also reduce energy consumption.
☐ Replacing **fluorescent and incandescent with low power led lights** is a fine approach to saving energy.
☐ **Sensors based light** in washrooms and other areas can save a lot of energy.

Energy Conservation in Industries

Power Factor

☐ The power factor shows the ratio of **what amount of power is utilize for doing useful work from the power that is supplied**.

For example, two industries are supplied by a grid having the following data:

DATA	INDUSTRY A	INDUSTRY B
Power utilized	1 MW	1 MW
Power factor (P.F)	0.5	0.8
Power required (MW/P.F)	2 MVA	1.25 MVA

The given data shows that both industries may have the same amount of motors utilizing 1 MW for doing useful work but due to the **difference in power factor the power supplied by the grid changes**. **Industry A will have to pay a high bill as the grid has to supply more power.**

Energy Conservation in Industries

Motor

☐ Due to overloading, **voltage fluctuation, and insulation damage, motors winding temperature increases and starts to get damage**. The rise in temperature leads to increased losses. The motor's life gets halved at every **10-degree rise** in its temperature.

☐ If **rewinding is performed** with a lack of care and precautions then every **rewinding could cause a 1% decrease in efficiency** which ultimately results in increasing the cost of electricity.

Motor Staggering

At the time when the motor starts, it consumes almost three times as much power than its rated power.

For Example: An industry consists of three motors each of 10 kW and having a starting power of 30 kW for a few seconds. If all the motors are started in one go, then the surge of 90 kW will appear at generation end. Instead of this if the motors started one at a time then the surge will be much less.

Energy Conservation in Industries

Housekeeping and Maintenance Plan

Proper scheduled maintenance and monitoring of loads in industries could **increase the life span of equipment** and also help in controlling the losses or failure.

- Lights can get dust easily and gets dims. **Scheduled cleaning of lights** results in proper brightness and increases its life span.
- Voltage imbalance can cause the failure of the motor. **Monitoring voltage imbalance and mitigating it** can save the motor from large damages.

Smart Energy Meter with Data Logging

- A smart energy meter is an advanced device that tracks the **amount of electrical energy consumed** in a building or by an electrical device.
- It provides **real-time data and logs energy** usage over time for further analysis.
- Smart energy meters often come **equipped with communication systems that allow remote monitoring** and data transmission to a central server.

Key Features of a Smart Energy Meter

- ☐ Real-Time Energy Monitoring
- ☐ Data Logging.
- ☐ Communication Capabilities.
- ☐ User Interface

Design Considerations

Before beginning the design, the following requirements should be considered:

- **Accuracy:** Ensure high accuracy for precise energy consumption measurement. The meter should comply with regulatory standards (e.g., IEC 62053-21 for Class 1 accuracy).
- **Power Supply:** Decide if the meter will be powered by the mains or an independent source such as a battery.
- **Data Logging Frequency:** Define how often the meter logs data (from every second to once a day depending on application needs).
- **Communication Method:** Select communication mode:
  - Wired (e.g., RS-485, Ethernet)
  - Wireless (e.g., Zigbee, Wi-Fi, LoRaWAN)

Key Components in smart Energy meter

Current Sensors

Choose current transformers (CTs) or Hall-effect sensors to measure the current flowing through the circuit.

- **Current Transformer:** A non-invasive solution that clamps onto the wire and measures current by inducing a current proportional to the flow.
- **Hall Effect Sensor**: Measures the current by detecting the magnetic field generated by the flow of current in a conductor.

Voltage Sensors

- **Resistive Divider Circuit**: A simple and cost-effective solution to scale down the mains voltage to safe levels that the microcontroller can process.
- **Precision Voltage Sensors**: For more accurate and isolated measurements.

Key Components in smart Energy meter

Microcontroller

The microcontroller is the brain of the smart meter and is responsible for **processing sensor data, managing communication, and storing data**.

For Example, ESP32, STM32, and ATmega328P microcontrollers are widely used due to their low **power consumption, sufficient processing power, and built-in communication interfaces**.

Energy Measurement IC

Dedicated energy measurement ICs simplify the design by handling the **complex calculations of energy parameters like power factor, active/reactive power, and energy**.

For Example, Analog Devices ADE7753 or Cirrus Logic CS5463 are popular ICs that handle **accurate energy calculations, reducing the computational load on the microcontroller.**

Key Components in smart Energy meter

Data Logging Module

☐ **SD Card Module:** Affordable and provides ample storage. However, it requires periodic access for data retrieval.
☐ **Flash Memory:** Compact and efficient for continuous data logging.
☐ **EEPROM:** Suitable for logging small amounts of data over time but has limited write cycles.

Communication Module

A communication module allows for **data transmission to a remote server or cloud platform**. There are various options depending on the application:
☐ **Wi-Fi (ESP8266/ESP32):** Ideal for home automation systems where the meter can connect to an existing Wi-Fi network.
☐ **LoRaWAN:** Suitable for long-range communication with low power consumption.
☐ **Zigbee:** Ideal for smart home networks with multiple connected devices.
☐ **GSM/4G Modules:** Suitable for systems in remote areas where cellular communication is the best option.