

Unit - 3

Energy Efficiency in Electrical Utilities

Electrical Utilities consume a large portion of energy in industrial & commercial sectors. Improving energy efficiency in these systems leads to reduced operational cost, lower emissions, and better utilization of resources.

Key areas -

1. Power Factor Improvement - Low power factor increases losses & higher electricity bill. Installing capacitor banks or synchronous condensers can improve power factor & reduce bill.
2. Reducing Transmission & Distribution Losses - losses occur in transmission lines, transformers & distribution networks. High efficiency transformers, higher voltage transmission & better conductor materials reduces losses.
3. Efficient Motor Management - Selecting high efficiency motors & using variable frequency drives can save energy. Regular motor maintenance reduces energy waste.
4. Load Management Strategies - Reducing demand during peak hours using load shifting. Adjusting electricity usage based on real time grid demand.

Tips for Energy Saving

Energy saving can be achieved through proper planning, technology adoption & behavioral changes.

1. Smart Technology & Automation for energy saving -

- Use IoT based Energy Monitoring
- Implement Smart Meters
- Use Renewable Energy Sources

Adopt Smart Home / Date _____
Office Automation

Strategies —

1. General Energy Saving Tips —

- Turn off unused equipment
- Use natural lighting & Ventilation
- Energy awareness program

• Upgrade to energy efficient
appliances

2. Energy Saving in Industrial Motors & Drivers —

- Use variable frequency drives.
- Use High Efficiency Motors

• Eliminate Idle running

• Use Proper Motor Sizing

3. Energy Saving in HVAC Systems —

- Optimize Thermostat Setting
- Seal & Insulate Ducts & windows
- Install energy efficient HVAC equipment

• Use ~~old~~ fans to reduce AC load

• Clean HVAC filters & coils regularly

4. Lighting Systems —

- Use motion sensors & timers
- Use task lighting

• Switch LED lighting

5. Refrigeration Systems —

- Keep refrigerator doors closed
- Use energy efficient refrigerators

• Check & Maintain Door seals.

• Place refrigerators in ventilated areas

6. Water Heating Systems —

- Insulate hot water pipes
- Set water heater to optimal temperature

• Use Solar Water Heaters

• Use instant water heaters instead of storage heaters.

7. Office & IT Equipment —

- Use laptop instead of computers

• Enable Power Saving mode in computers

8. Compressed Air Systems —

- Reduce Operating Pressure

• Fix Air leaks

• Recover waste heat

• Use energy efficient air compressors

Compressed Air Systems

It is widely used in industries for pneumatic tools, conveyors and control mechanisms. It is one of the most energy intensive utilities with significant energy loss.

Component

1. Air Compressor — Converts mechanical energy to electrical energy
2. Air Storage Tank — Stores compressed air to stabilize pressure
3. Air Dryer — Removes moisture to prevent corrosion.
4. Filters & Regulators — Maintain air quality & control pressure.
5. Piping System — Distributes compressed air to different applications

Energy Saving Opportunities in Compressed Air Systems.

1. Leak Detection & Repair — Regular ultrasonic leak detection and maintenance reduce losses
2. Use of Energy Efficient Compressors — Variable Speed Drive (VSD) compressors adjust speed based on demand. Choose the most efficient type based on application.
3. Proper Air Storage & Pressure Regulation — Avoid over pressurization as it increases energy consumption
4. Optimize Piping & Distribution System — Use larger diameter pipes to reduce pressure drop. Minimize bends & ~~for~~ joints to reduce friction losses
5. Recover Waste Heat — Air compressors generate heat that can be recovered for space heating or pre-heating water.

Energy Saving Opportunities in HVAC and Refrigeration Systems

Heating, Ventilation, and Air Conditioning (HVAC) systems are major energy consumers in buildings and industries.

Strategies in HVAC -

1. Optimized Temperature Control - Avoid excessive cooling or heating. Use programmable thermostats for precise temperature regulation.
2. Use of Energy Efficient Equipment - Install high efficiency air conditioners with inverter technology. Use heat pumps instead of electric heaters for better efficiency.
3. Airflow Management - Ensure proper duct design to minimize pressure losses. Use ceiling fans to enhance air circulation and reduce AC load.
4. Regular Maintenance & Cleaning - Clean air filters, coils and ducts to ensure efficiency. Check for leakages in ducts & refrigerant pipes.

Strategies in Refrigeration Systems -

1. Reduce Heat Load - Use thermal insulation to prevent unwanted heat transfer. Minimize door openings in cold storage.
2. Efficient Refrigerants & Compressors - Use eco-friendly refrigerants with lower global warming potential (GWP). Install variable speed compressors for better energy control.
3. Recover waste Heat - Capture heat from condensers for water heating or space heating.
4. Automated Control Systems - Install small thermostats and real time monitoring systems to optimize operation.

Impact of Power Electronics in Energy Efficiency

1. Variable Frequency Drives (VFDs) —

Control motor speed and reduce energy consumption in pumps, fans and compressors. Improves efficiency by matching motor speed to load demand.

2. Soft Starters — Reduce inrush current during motor startup, improving longevity and efficiency.

3. Switched Mode Power Supplies (SMPS) — Used in electronic devices for efficient power conversion.

4. Energy Efficient Converters & Inverters — Used in solar power systems, electric vehicles (EVs) and UPS (Uninterruptible Power Supplies). Convert DC to AC with minimum losses.

5. Smart Grid Technologies — Integrates IoT, AI, and automation to optimize energy distribution. Enables real time monitoring and predictive maintenance.