**The Energy Conservation Act of 2001**

is an important piece of legislation in India that aims to promote energy efficiency and conservation in various sectors of the economy.

**Salient features of energy conservation act 2001**

* The establishment of Bureau of Energy Efficiency (BEE) in place of existing Energy Management Centre (EMC) to implement the provisions of the act
* Declaration of a user or class of users of energy as a designated consumer
* To lay down minimum energy consumption standards and labeling for identified appliances/equipment and norms for industrial processes for energy intensive industries
* Formation of energy consumption codes
* Dissemination of information and best practices
* Establishment of Energy Conservation Fund both at the central and state levels
* Provision of penalties and adjudication
* The BEE would act as a facilitator for the evolution of a self-regulatory system and organizations would regulate on their own with a view to save energy and thereby bring the commercial concept in the organization

**The primary objective of the Energy Conservation Act 2001 is to:**

**Promote Energy Efficiency**

* To promote efficient use of energy resources in different sectors of the economy, including industries, commercial establishments, households, and more.
* It encourages the adoption of energy-efficient technologies and practices to reduce energy consumption.

**Reduce Environmental Impact**

* By promoting energy efficiency and conservation, the act aims to reduce the overall environmental impact of energy production and consumption.
* This includes the reduction of greenhouse gas emissions, air pollutants, and other environmental harm associated with energy generation.

**Strengthen Energy Security**

* By conserving energy resources and reducing energy wastage, the act contributes to enhancing energy security for the country.
* It reduces dependence on imported energy resources and helps in managing energy demand effectively.

**Encourage Energy Audits and Standards**

* The act establishes mechanisms for conducting energy audits and assessments in energy-intensive industries and commercial buildings.
* It also empowers the government to set energy consumption standards for appliances and equipment, thereby ensuring that energy-efficient technologies are used.
* **Establish Regulatory Mechanisms**
* The act establishes the Bureau of Energy Efficiency (BEE) as the central agency responsible for coordinating and implementing energy efficiency programs and policies.
* BEE works with various stakeholders to develop and implement energy efficiency initiatives.
* **Foster Public Awareness and Capacity Building**
* The act encourages public awareness campaigns and capacity-building initiatives to educate individuals, industries, and institutions about the importance of energy conservation and ways to achieve it.

**Monitor and Report:**

* The act requires designated consumers (large energy-consuming entities) to regularly report their energy consumption and measures taken to improve efficiency.
* This monitoring helps track progress and identify areas for improvement.

Overall, the Energy Conservation Act 2001 plays a pivotal role in India's efforts to mitigate climate change, enhance energy security, and promote sustainable development through the efficient utilization of energy resources.

**Key features of the Energy Conservation Act 2001 include:**

**Bureau of Energy Efficiency (BEE)**

* The act establishes the Bureau of Energy Efficiency as the central regulatory authority responsible for coordinating and overseeing energy efficiency initiatives.
* BEE plays a key role in formulating policies, promoting energy-efficient technologies, and implementing programs to improve energy efficiency.

**Role of Bureau of Energy Efficiency:**

The role of BEE would be to prepare

* standards and labels of appliances and equipment,
* develop a list of designated consumers,
* specify certification and accreditation procedure,
* prepare building codes,
* maintain Central EC fund and
* undertake promotional activities in co-ordination with center and state level agencies.

**Role of Central and State Governments**

The following role of Central and State Government is envisaged in the Act**:**

**Central:**

* to notify rules and regulations under various provisions of the Act,
* provide initial financial assistance to BEE and EC fund,
* Coordinate with various State Governments for notification, enforcement, penalties and adjudication.

**State:**

* to amend energy conservation building codes to suit the regional and local climatic condition,
* to designate state level agency to coordinate, regulate and enforce provisions of the Act and
* constitute a State Energy Conservation Fund for promotion of energy efficiency

**Enforcement through Self-Regulation:**

* The certification of energy consumption norms and standards of production process by the Accredited Energy Auditors is a way to enforce effective energy efficiency in Designated Consumers.
* For energy performance and standards, manufacturer's declared values would be checked in Accredited Laboratories by drawing sample from market

**Penalties and Adjudication:**

* Penalty for each offence under the Act would be in monetary terms i.e. Rs.10,000 for each offence and
* Rs.1,000 for each day for continued non Compliance.
* The initial phase of 5 years would be promotional and creating infrastructure for implementation of Act. No penalties would be effective during this phase.
* The power to adjudicate has been vested with state Electricity Regulatory Commission which shall appoint any one of its member to be an adjudicating officer for holding an enquiry in connection with the penalty imposed.

**Practice Questions- Part-1**

1. The maximum demand of a consumer is 15 A at 230 V and his/her total energy consumption is 9000 kWh. If the energy is charged at the rate of Rs. 5 per unit for 600 h use of the maximum demand per annum plus Rs. 2 per unit for additional units, calculate (1) annual bill and (2) equivalent flat rate
2. Analyse energy conservation through predictive control method
3. Explain ECBC for energy conservation
4. Discuss power factor tariff
5. Identify the factors affecting tariff
6. Discuss block meter rate tariff
7. Discuss the Cost benefits of PF improvement
8. State the advantages of PF improvement by capacitor addition
9. Discuss the need for Electrical Load Management
10. Identify the factors to be considered in case of energy efficient motor?
11. Explain Energy efficient motor
12. Define time off day tariff.
13. State the importance of Indian Energy Conservation Act regarding energy policies of industries.
14. Discuss the electricity rate tariff structure.
15. Explain the energy conservation in small scale and large scale industries.
16. Explain various forms of energy and Law of conservation of energy
17. State the equation of three part electricity tariff
18. State the Purpose of the EC act 2001
19. Define energy intensity
20. Define energy planning
21. Define energy management
22. Define energy policy
23. Define energy efficiency
24. State Important features of energy conservation act 2001

ENERGY CONSERVATION TECHNIQUES

1. EC in Power generating station

To generate 1MW power generation cost is Rs 4.5 to 5.25 crores and T& D cost is Rs.2 crores. But cost of saved power is Rs.1Crores/Mw.

The important note is time period to set a power plant is 5 years; to set up transmission line 1 year and to plan energy conservation is only 1 month. We have less opportunity for EC in generating area.

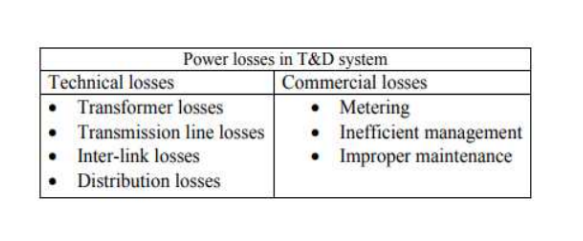
But we can improve the performance efficiency of generators by optimization of load, optimal distribution of load among different units, periodical maintenance and also increasing the capacity by adopting advanced technology using renewable energy sources.

1. **EC in Transmission & Distribution**

Areas Consumption (Year-2007) Domestic 21% Commercial 18.0% Industrial 32% Transportation 29% 3 In India the power transmission and distribution (T&D) system is a three tire structure comprising of state grids, regional grids and distribution network.

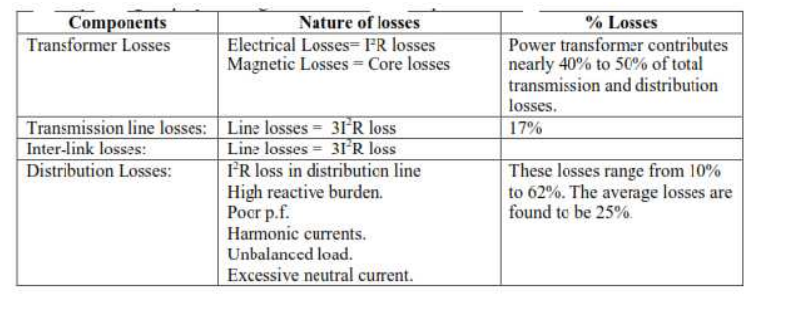
To meet the energy demand power system networks are interconnected through INTRA-REGIONAL LINK.

The inter-regional power transmission capacity of India at end of 2007 was 14000 MW. T&D system in India is characterized by heavy losses of about 34.54% according to statistics of 2005-06, as compared to 10-15% in developed countries Power losses in T&D system can be classified as Technical losses and Commercial losses.



1. Technical Losses in T&D System:

Power losses occurring in T&D sector due to imperfection in technical aspect which indirectly cause loss of investment in this sector, are technical losses. These technical losses are due to inadequate system planning, improper voltage and also due to poor power factor etc.



1. Commercial Losses:

Commercial losses are those, which are directly responsible for wastage of money invested in transmission and distribution system. These losses are effects of inefficient management, improper maintenance etc. Corruption is also the main reason contributing to the Commercial losses. Metering losses includes loss due to inadequate billings, faulty metering, overuse, because of meters not working properly and outright theft. Many of the domestic energy meters fail because of poor quality of the equipment.

**Energy Conservation in Transmission Line**

* To reduce line resistance-„R‟ solid conductors are replaced by stranded conductors (ACSR or AAC) and by bundled conductors in HT line.
* High Voltage Direct Current (HVDC) is used to transmit large amount of power over long distances or for interconnections between asynchronous grids
* By transmitting energy at high voltage level reduces the fraction of energy lost due to Joule heating. (V a1/I so I2R losses reduces).
* As load on system increases terminal voltage decreases. Voltage level can be controlled by using voltage controllers and by using voltage stabilizer
* If required reactive power transmitted through transmission lines, it causes more voltage drop in the line. To control receiving end voltage, reactive power controllers or reactive power compensating equipments such as Static VAR controllers are used.

**Energy Conservation in Distribution Line**

1. **Optimization of distribution system:**

The optimum distribution system is the economical combination of primary line (HT), distribution transformer and secondary line (LT), To reduce this loss and improve voltage HT/LT line length ratio should be optimized.

1. **Balancing of phase load**

As a result of unequal loads on individual phase sequence, components causes over heating of transformers, cables, conductors, motors. Thus, increasing losses and resulting in the motor malfunctioning under unbalanced voltage conditions.

1. **Harmonics**:

With increase in use of non-linear devices, distortion of the voltage and current waveforms occurs, known as Harmonics. Due to presence of harmonic currents excessive voltage and current in transformers terminals, malfunctioning of control equipments and Energy meter, over effect of power factor correction apparatus, interference with telephone circuits and broad casting occurs. Distribution Static Compensator (DASTACOM) and Harmonic filters can reduce this harmonics.

1. **Energy Conservation by using power factor controller:**

Low power factor will lead to increased current and hence increase losses and will affect the voltage. We can use Power Factor Controller or Automatic Power Factor Controller that can be located near receiving substations, load centres or near loads.

1. **Energy Conservation By Demand side management control:**

Demand-side management is used to describe the actions of a utility, beyond the customer's meter, with the objective of altering the end-use of electricity - whether it be to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands - in the overall interests of reducing utility costs. Nearly energy of 15,000 MW can be saved through end-use energy efficiency.

By using DSM saving potential in…

Industry and Agriculture - 30-35%

Commercial / Government establishments and residential houses. -25-30

**Energy Conservation in Motors**

Considering all industrial applications 70% of total electrical energy consumed by only electric motors driven equipments.

1. **Improving power supply quality:**

Maintaining the voltage level within the BIS standards i.e. with tolerance of +/-6%and frequency with tolerance of +/-3% motor performance improves and also life.

1. **Optimum loading:**

Proper selection of the rating of the motor will reduce the power consumption. If the motor is operating at less than 50% of loading significant power saving can be obtained by replacing with properly sized high efficiency motors. If the motor is operating at loads below 40% of it‟s capacity, an inexpensive and effective measure might be to operate in star mode.

1. **Improving transmission efficiency**:

Proper selection of power transmission means (belts, gears) will reduces transmission losses.

1. Stopping idle or redundant running of motors or lights will save 100% power.
2. **By use of Soft Starter:**

Soft starters are essentially stator voltage controllers; helps to overcome above problem. It helps to restrict starting current and also provide smooth start and stop operation

1. **By improving power factor:**

For improving p.f., connect the capacitor bank, which will improve the p.f. of the system from installation to generating station. Maximum improvement in overall system efficiency is achieved, which also reduces max. demand of the system and that will reflect in energy bill.

**g. Use of high efficiency or Energy efficient motors:**

The energy efficient motors have reduced losses through improved design, better materials and improved manufacturing techniques. Generally motor life doubles for each 100 C reduction in operating temperature. While selecting EEM, select with 1.15service factor, design for operation at 85% of rated load.

**Energy Efficient Lighting Techniques**

**Replacing an ordinary bulb** : replacing high Energy consuming bulbs with energy saving bulbs which gives efficient energy lighting system.

**Using Lighting Controls :** using GSM/SCADA/GPS based centralized systems also monitor and control the lighting system efficiently and reliably to save energy. By using Auto intensity of Street Lights an also be controlled through setting timer which gradually reduces the intensity as reducing traffic on late nights and ensures completely shut down at morning period.

**Use An Automated Device, Such As A Key Tag System :** The key tag system uses a master switch at the entrance of each guest room, requiring the use of a room key-card to activate them. Using this technique, only occupied rooms consume energy because most electrical appliances are switched off when the keycard is removed (when the guest leaves the room). Along with lighting, the heating, air conditioning, radio and television may also be connected to the master switch. This innovation has a potential savings of about $105.00 per room per year

**Add Lighting Controls Such As Photo Sensors Or Time Clocks :** Photo sensor controls monitor daylight conditions and allow fixtures to operate only when needed. Photo sensors detect the quantity of light and send a signal to a main controller to adjust the lighting. Photo sensors are commonly used with outdoor lighting to automatically turn lights on at dusk and off at dawn, a very cost-effective control device. This helps to lower energy costs by ensuring that unnecessary lighting is not left on during daytime hours.

**Using Day lighting** : Daylighting involves the efficient use of natural light in order to minimize the need for artificial lighting in buildings. Increasing levels of daylight within rooms can reduce electrical lighting loads by up to 70%. **Lighting system maintenance :** The regular maintenance is very important for the efficiency of the lighting system. Therefore, the maintenance must be carried out in regular intervals. A correctly scheduled maintenance plan helps to maintain the illumination, reduce investment and operational costs and operate the system safely. The plan of maintenance is to include [9]: x Interval of maintenance execution, x Description of activities performed within the framework of a regular maintenance, x description of activities performed within the framework of extraordinary maintenance (service action), x Way of luminaires and surfaces cleaning.

**Lighting Requirements in Streets :** When designing or making changes in street lighting, it is important to first understand the light requirements of the road. Street lighting in India is classified in the Indian Standard (BIS, 1981), based on the traffic density of the road . Based on the classification in the code, the local engineer matches the category of road, and designs and provides installation specifications for the street lighting system. 7. Globally about 75% of all power plant generated electricity is used just to Lighting. By adopting and enforcing intelligent and energy saving strategies we can assure the energy efficiency of Lightings. Peoples should be actively involved in energy saving also. Without their co-operation most control strategies will not be successful, because energy savings are not being made at the expense of their lighting conditions. Properly designed and implemented energy efficient lighting schemes will not degrade the working environment. Progressive and an achievable targets for lighting systems in industry is 1-3W / m2 / 100 lx. Saving energy is good business for everyone.

**Energy conservation in domestic gadgets and Transport**

**Energy conservation in domestic gadgets**

Energy conservation in domestic gadgets is essential for reducing electricity consumption, lowering utility bills, and minimizing the environmental impact associated with energy production. Here are some specific tips for conserving energy in your home through the efficient use of domestic gadgets:

1. **Choose Energy-Efficient Appliances:** When purchasing new appliances, look for the Energy Star label, which indicates that the appliance meets energy efficiency guidelines set by the Environmental Protection Agency (EPA). Energy-efficient appliances consume less energy while providing the same level of performance.
2. **Unplug Idle Devices:** Many electronic gadgets continue to draw power even when turned off (known as standby or phantom power). Unplug devices or use smart power strips to completely disconnect them from the electrical supply when not in use.
3. Optimize Refrigerator and Freezer Settings: Set your refrigerator and freezer temperatures to the recommended levels (typically around 37°F for the refrigerator and 0°F for the freezer). Ensure that the door seals are tight and avoid overloading them.
4. Use Energy-Efficient Lighting: Replace incandescent bulbs with energy-efficient LED or CFL bulbs. These bulbs use significantly less electricity, last longer, and produce less heat.
5. Programmable Thermostats: Install a programmable or smart thermostat to regulate heating and cooling in your home. Set it to reduce heating or cooling when you're not at home or during sleeping hours.
6. Regular Appliance Maintenance: Keep appliances well-maintained. Clean filters, coils, and vents on appliances like air conditioners, refrigerators, and dryers to ensure they operate efficiently.
7. Use Microwave and Toaster Oven: For smaller cooking tasks, use a microwave or toaster oven instead of a full-sized oven. These appliances typically consume less energy for shorter cooking times.
8. Washing Machines and Dishwashers: Use these appliances with full loads to maximize their efficiency. Also, consider using the cold water setting for laundry and air-drying dishes instead of the heated drying cycle in the dishwasher.
9. Reduce Water Heater Temperature: Lower the temperature setting on your water heater to 120°F (49°C) or lower. This reduces energy used to heat water and helps prevent scalding.
10. Insulate and Seal Your Home: Properly insulate your home and seal gaps around doors, windows, and ducts to minimize heat loss or gain. This reduces the workload on heating and cooling systems.
11. Smart Home Technology: Invest in smart home devices that allow you to control and monitor your gadgets remotely. You can optimize settings, schedule operation, and track energy consumption more effectively.
12. Energy Audits: Consider getting a professional energy audit of your home to identify areas where energy is being wasted. Auditors can suggest improvements tailored to your specific situation.
13. Upgrade Old Appliances: If you have older, inefficient appliances, consider upgrading to newer, more energy-efficient models, as they can save you money in the long run.

By implementing these energy-saving practices with your domestic gadgets, you can reduce your household's energy consumption, lower your energy bills, and contribute to a more sustainable and eco-friendly living environment.

**Energy conservation in Transport**

Energy conservation in transport is essential to reduce fuel consumption, greenhouse gas emissions, and dependence on fossil fuels. Implementing energy-efficient practices and adopting alternative transportation methods can make a significant impact. Here are some strategies for conserving energy in transport:

1. **Choose Fuel-Efficient Vehicles:** Opt for vehicles with high fuel efficiency, such as hybrid cars, plug-in electric vehicles (EVs), or vehicles with advanced fuel-saving technologies. Smaller and lighter vehicles generally consume less fuel.
2. **Carpool and Rideshare:** Share rides with others when possible, either through carpooling with colleagues or using ridesharing services. This reduces the number of vehicles on the road and saves fuel.
3. **Use Public Transportation:** Utilize buses, trains, trams, and subways for commuting and traveling. Public transportation is often more energy-efficient and reduces traffic congestion.
4. **Biking and Walking:** For short trips, consider cycling or walking. These modes of transportation are emissions-free and promote personal health.
5. **Plan Efficient Routes:** Combine errands and plan your routes to minimize the distance traveled. Avoid congested routes and traffic jams to save fuel and time.
6. **Eco-Driving Techniques:** Practice eco-driving by accelerating smoothly, maintaining a steady speed, and avoiding aggressive driving behaviors like rapid acceleration and hard braking. Proper maintenance of your vehicle also contributes to better fuel efficiency.
7. **Maintain Proper Tire Pressure:** Keep your vehicle's tires properly inflated to the manufacturer's recommended pressure. Under-inflated tires increase rolling resistance and decrease fuel efficiency.
8. **Remove Excess Weight:** Remove unnecessary items from your vehicle's trunk or cargo area, as excess weight reduces fuel efficiency.
9. **Limit Engine Idling:** Turn off your vehicle's engine if you expect to be stationary for more than a minute. Idling consumes fuel and emits pollutants.
10. **Hybrid and Electric Vehicles:** Consider driving a hybrid or electric vehicle (EV). EVs are powered by electricity, which can be generated from renewable sources, resulting in significantly lower greenhouse gas emissions.
11. **Alternative Fuels:** Explore alternative fuels like natural gas, hydrogen, or biofuels if they are available and suitable for your vehicle.
12. **Telecommuting and Remote Work:** If possible, work from home or telecommute to reduce the need for daily commuting, saving both energy and time.
13. **Use Public Charging Infrastructure:** If you own an electric vehicle, utilize public charging stations to charge your EV, reducing the reliance on fossil fuels for transportation.
14. **Consider Mass Transit for Long-Distance Travel:** For long-distance travel, consider taking a train or bus instead of flying or driving. Trains and buses are often more energy-efficient for longer journeys.
15. **Advocate for Sustainable Transportation:** Support policies and initiatives that promote sustainable transportation options, such as improved public transportation systems, bike lanes, and pedestrian-friendly infrastructure.
16. **Share Resources:** Explore shared mobility options like car-sharing and bike-sharing programs in your community.

Energy conservation in transport not only reduces your carbon footprint but also leads to cost savings on fuel and maintenance. By adopting energy-efficient practices and embracing alternative transportation methods, individuals can contribute to a more sustainable and environmentally friendly transportation system. Additionally, government incentives and policies can play a vital role in promoting energy-efficient transport options on a larger scale.

**Practice Questions- Part-2**

1. Design the Basic Principles Energy conservation planning.
2. Analyze the Energy efficiency of system.
3. Explain the process of energy conservation by Predictive and preventive control maintenance.
4. Describe Electric energy conservation in distribution system
5. Explain Electric Energy conservation in building heating and lighting
6. Develop the strategies to improve power factor
7. Demonstrate the Approach for Maximum Demand Control
8. Demonstrate the Selection and location of capacitors for power factor improvement
9. Demonstrate the Performance Assessment of Power Factor Capacitors
10. Demostrate Energy conservation through controls
11. Demonstrate How energy cost of electrical energy has helped to develop ‘ two-part’ Tariff?
12. Explain Time of Day (TOD) Tariff and how it is beneficial for the power system and consumers
13. Examine the need of Energy efficient motors
14. Demonstrate Electric energy conservation in transmission
15. Demonstrate Energy Conservation in lighting system
16. Analyze the Energy Conservation Opportunities