Sustainable Development and Management

Climate Change

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• The earth's climate is changing dramatically because of human intervantion. The climate is influenced directly by temperature and other metrological conditions such as wind, precipitation and glaciation.

• Long term variation in temperature is major cause of climatic change in environment.

1. Causes of Climatic Changes

1. Presence of green house gases in atmosphere.

2. Depletion of ozone layer.

Ozone Layer Depletion

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• The ozone in stratosphere protects living organisms from the ultraviolet radiation of the sun. In particular, it absorbs ultraviolet (UV) radiations and screens out harmful UV radiations.

1. Hole in Ozone Layer

• The amount of ozone present in atmosphere is delicate balance between the maning and destruction of ozone that depends upon the existence of naturally occuring trace compound.

• If some unnatural compounds are added to this balance that can provide extra catalytic species, then the destruction of ozone will be enhanced. This situation is known as hole in the ozone layer or depletion of ozone layer.

2. Ozone Depleting Substances

• Ozone layer is very much destroyed by the catalytic reactions having free radicals such as clorine (Cl), bromin (Br), hydrogen (H) and nitric oxide (NO).

• Following gases causes depletion of ozone in atmosphere

Sr. No.	Gases	Principal sources
1.	Chloro Fluoro Carbon (CFC)	Refrigerents in refrigerators propellent in aerosol spray cans.
2.	Hydro Chloro Fluoro Carbon (HCFC)	Refrigerents, blowing agents air conditioners.
3.	Bromo Fluoro Carbons (BFC)	Fire extinguishers.
4.	Nitric Oxide (NO)	Detonation of nuclear weapons, nitrogenous fertilizers.

3. Impact of Ozone Layer Depletion

• Effect / impact or consequences of ozone layer depletion are :

1. Effects on human health

UV rays damage genetic material in skin causing skin cancer.

Prolonged exposure to UV rays may cause blindness.

Human resistivity is reduced resulting in allergies and infections.

2. Effects on aquatic system

Kills lower fauna and flora

Affects photosynthesis process cause mutation.

3. Effect on materials

Degradation of point quality and plastics.

4. Effects on climate

Climate change.

Global warming.

4. Measurement of Ozone / Dobson Unit

• The amount of atmospheric ozone is measured by "Dobson spectrometer" and is expressed in Dobson Units (DU).

• One Dobson Unit (1 DU) is equivalent to 0.01 mm thickness of pure ozone at the density is poses it is brought to ground level (1 atm) pressure.

• In temperature latidue concentration of ozone is 350 DU and in tropics it is 250 DU.

5. Control Measures for Depletion of Ozone Layer

1. Reducing CFCs and other ozone depleting chemicals.

2. To make serious efforts to produce and propagate the use of alternative chemicals which do not deplete ozone in stratosphere.

Carbon Credit

Carbon Credit

• Carbon trading is currently the central pillar of the Kyoto Protocol and other international agreements aimed at slowing climate change. Carbon trading is a market-based approach to controlling pollution.

• Carbon trading is a emission trading specifically for carbon dioxide (CO_2) calculated in tonnes of carbon dioxide equivalent or tCO_2^e.

• Carbon trading is about the rights of greenhouse gas emissions. The idea is a response to the Kyoto Protocol. Under Carbon trading, a country having more emissions of carbon is able to purchase the right to emit more and the country having less emission trades the right to emit carbon to other countries.

• Both countries and companies can reduce their emissions below designated levels and sell this amount to a business or country with greenhouse gas emissions that are too high.

• The financial instrument used for this trade is called offset carbon/carbon credit which is equivalent to one metric ton of equivalent CO_2 equivalent.

• Carbon credits are measured in tonnes of carbon dioxide: 1 Credit = 1 Tonne of CO_2

• Difference between carbon footprints and carbon credits is: carbon offsets is total emissions where as carbon credits is total reduction in emission. Carbon credits are bought to compensate carbon footprints.

Carbon Footprint

"The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."

Carbon Footprint

• A carbon footprint is a measure of the amount of carbon dioxide emitted through the combustion of fossil fuels.

• The carbon footprint is total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO_2).

Definition

• "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."

For a Product or Process

• A carbon footprint is the total amount of CO_{2q} and other greenhouse gases, emitted over the full life cycle of a process or product. It is expressed as grams of CO_2 equivalent per kilowatt hour of generation (gCO_2eq/kWh), which accounts for the different global warming effects of other greenhouse gases.

For a Business Organisation

• In the case of a business organization, it is the amount of CO, emitted either directly or indirectly as a result of its everyday operations. It also might reflect the fossil energy represented in a product or commodity reaching market.

• When you drive a car, the engine burns fuel which creates a certain amount of CO_2 depending on its fuel consumption and the driving distance.

• When you heat your house with oil, gas or coal, then you also generate CO_2. Even if you heat your house with electricity, the generation of the electrical power may also have emitted a certain amount of CO_2.

• When you buy food and goods, the production of the food and goods also emitted some quantities of CO_2.

• Your carbon footprint is the sum of all emissions of CO_2, which were induced by your activities in a given time frame.

• Usually a carbon footprint is calculated for the time period of a year.

• The best way is to calculate the carbon dioxide emissions based on the fuel consumption. In the next step you can add the CO_2 emission to your carbon footprint. Below is a table for the most common used fuels :

Fuel Type	Unit	CO_2 emitted per unit
Petrol	1 liter	2.3 kg
Gasoline	1 liter	2.3 kg
Diesel	1 liter	2.7 kg
Oil (heating)	1 liter	3 kg

• **Example :** If your car consumes 7.5 liter diesel per 100 km, then a drive of 300 km distance consumes $3 \times 7.5 = 22.5$ liter diesel, which adds 22.5×2.7 kg = 60.75 kg CO_2 to your personal carbon footprint.

1. Reducing Carbon Footprint

• Carbon footprint can be reduced by several ways :

1. Alternatives to driving - When possible walk or ride your bike in order to avoid carbon emissions completely. Carpooling and public transportation drastically reduce CO_2 emissions by spreading them out over many riders.

2. Drive a low carbon vehicle - High mileage doesn't always mean low CO_2 emissions. All vehicles have an estimated miles-per-gallon rating. Electric cars emit no CO_2 if they're charged with clean electricity.

3. Driving style - Speeding and unnecessary acceleration reduce mileage by up to 33 %, waste gas and money and increase your carbon footprint.

4. Tyre inflation and other tuning - Properly inflated tires improve your gas mileage by up to 3 %. It also helps to use the correct grade of motor oil and to keep your engine tuned, because some maintenance fixes, like fixing faulty oxygen sensors, can increase fuel efficiency by up to 40 %.

5. Avoid traffic - Being stuck in traffic wastes fuel and unnecessarily creates CO_2. Use traffic websites and apps and go a different way or wait.

6. Excess weight - Remove excess weight from your car. Use cruise control.

7. Reduce your carbon footprint from air travel - Until petroleum-based aviation fuel is replaced, you should avoid flying when possible, fly less frequently, fly shorter distances and fly economy class.

Avoid air travel, instead increase your use of video-conferencing tools like Skype.

Economy class is best, for the same reasons as carpooling and public transportation. Each flyer's share of a flight's carbon emissions is relatively less because it's spread out over more people.

8. Don't fly on private jets - Fly first or business class if you must, because at least those seats always fill up anyway and avoid private jets.

9. Insulate and seal your home - Reduce drafts and air leaks with caulk, insulation and weather stripping.

10. Appliances - Make energy efficiency a primary consideration when choosing a new furnace, air conditioning unit, dishwasher or refrigerator. Products bearing the ENERGY STAR label are recognized for having superior efficiency.

11. Lighting - Turn off lights you're not using and when you leave the room. Replace incandescent light bulbs with compact fluorescent or LED ones.

12. Thermostat - Don't set it too high or low. Install a programmable model to turn off the heat/air conditioning when you're not home.

13. Solar - Add solar panels to the roof of your home. This costs a little more than the above options, but many providers offer financing options which minimize upfront costs.

14. Reduce your food carbon footprint from food - Eat locally-produced and organic food. Buy local food that is naturally growing in season. Do you really need to eat strawberries flown in from the other side of the planet ? You want to eat fresh food, so what better that stuff growing locally.

It has been estimated that 30 % of greenhouse gas emissions result from the production and transport of food. Transporting food requires petroleum-based fuels and many fertilizers are also fossil fuel-based.

15. Deforestation - Deforestation is a top contributor to carbon emissions and thus climate change.

16. Avoid partying - This is for both food sustainability and economic inequality.

17. Water usage - Lower the amount of energy used to pump, treat and heat water by washing your car less often, using climate-appropriate plants in your garden, installing drip irrigation

so that plants receive only what they need and making water-efficient choices when purchasing shower heads, faucet heads, toilets, dishwashers and washing machines.

Stop daydreaming in the shower and hurry up as lots of hot water is being wasted.

18. Avoid buying bottled water - Apart from being ridiculously expensive (it's just water!) it may have travelled half way round the planet to get to you. Surely tap water in your own reusable container will do.

19. Reuse and recycle - It has been estimated that 40 % of greenhouse gas emissions result from the "provision of goods," which means the extraction of resources, manufacturing, transport and final disposal of "goods" which include consumer products and packaging, building components and passenger vehicles, but excluding food. By buying used products and reselling or recycling items you no longer use, you dramatically reduce your carbon footprint from the "provision of goods."

20. Support clean energy sources - Whenever you can, advocate for clean alternatives to fossil fuels, such as wind, solar, geothermal and appropriately designed hydroelectric and biomass energy projects.

21. Use fountain pen rather disposable plastic pens.

22. Do not put your supermarket vegetables into separate little plastic bags - it's just a waste of bags. Use your own reusable bag to cart the entire goodies home.

23. Print on both sides of the paper and use recycled inks.

24. Use cleaning products that are not derived from oil - so look for vegetable based ones.

25. Wash your clothes at low temperatures, the detergents still work and the clothes don't mind.

Sustainability Practices

Zero Waste

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• Zero Waste is a philosophy and a design principle for the 21st Century. It includes 'recycling' but goes beyond recycling by taking a 'whole system' approach to the vast flow of resources and waste through human society.

• To make recycling work for everyone, we need to buy products made from the materials we recycle. This reduces the need to utilize non-renewable resources by reusing materials that have already been consumed.

• Zero Waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources and not bum or bury them.

• Producing recycled materials uses less energy and saves more trees than producing "virgin" materials.

• Implementing Zero Waste will help reduce discharges to land, water or air that may be a threat to planetary, human, animal or plant health and imitate sustainable natural cycles, where all discarded materials are resources for others to use.

• The zero waste approach seeks to maximize recycling, minimize waste, reduce consumption and ensures that products are made to be reused, repaired or recycled back into nature or the marketplace.

• Zero Waste systems reduce greenhouse gases by :

1. Saving energy - especially by reducing energy consumption associated with extracting, processing and transporting raw materials and waste.

2. Reducing and eventually eliminating the need for landfills and incinerators

Goal of Zero Waste

• The goal of Zero Waste is to :

1. Maximize recycling

2. Minimize waste

3. Reduce consumption

4. Ensure products are made to be reused, repaired or recycled

5. Purchase sustainable products

Concept of 5R (Refuse, Reduce, Reuse, Repurpose, Recycle)

Incorporating this methodology into your business' waste reduction and recycling efforts will minimize landfill waste and help take your recycling program to the next level.

Concept of 5R (Refuse, Reduce, Reuse, Repurpose, Recycle)

• According to the 5 R's, four actions should be taken, if possible, prior to 'recycling': refuse, reduce, reuse, repurpose and then recycle.

• Incorporating this methodology into your business' waste reduction and recycling efforts will minimize landfill waste and help take your recycling program to the next level.

1. Refuse : Do not buy anything which we do not really need.

2. Reduce : Reduce the amount of garbage generated. Alter our lifestyle so that minimum garbage is generated.

3. Reuse : Reuse everything to its maximum after properly cleaning it. Make secondary use of different articles.

4. Repurpose : For every item that can't be refused, reduced or reused, try repurposing it. Many people in the green community refer to this method as upcycling. You may be surprised to learn how many common office products serve more than one purpose.

5. Recycle : Keep things which can be recycled to be given to rag pickers or waste pickers (Kabadiwallahs). Convert the recyclable garbage into manures or other useful products.

Circular Economy

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• The circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste and pollution.

• In circular economy, products are designed for durability, reuse and recyclability and materials for new products come from old products.

• Circular economy is a new production and consumption model that ensures sustainable growth over time. With the circular economy, we can drive the optimization of resources, reduce the consumption of raw materials and recover waste by recycling or giving it a second life as a new product.

• The circular economy is important as it promotes sustainable development. It advocates using waste as an input for producing new finished goods.

• The circular economy supports creating reserves of raw materials and adopting innovative methods to eliminate any steps that reduce the cost and time to make new finished goods.

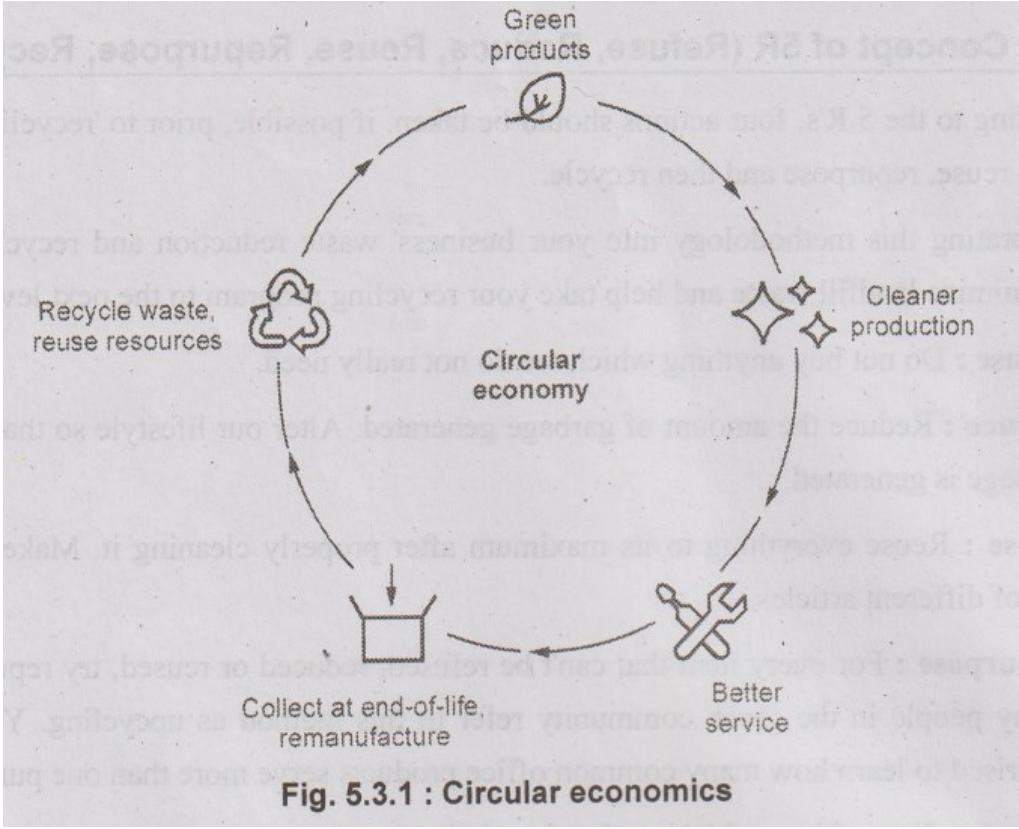

Fig. 5.3.1 : Circular economics

1. Linear Economy Versus Linear Economy

• In a linear economy, materials flow in a straight line from resource extraction, to manufacturing and then to landfill.

• Value is created by producing and selling as many products as possible. This model is characterized by wasted resources and excessive pollution, causing ecosystem degradation, wealth concentrations and social inequities.

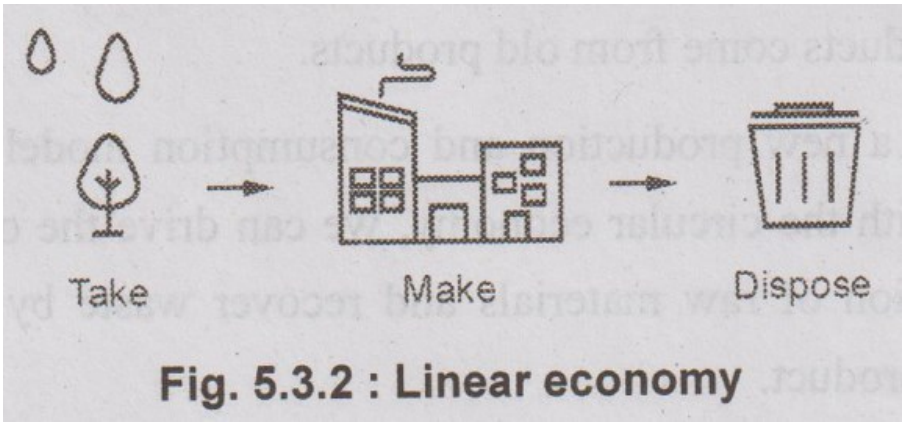

Fig. 5.3.2 : Linear economy

• A circular economy model, on the other hand, aims to redefine growth to benefit people and the planet. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system.

• Underpinned by a transition to renewable energy sources, the circular business model builds economic, natural and social capital.

2. Principles of Circular Economy

• The circular economy is based on three principles, driven by design :

1. Eliminate waste and pollution
2. Circulate products and materials (at their highest value)
3. Regenerate nature

3. Benefits of Circular Economy

1. It reduces waste as it promotes the recycling of finished goods.
2. It offsets any potential price rise of the commodity.
3. Its adoption helps achieve efficiency and effectiveness as resources are recycled to get new products.
4. It promotes the rental business by advocating to reuse of an economic entity rather than purchasing a new entity.

Quality System Standard ISO 14001: 2004

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• The ISO 14000 family addresses various aspects of environmental management. The very first two standards, ISO 14001:2004 and IS014004:2004 deal with environmental management systems (EMS).

• ISO 14001:2004 provides the requirements for an EMS and ISO 14004:2004 gives general EMS guidelines.

1. ISO 14000 Series Standards

1. ISO 14001 Environmental management systems-Requirements with guidance for use.

2. ISO 14004 Environmental management systems-General guidelines on principles, systems and support techniques.

3. ISO 14015 Environmental assessment of sites and organizations.

4. ISO 14020 series (14020 to 14025) Environmental labels and declarations.

5. ISO 14030 discusses post production environmental assessment.

6. ISO 14031 Environmental performance evaluation-Guidelines.

7. ISO 14040 series (14040 to 14049), Life Cycle Assessment, LCA, discusses pre- production planning and environment goal setting.

8. ISO 14050 terms and definitions.

9. ISO 14062 discusses making improvements to environmental impact goals.

10. ISO 14063 Environmental Communication-Guidelines and examples.

11. ISO 14064 Measuring, quantifying and reducing Greenhouse Gas emissions.

2. Uses of ISO 14004:2004

• ISO 14004:2004 provides guidance on the establishment, implementation, maintenance and improvement of an environmental management system and its coordination with other management systems.

• An EMS (Environmental Management Systems) meeting the requirements of ISO 14001:2004 is a management tool enabling any organization to :

1. Identify and control the environmental impact of its activities, products or services.

2. Improve its environmental performance continually.

3. Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

ENVIRONMENT IMPACT ASSESSMENT (EIA)

Environmental Impact Assessment (EIA) is a formal system to assess the environmental consequences of developmental activities before any project or major activity is undertaken so that it will help us to reduce or eliminate the adverse effects of such activities or projects on the biological, chemical, physical, social, and economic aspects of the environment. An Environmental Impact Assessment (EIA) report is often a key requirement for gaining Environmental Clearance (EC) for many development projects. Environmental impact assessment is a process with a series of steps.

The role of EIA was formally recognized at the earth summit held at the Rio conference in 1992. Principle 17 of the Rio Declaration states that –

"*EIA as a national instrument shall be undertaken for the proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent national authority"*.

Objectives of EIA

EIA can be considered as a project management tool for collecting and analyzing information about the environmental effects of a proposed project. The main objectives of EIA are:

1. Identification of potential impacts of a proposed project or potential impacts of activities or products of the project and to deal with it at an early stage in the project planning and design.
2. Assess the possibility of impact mitigation.
3. Recommendation of preventing and mitigating measures to the concerned authorities.
4. Provide unbiased information to decision makers about the environmental implications of the proposed project so as to enable them to decide whether the project is to be pursued or not.

Different steps involved in the conduct of EIA

The various activities to be considered for EIA are sector specific. However, in general, the following is common to EIAs prepared for all sectors.

1. **Scoping**: This is the first task of the EIA study team. The aim is to ensure that the study covers all the important issues that are liable to be raised by the decision makers. For this the team has to hold discussions (with the project proponents, decision makers, the regulatory agency, scientific institutions, local community representative and others) to include all the possible issues and concerns liable to be raised by various groups. Then the study team selects primary impacts that are required to be focused for the EIA depending on the basis of magnitude, geographical extent, and eco-sensitivity of the area.

2. **Collection of Baseline Data**: Collection of relevant data about the physical, biological and socio-economic conditions of the existing environment and all changes anticipated because of the project and also not directly connected to the project, within and around the project site is to be collected. Under current regulations in India this is a radius of 10 or 25km of the site, depending on whether the site is in the vicinity of sensitive areas such as National Parks, sanctuaries, or archaeological monuments.
3. **Assessment of environmental Impact**: Identifies, predicts and assesses the project's likely positive and negative impacts of the identified parameters in quantitative terms to the extent possible using questionnaires and other appropriate tools. This includes:
   i) Compilation of key impacts (e.g. Changes in air quality, noise levels, wild life habitats, species diversity, landscape views, social and cultural systems, settlement patterns and employment levels).
   ii) Listing all the project sources of impacts (e.g. Smoke emissions, water consumption, altered land use pattern).
   iii) Listing possible receptors in the environment (e.g. Crops, communities using the same water for drinking, migrant labour).
   iv) This step also identifies the impacts that need mitigation and any negative environmental impact that cannot be mitigated.

4. **Evaluation of impact assessment:** As a next step, evaluation of the predicated adverse impacts will be performed to determine whether they are significant enough to think about alternatives or demand mitigation. This is based on:
   i) Consultation of laws, regulations or accepted standards of the region.
   ii) Consultation with the relevant decision makers.
   iii) Reference to the eco-sensitivity of the area.
   iv) Acceptability to the local community or the general public.

5. **Analysis of alternatives**: Systematic comparison of feasible alternatives to the proposed projects regarding the site, technology, design and operation with and "without project" situation in terms of their potential environmental impacts will be done. Feasibility of mitigating these impacts, their capital and recurrent costs and their suitability under local conditions is performed. Possible alternatives include: changing project sites, routes, processes, raw materials, operating methods, disposal methods, disposal routes or locations, timing or engineering designs.
6. **Delineation of mitigation procedures**: A detailed procedure for mitigating the possible impacts resulting from the implementation of the project is made. Possible mitigation measures include:

i) Introducing pollution controls, waste treatment monitoring, phased implementation, landscaping, personal training, special social services or public education.
ii) Offering compensation, restoration of damaged resources, concessions on other issues or off site programmes to enhance some other aspects of the environment or quality of life for the community.

7. **Specification of Environmental Monitoring Programme:** Describes the required monitoring measures to be taken at the institutional level during construction and operation, to eliminate or reduce adverse impacts to acceptable levels.
8. **Environmental Management Plan:** Elaborate procedures for management plans to meet the environmental exigencies are worked out and documented. The action plan may include technical control measures, monitoring and contingency plans, operating practices, and project scheduling. Techniques like cost benefit analysis, pair-wise comparisons etc., are used for this purpose.
9. **Documentation:** This is the last step in the EIA process. A detailed draft record related to all the steps mentioned above and conclusions covering the justification for the project are prepared. Along with this an EIA report should contain:
    a. A brief description of the proposed development project.
    b. An executive summary of the EIA findings.
    c. The major environmental and natural resource issues that needed clarification and elaboration.
    d. An overview of gaps or uncertainties in the information.
    e. Disclosure about the consultants.
    f. A summary of the EIA for the general public.
10. **Review of report:** Drawn up reports are reviewed to evaluate the efficiency and quality of the EIA. If some items are missing, they are modified as required or accepted by the reviewers in order to facilitate the process of decision-making. Suggestions made by the experts are incorporated.
11. **Decision-making:** In the end, decision –makers decide the future prospects of the proposed projects based on the comments and recommendations of the reviews on the EIA report.

Benefits of EIA

It is widely acknowledged that EIA result in improved project design. The benefits can be both to the promoters of the project and to the local communities where the project is implemented.

i. Reduced time of project implementation.
ii. Cost-saving modification possible at the start of the project implementation.

iii. Sustainable utilization of resources.
iv. Fewer conflicts of interest.
v. Compliance with laws and regulations.
vi. Increased project acceptance among the public and sense of participation.
vii. Improved project performance.
viii. Reduction in cleanup costs.
ix. Better maintenance of biodiversity and environment.

Limitations of EIA

1. The range of possible alternatives in EIA is small.
2. Lack of baseline environmental database can reduce the outcome of EIA.
3. It is a complicated process involving experts in various fields.
4. Development of improved methodologies is required to reduce the uncertainties of EIA outcomes.
5. EIA reports are too academic, technical and lengthy with too many tables and figures.
6. Generally, EIA ends immediately after project clearance; no follow up action is taken.

ENVIRONMENT MANAGEMENT PLANS

Environment Management Plan (EMP) is a formal system with a set of management procedures that allows an organization to identify, evaluate and reduce the environmental impact of its activities, products and services. It refers to a system of managing the activities of organization for improving their concern and commitment to the environment in a planned, formal, comprehensive, systematic and documented manner.

The main objectives of environment management plan are:

1. Restrict and regulate overexploitation of natural resources.
2. Renew natural resources with suitable devices.
3. Set targets to reduce the use of energy and water, and waste going to landfill.
4. Set Environment-friendly purchasing procedures.
5. Improve management of environmental impacts.
6. Define key responsibilities for achieving targets.
7. Monitor and measure environmental performance with respect to key indicators.
8. Ensure compliance to legal and other environmental requirements.
9. Build goodwill among customers, employees and stakeholders.
10. Effect a change from the traditional management culture to that of the environmental-organization culture.

For the implementation of EMP, there is the need for an organizational structure, maintaining a policy, planning and implementation the details of which are given below.

1. **Environmental Policy** —Environmental policy is the road map that shows the commitment of management in matters concerning environmental issues. The policy has to be:
   a) A written document to be made available to the concerned employees, other stakeholders as well as to the public.
   b) Appropriate to the nature, scale and environmental impacts of an organisation's activities, products or services.
   c) A commitment to continuous improvement and prevention of pollution.
   d) In conformity with the laws and rules and regulations and must make a statement in regard to compliance.
   e) Lay down a framework of environmental objectives.

2. **Planning** -Planning is an important function of an organization. It takes into consideration a proper schedule to attain targets, successes and knowledge of likely failures. Planning takes into consideration the processes, resources, responsibilities, skills, authority and coordination. The Planning section has to care the following aspects:
   a) Environmental aspects - Establish procedures to identify, implement and document the environmental aspects of activities, products, and services of the organization. The plan includes a detailed approach to environmental impacts, contingencies and alternatives to mitigate the crisis if it occurs.
   b) Legal and other requirements - Establish procedures to identify, implement and clarify the legal and other requirements that is applicable to the organization.
   c) Objectives and targets - The objectives take into consideration the vision, mission and core values of the organization and the targets are quantifiable ends of the objectives.
   d) Environmental management program(s) - The organization should develop a plan to reduce any adverse effects of its operation that may have on the environment.

3. **Implementation and Operation** -The organization mobilizes support and capabilities for achieving objectives and targets set out in policy and plan of action. The process of implementation involves management skills in the following areas:
   a) Management of human, financial and natural resources.
   b) Motivation, training and competence.
   c) Structure and Responsibility.

d) Documentation.
e) Communication within the organization.
f) Operational control.
g) Preparedness for emergency and response.
h) Management of information and keeping of records.

4. **Monitoring and Evaluation** –EMS requires a mechanism for measuring performance and evaluation. For this a process for testing and verification has to be made. Such a process must be an ongoing process to identify environmental performance indicators that are verifiable. For this the organizations must establish a system and procedures for determining compliance and conformance with rules and regulations and corrective and preventive action. Legal and other requirements need to be identified and assessed on a regular basis to ensure legal compliance. Periodic audit of EMS should be conducted either by internal or external auditors who are trained and qualified for the job and proper records kept for the successes and failures.

5. **Management Review** –Review undertakes an in-depth analysis of all the issues related to the environment. It must pay full attention to the implementation of the objectives set out by the organization. Reviews must go beyond the stage of compliance and has to think in terms of continual improvements in environmental performance. Issues to be looked into during the process of review are:
   a) Recommendations of audit report.
   b) New regulations.
   c) Suitability of the environmental policy.
   d) Interest of stakeholders.
   e) Public awareness and pressures.

An EMP cannot be implemented in a random manner. ISO 14000 is a series of internationally recognized standards for structuring the EMP of an organization and managing the environmental performance of the system to induce environmental improvement and cost savings. The series of standards is managed by the International Organization for Standardization (ISO).

GREEN BUSINESS

Sustainable business, or a **green business**, is an activity that has minimal negative impact on the global or local environment, community, society, or economy. Green businesses adopt principles, policies and practices that improve the quality of life for their customers, employees, communities, and the planet. In general, business is described as green if it matches the following four criteria.

1. It incorporates principles of sustainability into each of its business decisions.

2. It supplies environmentally friendly products or services that replace demand for non-green products and/or services.
3. It is greener than traditional competition.
4. It has made an enduring commitment to environmental principles in its business operations.

ECO-LABELLING

"Eco-labelling" is a voluntary method of environmental performance certification and labelling that is practiced around the world. An eco-label identifies products or services proven environmentally preferable overall, within a specific product or service category. The International Organization for Standardisation (ISO) has identified three broad types of voluntary labels.

TYPE I: A voluntary, multiple-criteria based, *third party* programme that awards a license that authorises the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category.

TYPE II: informative environmental *self-declaration* claims

TYPE III: voluntary programmes that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party.

Benefits of eco-labelling:

1. Informing consumer choice: Eco-labeling is an effective way of informing customers about the environmental impacts of selected products, and the choices they can make. It empowers people to discriminate between products that are harmful to the environment and those more compatible with environmental objectives. For example, recycled paper or toxic-free cleaning agents.

2. Promoting economic efficiency: Eco-labeling is generally cheaper than regulatory controls. By empowering customers and manufacturers to make environmentally supportive decisions, the need for regulation is kept to a minimum. This is beneficial to both government and industry.

3. Stimulating market development: When customers choose eco-labeled products, they have a direct impact on supply and demand in the marketplace. This is a signal which guides the market towards greater environmental awareness.

4. Encouraging continuous improvement: A dynamic market for eco-labeled products encourages a corporate commitment to continuous environmental improvement. Customers can expect to see the environmental impacts of products decline over time.

5. Promoting certification: An environmental certification program is a seal of approval which shows that a product meets a certain eco-label standard. It provides customers with visible evidence of the product's desirability from an environmental perspective.

6. Assisting in monitoring: Another benefit of an official eco-labeling program is that environmental claims can be more easily monitored.

Ecomark: India

To increase consumer awareness, the Government of India launched the eco-labeling scheme known as `Ecomark' in 1991 for easy identification of environment-friendly products.
The criteria follow a cradle-to-grave approach, i.e. from raw material extraction, to manufacturing, and to disposal. The Ecomark label is awarded to consumer goods that meet the specified environmental criteria and the quality requirements of Indian Standards.

ECO-HOMES OR GREEN BUILDINGS

Green building is an approach to create a built environment on the principles of sustainability that use local or recycled materials in its construction, use less water, less dependence on grid energy, less waste generation; but provide healthy living conditions for the occupants in harmony with the environment.

Components (principles) of green building concept

Green buildings are built with the following concepts:

1. **Energy demand** - Dependency on grid energy is minimized by the use of natural ventilation and solar passive heating, depending on the predominant climatic conditions: use of passive lighting and energy-saving roofs, exteriors and building materials.
2. **Water demand** –Reduction of water demand by the use of water efficient products and services.
3. **Low energy building materials**: Use of low energy building materials, use of reuse or recycled building materials, use of locally available, nontoxic and recyclable building materials are preferred in the construction of green buildings.
4. **Waste reduction** – reduction of waste generation is aimed at right from the construction of the building, during renovation and even at the time of demolition.
5. **Indoor air quality** – This is maintained by providing proper ventilation and preventing dampness which will prevent the growth of fungi and algae inside buildings.
6. **Harmony with the environment** – Green buildings are designed in such a way as to cause minimum alteration to the environment and blending with the aesthetics of the environment.

Benefits of green buildings

Benefits from the concept of green buildings are many. They can be grouped as follows:

1. **Environmental Benefits**
    i. Reduced indoor pollution.
    ii. Reduced water consumption resulting in water conservation.
    iii. Reduced energy consumption, reducing the carbon footprint of the building.
    iv. Low alteration of the environment during the siting of the building adds to aesthetics.
    v. Limited waste generation during construction, occupation and demolition of the building.
2. **Economic Benefits**
    i. Cost saving from reduced water and grid energy use.
    ii. Enhanced image and marketability of the building.
    iii. Cost saving from the selection of low-energy building materials.

GREEN BUILDING CERTIFICATION

Green building certification is a system in which a building is certified that it has achieved certain requirements of environmental performance by assessing them with a rating system called green building rating system. This system is an evaluation tool that assesses the environmental performance of a building based on its predicted performance over the entire life cycle from inception through operation. Green building rating system consists of a set of criteria which covers various parameters related to design, construction and operation of a green building. Each criterion has pre-assigned points and performance benchmarks that are largely quantifiable.

A building is awarded points depending on the degree of fulfilling the rating criteria. The points are added up and the final rating of the building is given. The rating is done by an independent third party and different processes are there to ensure a fair evaluation. Evaluation of a building by such a rating system is voluntary in nature. But these rating systems are instrumental in raising awareness and popularizing green building designs.

There are different green building rating systems like:

1. Green Rating For Integrated Habitat Assessment (GRIHA) - developed in India
2. Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) developed by Japan.
3. Leadership in Energy and Environmental Design (LEED®) was developed in US.

Sustainable Habitat

A Green building focuses on increasing the efficiency of resource use - energy, water and materials - while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance and removal.

Sustainable Habitat

• Sustainable Habitat is defined as an approach towards a balanced and sustainable development of the ecosystem of habitat which offers adequate shelter with basic services, infrastructure, livelihood opportunities along with environmental and socio-economic safety including equality, inclusiveness and disaster-resilience.

1. Green Building

• A Green building focuses on increasing the efficiency of resource use - energy, water and materials - while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance and removal.

• Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings.

• Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by :

1. Efficient use of energy, water and other resources.

2. Protecting occupant health and improving employee productivity.

3. Reducing waste, pollution and environmental degradation.

• Effective green buildings are more than just a random collection of environmental friendly technologies, however.

• They require careful, systemic attention to the full life cycle impacts of the resources embodied in the building and to the resource consumption and pollution emissions over the buildings complete life cycle.

2. Planning for Sustainable Building

1. Green building materials

• Renewable plant materials like bamboo and straw, lumber from forests certified to be sustain ably managed, dimension stone, recycled stone, recycled metal and other products

that are non-toxic, reusable, renewable and/or recyclable (e.g. sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, seagrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone etc.)

• The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal -combustion products, foundry sand and demolition debris in construction projects.

2. Reduced energy use

• Designers orient windows and walls ahd place awnings, porches and tress to shade windows and roofs during the summer while maximizing solar gain in the winter.

3. Reduced waste

• During the construction phase, one goal should be to reduce the amount of material going to landfills.

4. Rain water harvesting

• Rain water harvesting is done by collecting the water from terrace or roof and storing in underground tanks for using it in the summer months.

5. Reduction of wastes and pollution

• By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced.

3. Advantages of Green Building

1. Green buildings harmonise with the local climate, traditions, culture and the surrounding environment.

2. Green buildings are designed to save energy and resources, recycle materials and minimise the emission of toxic substances throughout its life cycle.

3. Green buildings make efficient use of resources; have significant operational savings and increases workplace productivity.

4. Green buildings are able to sustain and improve the quality of human life whilst maintaining the capacity of the ecosystem at local and global levels.

5. Building green sends the right message about a company or organisation - that it is well run, responsible and committed to the future.

Energy Efficiency

Energy efficiency is defined as the use of energy in an optimum manner to achieve the same service that could have been achieved using a common less efficient manner.

Energy Efficiency

• Energy efficiency is the use of less energy to perform the same task or produce the same result.

• Energy efficiency is defined as the use of energy in an optimum manner to achieve the same service that could have been achieved using a common less efficient manner.

• Energy efficiency is the practice of reducing the energy requirements while achieving the required energy output.

• Energy-efficient homes and buildings use less energy to heat, cool and run appliances and electronics and energy-efficient manufacturing facilities use less energy to produce goods.

• Energy efficiency is one of the easiest and most cost-effective ways to combat climate change, reduce energy costs for consumers.

• Energy efficiency is also a vital component in achieving net-zero emissions of carbon dioxide through decarbonization.

• Efficient use of energy can be understood in terms of using energy in such a way as to obtain the maximum benefit.

Sustainable Transport

Energy efficiency is defined as the use of energy in an optimum manner to achieve the same service that could have been achieved using a common less efficient manner.

Sustainable Transport

• The sustainable transport definition can be best described as any type of transport that does not rely on the world's natural resources to power it.

• Sustainable Transportation refers to any means of transportation that is green and has low impact on the environment.

• Sustainable transportation is also about balancing our current and future needs. Examples of sustainable transportation include walking, cycling, transit, carpooling, car sharing and green vehicles.

• Sustainable Transport is sometimes known as Green Transport and it is any form of transport that does not use or rely on dwindling natural resources. Instead it relies on renewable or regenerated energy rather than fossil fuels that have a finite life expectancy. For this reason it is said to have a low or a negative effect on the environment since it makes use of energy sources that are sustainable.

• Walking, cycling and sailing are excellent examples of sustainable transport.

• The sustainable transport definition can be best described as any type of transport that does not rely on the world's natural resources to power it.

• Sustainable transportation options run on clean fuel, batteries or both. Alternative fuels can be used in flexible-fuel and dual-fuel vehicles as well as vehicles with advanced technology, such as hybrid power systems and fuel cells.

• Alternative fuels help conserve fuel and reduce emissions. They include :

a) Biodiesel

b) Electricity

c) Ethanol

d) Hydrogen

e) Natural Gas

f) Propane

1. Benefits of Sustainable Transport

• Sustainable modes of transportation have several benefits. These include :

1) Reduced traffic congestion

2) Cost savings on fuel and vehicles

3) Reduced greenhouse gas emissions

4) Reduced dependence on non-renewable energy sources

5) Reduced transportation costs

6) Increased physical activity

7) Increased social interaction

8) Support for local businesses and a vibrant economy

9) Healthier lifestyles and a better quality of life

10) Improved accessibility to reliable, affordable transportation options for all.

Sustainable Energy: Non-conventional Sources

The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent.

Sustainable Energy : Non-conventional Sources

• The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent.

• The sources of energy which are being produced continuously in nature and are in exhaustible are called non-conventional energy.

• Non-conventional sources are also known as renewable sources of energy.

• Various forms of renewable energy -

1. Solar energy

2. Wind energy

3. Bio energy

4. Hydro energy

5. Geothermal energy

6. Wave and tidal energy

Carbon Sequestration

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Carbon Sequestration

• Carbon dioxide is the most commonly produced greenhouse gas. Around 45 % of the CO_2 emitted by humans remains in the atmosphere, which is a significant factor behind global warming.

• Carbon sequestration is the process of capturing, securing and storing carbon dioxide from the atmosphere.

• Carbon dioxide (CO_2) Capture and Storage (CCS) is the idea to capture the CO_2 from industrial processes like coal plants and then store it in deep geological formations.

• Carbon sequestration is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

• The idea is to stabilize carbon in solid and dissolved forms so that it doesn't cause the atmosphere to warm. The process shows tremendous promise for reducing the human carbon footprint.

• Carbon sequestration is key method for removing carbon from the earth's atmosphere.

• There are two main types of carbon sequestration :

1. Biological carbon sequestration and

2. Geological carbon sequestration

1. Biological Sequestration

• Biological carbon sequestration happens when carbon is stored in the natural environment. This includes what are known as carbon sinks, such as forests, grasslands, soil, oceans and other bodies of water. This is also known as an indirect or passive form of sequestration.

1. Forests

• Forests and woodlands are considered one of the best forms of natural carbon sequestration. CO_2 binds to plants during photosynthesis, exchanging it for oxygen as a purifying emission.

• On average, forests store twice as much carbon as they emit, while an estimated 25 % of global carbon emissions are sequestered alongside forests in other vegetative forms, such as grasslands or rangelands (fields, prairies, shrub lands etc.).

• Protecting such natural environments is therefore crucial to ensuring carbon sinks capture CO_2 effectively. Deforestation poses the biggest threat to this natural process, as does construction or intensive agriculture.

2. Soil

• Through bogs, peat and swamps, carbon can be captured and stored as carbonates. These carbonates build up over thousands of years as CO_2 mixes with other mineral elements, such as calcium or magnesium.

• Eventually, carbon is released from the earth, but not for a very long time - after more than 70,000 years in some cases.

3. Oceans

• Aquatic environments and large bodies of water are also great absorbers of CO_2 They absorb another estimated 25 % of emitted CO_2 from the earth's atmosphere. This carbon is mostly held in the upper layers of the oceans.

• Too much carbon can acidify the water, posing a threat to the biodiversity that exists below - yet another reason to decarbonise our atmosphere.

2. Geological Carbon Sequestration

• Geological carbon sequestration happens when carbon is stored in places such as underground geological formations or rocks. This process is largely artificial or direct, representing an effective way of neutralising emissions put into human practices, such as manufacturing or construction.

• It's also largely technological as a result, with recent innovations showing carbon being sequestered more effectively on larger scales. They include :

1. Graphene production : The production of graphene requires CO_2 as a raw material. Although limited to certain industries, it's used heavily in the production of the tech devices we use on a day-to-day basis, such smartphones or computer processors.

2. Engineered molecules : A fairly new science, scientists can change the shape of molecules to form new compounds by capturing carbon from the air. In practice, this could present an efficient way of creating raw materials while reducing atmospheric carbon.

3. Carbon Capture and Storage (CCS) : CCS involves capturing carbon dioxide that's been produced by power generation or industrial activity, such as cement or steel-making. This CO-, is then compressed and transported to deep underground facilities, where it's injected into rock formations for permanent storage.

Green Engineering

Green Engineering can be defined as environmentally conscious attitudes, values and principles, combined with science, technology and engineering practice, all directed toward improving local and global environmental quality.

Green Engineering

• Green engineering is the design, commercialization and use of processes and products in a way that reduces pollution, promotes sustainability and minimizes risk to human health and the environment without sacrificing economic viability and efficiency.

• Green Engineering can be defined as environmentally conscious attitudes, values and principles, combined with science, technology and engineering practice, all directed toward improving local and global environmental quality.

• Green engineering utilizes engineering processes and methods that minimize pollution, improve a business' sustainability and decrease the potential for health issues caused by unsafe manufacturing and design methods.

• Green engineering embraces the concept that decisions to protect human health and the environment can have the greatest impact and cost-effectiveness when applied early, in the design and development phase of a process or product.

• Green Engineering is necessarily interdisciplinary and therefore, is best considered as a set of concepts which can be applied across engineering disciplines.

1. Processes in Green Engineering

• Engineers may use many processes when green engineering, including :

1. Waste reduction :

• Many commercial processes, such as manufacturing and shipping products, may waste energy through inefficient manufacturing and delivery methods.

• Green engineering seeks ways to minimize this waste, including finding new fuel methods and minimizing unnecessary production steps that needlessly use energy.

2. Materials management:

• Materials management entails finding better and safer materials for diverse engineering purposes, particularly in product design and manufacturing.

• Engineers may identify new and safer materials or invent options to integrate into their plans and find better and more efficient production methods.

3. Pollution prevention :

• Pollution prevention focuses on identifying a company's pollution sources and minimizing their waste.

• Engineers may identify why pollution occurs, find processing methods that decrease its spread, integrate newer and cleaner techniques and enhance manufacturing and delivery cleanliness.

4. Product enhancement:

• Green engineers seek to improve the products or services they're engineering while making them safer for the environment.

• This process may include finding alternate energy sources that work better than traditional options or identifying greener and more efficient manufacturing materials and methods.

2. Principles of Green Engineering

1. Inherent Rather Than Circumstantial : Designers need to strive to ensure that all materials and energy inputs and outputs are as inherently non-hazardous as possible.

2. Prevention Instead of Treatment : It is better to prevent waste than to treat or clean up waste after it is formed.

3. Design for Separation : Separation and purification operations should be designed to minimize energy consumption and materials use.

4. Maximize Efficiency : Products, processes and systems should be designed to maximize mass, energy, space and time efficiency.

5. Output-Pulled Versus Input-Pushed : Products, processes and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.

6. Conserve Complexity : Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse or beneficial disposition.

7. Durability Rather Than Immortality : Targeted durability, not immortality, should be a design goal.

8. Meet Need, Minimize Excess : Design for unnecessary capacity or capability (e.g., “one size fits all”) solutions should be considered a design flaw.

9. Minimize Material Diversity : Material diversity in multicomponent products should be minimized to promote disassembly and value retention.

10. Integrate Material and Energy Flows : Design of products, processes and systems must include integration and interconnectivity with available energy and materials flows.

11. Design for Commercial Afterlife : Products, processes and systems should be designed for performance in a commercial afterlife.

12. Renewable Rather Than Depleting : Material and energy inputs should be renewable rather than depleting.

3. Cradle to Cradle Concept

• Cradle-to-cradle (C2C) is a way of designing products or processes that work more like natural systems.

• Cradle-to-cradle is a term used in life-cycle analysis to describe a material or product that is recycled into a new product at the end of its life, so that ultimately there is no waste. Zero waste, Zero trash, Zero litter, Zero garbage, Nothing to throw away.

• Cradle to Cradle design refers to a production process where products are developed for closed-loop systems in which every output ingredient is safe and beneficial - either to biodegrade naturally and restore the soil (called a biological nutrient) or to be fully recycled into high-quality materials for subsequent product generations (called a technical nutrient).

• C2C design method is intended to replace a make-take-dispose approach which begins with new raw materials mined from the earth and ends with piles of garbage.

• C2C is used to minimise the environmental impact of products by employing sustainable production, operation and disposal practices and aims to incorporate social responsibility into product development.

Urbanization

Urbanization is a process of moving population from rural areas to urban areas for improving life standards and life style through scientific and technological developments.

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• Urbanization is a process of moving population from rural areas to urban areas for improving life standards and life style through scientific and technological developments.

• The energy related problems due to urbanization include -

1. Pollution from coal: The use of coal pollutes the environment.

2. Acid rain : Various industries are releasing harmful gases like sulphur oxides, nitrogen oxides which reacts with water or moisture in the environment produces sulphuric acid.

3. Pollution from vehicle : The exhausts from two-wheeler, four wheeler and other transport vehicles produces huge level of air pollution.

4. Deforestation : Human needs space to live hence this requirement is fulfilled by deforestation and building houses. Even after this human needs wood for house furniture and timber as fuel.

5. Global warming : Combustion of fossil fuels (oil, petrol, diesel, gas) produces harmful gases, which acts as green house i.e. short wave and natural light can pass but traps heat radiation hence overall environment temperature rises.

6. Use of electricity : Large amount of electricity is utilized for human comforts like - A/C, washing machine, refrigerator, water heater etc. Hence, electricity requirement is increasing day by day.

1. Solution for Urban Energy Problem

1. Use of public transport instead of using private vehicles.

2. Reducing energy consumption in all respect.

3. Using energy efficient devices.

4. Encourging use of solar and wind energy.

5. Imposing strict laws, penalties and energy audits.

Low Carbon Life Cycle

Low carbon lifestyles create less carbon dioxide emissions.

Low Carbon Life Cycle

• Low carbon refers to a minimal output of greenhouse gas emissions into the biosphere, specifically refers to the greenhouse gas carbon dioxide. So, low carbon life means a kind of lifestyle in which people do their best to reduce energy consumption and carbon greenhouse gas emissions. Low carbon economy is an economy model based on low energy consumption, low pollution and low emission.

• Low carbon lifestyles create less carbon dioxide emissions. Activities that create carbon dioxide are driving cars, heating homes, generating electricity, flying planes, making goods in factories and transporting things a long way.