UNIT-III	4 Hours
Sustainable Practices	
Zero waste and R concept - concept of 5R (Refuse, Reduce, Reuse, Repurpose, Recycle), Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings and rating system in India, Green materials, Energy efficiency, **Sustainable transports, Sustainable energy:** Non-conventional Sources, Energy Cycles carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization Socioeconomical and technological change	

Sustainable Practices: Notes

1. Zero Waste and the 5R Concept

• **Zero Waste**: A philosophy aiming to minimize waste generation by redesigning resource life cycles to ensure all products are reused, avoiding landfills or incinerators.

• **5R Concept** (Refuse, Reduce, Reuse, Repurpose, Recycle):

• **Refuse**: Decline unnecessary items (e.g., single-use plastics).

• **Reduce**: Minimize resource use (e.g., buying in bulk to reduce packaging). •

Reuse: Use items multiple times (e.g., reusable water bottles).

• **Repurpose**: Transform items for new uses (e.g., turning glass jars into storage containers).

• **Recycle**: Process materials into new products (e.g., recycling paper into cardboard).

Examples:

• **Refuse**: Saying no to plastic straws in cafes (e.g., Starbucks' straw-less lids initiative). •

Reduce: Using energy-efficient appliances to lower electricity consumption.

• **Reuse**: Cloth bags for grocery shopping in India (e.g., Dabbawala reusable tiffin systems).

• **Repurpose**: Converting old tires into garden planters.

• **Recycle**: India's Swachh Bharat Mission recycling programs for plastic waste.

Diagram: *5R Hierarchy Pyramid*

• A triangular pyramid with five layers, from bottom (broadest) to top (narrowest): •

Bottom: Refuse (largest impact, prevents waste).

• Next: Reduce (minimize waste generation).

• Middle: Reuse (extend product life).

• Next: Repurpose (creative reuse).

• Top: Recycle (last resort, resource recovery).

• Arrows loop from top to bottom, indicating preference for higher-impact strategies. •

Benefits:

• Reduces landfill waste and pollution.

• Conserves resources and lowers carbon footprint.

2. Circular Economy

• **Definition**: An economic system that eliminates waste by keeping resources in use through closed-loop systems.

• **Key Principles**:

• Design products for durability, reuse, and recyclability.

• Extend product lifespans via repair and sharing.

• Regenerate natural systems using renewable resources.

• **Examples**:

• **India**: Amul's cooperative model reuses milk containers and promotes sustainable dairy practices.

• **Global**: Patagonia's Worn Wear program repairs and resells used clothing. •

Local: Mumbai's Dabbawalas use reusable tiffins, reducing packaging waste.

Diagram: *Circular Economy Loop*

• A circular flowchart with arrows connecting:

• Raw Material Extraction → Product Design → Manufacturing → Use → Repair/Reuse → Recycling → Back to Raw Materials.

• A parallel "Linear Economy" line (Take → Make → Dispose) contrasts with the circular loop, showing waste output.

Contrast with Linear Economy:

• Linear: Extract, produce, discard.
• Circular: Continuous resource cycles, minimizing waste.

3. ISO 14000 Series

• **Overview**: International standards for environmental management systems (EMS) to reduce environmental impact.

• **Key Standards**:

• **ISO 14001**: Requirements for EMS implementation.

• **ISO 14004**: Guidelines for EMS.

• **ISO 14040-14044**: Life Cycle Assessment (LCA) standards.

Examples:

• **Tata Steel, India**: ISO 14001 certified for reducing emissions in steel production. •

Infosys: Uses ISO 14001 to manage energy and water use in IT campuses. •

Diagram: *ISO 14001 EMS Cycle*

• A Plan-Do-Check-Act (PDCA) cycle:

• **Plan**: Set environmental goals (e.g., reduce emissions by 10%).

• **Do**: Implement green practices (e.g., energy-efficient machinery). •

Check: Monitor performance (e.g., track carbon footprint).

• **Act**: Adjust strategies based on results.

• Arrows connect each stage in a continuous loop.

Applications:

• Certifies eco-friendly practices.

• Reduces resource waste and ensures regulatory compliance.

4. Material Life Cycle Assessment (LCA)

- **Definition**: A method to evaluate a product's environmental impact across its life cycle, from extraction to disposal.

- **Stages**:

- **Goal and Scope**: Define assessment purpose (e.g., compare plastic vs. jute bags). •

Inventory Analysis: Quantify inputs/outputs (e.g., energy, emissions).

- **Impact Assessment**: Measure effects (e.g., global warming potential). •

Interpretation: Recommend sustainable alternatives.

  Examples:

- **India**: LCA of jute bags vs. plastic bags, showing jute's lower environmental impact due to biodegradability.

- **Global**: LCA of electric vs. petrol cars, favoring EVs for lower lifecycle emissions.

  Diagram: *LCA Process Flow*

- A linear flowchart:

- Raw Material Extraction → Manufacturing → Distribution → Use → End-of-Life (Recycling/Disposal).

- Each stage has arrows indicating inputs (e.g., energy) and outputs (e.g., CO_2 emissions).

- A feedback loop from End-of-Life to Raw Materials highlights recycling.

  Applications:

- Guides eco-friendly product design.

- Supports corporate sustainability reporting.

  5. Environmental Impact Assessment (EIA)

- **Definition**: A process to assess environmental impacts of proposed projects before implementation.

- **Key Steps**:

- **Screening**: Determine if EIA is needed (e.g., for a new highway). •

Scoping: Identify key issues (e.g., impact on local biodiversity). • **Impact**

Analysis: Quantify effects (e.g., air pollution from construction). •

Mitigation: Propose solutions (e.g., green buffers to reduce noise). •

Reporting: Submit EIA report to authorities.

• **Monitoring**: Track impacts post-implementation.

Examples:

• **India**: EIA for Navi Mumbai International Airport, addressing wetland conservation.
• **Global**: EIA for wind farms, mitigating bird migration impacts.

Diagram: *EIA Process Flowchart*

• A sequential flowchart:

• Screening → Scoping → Impact Analysis → Mitigation → Reporting → Monitoring.

• Arrows connect each step, with a feedback loop from Monitoring to Scoping for iterative improvement.

Importance:

• Ensures sustainable project development.

• Mandated in India under the Environment Protection Act, 1986.

6. Sustainable Habitat

• **Green Buildings and Rating Systems in India**

• **Definition**: Buildings designed for minimal environmental impact via energy efficiency and sustainable materials.

• **Rating Systems**:

• **GRIHA**: Evaluates energy, water, and waste management (e.g., Infosys Hyderabad campus, 5-star GRIHA-rated).

• **IGBC**: LEED India certification (e.g., ITC Green Centre, Gurugram, Platinum-rated). • **BEE**

Star Rating: Rates energy performance (e.g., 5-star-rated government buildings).

Examples:

• **CII-Sohrabji Godrej Green Business Centre, Hyderabad**: Uses solar power and rainwater harvesting.

• **Suzlon One Earth, Pune**: Zero-energy building with 100% renewable energy.

Diagram: *Green Building Components*

• A labeled building diagram showing:

• Solar panels on the roof.

• Rainwater harvesting system.

• Green walls/roof for insulation.

• Energy-efficient windows and LED lighting.
• Recycling bins for waste segregation.

Green Materials

Examples: Bamboo flooring, fly ash bricks, recycled steel, low-VOC paints.

Case Study: Fly ash bricks used in Delhi's Eco Park construction, reducing cement use by 30%.

• **Energy Efficiency**

• **Strategies**: LED lighting, passive cooling, solar panels.

• **Example**: Bengaluru's T-Zed homes use 50% less energy via natural ventilation and insulation.

7. Sustainable Transport

• **Definition**: Transport systems reducing emissions and promoting accessibility. •

Key Approaches:

• **Public Transport**: Delhi Metro reduces CO_2 by 6.3 lakh tons annually. •

Electric Vehicles: Tata Nexon EV adoption in India under FAME II scheme. •

Non-Motorized: Cycle tracks in Chandigarh.

• **Shared Mobility**: Ola/Uber pooling services.

Diagram: *Sustainable Transport Ecosystem*

• A circular diagram with a city at the center, connected to:

• Metro/Bus (public transport).

• EV charging stations.

• Bicycle lanes.

• Carpooling hubs.

• Arrows show reduced emissions flowing outward.

• **Benefits**:

• Lowers air pollution and fuel dependency.

• Enhances urban mobility.

8. Sustainable Energy
• **Non-Conventional Sources**

• **Solar**: Rooftop solar in Gujarat (e.g., 600 MW installed capacity). •

Wind: Tamil Nadu's wind farms (8 GW capacity).

• **Biomass**: Punjab's biomass plants using agricultural waste.

• **Hydropower**: Small hydro projects in Himachal Pradesh.

• **Energy Cycles**

• **Carbon Cycle**:

• Natural: CO_2 absorbed by plants, released by respiration/decomposition. •

Disrupted by fossil fuel burning, increasing atmospheric CO_2.

• **Emission and Sequestration**:

• **Emission**: Coal plants in India contribute 60% of CO_2 emissions. •

Sequestration: Afforestation in Aravalli hills; CCS in NTPC plants.

Diagram: *Carbon Cycle*

• A cycle diagram showing:

• Atmosphere → Plants (photosynthesis) → Soil/Animals → Atmosphere
   (respiration/decay).

• Human activities (factories, vehicles) add CO_2; sequestration (forests, CCS) removes
   it.

• **India's Goal**: Net-zero emissions by 2070.

9. Green Engineering

• **Definition**: Engineering for sustainable systems and processes. •

Sustainable Urbanization:

• **Socioeconomic**: Smart cities like Bhubaneswar with waste-to-energy plants.

• **Technological**: IoT-based smart grids in Surat; 3D-printed affordable housing in Chennai.

Examples:

• **Amaravati Smart City**: Uses green infrastructure like permeable pavements. •

IIT Madras: Research on low-carbon concrete for sustainable construction.

Diagram: *Smart City Framework*

• A city map with labeled zones:

• Solar-powered buildings.

• Smart traffic signals.

• Urban forests and green roofs.

• Waste recycling centers.

• Arrows show connectivity via IoT networks.

Benefits:

• Reduces urban environmental impact.

• Creates green jobs and resilient cities.

Key Takeaways

• **5R and Circular Economy**: Core strategies for waste reduction and resource efficiency.

• **ISO 14000, LCA, EIA**: Tools for environmental accountability. • **Sustainable**

Habitat/Transport/Energy: Practical solutions for low-carbon living. • **Green**

Engineering: Drives innovation for sustainable urban futures. • **Diagrams Summary**

(for visualization):

• 5R Pyramid: Prioritizes waste prevention.

• Circular Economy Loop: Contrasts with linear model.

• ISO 14001 PDCA: Continuous EMS improvement.

• LCA Flow: Tracks product impacts.

• EIA Flowchart: Project assessment process.

• Green Building: Sustainable design elements.

• Sustainable Transport: Urban mobility ecosystem.

• Carbon Cycle: Natural and human impacts.

• Smart City: Integrated green technologies.

References:

• GRIHA Council: www.grihaindia.org

• IGBC: www.igbc.in

• MNRE, India: mnre.gov.in

• ISO: www.iso.org

• Swachh Bharat Mission: swachhbharatmission.gov.in