

MCN-201 :

SUSTAINABLE ENGINEERING

Module 5

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Module 5

Sustainability practices:

- ❑ Basic concept of sustainable habitat
- ❑ Methods for increasing energy efficiency in buildings
- ❑ Green Engineering
- ❑ Sustainable Urbanisation
- ❑ Sustainable cities
- ❑ Sustainable transport.

1. Basic concept of sustainable habitat

sustain = Maintain

Habitat = Natural home for one or more species.

- A sustainable habitat is an **ecosystem** that produces food and shelter for people and other organisms, **without resource depletion** and in such a way that no external waste is produced.
- Thus the habitat can **continue into the future** without **external inputs** of resources.
- Such a sustainable habitat may evolve naturally or be produced under the influence of man.

- ❖ A sustainable ecosystem is the achievement of a **balance** between **economic** and **social development** of the human ecosystem along with environmental protection, housing, basic services, social infrastructure and transportation.
- ❖ A stable habitat is necessary to ensure that **one species' waste becomes another species' energy or food source.**
- ❖ It involves preserving ecological balance based on a **symbiotic perspective on urban development** while **developing urban extensions of existing towns.**

For maintaining our natural habitat(Earth),

we should:-

- 1. Promote energy efficiency**
- 2. Promote the use of eco-friendly fuels. (e.g. LPG,CNG, etc.)**
- 3. Better manage municipal solid waste**
- 4. Better manage the sewage disposal system**
- 5. Promote public transport**

PROMOTE ECO-FRIENDLY FUELS

- Eco-Friendly fuels include LPG and CNG
- These fuels emit a smaller amount of carbon monoxide (CO) per joule.
- They are considered to burn cleanly. Therefore, the use of such fuels help reduce air pollution. This helps in sustaining our habitat.
- Use Biofuels like biodiesel



BETTER SEWAGE DISPOSAL SYSTEM

- ❖ A proper sewage disposal system helps in sustaining our habitat.
- ❖ The sewage is disposed off into a nearby river.
- ❖ The river thus gets polluted and the marine life, depleted. This leads to loss in biodiversity.
- ❖ Loss in biodiversity destroys man's habitat and ultimately man himself.



BETTER PUBLIC TRANSPORT

- Using public transport reduces the carbon emissions in the environment.
- Many people travel together in the modes of public transport(i.e. bus, trains, etc.).
- If a condition arises that all the people travelling by bus use their own vehicles instead, the carbon emissions will be higher.



2. Methods for increasing energy efficiency in buildings

- ❖ Keeping energy consumption down is one of the biggest challenges that facilities managers face. The need for reduced energy waste is not only driven by economic factors, but by an increased focus on sustainability. By optimizing the energy usage in your buildings, you can improve your bottom line and dramatically reduce your carbon footprint.

A. Reduce the Need for Heating and Ventilation

- ❖ Based on research from the US Department of Energy, heating, ventilation and air conditioning (HVAC) represent **a total of 35% of total building energy**. Luckily, there are several measures you can take to reduce energy consumption in these areas.
- ❖ The first step is to get **control of the temperature in your buildings**. Unless you know when and where the air conditioning should be on, it will be impossible to optimize energy usage. Once you have control of the temperature in your facilities, you can start taking action. Key opportunities include:

- **Replacing old windows** with energy-conserving windows. Energy conserving glass reduces heat loss through windows while allowing more heat from the sun to enter the building.
- Using **high-efficiency heat pumps** that can eliminate the use of refrigerants. This is a long-term investment, but one that pays off. It's also a far more sustainable option than a regular heat pump. Using high-efficiency heat pumps instead leads to a more favorable bottom line and fewer greenhouse gas emissions.
- **Ensuring proper insulation in the building.** A building should be insulated continuously around the thermal boundary. The insulating material should have a suitable thermal resistance for the climate zone where the facility is located. According to recent studies, the use of the most efficient wall, window, and HVAC equipment could reduce commercial cooling by 78%.

B. Optimize your Light Sources

- ❖ Lighting is the second most energy-consuming source in facilities. While lighting represents approximately **11% of the energy usage in American buildings**, this percentage will vary from country to country.
- ❖ Some countries, for example, **Australia**, are further ahead in adapting LED lighting as a standard. According to research from Statista, the global LED lighting market is on track to grow almost 30% between 2020 and 2023.
- ❖ And with good reason: **replacing your lighting with LED lighting** can reduce your energy use by up to **75%** compared to incandescent lighting.

C. Use Smart Technology to Optimize Energy Usage

- ★ Today, there are numerous technology solutions that can help you continuously measure and optimize your energy consumption.
- ★ One of the key research opportunities that the US Department of Energy has identified is utilizing “**low cost, easy to install, energy harvesting sensors and controls**”.

Every action can make a difference! **By reducing the need for HVAC, optimizing your light sources and using smart technology**, you will increase your energy efficiency in no time.

3. Green Engineering

- ❖ Green engineering approaches the design of products and processes by applying financially and technologically feasible principles to achieve one or more of the following goals:
 1. **decrease in the amount of pollution** that is generated by a construction or operation of a facility
 2. **minimization of human population exposure** to potential hazards (including reducing toxicity)
 3. **improved uses of matter and energy** throughout the life cycle of the product and processes.
 4. **maintaining economic efficiency and viability.**
- Green engineering can an guiding principle framework for all design disciplines.**

12 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

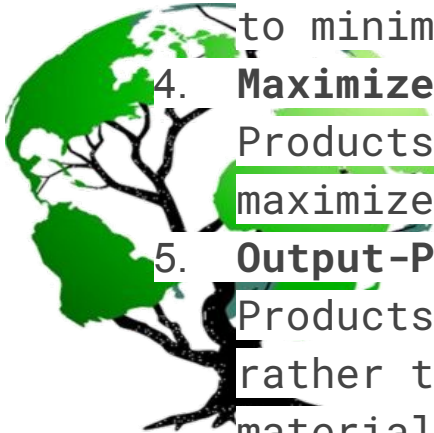
Separation and purification operations should be designed to minimize energy consumption and materials use.

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.

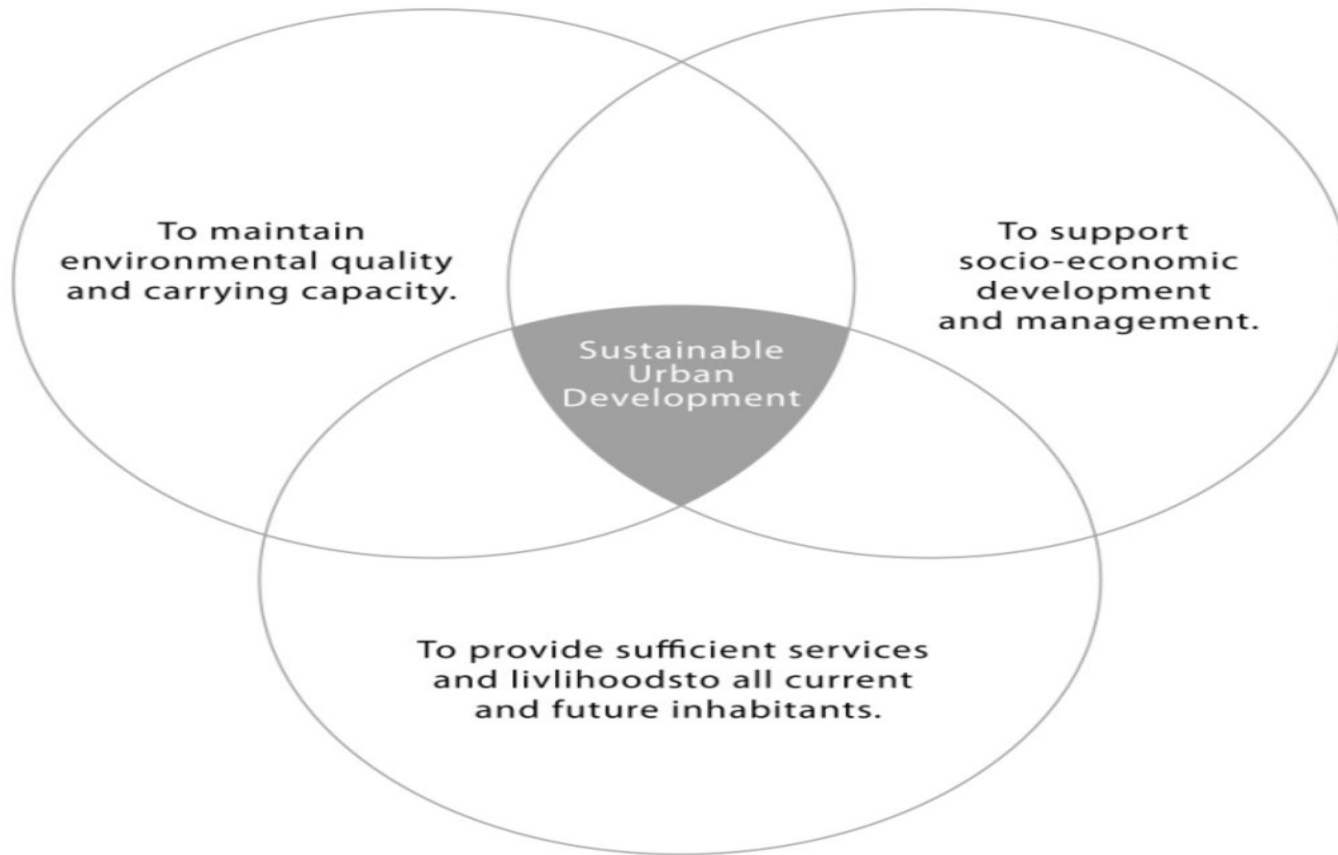
4. Sustainable Urbanisation

- ★ Sustainable urbanism is both the study of cities and the practices to build them (urbanism), that focuses on promoting their long term viability by reducing consumption, waste and harmful impacts on people and place while enhancing the overall well-being of both people and place.



Goal of Sustainable Urbanization

- ❖ **Industries(existing and upcoming) should switch to clean and renewable energies as far as possible.**
- ❖ **Appropriate development of the existing basic urban infrastructure to provide water, sanitation & housing for urban residents.**
- ❖ **Monitoring and improving air quality in built environment and cities.**
- ❖ **Energy efficient buildings in the construction sector makes cities to reduce carbon emissions.**
- ❖ **City transport has to be planned properly to reduce carbon emissions.**
- ❖ **Practice of sustainable water harvesting and management.**



Sustainable urban development—defined as capability in three aspects

Positive Effects of Urbanization:

- Creation of employment opportunities
- Technological and infrastructural advancements
- Improved transportation and communication
- Quality educational and medical facilities
- Improved standards of living

Negative effects of urbanisation:

- Population increase causes housing problems.
- Overcrowding
- Unemployment
- Development of Slums
- Water and Sanitation Problems
- Poor Health and Spread of Diseases
- Traffic Congestion
- Urban Crime

5. Sustainable cities

- ❖ A sustainable city **enhances the economic, social, cultural and environmental well-being** of current and future generations
- ❖ These **can be pre-existing cities** that feature management directed towards reducing the inputs of energy, water and food and reducing the outputs of heat, water and air pollution, or they **can be cities designed from scratch** with these concerns in mind.

Characteristics of Sustainable Cities

- ❑ **Planned housing colonies** with adequate infrastructure like schools, parks, drainage system, local Medicare establishments.
- ❑ Effective **environmental infrastructure** to address the issues of untreated sewage and waste polluting rivers, lakes and coastal zones
- ❑ **Adequate governance set-up** which can meet the needs of the people and ensures civic responsibilities, transparency and equity in local institutions
- ❑ A **controlled population** for whom adequate, meaningful employment is available

- ❑ **Empowerment of women** and encouraging their participation in the political, social and economic life of a city and adoption of urban policies that take into account women's needs and initiatives
- ❑ An **efficient health-care system** which would also address issues of nutrition, family planning and sanitation
- ❑ Development of an **efficient urban private sector**, both formal and non-formal which reduces poverty by generating jobs and helping in economic growth
- ❑ Better use of **solar energy and shade trees** to reduce the use of resources

Top 5 sustainable cities

1. **Copenhagen, Denmark** -
Turning waste into power and profit.



2. **Frankfurt, Germany** -
Harnessing teamwork to innovate faster.



Top 5 sustainable cities

3. **San Francisco, US** -
Focusing on local production to offer global savings.
4. **Reykjavík, Iceland**-
Collaborating to unlock cheaper renewable energy.
5. **Singapore** - *Harnessing greener designs that work for people and the planet.*



6. Sustainable transport

SUSTAINABLE DEVELOPMENT

Sustainable Transportation

Modes

Infrastructures

Operations

Society

Safety
Health
Disturbance
Access
Opportunity

Economy

Materials and energy
Growth
Employment
Pricing
Competitiveness

Environment

Climate change
Air quality
Noise
Footprint
Waste

Core SDGs

3

Health and wellbeing

9

Industry and infrastructure

11

Sustainable cities

Secondary SDGs

7

Energy systems

13

Climate change

8

Work and economic growth

14

Water ecosystems

12

Consumption and production

15

Land ecosystems

- ➔ The concept of sustainable transportation is linked with the development of **sustainable transport modes, infrastructures, and operations**. Three major dimensions are considered:
 - ❖ **Environment**. A reduction of the environmental impacts of transportation is a likely strategy for sustainability.
 - Transportation contributes to **harmful emissions, noise, and climate change**.
 - Transportation systems are also **waste generators** that must be reduced, reused, and recycled.
 - ❖ **Economy**. Transportation is a factor in economic growth, development, and employment. It requires materials for modes and infrastructure and energy for operations, which can be used more efficiently.
 - ❖ **Society**. Sustainable transportation should benefit society, and it should be safe, not impair human health, and should minimize disturbance in communities.

- ❑ Sustainable transportation fits within the sustainable development goals (SDG).
- ❑ Some SDGs are core to sustainable transportation, such as:
 - ❑ (3) **Health and wellbeing**. Ensuring transportation safety and the provision of opportunities through improved mobility.
 - ❑ (9) **Industry and infrastructures**. Supply chains and the mobility of passengers and freight.
 - ❑ (11) **Sustainable cities**. Urban mobility and logistics.

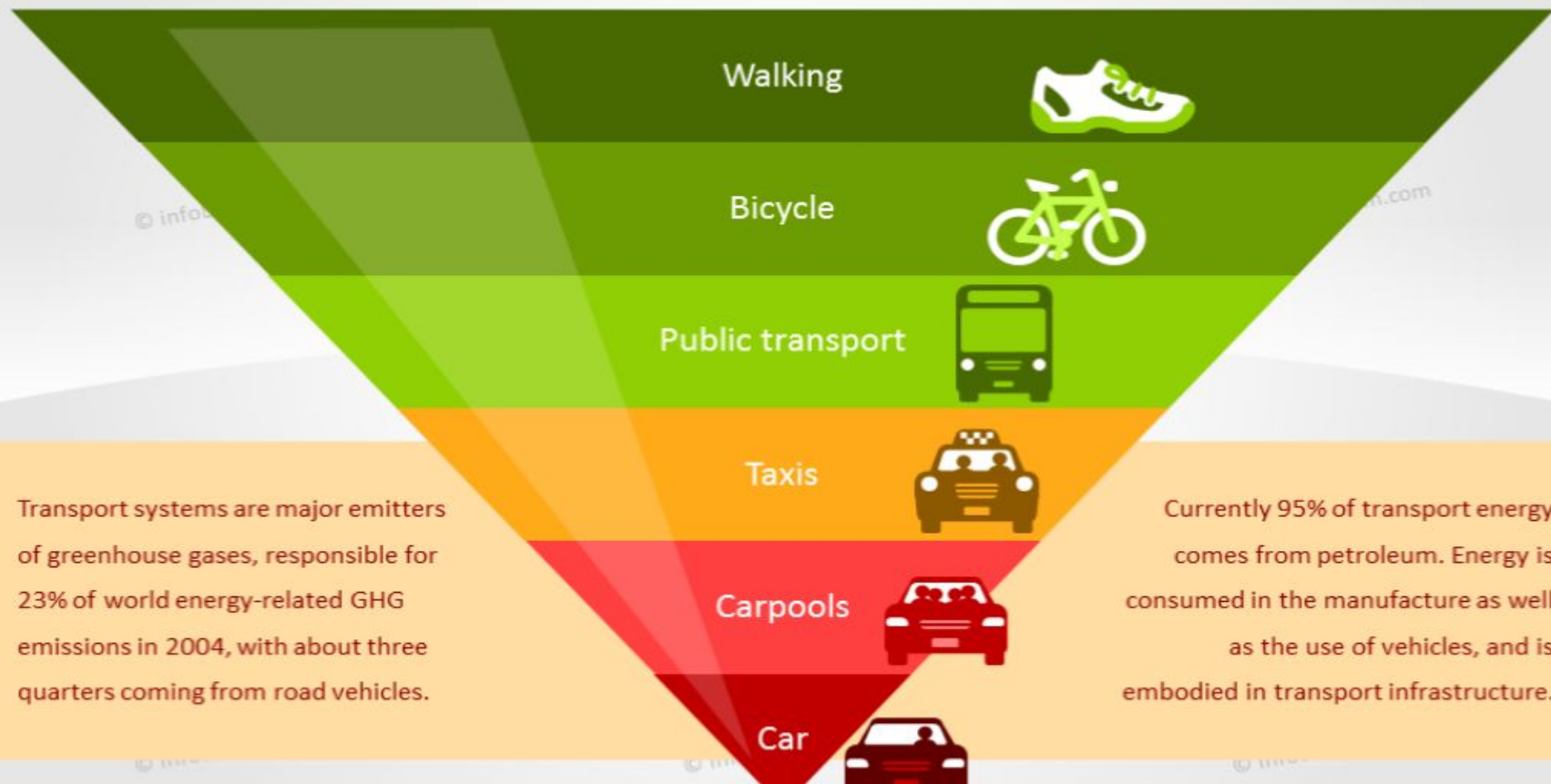
- ❖ Other SDGs are more secondary to sustainable transportation, including
 - energy systems
 - work and economic growth
 - consumption and production
 - climate change
 - water ecosystems, and
 - land ecosystems.

Benefits

Leaving your car at home and taking more sustainable modes of transportation will provide benefits for yourself and the City. These include:

- Reduced traffic congestion
- Reduced air pollution and related risks such as asthma
- Reduced greenhouse gas emissions
- Reduced dependence on non-renewable energy sources
- Reduced transportation costs
- Increased physical activity
- Increased social interaction
- Healthier lifestyles and a better quality of life

Green Transportation pyramid



Transport systems are major emitters of greenhouse gases, responsible for 23% of world energy-related GHG emissions in 2004, with about three quarters coming from road vehicles.

Currently 95% of transport energy comes from petroleum. Energy is consumed in the manufacture as well as the use of vehicles, and is embodied in transport infrastructure.