Green Technology

- It is a technology which is environmentaly friendly developed and used in such a way that it doesn't disturb our environment and conserves natural resources.
- It is also known as environmental technology and clean technology.

→ Scope of Green Technology:

- Green technology is a system that uses innovative methods to create an environmental friendly products.
- It uses renewable natural resources that never depletes, so future generation can also get benefit from it.
- It can effectively change waste pattern and production in a way that it won't harm the planet.

Sustainable development: It is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend.

- The desired result is a state of society where living conditions and resource use continue to meet human needs without undermining the integrity and stability of the natural system.
- Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations.

Goals of green technology:

(1) Reduce
(2) Reuse Recycle
(3) Refuse
(4) Renew
(5) Responsibility.

(1) Reduce — Fuels
waste
Energy consumption
Wastage of clean water

(2) Recycling - Paper
plastic
Cans
Batteries
Clothing.

(3) Renewing - Renewing energy:
wind power
water power
solar Energy
Biofuel
Waste water.

(4) Refuse - Refuse the use of plastic bags, plastic things, things harmful for environment.

(5) Responsibility:
Don't waste electricity
Don't waste water
Don't waste fuel
Don't waste food.

Branches of green technology:

(1) Green chemistry.
(2) Green Energy.
(3) Green I.T
(4) Green Building.
(5) Green Nanotechnology.

Green chemistry:

- The term green chemistry was coined by Paul Anastas in 1991.
- Also called sustainable chemistry.
- This includes the invention, design and application of chemical products and processes to reduce or to eliminate the use of hazardous substances.

(1) Super critical carbon dioxide:

- It is a fluid state of CO_2 where it is held above its critical temp and critical pressure.
- CO_2 usually behaves as a gas in air at standard temp and pressure (STP) or as a solid called dry ice when frozen.

- It behaves as a supercritical fluid above its critical temperature (304.25K) and critical pressure (72.9 atm).

uses: (194.7K)

- In laboratories, supercritical CO_2 is used as an extraction solvent.
  ex: In determination of total recoverable hydrocarbons from soils, sediments, fly ash, and other media.
- Super critical CO_2 is used to remove organichloride pesticides from agricultural crops without adultering the desired constituents from plant matter in the herbal supplement industry.
  - eg: DDT, Dicofol, Aldrin etc.
- Supercritical CO_2 can also be used as a more environmentally friendly solvent for dry cleaning. (perchloro ethylene or tetrachloro ethylene, PERC).

principles of green chemistry:

- Prevent waste (hazardous waste generation)
- Less hazardous chemical syntheses
- Safer chemical and products.
- Safer solvents and reaction conditions.
- Increase energy efficiency.

Design for Environment: (Environmental Protection Agency, US)

EPA's Design for Environment (DfE) works on partnership with industry, environmental groups and academia to reduce risk to people and the environment by finding ways to prevent pollution.

- DfE has evaluated human health and environmental concerns associated with traditional and alternative chemicals and processes in a range of industries.
- EPA allows safer products to carry the Design for the Environment (DfE) label. This label enables consumers to quickly identify and choose products that are safer for them.
- When you see the DfE logo on a product it means that the DfE scientific review team has screened each ingredient for a potential human health and environmental effects.
- Green circle - chemical is safe to use and it doesn't cause any harm to human health and environment.
  eg: Citric acid.
- Green half circle - The chemical is expected to be of low concern based on experimental and modeled data.
  eg: Aspartic acid, Monosodium-D-glucoheptone
- Yellow triangle - This chemical has some hazardous material.
  eg: Terpinolene, methyl benzoate.
- Grey square - This chemical will not be acceptable for use in products.
  eg: Sodium sulfosuccinate
  Benzyl alcohol.

Green Energy

- Green energy comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat.
- These energy resources are renewable.

Types of green Energy :

Solar power
Wind power
water power
Geothermal energy
Biofuel
Biogas

① Solar power :

- Conversion of sunlight into electricity, either directly using photovoltaics (PV) or indirectly using concentrated solar power (CSP).
- Can be used for pumping water, refrigerator, communication and charging batteries.
- In 1955 the first solar car was invented by William G. Cobb called sunmobile.
- Samsung India launched first solar powered phone, the 'Solar Guru 1107' which allows users to charge the phone anywhere and 1 hour of solar charging gives 5 to 10 minutes of time to talk.
- Solar road :
Netherlands on 12/11/14 unveiled the world's first solar bike path. It is made of concrete modules each measuring 2.5 by 3.5 m embedded with solar panels covered in tempered glass. To prevent accident the glass has been given a special non-slip surface.

② Wind Power :

- Wind turbines converts the kinetic energy into mechanical power that runs a generator to produce electricity.
- wind energy contributes only 1% of global electricity generation
- The amount of electricity produced by one turbine depends on its size and quality of wind resources.
- A typical 2-megawatt turbine, when placed in an appropriate wind resource, can provide enough emission free electricity to power about 500 avg homes for a full year.

③ water power :

- Hydroelectricity uses the energy of running water to make electrical energy.
- Hydroelectric stations are built where there is running water is stored and the amount of electricity generated is determined by the volumes of water and the amount of 'head' (height from the turbines in the powerplant to the water surface) created by the dam.
- The greater the flow and head, the more electricity is produced.

④ Wave power / Tidal power :

- Waves are generated by the wind as it blows across the sea surface. Energy is transferred from the wind to the waves.
- Wave energy has the potential to be one of the most eco friendly forms of electricity generation.
- The first tidal power station was the Rance tidal power plant at La Rance France, it took 6 years to complete (1960 - 1966).

→ The pelamis is an offshore wave energy converter that uses the motion of waves to generate electricity.

- The machine operates in water depths greater than 50 m and is typically installed 2 - 10 km from the coast.
- On average one machine will provide sufficient power to meet the annual electricity demand of approximately 500 homes.

⑤ Geothermal Energy :

- The Greek word 'geo' means the earth and therm means heat from the earth.
- So geothermal energy is energy derived from the heat of the earth.
- Energy from volcanic eruption

⑥ Bio fuel and Bio gas :

- Fuel made from biological sources like straw, wood, wood waste, sugarcane and by products from agriculture industry.
  Ex: corn, sugarcane, soybean etc.
- In bio-gas plant waste from human and animals can be converted into fuel gas.

Green IT :

- Also called green computing, it describes the study and the using of computer resources in an efficient way.
- Green IT starts with manufactures producing environmental friendly products and encouraging IT departments to conseder more friendly options like virtualization, power management and proper recycling habits.

Green Building

- Green building is the practice of increasing the efficiency of buildings and their use of energy, water and materials and reducing building impacts on human health and environment through better design, construction, operation and maintenance.

→ Materials used for green building :

- less volatile organic compounds paint.
- Bambo flooring.
- Woven wool for carpenting.
- Ecological concrete (special admixture, dicalcium silicate $2CaO.SiO_2$)

- Proper insulation panel.

Famous Green Buildings of the world :

① Bahrain world Trade center, Manama
- First skyscraper in the world to integrate wind turbines into its design.
- The turbines supply 15% of the electricity used by the skyscraper (approx same amount of electricity used by 300 homes).

② Skyscraper Farming :
- Process of convertion of skyscrapers into crop farms that could help reduce global warming, improve the urban environment and help feed the world's growing population.
- Sonal panel - Energy is supplied by a rotating solar panel that follows the sun, drives interior heating/cooling system.
- Glass panel - clear coating of titanium oxide collects pollutants and makes rain slides down the glass where it is collected and used for watering.
- Architecture - Circular design allows maximum light into center.
- Economy - The plan combines farming with office and residential stories.
- Irrigation - Filtered, sterilized wastewater from sewage system can be used for irrigation.

③ National Library, Singapore :
- Building is oriented away from the east-west sun, combined with sun shading features on the west face of the building as an additional shield against solar heat gain.
- An open area bet° 2 blocks, which allows natural ventilation and day lighting.
- Extensive landscaping, and roof gardens are utilized to ~~local~~ lower local ambient temp.
- Use of rain sensors as part of the automatic irrigation system for rooftop gardens.

④ Resedence Antilia, Mumbai :
- Designed by perkins in 2010.
- Design is innovative with rooftop gardens.

⑤ India Tower, Mumbai :
- Solar shading, natural ventilation, day lighting, rainwater harvesting are used in this building.

LEED Rating :

The U.S Green Building Council (USGBC) created a program called : Leadership in Energy and Environmental Design (LEED).
- Five key areas :

Sustainable site development
water savings
Energy efficiency.

Material selection,
Indoor environmental quality

→ The certification process:

certified : 29 - 36 points
silver : 37 - 43 points
Gold : 44 - 57 points
platinum : > 57 points

(1) The building construction site
(2) Environmental concerns in architectural planning
(3) Energy conservation and its better management.
(4) Water conservation
(5) waste management
(6) Social relevance

Measures to be taken for Green City:

Green City; A city that promotes energy efficiency and renewable energy in all its activities, extensively promotes green solution, applies land compactness with mixed land use and social mix practices in its planning systems and anchors its local development in the principles of green growth and equity.

→ Important considerations for green city:

- Good urban planning is necessary.
- Being located in an area of natural beauty helps,
- It's not just about saving the planet, going green drives revenue for a city, there is money to be made in sustainable manufacturing and services,

Best practices of green cities:

Becoming a green city is more complicated than just good urban planning and stricter codes.

(1) Ambitious, well defined goals and regular reporting of progress.
(2) Electricity generation using renewable resources,
(3) Strict building codes favouring green technology.
(4) Investment in public transportation
(5) Efforts and policies to cut waste, reduce water consumption,
(6) Encourage knowledge-based, creative economies,

(7) Access to affordable, healthy food.

(8) City government who leads by example.

(9) Encourage grass roots efforts to engage citizens.

(10) Reprogramming space (repurposing and densifying use of existing urban land rather than building out, and by designing buildings in a way that allows them to switch functions) (Zoning law)

(11) An internet of pipes (clean, readily available water supplies are a growing concern for growing cities. Efforts to meet future needs include a variety of internet-based innovations aimed at managing water challenges such as flood control, rainwater management, supply distribution, pipe leakage reduction and sanitation management.

(12) Twitter for trees: (Urban trees help reduce temp extremes, moderate storm water surges, sequester carbon and capture nutrients from runoff.
Melbourne is boosting interest in and appreciation for urban forests by inviting its residents to adopt and name individual trees and share updates, including carbon offset and other information via social media.

(13) Augmented Humans (people-powered transit not only helps make cities cleaner and less congested, it also boost human health and well-being (Bicycling.

(14) Co-heating, co-cooling, CO_2 capture.
Cco-generation facilities boost energy efficiency by taking waste heat from electricity generation and using it to heat or cool buildings.
The CO_2 generated in the process can be captured and used for horticulture, manufacturing or other process.

(15) Sharing spare capacity:
Carpooling, Bikepooling, lodging rental and shared ownership, co-locating enterprises to allow them to share facilities such as gyms or classrooms.

(16) Mobility on demand:
- Computer based and smartphone assisted traffic management and vehicle routing can reduce time and fuel wasted while travelling through congested areas.
- Self driving vehicles and car sharing can boost efficiency by maximizing use of vehicles and reducing need for space to park.

(17) Smart street poles:
Switching from polluting conventional streetlights to LED based street lights.
They can be connected to form a web of information sensors that can gather information of air quality data, monitor traffic and reduce the risk of crime.

(18) Vertical vegetables:

Cities can help cut food waste by growing perishable produce right in town, boosting individuals connections to food and reducing spoilage, promoting lengthy transit distance and time.

The Essential Elements of Green cities:

① Green and blue oxygen producing areas

Green infrastructure

- Bioarchitecture → Green roofs
  - outdoor green walls
  - Green houses
- Green spaces
- Green paths – green and blue ecological corridors
  - Bicycle lanes
- Urban forests
- Urban farms
- Green belts – Forests
  - Riparian vegetation
  - crops.
- Green Energy

① Green and blue oxygen producing areas:

These areas encompass all the spaces with planted flowers, shrubs and trees, while the urban green area system includes both the green spaces within the city and those lying on its out-skirts.

② The green corridors (or greenways):

These are a network of linear space conceived, planned and managed for multiple purposes, including recreation and biodiversity conservation. At the same time, they have an aesthetic and cultural role or any other role that is compatible with the sustainable use of the territory.

③ The blue green corridors:

May be used as instruments for integrating water surfaces and green areas as a part of the strategic spatial planning of urban environments, with the intention to manage the flood risk and to maintain the biodiversity of fauna and flora. This concept primarily applies to the cities that are crossed by rivers or those lying in the proximity of water courses or canals.

④ The green belts:

These are areas delimited around the large cities with a view to protect the elements of natural setting. At the same time, they are meant to prevent their uncontrolled expansion, to preserve the valuable traditional landscapes and to ensure additional areas for leisure and recreation.

(5) Urban Forests :
- It represents the tree vegetation within the cities or around them (excluding isolated trees within the private gardens, street lining trees, small cluster of trees around the residential buildings, parklands)
- Urban forests are areas with natural, semi natural or planted forests situated in the cities or outskirts.

(6) Green walls and vertical gardens :

(7) Green houses.

(8) The street network :
In green cities transport infrastructure should have a minimum impact on the natural components of the environment and specially on soil permeability and oxygen producing areas.

Challenges for green city :

Environmental challenges
- Air pollution
- Water pollution
- Land consumption
- Transportation choices
- Limited Connectivity
- mixed use development

Sustainability principles
- open space
- sustainable water sources
- Integration of Diverse community features.

Benefits of Green city :

Environmental Benefits :

① Urban advantages :- More green space within a city's boundries can improve the urban environment, helping regulate air quality and climate, reducing energy consumption by countering the warming effects of paved surfaces, recharging groundwater supplies and protecting lakes and streams from polluted runoff.

② Improved air quality :- Trees, shrubs and turf remove smoke, dust and other pollutants from the air. One acre of trees has the ability to remove 13 tons of particles and gases anually.

③ Reduce soil Erosion :- A dense cover of plants and mulch holds soil in place, keeping sediment out of lakes, streams, storm drains and roads, and reducing flooding, mudslides and dust storms.

④ Natural Resource conservation :- By using trees to modify temperatures, the amount of fossil fuels used for cooling and heating is reduced.

Economical Benefits :

① Views of plants increase job satisfaction.

② Nature increases work productivity.

③ landscape renews business districts - Greening of business district increases community pride and positive perception of an area, drawing customers to the business.

④ Employment and tourism boost - Employment opportunities

are associated with the creation and long term maintenance of urban open space, as well as tourism dollars of visitors from parks, gardens and civic areas

(5) Green space can improve property value.

(6) Green space helps decreasing air conditioning cost and leads to energy saving.

Health Benefits:

(1) Better health linked to green space regardless of socioeconomic status.

(2) People who use green spaces are more likely to take exercise than who don't.

(3) The more time people spend outdoors the less stressed they feel.

(4) Improved mental health and wellbeing for children, young people and adults.

(5) Increased likelihood of physical activity across all age groups.

(6) Reduced violence and aggression.

(7) A reduction in anti-social behaviour and incidence of crime in urban areas with green spaces.

(8) Improvement in air and noise quality.

Lifestyle Benefits:

(1) Privacy and tranquility: Well placed planting can offer privacy and tranquility by screening out busy streets, noises and reducing glare from headlights.

(2) Lower crime and enhanced self esteem.

(3) Good landscaping increases community appeal.

(4) Mood enhancer.

(5) Road rage reduction.

Carbon emission Reduction at personal level:

- Carbon reduction can be achieved at personal level through many possible ways such as in travel, in the use of electricity at home, in avoiding imports and in dietary habits.
- Emissions due to travel (by air and cars) are responsible for 14.5 % of world's carbon emission. Both car travel and air travel have to be reduced.

Travel:

Emissions vary per passenger per km travelled with the mode of travel, being maximum for air travel, lesser for cars, still less for buses, least for trains and zero if you walk or use bicycle.

- walk for walkable distance or use bicycle
- Send your children by school bus and use office bus to reach work place.
- car-pooling
- prefer public transports.
- For business visit to nearby city instead of private vehicle prefer bus or train.
- Video conferencing

- Holiday travel by air, should be avoided.
- Avoid food and flower travel through air craft.
→ change from fossil fuel to Biofuel.
- Avoid imports, prefer local products, local labours.
- Forget stand-by
- Use eco-friendly products
- Switch to renewable energy resources for personal use.
- online shopping, online teaching

Carbon Emission Reduction at Local authority and citywide level:

Electric consumption in a community is much affected by:

(1) Presence of endustries
(2) Residential consumption
(3) General lighting (traffic lights, street lights, advertisment hoardings, lighting for open air marriages and other functions and public purpose, TV's etc.)
(4) Timer switches
(5) Use certified Fittings / Fixtures.
Bureau of Energy Efficiency (BEE)
(6) Provide solar water heaters.
(7) Reduction in cooking fuel.
(8) Economic air conditioning. (proper spacing, cavity walls, double glazed window panes, reduce sunlight penetration.

→ Miscellaneous sources of carbon emission:

Computers: production of single desktop computer produce ½ tonne of CO_2 per unit.

mobile phones: for production costly metals are used. (the processing need much power in their ~~recycling~~ refining, so should be recycled)

Cattle and other animals:

Carbon emissions from Imports:

- Carbon emissions from imports are two-folds as they are due to two separate activities
(i) the manufacture of the product causes emission in its original country
(ii) its inter-country transport by air which may produce even more emissions spread over several countries.
- Carbon emission due to imports are estimated to be as high as 33% of the total emission.
- Top five sources of emported carbon overall:
(i) Machinery and equipment from china
(ii) Metals from Russia
(iii) chemicals, rubber and plastic products from US
(iv) chemicals, rubber and plastic products from china

(v) Electronic equipment from china.

→ Kyoto protocol:

It is an international agreement linked to the United Nations framework convention on climate change, which commits its parties by setting internationally binding emission reduction targets.

- The kyoto protocol was adopted in kyoto, Japan on 11 Dec 1997 and entered into force on 16 February 2005.

Green Technologies for specific Applications:

Green Buildings:

2 types:

(i) First generation green building

(ii) Second generation green building

(i) First generation green building: are those which use various architectural and engineering devices in planning and constructing the buildings so as to minimize electric power and other resources consumed, but do not generate any power of their own.

(ii) Second generation green buildings: Minimize use of power and resources needed to operate the buildings but also generate some or all of their powers requirements at the building site itself.

- When the entire power needs of the building are met from local generation, the building is known as 'zero-energy building'.

Green Building Guidelines:

① LEED (Leadership in Energy and Environmental design)

② GRIHA (Green Rating for integrated Habitat Assessment)

developed by TERI (The Energy Research Institute), New Delhi

- more suited to Indian conditions and approved by the Government of India.
- Private architects prefer LEEDS guidlines. Govt architects prefer GRIHA system.

The Leeds Rating System Guidelines:

- Created by U.S Green Building council (USGBC).
- LEED guidelines promote environment-friendly acts but suffer from the fact that no negative marking is given for an environment-unfriendly act committed by a developer.
- All new green buildings are required to comply with the guidelines suggested for each of the following aspects of a project:

① The building construction site
② Environmental concerns in architectural planning
③ Energy conservation and its better management
④ Water conservation,
⑤ Waste management
⑥ Social Relevance,

① The building construction site :-

- Design with minimum disruption to the site, minimum soil displacement and min^m soil erosion,
- Preserve and reuse nutrient rich top soil for landscaping,
- Reduce micro climate temperature rise by planting shady trees,
- Minimum pumping, let drainage follow existing slopes / contours which facilitate easy maintenance.
- Preserve biodiversity, compensate by reforestation and replanting,
- Facilitate groundwater recharge, restrict rainwater run-offs by constructing small bunds,

② Environmental concern through choice of materials and architectural planning :-

- recommended to keep a building more cool and comfortable and reduce power costs on A/cs,
+ Achieve thermal comfort (use hollow blocks for walls to keep hour cool & cut down on use of A/c, double-wall construction for insulation view point.
- Avoid use of glass facades especially on sunnysides
- Achieve visual comfort (through choice of colors, materials, etc)
- Prevent heat gain (through use of larger roof overhangs to extend shade for longer hours)
- Where sloping roof is provided, use double-roofing for heat insulation
- Where roofing is in the form of a terrace, a roof garden may be provided to keep heat away from the floor below.
- Scientifically designed vertical and horizontal fins could be provided in some cases, Double glazed window panes would reduce heat transfer.
- Ensure entry of adequate daylight inside the house to avoid use of electric lights during day time, (use of skylights, transparent sheets etc)

③ Energy Conservation and better management :-

Heating, ventilation and air conditioning (HVAC) are usually the 3 heaviest users of electricity.
- LEED recommends to restrict light power density to 7.5 w/sq m or less as far as possible in a green building.

Stepwise approach in the case of energy conservation is as follows:

- Use architectural features and materials as suggested earlier to reduce air-conditioning and lighting demands as far as possible.
- Adopt power conserving devices (thermostats etc)
- Adopt more advanced waste heat recovery devices such as heat pumps to recover heat from warm effluents / air discharged after use.
- Supplement conventional energy sources by renewable energy sources if possible.

(4) Water conservation:

- Minimise use of public water supplies. Conserve water, reuse wherever possible.
- Provide for rain water harvesting and groundwater recharge to minimize use of water from public water supplies.
- Provide low flow fixtures, orifices in pipes and dual flushing tanks to minimize use of water.
- Provide waterless urinals where power supply is dependable.
- Reuse grey/black waters after suitable treatment either for flushing in toilets or for gardening.
- In garden, plant trees which inherently require less water.

(5) Waste Management:

- Use a natural method of treatment such as a lagoon, pond or constructed wetland or land irrigation which avoids use of electric power for aeration in wastewater treatment, pumping etc.
- Reuse wastewater as far as possible for gardening, crop irrigation, ground water recharge and other uses at site after minimal treatment.
- Reuse solid wastes after segregation. (to recover reusable materials and use the waste to prepare compost from the organic wastes and recover biogas and manure for use)

(6) Social Relevance:

- be good for the local people.
- use affordable, durable and low maintenance building materials which are locally available.
- Use locally available skills and management systems to maintain and avoid use of fuel for transportation of men and material.
- Reduce consumption of all resources, promote reuse of water and avoid wastage of materials and production of wastes.
- Use green plants to keep up air quality (areca palm, sansvieria trifasciata)

40-49 - Certified
50-59 - Silver
60-79 - Gold
80+ - platinum.

GRIHA Rating System :

- Developed by TERI
- Indian version of LEEDS.
- Govt. funded buildings in India are required to meet GRIHA guidelines,

→ Depletion of the natural resources should be minimum.
- Uses minimum energy to power itself.
- uses efficient waste and water management practices.

→ The following aspects of the building design are considered :

(i) Site planning
(ii) Building envelope design
(iii) Building system design (HVAC), heating, ventilation and air conditioning, lighting, electrical and water heating.
(iv) Integration of renewable energy sources to generate energy onsite.
(v) water and waste management
(vi) Selection of ecologically sustainable materials (high recycled content, rapidly renewable resources with low emission potential)
(vii) Indoor environmental quality (maintain indoor thermal and visual comfort, air quality)

Need for GRIHA Rating system :

- The US-based LEED Rating system is more meant for energy efficiency measures in A/c buildings which is not much applicable for the Indian agro-climate conditions and in particular the predominance of non-AC buildings, thats why a National rating system - GRIHA - has been developed which is suitable for all kinds of buildings in different climate zones of India.
- It takes into account the provisions of the National Building code 2005, the energy Conservation Building code (ECBC) 2007 announced by BEE (Bureau of Energy Efficiency) and other IS codes, local bye-laws and other local standards and laws.
- GRIHA guidelines consider 33 different criterias during design and construction of green buildings.
- All the criteria are rated and total ratings are converted to stars :

1 stars : points 51 to 60
2 stars : points 61 to 70
3 stars : from 71 to 80
4 stars : from 81 to 90
5 stars : From 91 to 100.

List of criteria :

The Energy Conservation Building code (ECBC)

- Electrical performance index (EPI)
  For India = 200 - 400 Kwh/m^2/year.
  For Europe and USA = 150 - 200 kwh/m^2/year.
- over 55% electric consumption in HVAC
  14% in lighting
  24% in electronics equipments
  >4% other.
- ECBC has prepared guidelines covering:
  (i) Building envelope (walls, roofs, windows)
  (ii) Lighting (indoor, outdoor)
  (iii) HVAC
  (iv) Solar water heating
  (v) Electrical systems.
- In 2001, Govt of India introduced Energy conservation act under which it prescribed the ~~EBC~~ ECBC code.
- All GRIHA buildings are ECBC compliant.

→ First building in India to be certified as platinum under LEED system is CII - Sohrab Godrej Green Business Center, at Hyderabad.

Features of first generation green building:

- An open atrium bringing natural daylight into working areas.
- Construction in hollow block walls,
- Interior gardens,
- A green roof garden as an amenity and way of keeping the floor just below cool.
- Solar heaters for hot water
- Light fixtures adjustable according to occupancy.
- Water efficient fixtures,
- Reuse of wastewater to reduce fresh water use, especially in garden,
- Garbage conversion to compost for reuse in garden.
- All construction materials, fixtures and fittings should be locally sourced.
- Bore holes/ponds to store water and supplement rainwater harvesting.

Greening of old Existing Buildings:

- New green building in India is <1% of the total building stock in India.
- There are yet many old existing buildings in every city that need to be brought into this green category to whatever extent is possible.
- For beginning this approach, first step is testing or benchmarking the facilities provided by existing

buildings and second step is retrofitting and upgrading work as necessary.

- Siemens and McGraw Hill construction (MHC) undertook studies in USA covering 3 sets of buildings i.e commercial, health care and educational.
- Performance of old buildings can be rated in terms of:
  (i) Energy and water requirements
  (ii) Environmental impact
  (iii) comfort and well-being of the occupants.
- Upgrading activity is relatively low in India because of several reasons i.e
  - access to funding
  - insufficient incentives
  - general lack of interest

→ Responds from Indian Citizens to Upgrading Suggestions are:

- Issue circulars to tenants to conserve electricity usage in buildings.
- Change over to CFL and LED bulbs when buying new replacements.
- Seek switch over to chapter rate of electric supply for bulk consumption.
- Air conditioned areas keep increasing.
- Install low water consuming fittings and fixtures
- No changes to building envelopes are possible to undertake at this stage.
- No terrace garden is attempted as leakages are feared.
- No plantations or changes are possible on site as the site is already crowded.
- Meanwhile building inmates keep increasing and toilet and other facilities are overcrowded.
- Any switch over to renewable energy (wind or solar) is put off as expensive.
- Automation system are considered unaffordable.

→ At present India is generally enthusiastic about new green buildings. India's interest in retrofitting and renovating existing buildings is still in dormant state.

Green Hotels:

- Invariably designed as green buildings first, along with green services to their guest.
  Hotels present an greater scope for saving power, water etc than green buildings do.
- Example: 'Ecotel'
  Hotels use this concept to increase their brand value as these aspects appeal to environment-friendly guests.

→ Hotels try to become water positive i.e they try to generate more fresh water than they use.
(This is done by rainwater harvesting and reuse of

waste water after treatment- for gardening and non potable use.
They save water by using dual flushing tanks, pressure reducing devices, dual plumbing etc.

→ Hotels also try to become 'carbon positive' (through afforestation and minimum use of fossil fuels) some hotels are also beneficiaries of carbon credits under CER schemes (clean energy. Regulator)

→ Hotels try to have 'zero solid wastes' (through salvaging, recycling and composting).

→ Hotels also make extensive use of wastewater after treatment- to meet cooling, gardening and other needs and ensure solid waste segregation and re use, composting, use of recycled paper, use of less water consuming plants in their gardens etc.

→ These hotels use several energy saving devices (CFL bulbs, efficient- pumps, timer switches etc) Their door keys are smart cards which are also used to operate room lights and air-conditioners by the customers.

→ Examples :

① Orchid Hotel near Mumbai Santa cruz airport (got its Ecotel brand name)

② Chain of ITC hotels in India and Hotels

③ Hotel Gardenia in Bangalore (wind - funnel- shaped atrium requiring no AC, drip-fed vertical wall garden economising on water)
Got platinum rating in LEED rating system.

Green Hospitals :

- Combination of green building concepts, green hotels and green technologies for municipal services.
- Key successful operation involving involves :
  (i) proper segregation of infectious waste from municipal waste, and its proper disposal.
  (ii) Hospitals must check the reuse of used needles and sharp objects used for cutting by breaking it before disposal.
  (iii) With infectious wastes 'no burn' technologies (such as autoclaves, hydroclaves etc) should be used instead of incineration.
  (iv) Radioactive wastes and cytotoxic drugs need separate disposal as per their own guidelines.
  (v) Body parts are generally sent to local crematoria for incineration.

Green Technologies for Transport :

Transport can be placed under 2 broad groups.

(1) Private modes of transport
(2) mass transport

Private Transport :

- In greening modes of transport, use of following has been given focussed.

(i) Bio fuels
(ii) Use of small cars
(iii) switch over to CNG or LPG gas
(iv) Facilitation of traffic by providing flyovers, tunnels, wider roads etc,
(v) Discouraging of traffic in certain areas by various means. (congestion tax).
(vi) Mass transport
(vii) Better planning and layout of new towns with walkways, cycle paths etc

Mass Transport :

- In our greening effort, mass transport is our main preference over individual transport as its per capita emissions of CO_2 is minimum,
- Mass transport is often installed because of its lower per capita emission, for ensuring better traffic conditions and lower fuel consumption.
- 14 Indian cities have installed metros at present.

Mumbai Transport :

- Transport - a large source of emission in Mumbai.
- To improve air quality 50,000 cars and buses switched over from conventional fuels (diesel and petrol) to using CNG gas.
- Citizens are advised to use small cars rather than big SUVs (as emission is directly proportional to size)
- The city's fascination with flyovers are proving useful in decongesting Mumbai.
- Other forms of transport such as water transport should be encouraged.
- Mass transport - electrified local train services.
  - metros, monorails.
- Delhi metro and Indian Railways - installing more efficient railway systems and signaling to qualify for certified emission reductions (CERs) under Kyoto protocol.
- Delhi metro has been awarded ISO 14001 for undertaking extensive noise and pollution control measures, relocating thousands of trees and disposing soil from tunneling without harming the environment.

Electric cars :

- Solar energy converted into electric energy at building level can be used to recharge car batteries at night.

→ ISO 14001 - international standard that specifies requirement for an effective env. management system (EMS)

Green Roads :

- Green roads exist already in the form of expressway or autobahns which pass through rural and semirural territory and carry relatively high speed intracity traffic.
- Their design is mainly affected by need for isolating the expressway section for only highway speed traffic, maintaining relatively easy slopes and curves at all times and providing special care for drainage, telecommunication and lighting in tunnels in mountainous terrain,
- All intracity highways have to exclude slow moving traffic, keep animals movement corridors open at all times and respect the local ecosystem,
- The intercity roads have to cater to multispeed traffic varying from cars and trucks to bicycles and pedestrian, so special attention has to be paid to cross overs,
- The city's drainage and other services including water supply, telephones, waste water etc have to be accomodated and maintained on a daily basis,
- Thus green roadways would have to deal with :
  - Environment
  - water
  - access, congestion
  - safety
  - construction activity
  - Materials
  - Technology,

→ Problems that may occur due to improper road planning and construction :-

- The construction process itself generate large quantity of debris, produce runoff that chokes the sewer system and pollutes the receiving water bodies,
- The massive traffic may cause its own problems like congestion, excess carbon emission etc.
- The society may be left with impervious, heat holding islands and carbon emitting vehicles,

Ports and Harbours :

- The design of ports and harbours is intimately tied up with design concerning other infrastructure such as roads, railways, bridges, tunnels, waterways, airfields, buildings and their drainage systems,
- Besides all the features listed in regard to green roads, designer has to consider of the coastal environment and long term safety,
- Sea level rise and climate change are two factors that affect cargo handling facility of ports,

→ New york city Harbour authority conducted a study on climate change and its likely effects on infrastructure over a period of several decades : 2020, 2050, 2080.

The study panel found the following:

(i) Air temp would increase from its present annual mean of 12.8 C to as much as 15.5 to 17C in the period.

(ii) Precipitation would increase from its present annual mean of 118 cm by about 5-10% in the same period.

(iii) Sea level would rise from its present mean sea level by 5.1 - 12.7 cm in 2020
17.8 - 30.5 cm in 2050
30.5 - 58.4 cm in 2080

(iv) Coastal storms with present return period of 100 years would have a shorter return period of once in every 35-55 years in 2050 and roughly once in every 15-35 years by 2080.

(v) Effects of climate change would include increased flooding, lowered clearances in bridges, increased risk of power failure etc.

Green Technologies for Industries:

- Greenhouse gas emission data from various industries in different parts of India have to be benchmarked so as to be able to compare their carbon emissions with those of similar industries in other areas on a national and international bases.
- Industries often constitute a big part of our carbon footprint.
- Industries generate carbon emissions right from the start of mining operations for their raw materials to the chemicals and processes used in their manufacture and continue to emit during transport and use of their products and even during their disposal after their useful life is over.

Manufacturing emissions and secondary emissions:

- Emissions occurring from manufacturing operations at the factory site may be called manufacturing emissions.
- The emissions occurring elsewhere (on the road during transport etc) are termed as secondary emission.
- Emissions occurring anywhere must be accounted for as they equally affect global warming.

- The total emissions from any industry depend on the process involved, the vintage of the manufacturing plant, the capacity of the unit, the processes used in manufacture, the efficiency of power generation, the nature of fuel used to generate the power and the location of the factory.

Role of Consultants:

- Consultants should be engaged to study the specific local situation regarding energy consumption and actual manufacturing process used and recommend cleaner technologies.
- Consultants undertake studies to
  (i) Minimize electric power consumption in manufacture
  (ii) Minimize water use
  (iii) Develop waste water treatment manageable within available land, manpower and other resources and needing minimum electricity for operation.
  (iv) Advice on taxation and subsidy matters on country use or export.
  (v) Review of the manufacturing processes and chemicals / solvents used.

Carbon Emissions from Industries in General and carbon Tax:

→ Carbon emission from industries depend on several factors such as (i) requirement of electric power for operating its various machinery and manufacturing process,
(ii) type of fuel used for generating additional power locally
(iii) type of devices which require pumping, compression, pressure built up etc.
(iv) type of solvents and other chemicals used in manufacture.

→ Industries listed by the CII are:
(Confederation of Indian Industry)
(works to create and sustain an environment conductive to the growth of industry in India)
Aluminium, cement, ceramics, electrical systems, engineering, foundry, fertiliser, glass, iron and steel, pulp and paper, sugar.

→ Top 10 Indian companies which have started measuring and controlling emissions are:
- The tata companies (TCS, Tata global beverages, Tata chemicals, Tata power)
- Wipro
- Yes bank
- ACC

• Sesa Goa
• GVK power and Infra
• ABB

→ Some countries visualising a carbon tax to promote use of cleaner fuels in their countries.

Carbon Emissions from a Few selected industries in India :

- From green house gas (GHG) emission point of view, 3 most widespread industries in India are : cement, steel and brick making.
- Other industries with significant emissions are: food and fertilizer industries, aluminium manufacture.

Cement Industry :

- associated with a particulate air pollution problem and to check that bag filters and electrostatic precipitators are used.
- Total carbon emission from world cement industry have been estimated at 160 million MT per year.
- The avg emission factor for the cement industry in India is estimated to be in range of 0.5190 - 0.5408 tons of CO_2 per tonne of clinker, i.e the total emissions are 43.43 million tons of CO_2.
- GHG emission from cement plants can arise from both fuel and the feed materials such as limestone and dolomite.
  ACC is trying to develop renewable energy instead of coal, but replacing limestone is a challenge.
- Emissions in cement industries can be minimized by,
  - replacing high carbon fuels by low carbon fuels
  - By applying lower cement/clinker ratio
  - By increasing the additives in proportion to the cement.
  - By use of blended cements and application of alternative cements

Steel plants :

- In steel plants, the coke ovens help convert raw coal into coke of required quality, while producing by-products which become raw materials for other operations.
- This coke along with limestone and iron ore brought from mines are fed into blast furnaces to make pig iron.
- The resulting pig iron from the blast furnaces is treated further in open hearth or electric furnaces for conversion into steel.
- All the fumes and polluted air are passed through

dry and wet scrubbers and electrostatic precipitators for cleaning before disposal to the open atmosphere.

- The cleaning process traditionally concentrates on particulates, both in air and water but no attempts are made to remove or treat CO_2 and other GHGs before release.
- Further some of the products undergo pickling, galvanising and plating which generate water polluting substances.
- An integrated steel plant may consist of a battery of coke ovens, blast furnaces, steel melting shops, sinter plants and annealing planting plants. Use of different solid and gaseous fuels are done to operate the different units. These fuels of varying qualities give CO_2 and other GHGs in different proportions.
- Besides, flux such as lime stone and dolomite added in the process also contribute to the emissions. Thus emission factors depend much on fuel quality.

According to a study in Canada, reported an emission factor of 1.6 tons of CO_2 per tonne of hot metal from fuel consumption.

The emission factor estimated for an Indian integrated steel plant was noted to be 2.04 tons of CO_2 per tonne of hot metal.