18CE0406T GLOBAL WARMING AND CLIMATE CHANGE

UNIT – 5

[S1 – S3]

S1: SLO 1: Climate change negotiations

The climate negotiation process occurring through the United Nations Framework Convention on Climate Change (UNFCCC) and its related agreements is the primary forum for international cooperation on stabilizing atmospheric greenhouse gas concentrations at a level that would prevent catastrophic anthropogenic substances.

The United Nations Framework Convention on Climate Change (UNFCCC), agreed in 1992, is the main international treaty on fighting climate change. Its objective is **to prevent dangerous man-made interference with the global climate system**. The European Union (EU) and all its member countries are among the 197 Parties of the Convention.

The Intergovernmental Panel on Climate Change (IPCC) is a scientific and intergovernmental body of the United Nations (UN) tasked with providing an objective scientific assessment of climate change and its potential political, economic, social and environmental impacts.

IPCC reports support the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty on climate change that has the purpose of stabilising greenhouse gas (GHG) emissions at a level that will prevent 'dangerous' anthropogenic climate change (i.e. that caused by human activity).

An annual 'Conference of Interested Parties' (COP) assesses progress towards achieving this goal, and in December 2015 agreed the 'Paris Agreement' that set out member countries obligations to reduce GHG emissions and fund measures to mitigate the effects of climate change.

195 countries signed the agreement. This activity simulates the negotiation process that created it.

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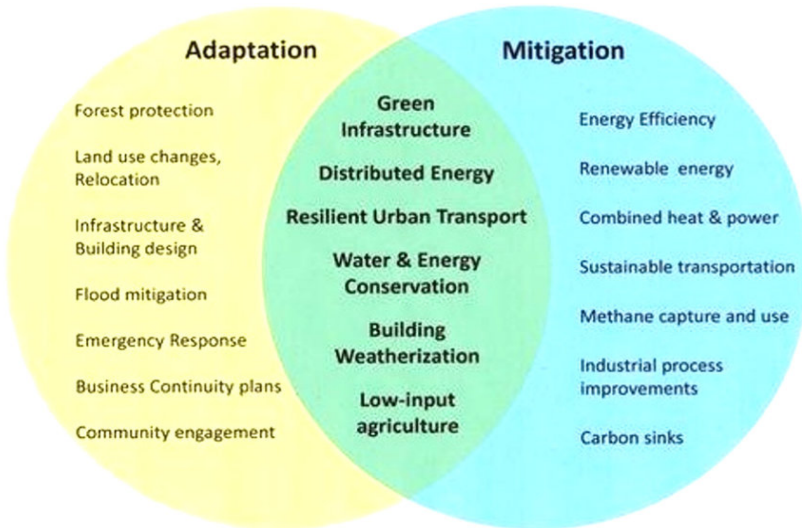
S1: SLO2: Mitigation measures

	Mitigation policy	Mitigation technology
Energy supply sector	• reduction of fossil fuel subsidies • taxes or carbon charges on fossil fuels	• switching fuel from coal to gas
Waste sector	• financial incentives for improved waste and wastewater management • renewable energy incentives • obligations and waste management regulations	• waste incineration with energy recovery • composting of organic waste • controlled wastewater treatment and recycling • waste minimization
Buildings sector	• appliance standards and labeling • building codes and certification	• efficient lighting and daylighting • more efficient electrical appliances • heating and cooling devices



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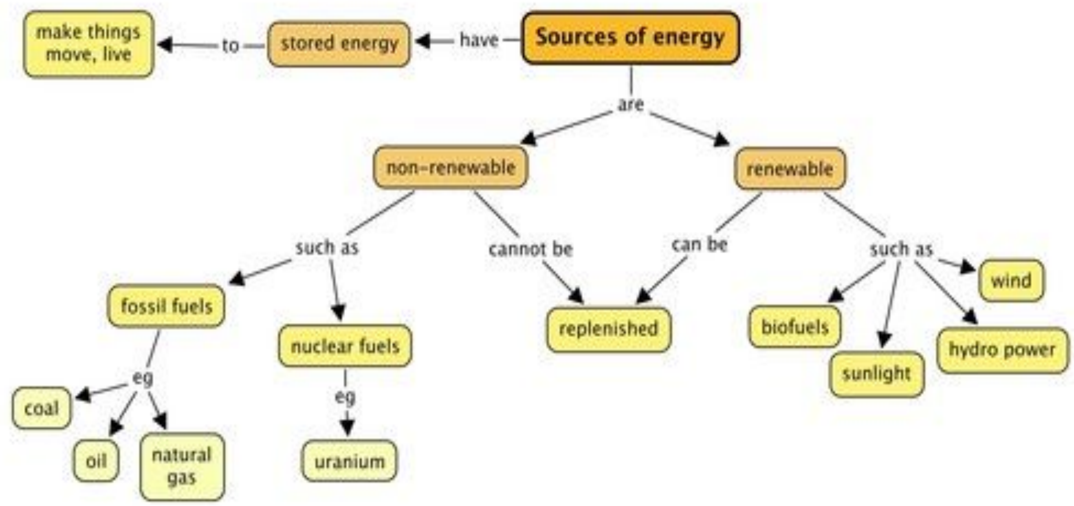
S2: Use of renewable resources

- **(i) Solar energy**
- **(ii) Wind energy**
- **(iii) Tidal energy**
- **(iv) Hydrothermal energy**
- **(v) Geothermal energy**

Renewable energy is energy that is collected from renewable resources, **which are naturally replenished** on a human time scale, such as **sunlight, wind, rain, tides, waves, and geothermal heat.**

Non-renewable energy comes from sources that will run out or will not be replenished in our life times—or even in many, many life times. Most non-renewable energy sources are **fossil fuels: coal, petroleum, and natural gas**. Carbon is the main element in fossil fuels.

When we pump gas at the station, we're using a finite resource refined from crude oil that's been around since prehistoric times.



Renewable Energy Source	Non-Renewable Energy Source
Renewable Sources of Energy are those Sources of Energy which can be renewed naturally over time.	Non-Renewable Sources of Energy are those sources which are available in limited quantity..
They are replaced by nature in a short period of time	They cannot be replaced by nature
They are inexhaustible.	They will be exhausted one day
They do not cause any pollution	They cause pollution when used
Example - Solar Energy, Wind Energy	Example - Fossil Fuels, Nuclear Energy

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Solar Energy

Humans have been harnessing solar energy for thousands of years—to grow crops, stay warm and dry foods. According to the **National Renewable Energy Laboratory**, "more energy from the sun falls on the earth in one hour than is used by everyone in the world in one year." Today, we use the sun's rays in many ways—to heat homes and businesses, to warm water, or power devices.

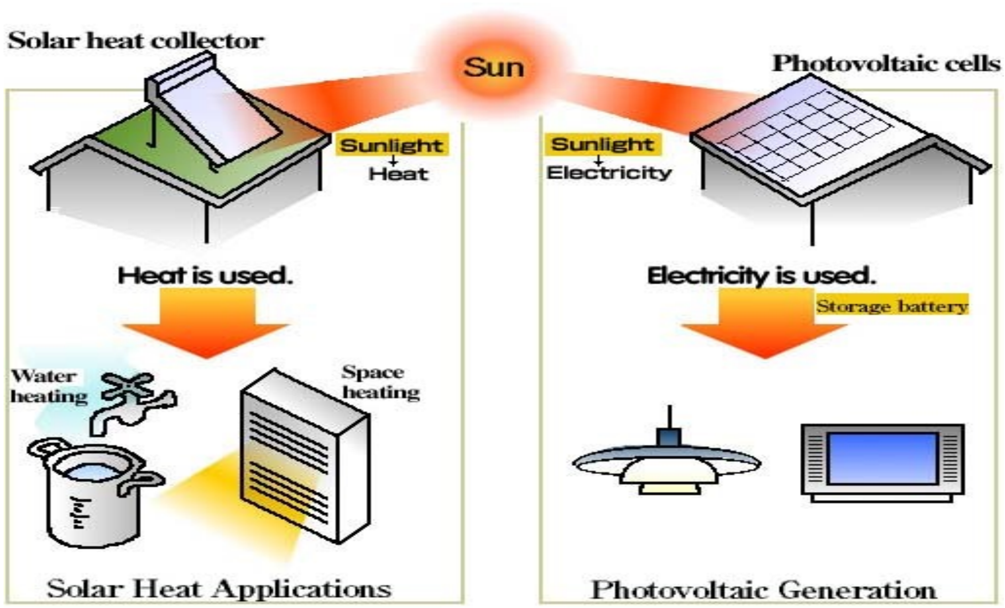
Solar, or photovoltaic (PV), cells are made from **silicon** or other materials that transform sunlight directly into electricity. Distributed solar systems generate electricity locally for homes and businesses, either through rooftop panels or community projects that power entire neighborhoods. Solar farms can generate power for thousands of homes, using mirrors to concentrate sunlight across acres of solar cells. Floating solar farms—or “floatovoltaics”—can be an effective use of wastewater facilities and bodies of water that aren’t ecologically sensitive.

Solar supplies a little more than 1 percent of U.S. electricity generation. But nearly a third of all new generating capacity came from solar in 2017, second only to natural gas.
Solar energy systems don’t produce air pollutants or greenhouse gases, and as long as they are responsibly sited, most solar panels have few environmental impacts beyond the manufacturing proces.

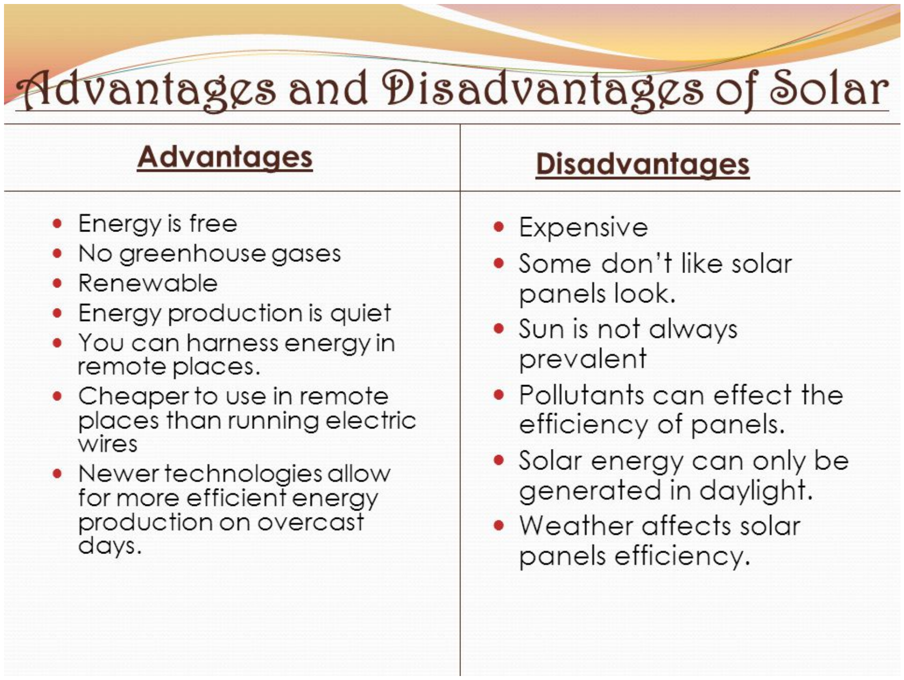
Concentrated solar power (CSP), uses mirrors to concentrate solar rays. These rays heat fluid, which creates steam to drive a turbine and generate electricity. CSP is used to generate electricity in large-scale power plants.

Solar energy corporation of India

- Installed grid connected solar power capacity is 4,229.36 MW (2015)
- Solar Thermal
- Solar PV system
- Solar concentrator
- Solar cookers
- Solar electrification for rural areas
- Solar pumping
- Solar dryers



Merits & demerits of solar energy



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Wind Energy

Wind energy is a form of solar energy. Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity.

Wind power is a clean energy source that we can rely on for the long-term future. ... Because wind is a source of energy which is non-polluting and renewable, the turbines create power without using fossil fuels. That is, without producing greenhouse gases or radioactive or toxic waste.

Wind in India are influenced by the strong south-west summer monsoon, which starts in May-June, when cool, humid air moves towards the land and the weaker north-east winter monsoon, which starts in October, when cool, dry air moves towards the ocean.

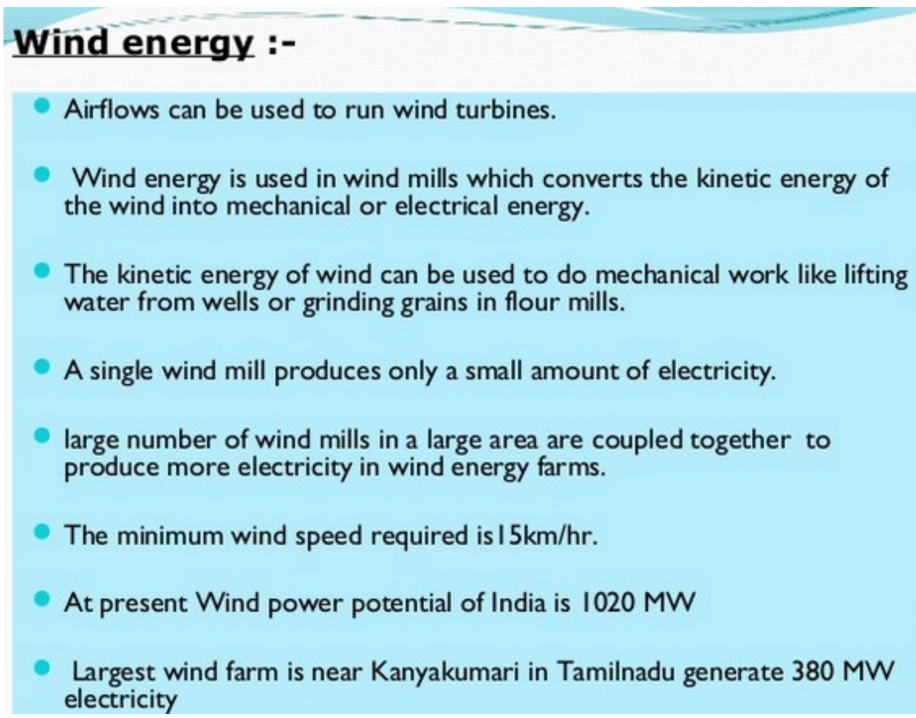
During the period march to August, the winds are uniformly strong over the whole Indian Peninsula, except the eastern peninsular coast. Wind speeds during the period November to march are relatively weak, though higher winds are available during a part of the period on the Tamil Nadu coastline.

Indian Wind Energy Association

The Indian wind energy sector has an installed capacity of **23,439.26 MW (as on 2015).**

In terms of wind power installed capacity, **India is ranked 5th in the World**. Today India is a major player in the global wind energy market. The potential is far from exhausted. Indian Wind Energy Association has estimated that with the current level of technology, the 'on-shore' potential for utilization of wind energy for electricity generation is of the order of 102 GW.

The unexploited resource availability has the potential to sustain the growth of wind energy sector in India in the years to come.



Challenges of Wind Power

Wind power must still compete with conventional generation sources on a cost basis. Even though the cost of wind power has decreased dramatically in the past several decades, wind projects must be able to compete economically with the lowest-cost source of electricity, and some locations may not be windy enough to be cost competitive.

Good land-based wind sites are often located in remote locations, far from cities where the electricity is needed. Transmission lines must be built to bring the electricity from the wind farm to the city. However, building just a few already-proposed transmission lines could significantly reduce the costs of expanding wind energy.

Wind resource development might not be the most profitable use of the land. Land suitable for wind-turbine installation must compete with alternative uses for the land, which might be more highly valued than electricity generation.

Turbines might cause noise and aesthetic pollution. Although wind power plants have relatively little impact on the environment compared to conventional power plants, concern exists over the noise produced by the turbine blades and visual impacts to the landscape.

Wind plants can impact local wildlife. Birds have been killed by flying into spinning turbine blades. Most of these problems have been resolved or greatly reduced through technology development or by properly siting wind plants. Bats have also been killed by turbine blades, and research is ongoing to develop and improve solutions to reduce the impact of wind turbines on these species.

Advantages of Wind Power

(i) Wind power is cost-effective.

(ii) Wind creates jobs.

(iii) Wind enables U.S. industry growth and U.S. competitiveness

(iv) It's a clean fuel source.

(v) Wind is a domestic source of energy

(vi) It's sustainable.

(vii) Wind turbines can be built on existing farms or ranches, the energy it produces doesnot cause green house gases.

Disadvantages of Wind Power

i. Wind is not available at all times.

ii. It requires a large area of land.

iii. **A minimum wind speed of 15km/hr is required.**

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S3: Tidal energy

Tide is created due to gravitational force between earth sun and moon. Tidal energy is a renewable energy powered by the natural rise and fall of ocean tides and currents. Some of these technologies include turbines and paddles.

Although not widely used, tidal energy has the potential for future electricity generation.

Tidal power is one of the major renewable energy sources, but also one of the most infantile.

Using the power of the tides, energy is produced from the gravitational pull from both the moon and the sun, which pulls water upwards, while the Earth's rotational and gravitational power pulls water down, thus creating high and low tides.

This movement of water from the changing tides is a natural form of kinetic energy.

How does it work?

Tidal energy is produced through the use of tidal energy generators. These large underwater turbines are placed in areas with high tidal movements, and are designed to capture the kinetic motion of the ebbing and surging of ocean tides in order to produce electricity.

How Tidal energy is generated?

Tidal energy is created using the movement of our tides and oceans, where the intensity of the water from the rise and fall of tides is a form of kinetic energy. Tidal power surrounds gravitational hydropower, which uses the movement of water to push a turbine to generate electricity

How is tidal energy used today?

We can use tidal energy to supply electricity to our homes and businesses. We can use tidal energy in some places instead of burning coal and oil that contribute to global warming. Tidal generators (or turbines) work like wind turbines, except it is ocean currents, not wind, that turns them.

How does tidal energy affect the environment?

Tidal energy is a renewable source of electricity which does not result in the emission of gases responsible for global warming or acid rain associated with fossil fuel generated electricity. Use of tidal energy could also decrease the need for nuclear power, with its associated radiation risks.

Advantages of Tidal Energy

❖ It is an inexhaustible source of energy.
❖ Tidal energy is environment friendly energy and doesn't produce greenhouse gases.
❖ As 71% of Earth's surface is covered by water, there is scope to generate this energy on large scale.
❖ Efficiency of tidal power is far greater as compared to coal, solar or wind energy. Its efficiency is around 80%.
❖ Tidal Energy doesn't require any kind of fuel to run.
❖ The life of tidal energy power plant is very long.
❖ The large density of water, almost 1000 times greater than in air, results in very large amounts of energy to get out of the tidal currents even if the speed is low.

Disadvantages of Tidal Energy

❖ Cost of construction of tidal power plant is high.
❖ There are very few ideal locations for construction of plant and they too are localized to coastal regions only.
❖ Intensity of sea waves is unpredictable and there can be damage to power generation units.
❖ Influences aquatic life adversely and can disrupt migration of fish.
❖ The actual generation is for a short period of time. The tides only happen twice a day so electricity can be produced only for that time.
❖ Usually the places where tidal energy is produced are far away from the places where it is consumed. This transmission is expensive and difficult.

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Geotehermal energy

The word geothermal comes from greek word Geo- Earth and Thermal – Heat.

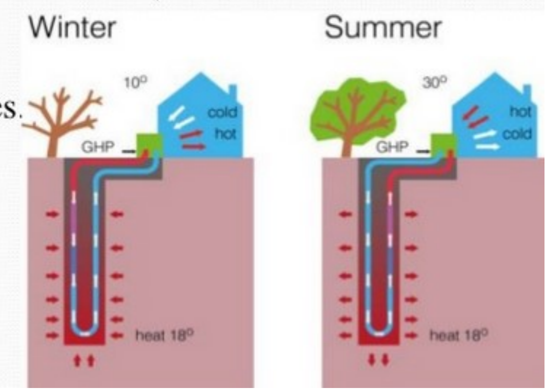
Geothermal energy is the heat from earth. It's source lies 6500 km beneath the earth surface, core containing hot magma. Geothermal energy is a clean renewable energy resource. It accounts for 3% of the total renewable based energy electricity.

What is Geothermal Energy ?
Geothermal Energy is thermal energy generated and stored in the earth.
Thermal energy determines the temperature of the matter.
Earth's geothermal energy originates from the original formation of the Planet and from radioactive decay of minerals.

Geothermal Power Plant uses superheated water to generate electricity. It is a most efficient way or we can say a much better way to generate electricity because they require no raw materials and having little or no impact on the environment

Direct use of Geothermal Energy

- Hot springs, used as spas.
- Heating water at fish farms.
- Provide heat for buildings.
- Raising plants in greenhouses, drying crops.
- Provides heat to industrial processes.



Geothermal energy potential: India

- India has about 400 thermal springs distributed in 7 geothermal provinces
  - These springs are perennial and their surface temperature range from 37 to 90°C and their cumulative surface discharge is over 1000 l/m.
  - Temperature of the water at Tattapani is 90°C; at Puga (Himalaya) it is 98°C and at Tuwa (Gujarat) it is 98°C
- Estimated reservoir temperature are 120°C (west coast), 150°C (Tattapani) and 200°C (Cambay)
- The geothermal systems are mostly liquid dominated (steam dominated systems are seen in Himalayan & Sonata provinces)
- Depth of the geothermal reservoir is about 1 to 2 km
- The power generating capacity of the thermal springs is estimated at about 10,000 MW
  - Binary cycle method can be utilized to generate power
  - Puga valley (Ladakh) has the most promising geothermal field

Technologies

- Traditional/ conventional hydrothermal power production systems (geothermal power plants) types
  - Dry steam
  - Flash steam (2 types: single flash and double flash power plants
  - Binary cycle
  - Combined cycle and Hybrid
- Coproduction, Enhanced Geothermal Systems (EGS), Geo-pressured and Supercritical systems
- Direct use of geothermal heat (without involving a power plant or a heat pump)
  - Space heating and cooling, food preparation, hot spring bathing and spas, agriculture, aquaculture, green houses, snow melting and industrial uses
  - These are applied at aquifer temperatures 90-200C.
  - The geothermal water/steam is accessed and brought to a plate heat exchanger
- Ground Source Heat Pumps (GSHP)/ Geothermal Heat Pumps (GHPs) – Geothermal Heating and Cooling Systems

Geothermal Energy

Advantages

- Geothermal energy does not produce any pollution i the form of greenhouse gases.
- Running costs for a geothermal power station are very low.

Disadvantages

- It is difficult to find suitable sites to put a geothermal power station.
- If not carefully managed, a borehole can 'run out of steam' and may not be useable for several decades.
- Dangerous gases and minerals can come out of a borehole, which may be difficult to dispose of.

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Hydrothermal energy

Hydrothermal energy is the process of obtaining heat or energy from a large body of water. 'Heat', in this case should not be associated with high temperature (as it may be with geothermal energy) but rather a relative heat content or relative temperature difference.

What is the source of hydrothermal energy?

Magma heats nearby rocks and underground aquifers. Hot **water** can be released through geysers, hot springs, steam vents, underwater hydrothermal vents, and mud pots. These are all sources of geothermal energy. Their heat can be captured and used directly for heat, or their steam can be used to generate electricity.

Hydropower uses a fuel—water—that is not reduced or used up in the process. Because the water cycle is an endless, constantly recharging system, hydropower is considered a **renewable energy**. When flowing water is captured and turned into **electricity**, it is called **hydroelectric** power or hydropower.

Why is hydrothermal energy important?

Hydropower is fueled by water, so it's a clean fuel source, meaning it won't pollute the air like **power** plants that burn fossil fuels, such as coal or natural gas. ... Because hydropower plants can generate **power** to the grid immediately, they provide **essential** back-up **power** during **major electricity** outages or disruptions.

Why is hydropower better than geothermal energy?

Geothermal and hydroelectric are renewable sources of **energies** and produce "clean" fuel sources. **Geothermal energy** is heat stored deep inside the earth or occasionally in hot springs. ... **Hydropower** is fueled by water and driven by the sun, therefore; it is a sustainable fuel source

Who uses hydropower the most?

Hydropower is the most important and widely-used renewable source of energy. Hydropower represents about 17% (International Energy Agency) of total electricity production. China is the largest producer of hydroelectricity, followed by Canada, **Brazil**, and **the United States** (Source: **Energy Information Administration**).

Disadvantages of Hydroelectric Energy

- Environmental Consequences. The environmental consequences of **hydropower** are related to interventions in nature due to damming of water, changed water flow and the construction of roads and power lines. ...

- Expensive. ...
- Droughts. ...

- Limited Reservoirs.

18CE0406T GLOBAL WARMING AND CLIMATE CHANGE

UNIT – 5

[S4 – S6]

S4: SLO 1: Clean Technology, biodiesel, compost, biodegradable plastics,

SLO 2: Concept of sustainable development

Clean Technology

- Clean technology, in short cleantech, is any process, product, or service that reduces negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, or environmental protection activities.

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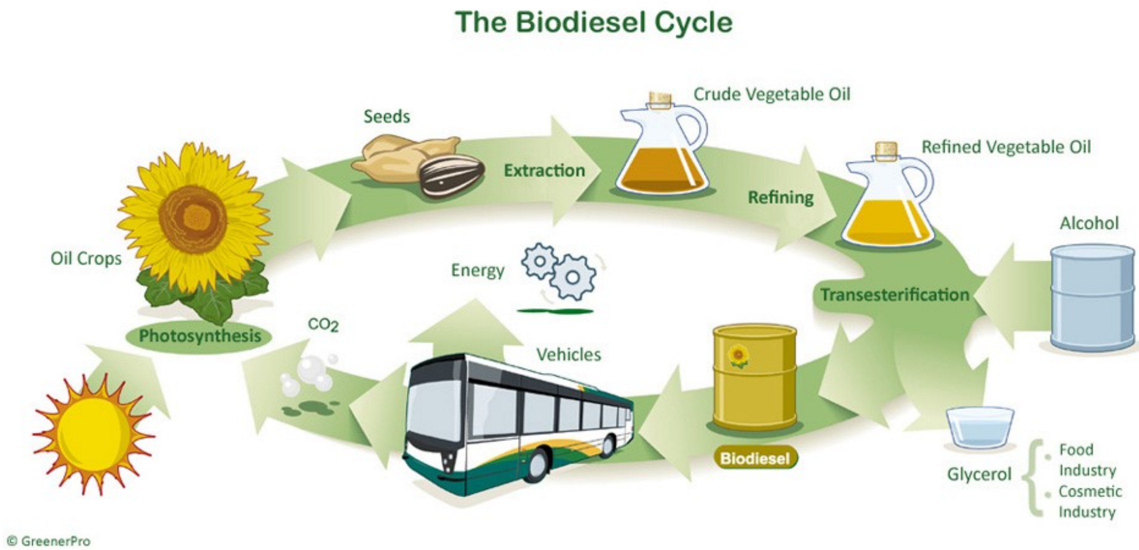
BIODIESEL

- Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant grease for use in diesel vehicles.
- Biodiesel's physical properties are similar to those of petroleum diesel, but it is a cleaner-burning alternative.
- Using biodiesel in place of petroleum diesel, especially in older vehicles, can reduce emissions.
- Biodiesel is a liquid fuel often referred to as B100 or neat biodiesel in its pure, unblended form. Like petroleum diesel, biodiesel is used to ***fuel compression-ignition*** engines, which run on petroleum diesel.

➢ How well biodiesel performs in cold weather depends on the blend of biodiesel. The smaller the percentage of biodiesel in the blend, the better it performs in cold temperatures.



1) Biodiesel is a clean burning renewable fuel made using natural vegetable oils and fats.
2) Biodiesel is made through a chemical process which converts oils and fats of natural origin into fatty acid methyl esters (FAME) through a process called trans-esterification.
3) Biodiesel is intended to be used as a replacement for petroleum diesel fuel, or can be blended with petroleum diesel fuel in any proportion.
4) Biodiesel does not require modifications to a diesel engine to be used.
5) Biodiesel has reduced exhaust emissions compared to petroleum diesel fuel.
6) Biodiesel has lower toxicity compared to petroleum diesel fuel.
7) Biodiesel is safer to handle compared to petroleum diesel fuel.
8) Biodiesel quality is governed by ASTM D 6751 quality parameters.
9) Biodiesel is biodegradable.

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COMPOST

- Composting is the process that speeds up decomposition of organic materials by providing ideal conditions for microorganisms to thrive.
- Compost is rich in nutrients. It is used, for example, in gardens, landscaping, horticulture, urban agriculture and organic farming. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil.
- Compost is simply decayed organic matter — and "organic matter" is a pretty wide-ranging label. A twig can be organic matter, but so can a banana peel. When you mix a bunch of these items together in a compost pile, they break down naturally into a nutrient-rich fertilizer that helps gardens grow.enhouse gas emissions.
- Studies further show that compost can aid in **carbon sequestration**. When applied to soil, compost potentially functions as a "carbon sink," trapping and containing the element in the dirt. And if the carbon is in the ground, it isn't in our atmosphere, where it can wreak havoc on the planet.

Types of Composting

- Composting Basics.
- Onsite Composting.
- Vermicomposting.
- Aerated (Turned) Windrow Composting.
- Aerated Static Pile Composting.
- In-Vessel Composting.

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Biodegradable plastics

- **Biodegradable plastics** are **plastics** that can be decomposed by the action of living organisms, usually microbes, into water, carbon dioxide, and biomass. **Biodegradable plastics** are commonly produced with renewable raw materials, micro-organisms, petrochemicals, or combinations of all three.

- While the words "bioplastic" and "biodegradable plastic" are similar, they are not synonymous. Not all bioplastics are biodegradable.

Which plastic is biodegradable?

- One set of degradable plastics are **materials** such as PLA (**Polylactic Acid**) that are unique plastics for which biological degradation potential is part of the nature of the plastic. The second set is **materials** of the standard #1 **PET**, #2 HDPE, #4 LDPE, #5 PP and #6 PS with special degradable additives included.
- **Biodegradable plastics** are very rarely recyclable, and **biodegradable** does not mean **compostable**–so they often up in the landfill. **Compostable** and bioplastic goods can be a better choice than **biodegradable** ones, but often still end up in landfills unless you can compost appropriately.

What are the problems with biodegradable plastics?

- When some biodegradable plastics decompose in landfills, they produce methane gas. This is a very powerful greenhouse gas that adds to the problem of global warming. Biodegradable plastics and bioplastics don't always readily decompose.
- Biodegradable plastics take **three to six months** to decompose fully. That's much quicker than synthetic counterparts that take **several hundred years**. Exactly how long a biodegradable bag takes to break down depends on various factors, such as temperature and the amount of moisture present.

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Concept of Sustainable development

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- The aim of sustainable development is to balance our economic, environmental and social needs, allowing prosperity for now and future generations. ... These include social progress and equality, environmental protection, conservation of natural resources and stable economic growth.
- Sustainable development is maintaining a delicate balance between the human need to improve lifestyle and feeling of well being on one-hand and preserving natural resources and ecosystems on which we and future generations depend.
- Political **barriers**: Inadequate economic, social and environmental **methods** for policies, plans and projects are the **major barrier** combating the implementation of **sustainable development.**

The aim of sustainable development

The aim of sustainable development is to define viable schemes combining the economic, social, and environmental aspects of human activity. That is making sure that there is a balance between the three types of sustainable development:

***Environmental sustainable development**

***Economic sustainable development**

***Social sustainable development**

It is Constant tussle between the Planet(environment), the People(social) and Profit(profits)

Why sustainable Development is Important

It's no secret that people are living longer and that the global population is on the rise. In fact, the United Nations projects that there will be more that 10 billion people living on the Earth by the year 2100. This explosion in population is perhaps one of the greatest reasons why sustainable development is so important.

Provide Basic Human Needs (social)

A rising population will also make use of the bare essentials of life such as food, water, and shelter.

Agricultural Necessity

Agriculture will have to catch up with that growing population as well, figuring out ways to feed around 3 billion more people than it currently does

Accommodate City Development (social)

As populations rise, cities will need to become larger to accommodate the influx of new residents.

Control Climate Change

Climate change is another issue that can be at least partially remedied through sustainable development. Sustainable development practices would mandate a lower use of fossil fuels, which are not sustainable and which produce greenhouse gases.

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S5: Concept of Carbon sequestration, Terrestrial sequestration

S6: Ocean sequestration

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Concept of Carbon sequestration

Carbon Sequestration is capturing and securely storing carbon dioxide emitted from the global energy system. Carbon sequestration is the placement of CO_2 into a depository in such a way that it remain safely and not released back into the atmosphere.

Sources of CO_2 emission	
Natural sources	**Manmade sources**
Volcanoes	Industries
Wild fires	Transportation
Decomposition	Soil cultivation
Respiration	Biomass burning

Objectives of carbon sequestration

i. Reducing pollution in air as well as improving natural carbon content in soil.

ii. Improvement of soil structure

iii. Restoring degraded soil leading to increase yield in crops.

iv. Developing technology to reduce rate of concentration of green house gases in air

Types of carbon Sequestration:

i. Ocean Sequestration: Carbon stored in oceans through direct injection or fertilization.

ii. Geologic Sequestration: Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.

iii. Terrestrial Sequestration: A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks.

The main strategies for using forests for carbon sequestration

Active forest management

Avoided deforestation

Forest preservation

Afforestation

Challenges in soil carbon sequestration

- Deforestation
- Residue burning
- Conventional tillage
- Imbalanced use of fertilizers
- Reduced inputs of organic matter

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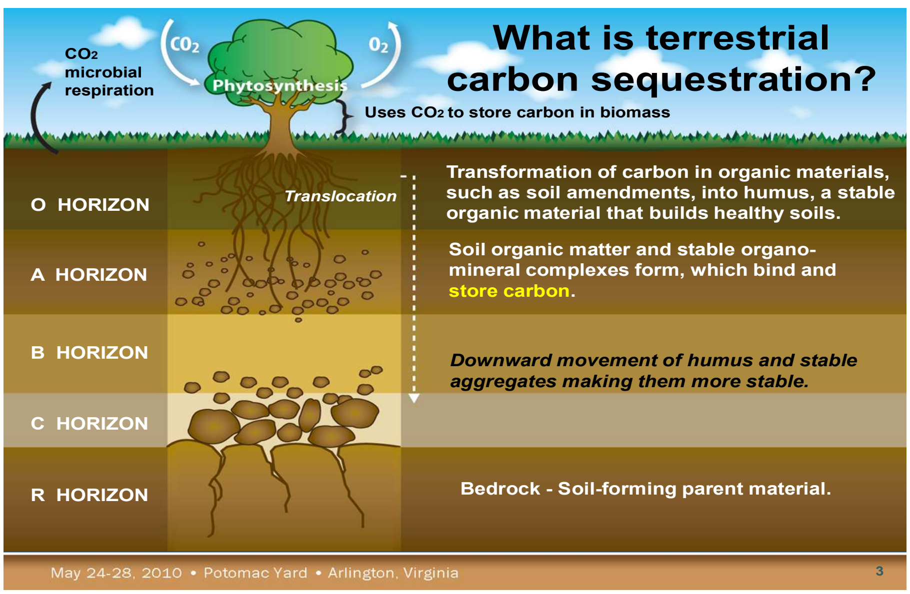
Terrestrial Sequestration

Terrestrial sequestration is a process that captures and stores carbon dioxide (CO_2) in vegetation and soil within a few feet of the Earth's surface, providing them with the components they need to live and grow and reducing CO_2 in the atmosphere.

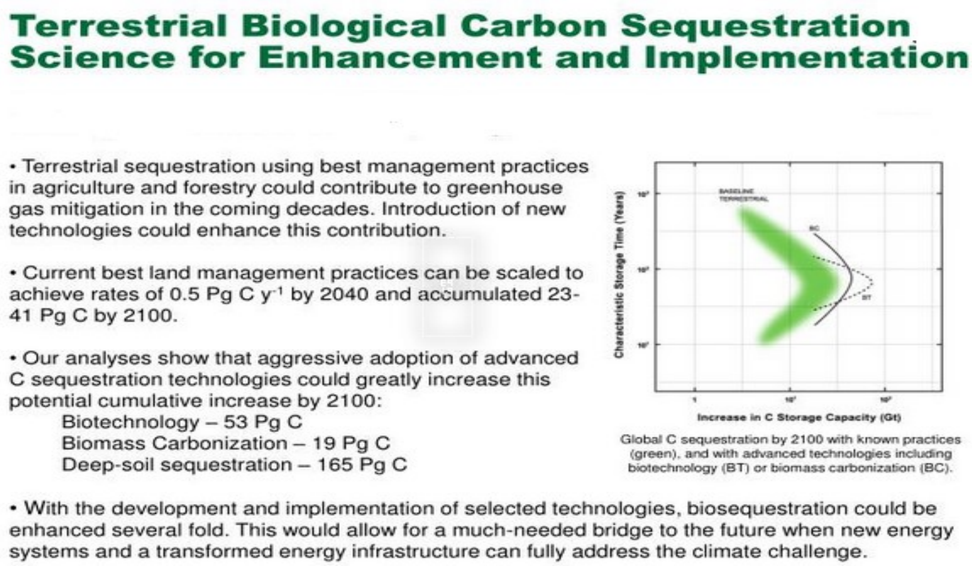
The process through which CO_2 from the atmosphere is absorbed naturally through photosynthesis and stored as Carbon in biomass and soil.

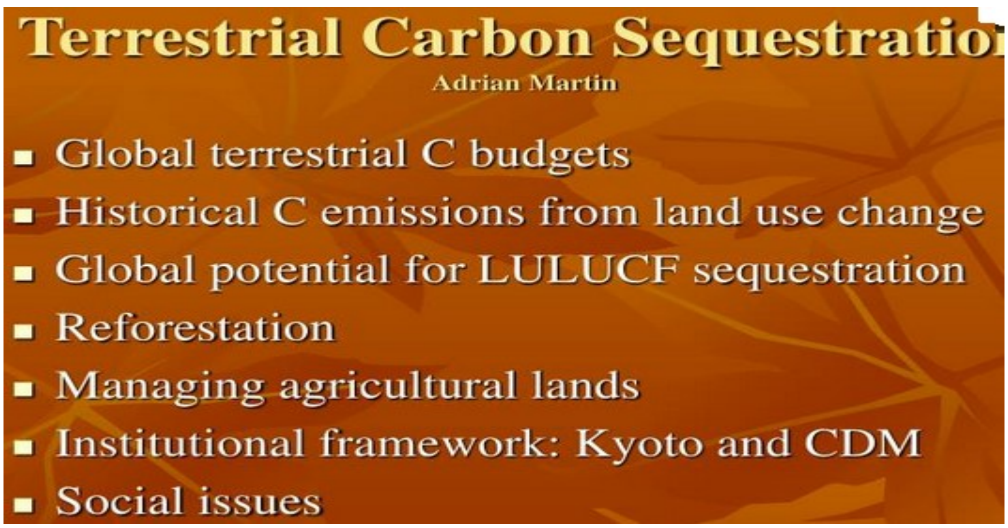


The amount of carbon stored in terrestial carbon sequestration is obtained through the process of **photosynthesis.**

The carbon from corbon di oxide is biochemically transformed into carbohydrates necessary for plant growth and structure.

Most of the carbon eventually cycles back to the atmosphere through the decomposition of plant material, but a fraction is retained in soil and wetland sediments.





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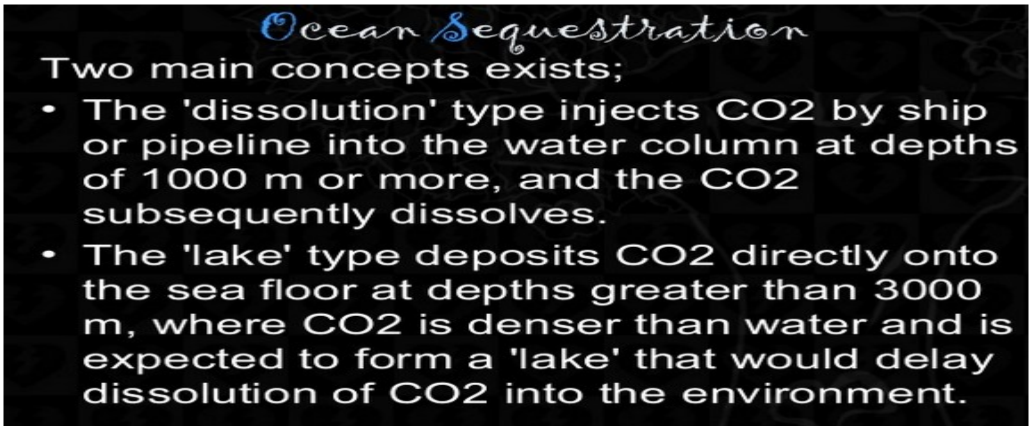
S6: Ocean Sequestration

The ocean represents the largest potential sink for anthropogenic CO_2. Discharging CO_2 directly to the oceanwould accelerate the ongoing, but slow, natural processes by which over 90% of present-day emissions arecurrently entering the ocean indirectly and would reduce both peak atmospheric CO_2 concentrations and their rateof increase.

In the ocean, carbon sequestration, a fancy word for the process by which carbon dioxide is removed from the atmosphere, is achieved through various chemical and biological processes. Plankton at the ocean surface use photosynthesis to convert carbon dioxide into sugars in the same way trees and land plants do on land.

Carbon is naturally stored in the ocean via two pumps, solubility and biological and there are analogous man made methods, direct injection and ocean fertilization, respectively. At the present time, approximately one third of human generated emission are estimated to be entering the ocean.

Carbon sequestration by direct injection into the deep ocean involves the capture, separation, transport and injection of CO_2 from land or tankers. One-third of CO_2 emitted a year already enters the ocean. Ocean has 50 times more carbon than the atmosphere.



18CE0406T GLOBAL WARMING AND CLIMATE CHANGE

UNIT – 5

[S7 – S9]

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S7: Green building technology, Landscaping restoration and plantation

S8: ***Mitigations and adaptation in India, Prevent and precaution measures (health issues, environmental damages)***

S9: ***Energy policies for a cool future, Energy Audit.***

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S7: Green building technology, Landscaping restoration and plantation

Green building technology

What is green building?

A Green building is nothing more than a building which is built using reusable materials and other materials which make the building efficient and environmentally friendly. And Green building technology typically covers everything from geothermal heating to energy-efficient appliances.

The expression 'green building' refers to both the eco-friendly process of construction and the concrete structure itself, which is realised following the above mentioned sustainable processes.

In this way, with the term green building we can point to the process of construction, but also to the environmentally sustainable building designed to minimise the total environmental impacts on nature.

From the aesthetic point of view, green building follows the philosophy of designing buildings that are in harmony with the surrounding site. Architectural forms must be inspired by nature, with colours that do not seem artificial and using only the materials that nature provides.

Solar, wind, and hydroelectric dams are all examples of green technology because they are safer for the environment and don't produce fossil fuel waste by-products. Besides the environmental benefits of these alternative energy sources, they can also be used to power a home or a utility power plant.

What are the 7 components of green building?

Goals of green building

- Life cycle assessment.
- Siting and structure design efficiency.
- Energy efficiency.
- Water efficiency.
- Materials efficiency.
- Seperior Indoor environmental quality enhancement.
- Operations and maintenance optimization.
- Waste reduction.
- Storm water management

How is green building produced?

The processes involved in green building cover all the fields of the construction industry, from the siting and the initial design of a building, to the renovation of it, always considering the need for sustainability.

In this way, the mail goal of sustainable building is to reduce the impact of building on the environment. More in particular, renewable resources which provides clean energy with zero **CO_2 emissions** (such as solar, geothermal, biomass energy and wind and hydro power) can be employed, thus resulting in a reduction of waste, pollution and contamination.

How can green building improve human health?

Green building takes into consideration also the protection and preservation of human health, through the use of natural materials, improving indoor air quality and the design of healthy indoor environment. Human health can be improved in different ways, for example, as we already said, green buildings can reduce illnesses caused by poor air quality issues. Using nontoxic building materials green building help fight indoor air pollution. Green building can also really improve the quality of life, for example using materials which can reduce noise on the workplace will improve employees' health, as well as preserving their productivity.

What are the other benefits deriving from green building?

Well designed green buildings will not only create healthier environments for people to live and work, but they will also save your money. First of all, as already said, using green materials will cut energy and water costs.

Experts report that businesses that pay the initial 2% increase for green materials as opposed to traditional building materials (on average) will recoup this initial outlay by as much as six to seven times.

Moreover, sustainable building materials save money in maintenance and reparation costs. Sustainable building materials require less energy to be used, and thus, they are low cost.

Try to imagine a building which is totally enlightened or heated by using only natural daylight; that will incredibly help in reducing energy use in buildings and cut the power source costs.

In addition, the federal, the state and the local governments offer rebates, tax credits and other financial incentives for building green (depending upon where you operate your business).

So, even if initial construction costs may be higher, lower operating and energy costs mean that green buildings provide a long-term return on investment.

What are the benefits of green buildings?

- Low Maintenance and Operation Cost. Green buildings incorporate unique construction features that ensure efficient use of **resources** such water and **energy**. ...
- **Energy** Efficiency. ...
- Enhances Indoor Environment Quality. ...

- Water Efficiency. ...
- Better Health. ...
- Material Efficiency. ...
- Better Environment. ...
- Reduces Strain on Local **Resources**.

Green Building Materials used in Construction

Following is the list of Green building materials used in construction :

1. Earthen Materials
2. Wood
3. Bamboo
4. SIPs
5. Insulated Concrete Forms
6. Cordwood
7. Straw Bale
8. Earth Bags
9. Slate/ Stone Roofing
10. Steel
11. Thatch
12. Composites
13. Natural Fiber
14. Polyurethane
15. Fiber Glass
16. Cellulose
17. Cork
18. Polystyrene and isocyanurate
19. Natural Clay
20. Non- VOC paints
21. Natural Fiber Floor
22. Fiber Cement
23. Stone

Top sustainable technologies in green construction

- **Solar power**. In green construction, there is active **solar power** and the other is passive **solar power**. ...
- Biodegradable materials. ...
- Green insulation. ...
- The use of smart appliances. ...
- Cool roofs. ...
- Sustainable resource sourcing. ...
- Low-energy house and Zero-energy building design. ...
- Electrochromic Smart Glass

Landscaping restoration and plantation

Principles of a landscape approach

- Continual Learning and Adaptive Management
- Common Concern Entry-Point
- Multiple Scale
- Multi-Functionality
- Multi-Stakeholder
- Negotiated and Transparent Change Logic
- Clarification of Rights and Responsibilities
- Participatory and User-Friendly Monitoring
- Resilience
- Strengthened Stakeholder Capability

FLR: Forest landscape Restoration

Designing a FLR Project

Identify clear goals & turn them into measurable objectives

	Goal	Objective	Plan
Meaning	Purpose of FLR project	Accomplishment	Activities that result in accomplishment
Measure	Not measurable/tangible	Measurable	Sequenced list of what, where, when, by whom, at what cost
Timeframe	Long-term	Short to mid-term	Short to mid-term
FLR Example	Restore degraded land along river basin	20 m buffer along rivers	Plant 100 ha of native species along rivers in Kigali provice by end of 2016 by local farmers

Technical aspects of FLR implementation

- Implementation specific for landscape units
  - Restoration methods for forest functions (hydrological, protection, biodiversity, carbon, production)
  - Restoration strategies (active/passive)
  - Species choice/planting design
  - Agriculture crops
- Landscape unit plan – overarching FLR plan
- Capacity building

key guiding principles of landscape restoration

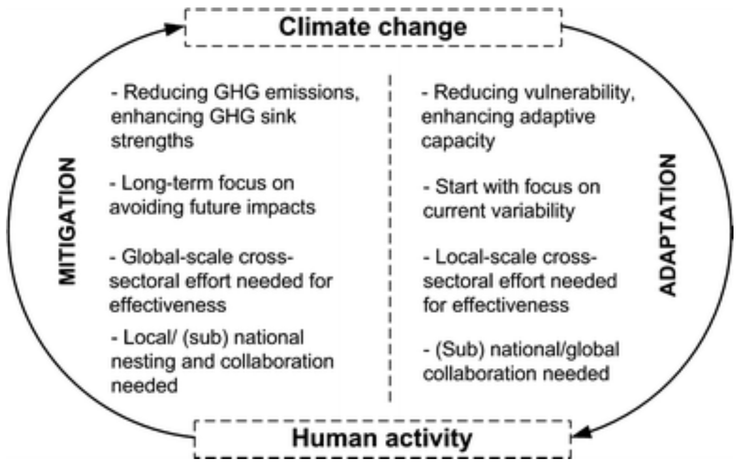
Select site
Identify Stakeholders
Analyze - why forest degradation
Discuss Goals
Prepare for planting
Implement - Plant trees
Monitor the areas
Consider the climate change Impacts
Develop Restoration Plan

i. Select a suitable site or landscape, including the analysis and evaluation of current land uses and land tenure/ownership, and1.identify involved stakeholders.
ii. Analyse and evaluate the drivers of deforestation or forest degradation.
iii. Engage stakeholders, discuss long-term goals of forest restoration considering the interests of all stakeholder groups, and draft a3.preliminary restoration/rehabilitation plan.
iv. Collect seeds, produce seedlings in nurseries and prepare for planting.
v. Plant trees.
vi. Assess capacity-building needs and plan for the necessary training
vii. Establish realistic time schedules and plan for financial requirements.
viii. Monitor restored/rehabilitated areas, and conduct maintenance activities as required.
ix. Consider possible climate-change impacts.
x. Develop a restoration management plan, including:
    - preparing a topographic land-use map, including a designation of forest functions, assessment of road accessibility,existence of natural regeneration and needs for planting;
    - agreeing on restoration/rehabilitation objectivess
    - selecting the restoration/rehabilitation method
    - choosing the species to be used, and establishing a nursery and
    - assessing possible positive and negative social and environmental impacts.

S8: Mitigations and adaptation in India

To promote sustainable, low-carbon, and climate-resilient growth, India will require continuous efforts in mitigation and adaptation through Nationally Appropriate Mitigation Actions and National and State Adaptation Plans.

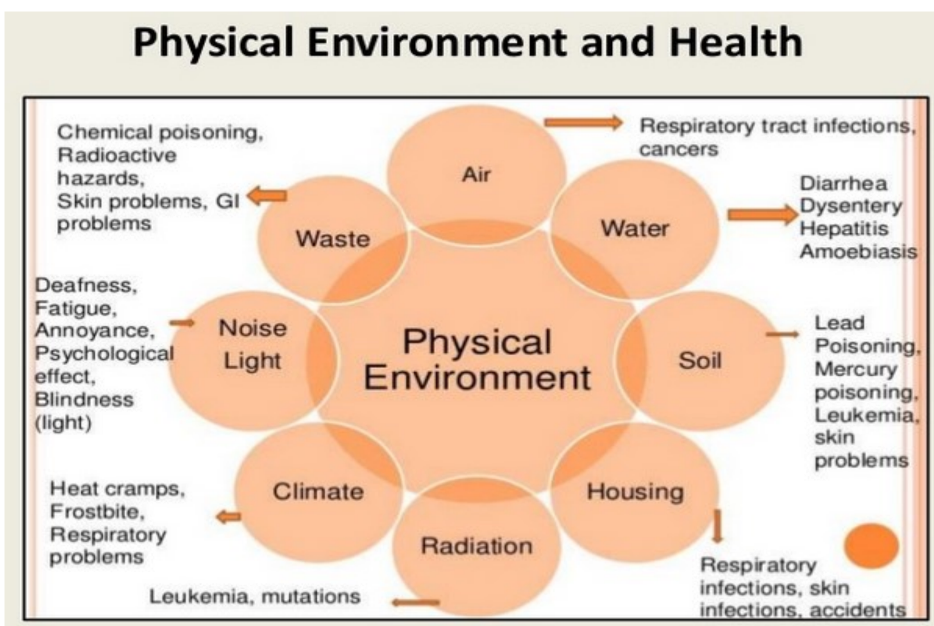
The difference between climate change **mitigation** strategies and climate change **adaptation** is that **mitigation** is aimed at tackling the causes and minimising the possible impacts of climate change, whereas **adaptation** looks at how to reduce the negative effects it has and how to take advantage of any opportunities.

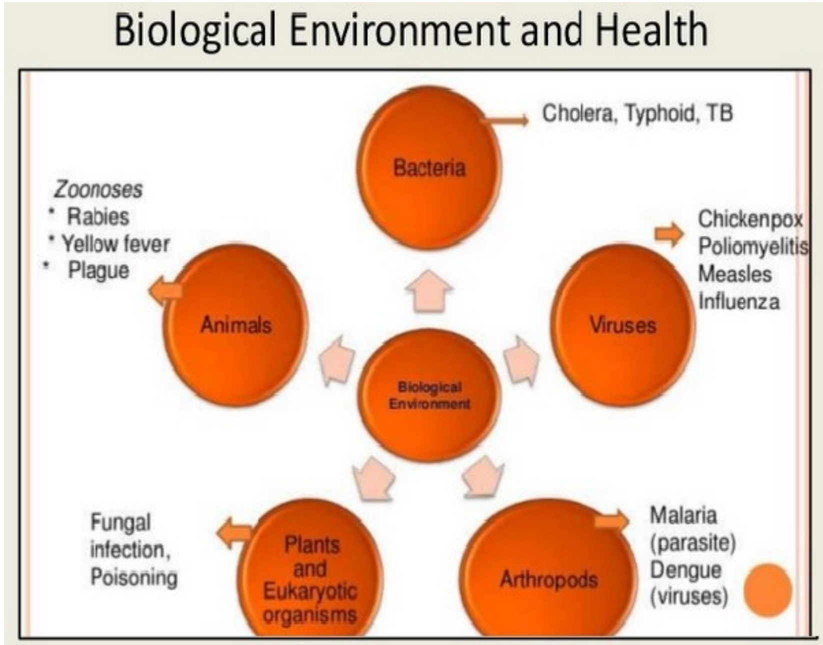


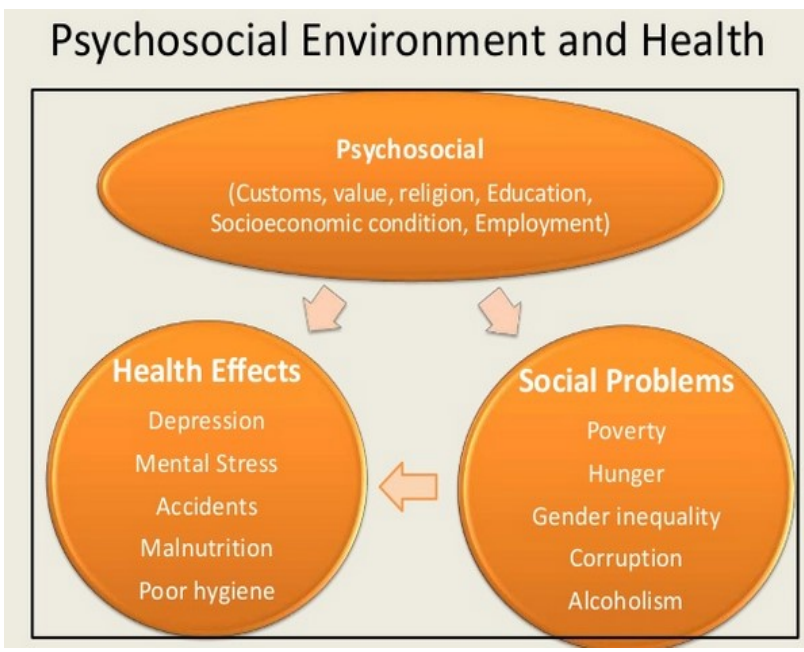
Prevent and precaution measures (health issues, environmental damages)

Environmental Concerns for 2019?

- Biodiversity. Biodiversity is the most complex and vital feature of our planet. ...
- Water pollution is a huge concern for us and our environment. ...
- Air pollution
- Deforestation. We need plants and trees to survive. ...
- Climate Change.




Biological Environment and Health
Cholera, Typhoid, TB
Bacteria
Zoonoses
* Rabies
* Yellow fever
* Plague
Chickenpox
Poliomyelitis
Measles
Influenza
Animals
Viruses
Biological Environment
Fungal infection, Poisoning
Plants and Eukaryotic organisms
Arthropods
Malaria (parasite)
Dengue (viruses)


Psychosocial Environment and Health
Psychosocial
(Customs, value, religion, Education, Socioeconomic condition, Employment)
Health Effects
Depression
Mental Stress
Accidents
Malnutrition
Poor hygiene
Social Problems
Poverty
Hunger
Gender inequality
Corruption
Alcoholism

Effects on Environment

- Plastic waste disposal on land makes it infertile
- Burning generates toxic emissions -CO, HCl, Dioxin, Furans
- Leaching out of toxic chemicals added as additives
- Littering
- Choked drains can cause flooding
- Affects waste processing facilities like composting
- In environment, plastic breaks down into smaller particles, are ingested by wildlife on land and in the ocean and enter human food chain.

Prevention and control

- Some measures which can be adopted in this direction are as follows:

1. Use of unleaded petrol
2. Using fuels with low sulphur and ash content
3. Promotion of use of public transport
4. Sensitive locations (hospitals, schools, playgrounds etc.) should not be located along the busy streets
5. Vegetation cover should be increased along the roadside, busy traffic intersection points, and on the road dividers.
6. Industries and waste disposal sites should preferably be situated in outskirts of the city.

Prevention & Control

- Encourage plantation of trees
- Less use of air conditioners & refrigerators
- Use solar energy, wind mills for power supply
- Cautious use of vehicles
- Preserve wet lands
- Improve water harvesting
- Ban the plastic bag
- IEC activities

....

S9: Energy policies for a cool future, Energy Audit.

Energy policies for a cool future

What type of energy will we use in the future?

Atomic energy, **solar energy**, and energy from **wind** and **bio fuels** are just a few of the promising alternatives for a cleaner and greener future. Other relatively new **sources** of energy such as fuel cells, **geothermal energy**, and ocean energy are also being explored.

Energy sector in India: it challenge

- India, one of the fastest under developing country
- Its population is second in world and first in term of density
- In last thirty year, there is boom in power sector with formation of NTPC, NHPC
- 2003 ACT, allowing private player to invest in generating sector change whole picture
- 70% of electricity generation is depend upon coal
- Coal is limited and demand of energy generation rising day by day
- It is need to change the electricity generation pattern.
- Nuclear and Hydro generation may come in picture in future
- Need to invest in renewable form of energy for sustainable growth

Ministry of New and Renewable Energy

- Name it self explain the objective of ministry "to work for exploring and implementation of non conventional and new form of energy"
- MNRE work in five major area:
  1. Grid-interactive renewable power (wind power, Small hydro power, Urban & industrial waste to energy and solar power)
  2. Distributed renewable power (Biomass, Biomass gasifier, waste to energy, Aero generator/ hybrid system)
  3. Rural and Decentralized energy system (family type biogas plant, solar street lamp, home lighting system, Solar Photovoltaic system and wind pump)
  4. Remote village electrification
  5. Other program (energy Park, Akshay urja and hybrid car)

Future Prospective of Renewable Energy in India

- The Integrated Energy Policy Report (IEPR), prepared by the planning commission of India, has recognized renewable energy sources remain important to Indian's energy sector
- With a concerted push and a 40 fold increase in their contribution to the primary energy, renewables may account for only 5-6% of India's energy mix by 2031-32

Resources	Upto 10th plan	11th plan	12th -13th plan	Total
Wind Power	7000 MW	10500 MW	22500 MW	40000 MW
SHP	1960 MW	1400 MW	3140 MW	6500 MW
Bio Power	1037 MW	2100 MW	4363 MW	7500 MW
Solar Power	3 MW	1000 MW	20000 MW	22000 MW
Total				

Energy Audit

An energy audit is an inspection survey and an analysis of energy flows for energy conservation in a building. It may include a process or system to reduce the amount of energy input into the system without negatively affecting the output.

The **main purpose of an energy audit** is to determine whether your home wastes energy, and to pinpoint where energy is being lost so you can evaluate what measures you can take to make your home more energy efficient.

An energy audit is designed to help you identify the most cost effective and practical options to reduce your energy consumption and costs. ... In some cases, identifying billing discrepancies may alone pay for the cost of the audit. An energy audit will look at all common area equipment and central building services.

Energy audits are way for businesses to understand how and where they use energy. An energy audit requires a detailed survey of a business's equipment and an analytical understanding of a business's operating patterns.

Energy audits can be characterised into 4 broad types, they are:

1. Benchmarking
2. Walkthrough Audit
3. Detailed Audit
4. Investment-grade audit

How is an energy audit done?

An **energy audit** is an assessment of your home that takes a look at current **energy** consumption and then identifies **energy** efficiency measures that you can conduct to make your home more efficient. ... Professional **energy audits** can take anywhere from 30 minutes to 4 hours to complete, depending on the size of your home.

Can you do your own energy audit?

To complete your own energy audit, take the following steps.

1. Step 1: Check Heating and Cooling Systems. Heating and air conditioning is the largest **energy** consumer in the United States, accounting for around 48% of the average home's **energy** use. ...
2. Step 2: Inspect Insulation and Sealing. ...
3. Step 3: Account for Electricity Waste.

Energy Audit Instrument

No.	Name of the Instrument	Intended Use
1.	Flue Gas Analysers	Used for optimizing the combustion efficiency by measuring/monitoring the oxygen and CO levels in flue gas of boilers, furnaces etc. and calculation of CO2 percentage in excess air level and efficiency.
2.	Temperature Indicators	Used for measuring temperatures of gases/air, liquids, slurries, semi solids, powders etc. Using different types of probes.
3.	Infrared Thermometers	Used for measuring temperatures from a distance using infrared technology.
4.	Thermal Insulation scanner	Used for measuring loss of energy in Kcal per unit area from hot/cold insulated surfaces. The total loss can be obtained by multiplying the total surface under study.
5.	Steam Trap Monitor	Used for performance evaluation of steam Traps.
6.	Conductivity Meter	Used for on the spot water analysis of the amount of dissolved solids in water.
7.	pH meter	Used for on the spot analysis of effective acidity or alkalinity of a solution/water. Acidity /alkalinity water.
8.	Thermo-hygrometer	Used for measurement of air velocity & humidification, ventilation, Air-conditioning and refrigeration systems etc.
9.	Thermo-hygrometer	Used for measurement of humidity and temperature and the calculation of dew point to find out the heat being carried away by out going gases in industries. Where product drying requires hot air.
10.	Ultrasonic Flow Meter	Used for measurement of flow of liquids through pipelines of various sizes through ultrasonic sensors mounted on the pipelines.
11.	U-Tube Manometer	Used for measurement of differential pressure.
12.	Digital Manometer	Used for measurement of differential pressure.

Unit 5

S4 and S5

SLO-1 Clean Technology, Biodeisel, compost, biodegradable plastic

SLO-2 Concept of sustainable development

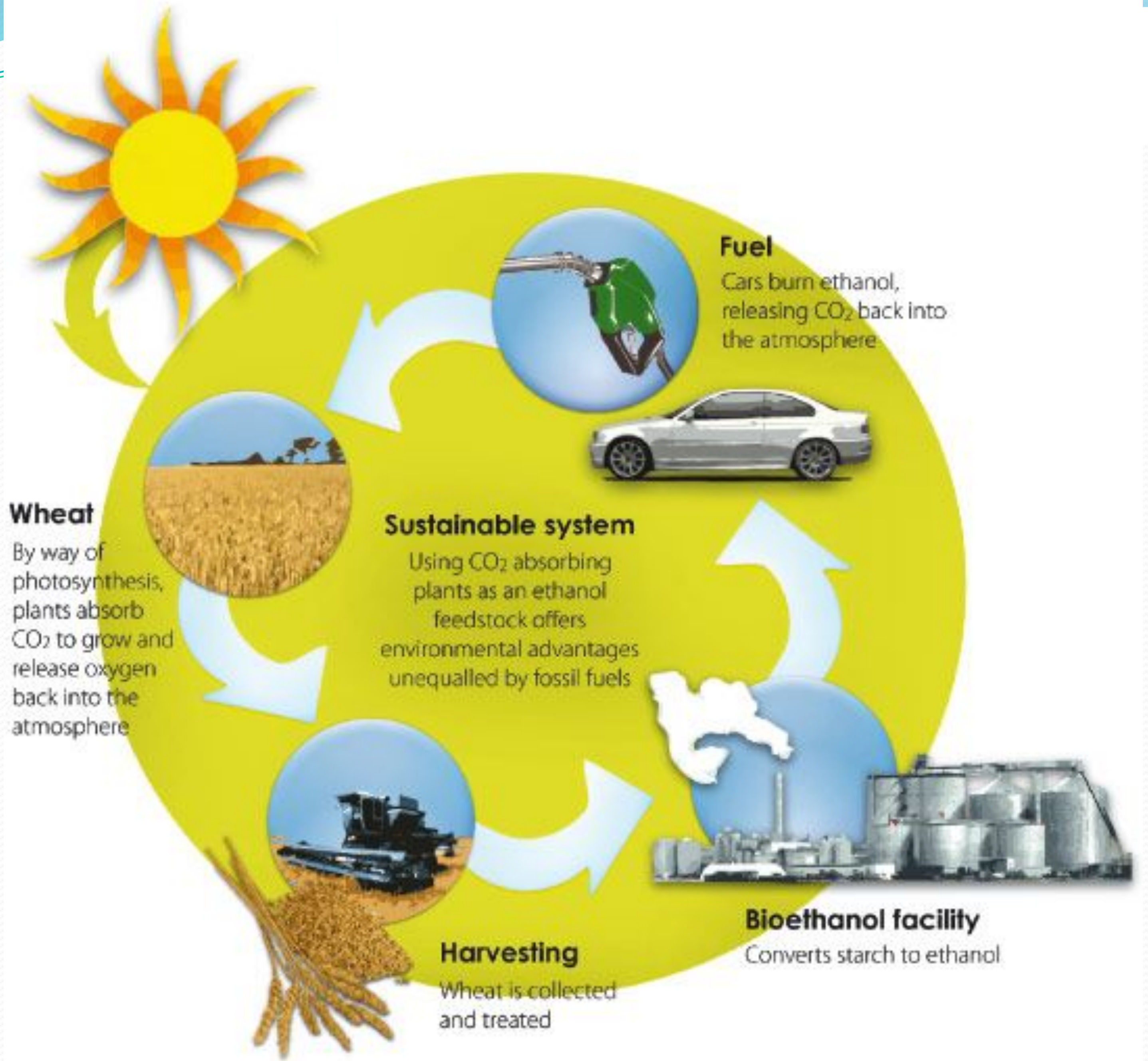
Clean Technology

- **Clean technology**, in short cleantech, is any process, product, or service that reduces negative environmental impacts through significant **energy** efficiency improvements, the sustainable use of resources, or environmental protection activities.

Clean Technology
Clean Energy
Bio-fuels
Energy efficiency
Fuel cells
Microturbines
Photovoltaics
Small-scale hydro
Wave/tidal power
Wind power
Clean Transportation
Advanced battery storage
Electro propulsion
Fuel-cell vehicles
Hybrid-electric vehicles
Solar-powered vehicles
Stirling engines
Clean Water
Biological water filtration
Decentralized filtration systems
Small-scale desalination
Ultraviolet purification
Wetlands restoration
Clean Materials
Biobased materials
Biomemetics
Green buildings
Green chemistry
Phytoremediation

Biofuels

- Unlike other renewable energy sources, biomass can be converted directly into liquid fuels, called "biofuels," to help meet transportation fuel needs. The two most common types of biofuels in use today are ethanol and biodiesel.
- Ethanol is an alcohol, the same as in beer and wine (although ethanol used as a fuel is modified to make it undrinkable). It is most commonly made by fermenting any biomass high in carbohydrates through a process similar to beer brewing.
- Today, ethanol is made from starches and sugars
- Ethanol can also be produced by a process called gasification. Gasification systems use high temperatures and a low-oxygen environment to convert biomass into synthesis gas, a mixture of hydrogen and carbon monoxide. The synthesis gas, or "syngas," can then be chemically converted into ethanol and other fuels.
- Ethanol is mostly used as blending agent with gasoline to increase octane and cut down carbon monoxide and other smog-causing emissions. Some vehicles, called Flexible Fuel Vehicles, are designed to run on E85, an alternative fuel with much higher ethanol content than regular gasoline.



Fuel
Cars burn ethanol, releasing CO_2 back into the atmosphere
Wheat
By way of photosynthesis, plants absorb CO_2 to grow and release oxygen back into the atmosphere
Sustainable system
Using CO_2 absorbing plants as an ethanol feedstock offers environmental advantages unequalled by fossil fuels
Harvesting
Wheat is collected and treated
Bioethanol facility
Converts starch to ethanol

Food security???

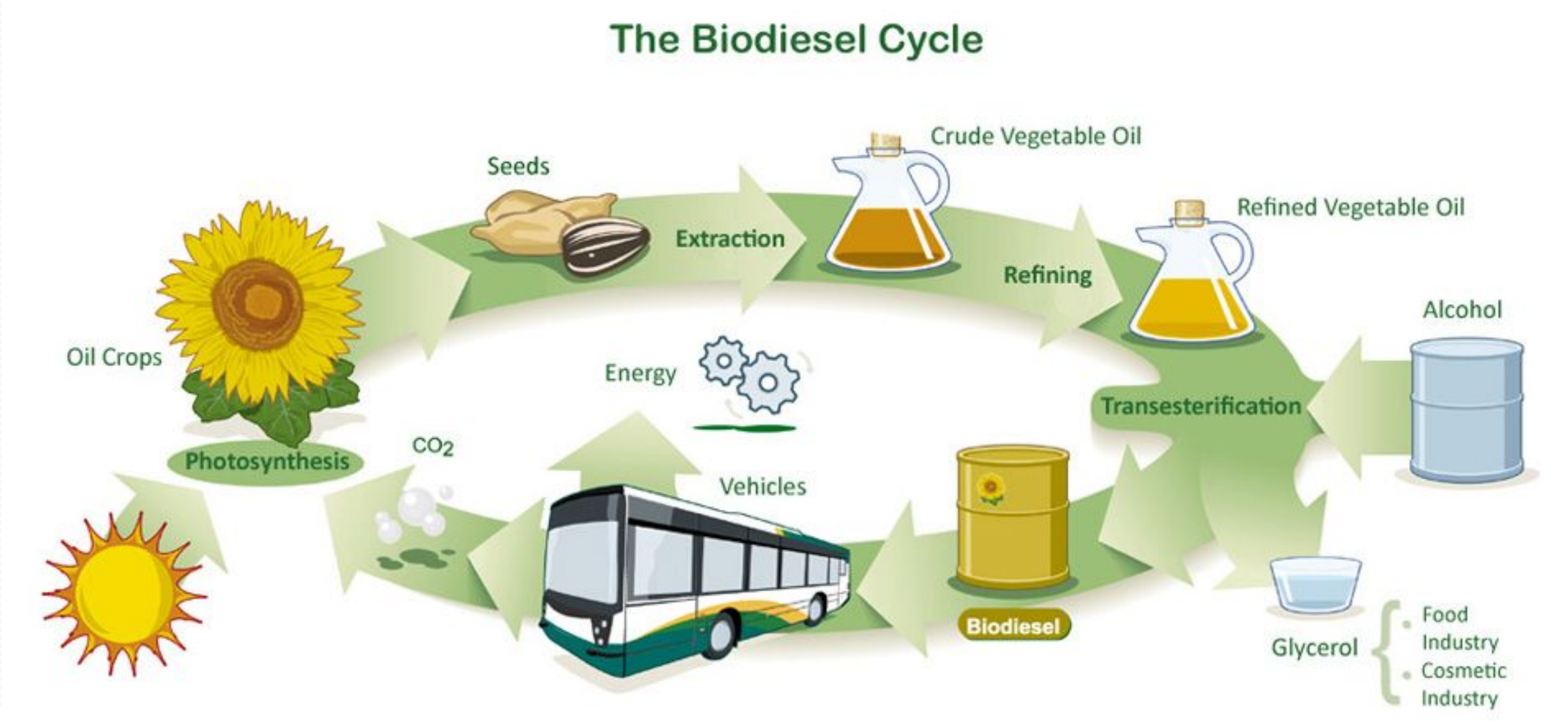
- Biofuel crops increase emissions through land clearance, fertiliser use, and by displacing other crops.
- When millions of hectares of land are switched from food to biofuel crops, food prices rise and food production is displaced, triggering a domino-like chain of events ending in cropland expansion elsewhere, including into the tropical forests of Southeast Asia and the savannas of South America and Africa.
- So, proper policies should be framed for areas that should be used for cultivation of biofuel crops and edible crops not to threaten the food security of any country that cultivates crops for biofuels.

Biofuels can come from a wide variety of sources and can be roughly divided into four categories or "generations:"

- First generation biofuels are made from sugars, starches, oil, and animal fats that are converted into fuel using already-known processes or technologies. These fuels include biodiesel, bio-alcohols, ethanol, and bio-gasses, like methane captured from landfill decomposition.
- Second generation biofuels are made from non-food crops or agricultural waste, especially ligno-cellulosic biomass like switch-grass, willow, or wood chips.
- Third generation biofuels are made from algae or other quickly growing biomass sources.
- Fourth generation biofuels are made from specially engineered plants or biomass that may have higher energy yields or lower barriers to cellulosic breakdown or are able to be grown on non-agricultural land or bodies of water.

Biodiesel

- Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant grease for use in diesel vehicles.
- Biodiesel's physical properties are similar to those of petroleum diesel, but it is a cleaner-burning alternative.
- Using biodiesel in place of petroleum diesel, especially in older vehicles, can reduce emissions.


The Biodiesel Cycle
Seeds
Crude Vegetable Oil
Extraction
Refined Vegetable Oil
Refining
Alcohol
Oil Crops
Energy
Transesterification
CO_2
Photosynthesis
Vehicles
Biodiesel
Glycerol
Food Industry
Cosmetic Industry

- Biodiesel is a liquid fuel often referred to as B100 or neat biodiesel in its pure, unblended form. Like petroleum diesel, biodiesel is used to ***fuel compression-ignition*** engines, which run on petroleum diesel.
- How well biodiesel performs in cold weather depends on the blend of biodiesel. The smaller the percentage of biodiesel in the blend, the better it performs in cold temperatures.

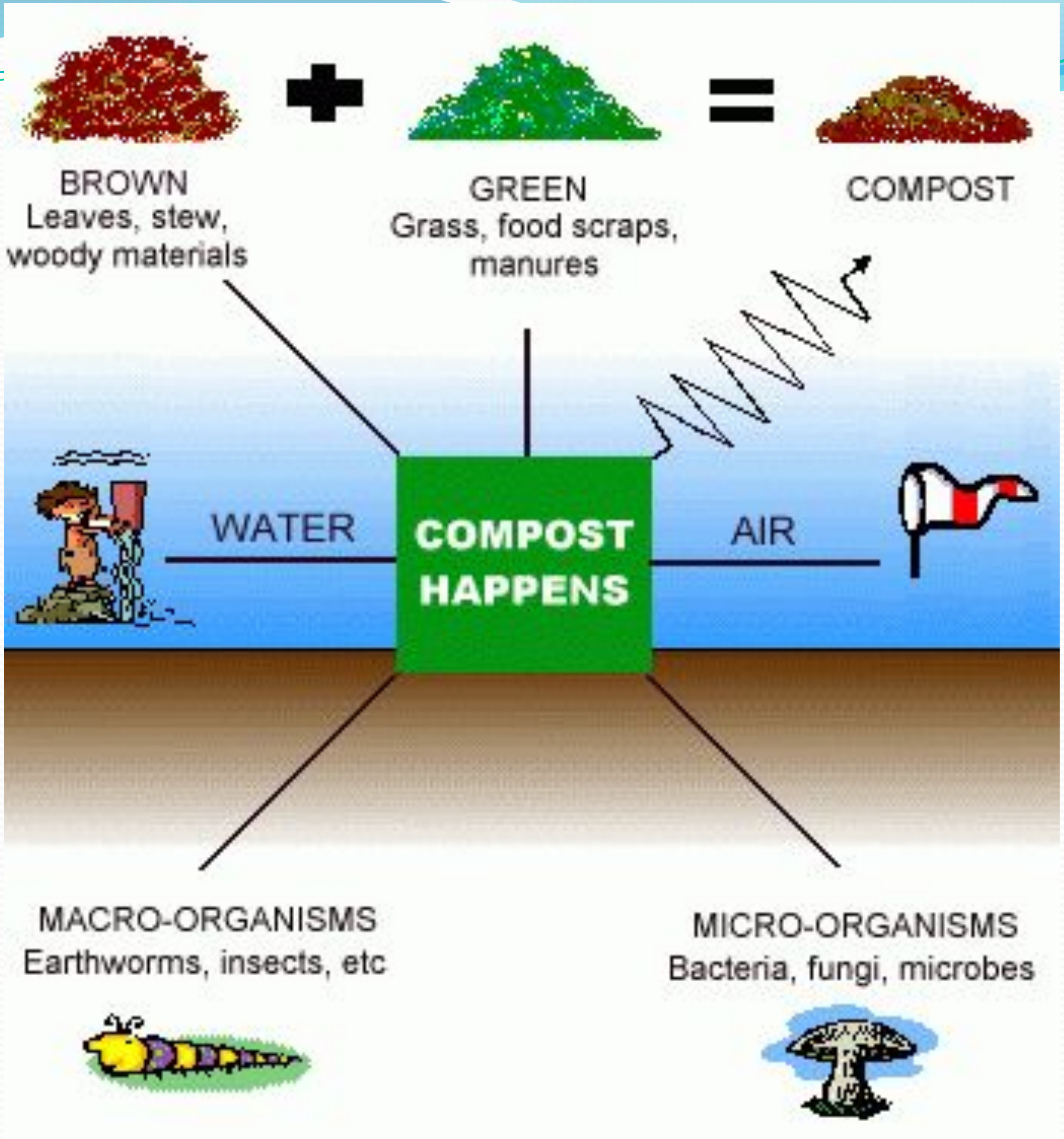
1) Biodiesel is a clean burning renewable fuel made using natural vegetable oils and fats.
2) Biodiesel is made through a chemical process which converts oils and fats of natural origin into fatty acid methyl esters (FAME) through a process called trans-esterification.
3) Biodiesel is intended to be used as a replacement for petroleum diesel fuel, or can be blended with petroleum diesel fuel in any proportion.
4) Biodiesel does not require modifications to a diesel engine to be used.
5) Biodiesel has reduced exhaust emissions compared to petroleum diesel fuel.
6) Biodiesel has lower toxicity compared to petroleum diesel fuel.
7) Biodiesel is safer to handle compared to petroleum diesel fuel.
8) Biodiesel quality is governed by ASTM D 6751 quality parameters.
9) Biodiesel is biodegradable.

Compost

- **Composting** is the process that speeds up decomposition of organic materials by providing ideal conditions for microorganisms to thrive.
- **Compost** is rich in nutrients. It is **used, for** example, in gardens, landscaping, horticulture, urban agriculture and organic farming. The **compost** itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil.

- Composting is a great way to reduce your food waste and contributions to GHG
- Compost is simply decayed organic matter — and "organic matter" is a pretty wide-ranging label. A twig can be organic matter, but so can a banana peel. When you mix a bunch of these items together in a compost pile, they break down naturally into a nutrient-rich fertilizer that helps gardens grow. Green house gas emissions.

- Studies further show that compost can aid in carbon sequestration. When applied to soil, compost potentially functions as a "carbon sink," trapping and containing the element in the dirt. And if the carbon is in the ground, it isn't in our atmosphere, where it can wreak havoc on the planet.


BROWN
Leaves, stew,
woody materials
GREEN
Grass, food scraps,
manures
COMPOST
WATER
COMPOST
HAPPENS
AIR
MACRO-ORGANISMS
Earthworms, insects, etc
MICRO-ORGANISMS
Bacteria, fungi, microbes

Types of Composting

- **Composting** Basics.
- Onsite **Composting**.
- Vermicomposting.
- Aerated (Turned) Windrow **Composting**.
- Aerated Static Pile **Composting**.
- In-Vessel **Composting**.

Biodegradable plastics

- **Biodegradable plastics** are **plastics** that can be decomposed by the action of living organisms, usually microbes, into water, carbon dioxide, and biomass. **Biodegradable plastics** are commonly produced with renewable raw materials, micro-organisms, petrochemicals, or combinations of all three.
- While the words "bioplastic" and "biodegradable plastic" are similar, they are not synonymous. Not all bioplastics are biodegradable.

What plastic is biodegradable?

- One set of degradable plastics are **materials** such as PLA (**Polylactic Acid**) that are unique plastics for which biological degradation potential is part of the nature of the plastic. The second set is **materials** of the standard #1 **PET**, #2 HDPE, #4 LDPE, #5 PP and #6 PS with special degradable additives included.

- **Biodegradable plastics** are very rarely recyclable, and **biodegradable** does not mean **compostable**–so they often up in the landfill. **Compostable** and bioplastic goods can be a better choice than **biodegradable** ones, but often still end up in landfills unless you can compost appropriately.

What are the problems with biodegradable plastics?

- When some biodegradable plastics decompose in landfills, they produce methane **gas**. This is a very powerful greenhouse **gas** that adds to the problem of global warming. Biodegradable plastics and bioplastics don't always readily decompose.

- Biodegradable plastics take **three to six months** to decompose fully. That's much quicker than synthetic counterparts that take **several hundred years**. Exactly how long a biodegradable bag takes to break down depends on various factors, such as temperature and the amount of moisture present.

Concept of **Sustainable development**

- "**Sustainable development** is **development** that meets the needs of the present without compromising the ability of future generations to meet their own needs.“
- The **aim of sustainable development** is to balance our economic, environmental and social needs, allowing prosperity for now and future generations. These include social progress and equality, environmental protection, conservation of natural resources and stable economic **growth**.

- Political **barriers**: Inadequate economic, social and environmental **methods** for policies, plans and projects are the **major barrier** combating the implementation of **sustainable development**.

Concept of sustainable development

Sustainable development is maintaining a delicate balance between the human need to improve lifestyles and feeling of well-being on one hand, and preserving natural resources and ecosystems, on which we and future generations depend.

Why sustainable Development is Important

It's no secret that people are living longer and that the global population is on the rise. In fact, the United Nations projects that there will be more that 10 billion people living on the Earth by the year 2100. This explosion in population is perhaps one of the greatest reasons why sustainable development is so important.

Provide Basic Human Needs(social)

A rising population will also make use of the bare essentials of life such as food, water, and shelter.

Agricultural Necessity

Agriculture will have to catch up with that growing population as well, figuring out ways to feed around 3 billion more people than it currently does

Accommodate City Development(social)

As populations rise, cities will need to become larger to accommodate the influx of new residents.

Control Climate Change

Climate change is another issue that can be at least partially remedied through sustainable development. Sustainable development practices would mandate a lower use of fossil fuels, which are not sustainable and which produce greenhou gases.

Provide Financial Stability(economic) Sustainable development can also produce more financially sustainable economies throughout the world.

Sustain Biodiversity(Environmental) Biodiversity suffers through overconsumption and unsustainable development practices.

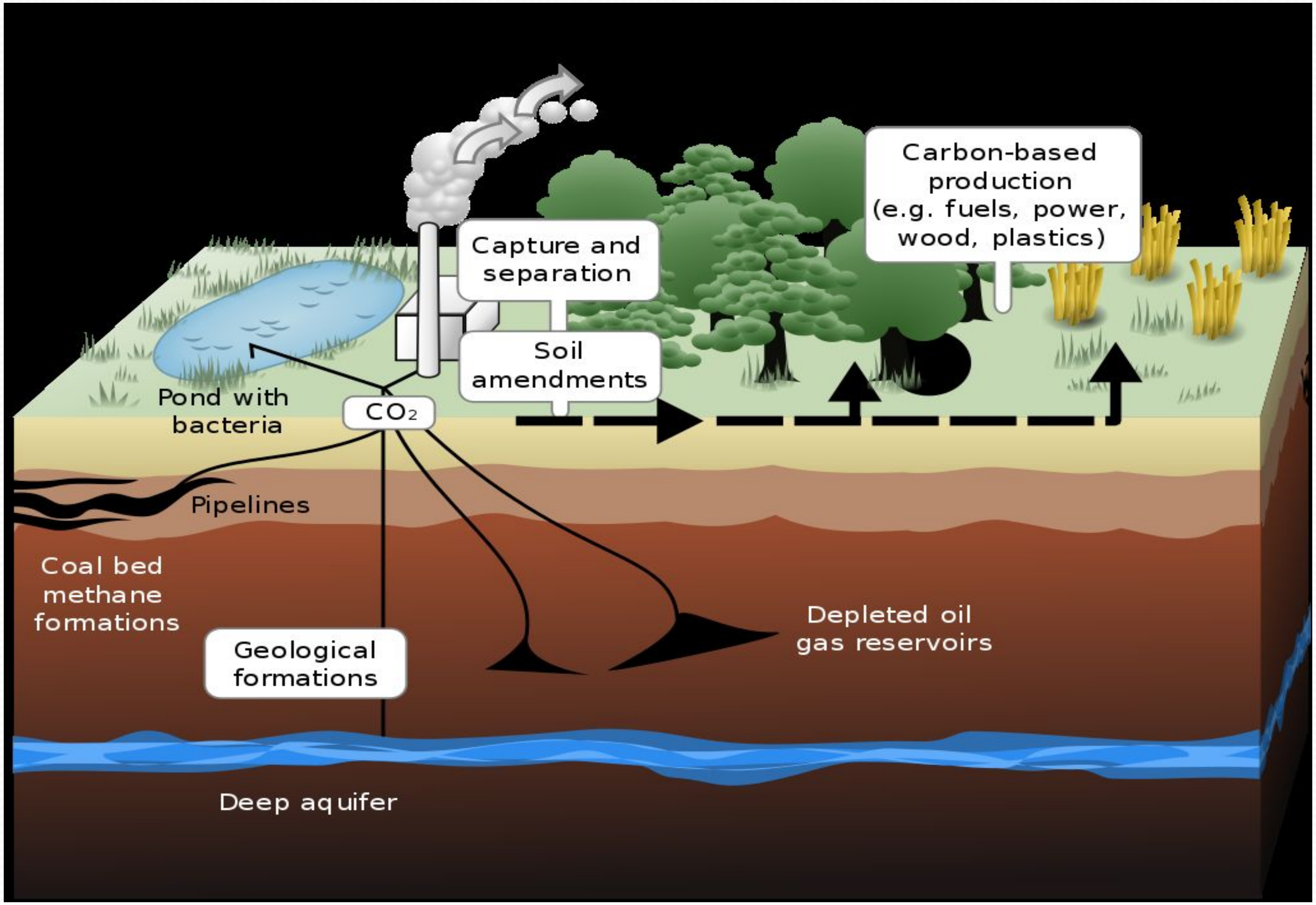
- For example, if unsustainable agricultural practices are used in regard to pesticides, bees and other pollinators could be negatively impacted. Without bees, at least 19 major food crops would suffer and nearly 50% of the food in most grocery stores would be non-existent.

Technology: we are living in a world where almost everything is done technologically. We need sustainable development in managing these resources through recycling and other methods

Concept of carbon sequestration

- **Carbon sequestration** is the process of capturing and storing atmospheric **carbon** dioxide. It is one method of reducing the amount of **carbon** dioxide in the atmosphere with the goal of reducing global climate change.

Schematic showing both terrestrial and geological sequestration of carbon dioxide emissions from heavy industry, such as a chemical plant



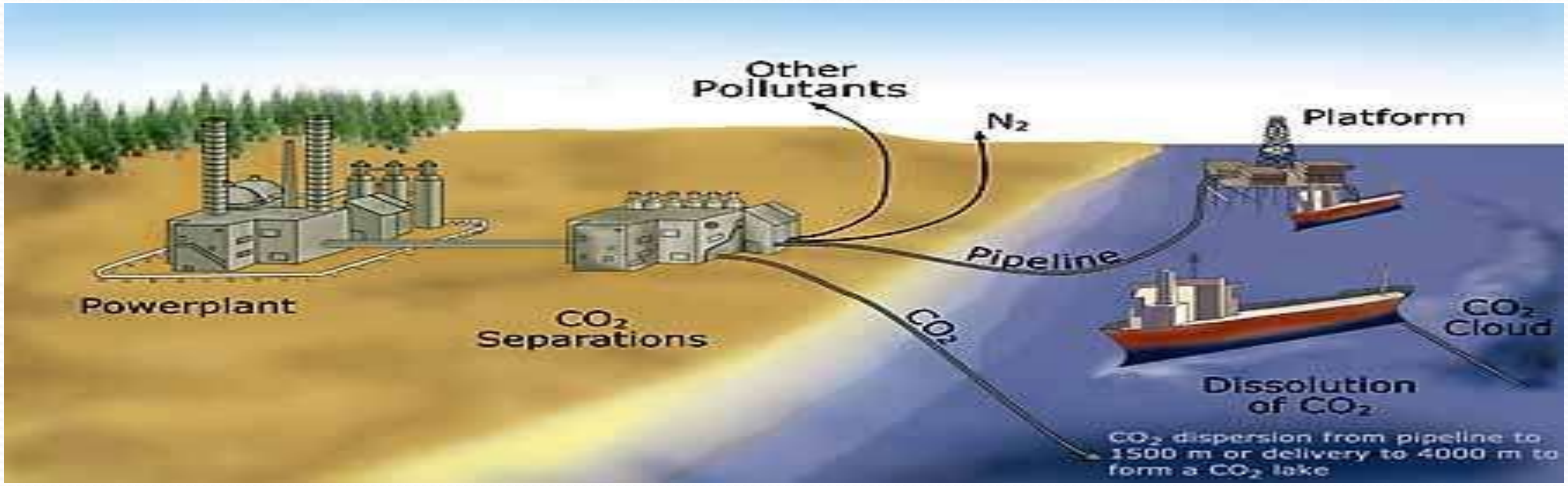
Ways that carbon can be sequestered

1. Geological sequestration : Underground
2. Ocean Sequestration : Deep in ocean
3. Terrestrial Sequestration : In plants and soil

1.Geological sequestration

- Geologic Storage involves capturing anthropogenic CO_2 before it enters the atmosphere and injecting it into underground formations. Once CO_2 is injected deep underground (typically more than 800 meters) it is trapped in minute pores or spaces in the rock structure. Impermeable cap rocks above the storage zones act as seals to ensure the safe storage of CO_2.

2.Ocean sequestration



- Carbon is naturally stored in the ocean via two pumps, solubility and biological and there are analogous man made methods, direct injection and ocean fertilization, respectively.
- At the present time, approximately one third of human generated emission are estimated to be entering the ocean.

3.Terrestrial Sequestration

The process through which CO_2 from the atmosphere is absorbed naturally through photosynthesis & stored as carbon in biomass & soils.

- Terrestrial (or biologic) sequestration means using plants to capture CO_2 from the atmosphere and then storing it as carbon in the stems and roots of the plants as well as in the soil.

- Terrestrial sequestration is a set of land management practices that maximizes the amount of carbon that remains stored in the soil and plant material for the long term. No-till farming, wetland management, rangeland management, and reforestation are examples of terrestrial sequestration practices that are already in use.

Methods that enhance carbon buildup in biomass and soils include:

- Adopting conservation tillage
- Reducing soil erosion
- Minimizing soil disturbance
- Using buffer strips along waterways
- Enrolling land in conservation programs
- Restoring and better managing wetlands
- Eliminating summer fallow
- Using perennial grasses and winter cover crops
- Fostering an increase in forests

CO_2 Capture Technologies

- Pre-combustion
  - In this process, the fuel is pre treated before combustion.
- Post-combustion
  - This process removes CO_2 from the flue gas after combustion has taken place.
- Oxyfuel combustion
  - In Oxyfuel combustion, oxygen, instead of air, is used for combustion.

CO_2 Separation Technologies

The main CO_2 separation technologies that can be applied to isolate the CO_2 from the fuel gas stream prior to transportation.

1. Absorption

A liquid sorbent is used to separate the CO_2 from the flue gas. The sorbent can be regenerated through a stripping or regenerative process by heating and/or depressurization.

2. Adsorption

In contrast to absorption processes which use a liquid absorbent, a solid sorbent is used to bind the CO_2 on its surfaces. Large specific surface area, high selectivity and higher generation ability are the main criteria for sorbent selection.

3. Chemical looping combustion

A metal oxide is used as an oxygen carrier instead of using pure oxygen directly for the combustion as in the case of oxyfuel combustion. During the process the metal oxide is reduced to metal while the fuel is being oxidized to CO_2 and water.

4. Membrane separation

Membranes can be used to allow only CO_2 to pass through, while excluding other components of the flue gas.

5. Hydrate-based separation

Hydrate-based CO_2 separation is a new technology by which the exhaust gas containing CO_2 is exposed to water under high pressure forming hydrates. The CO_2 in the exhaust gas is selectively engaged in the cages of hydrate and is separated from other gases.

6. Cryogenic distillation

Cryogenic distillation is a gas separation process using distillation at very low temperature and high pressure, which is similar to other conventional distillation processes except that it is used to separate components of gaseous instead of liquid.

Carbon sources and carbon sinks

- **Carbon source**

- A forest is considered to be a carbon source if it releases more carbon than it absorbs.
- Anthropogenic activities such as the burning of fossil fuels have released carbon from its long-term geologic storage as coal, petroleum and natural gas and have delivered it to the atmosphere as carbon dioxide gas.

Carbon sink

The main natural carbon sinks are plants, the ocean and soil. Plants grab carbon dioxide from the atmosphere to use in photosynthesis; some of this carbon is transferred to soil as plants die and decompose. The oceans are a major carbon storage system for carbon dioxide. Marine animals also take up the gas for photosynthesis, while some carbon dioxide simply dissolves in the seawater.

What is Carbon Credits

A carbon credit is a a market term or generic term for any tradable certificate or permit representing the right to emit one tonne of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent to one tonne of carbon dioxide.

The Role of Trees & forest in Reducing Atmospheric Carbon.

- Trees it's the Carbon Storage Experts. One half the dry weight of wood is carbon. Trees take in CO_2 from the air in the process called photosynthesis.
- The tree effectively breaks down the CO_2, stores the carbon in all parts of the tree, and releases the oxygen back into the atmosphere. Fast growing trees are, in fact, the most efficient way to sequester atmospheric carbon.

- As forests grow, they store carbon in woody tissues and soil organic matter. The net rate of carbon uptake is greatest when forests are young, and slows with time. Old forests can sequester carbon for a long time but provide essentially no net uptake.
- The main strategies for using forests for carbon sequestration
  - **Active forest management**
  - **Avoided deforestation**
  - **Forest preservation**
  - **Afforestation**

Benefits of Soil Sequestration of Carbon

- Improved soil structure
- Better water use and storage
- Less erosion
- Increased soil fertility
- Improved biodiversity
- Healthier ecology
- Improved agricultural performance.

Challenges in soil carbon sequestration

- Deforestation
- Residue burning
- Conventional tillage
- Imbalanced use of fertilizers
- Reduced inputs of organic matter

Conclusions

- Greenhouse gas concentration in the atmosphere are increasing and the threat of global climate change requires our attention.
- Soil carbon sequestration is an effective tool to sequester atmosphere CO_2 with better practical application than other approaches.
- Soil carbon sequestration provide vast opportunity to sequester carbon in the soil.

- A diversity of agricultural management practices can be employed to sequester more carbon in plants and soil:
  - Crop management.
  - Nutrient management.
  - Residue management and conservation tillage.
  - Agro-forestry.
- Soil carbon sequestration using innovate soil and crop management practices is needed to augment soil carbon storage.
- Combination of different agricultural management practices can enhance soil carbon sequestration.