

Environment & Sustainability (CV232AT)

III SEM B.E. 2022 SCHEME BASKET COURSES

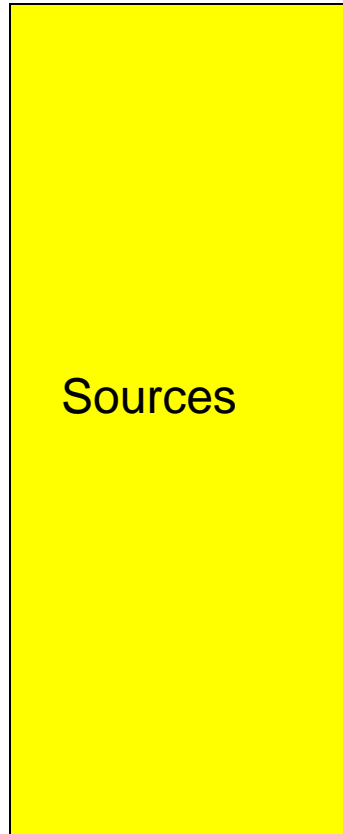
UNIT 2

RENEWABLE SOURCES OF ENERGY (RES)

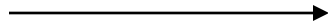
Energy

- Energy is a measure of all kinds of work done by human beings and nature.
- Any activity, requires the flow of energy in one form or the other.
- The standard of living of a community can be directly related to the per capita energy consumption, because energy consumption is a reflection of the per capita income.
- The energy for most modern day human activities comes from sources such as oil and coal. At the current rate of consumption, these resources will get depleted within the next 10 years.

INPUT (from
environment)



Lithosphere-energy
and minerals



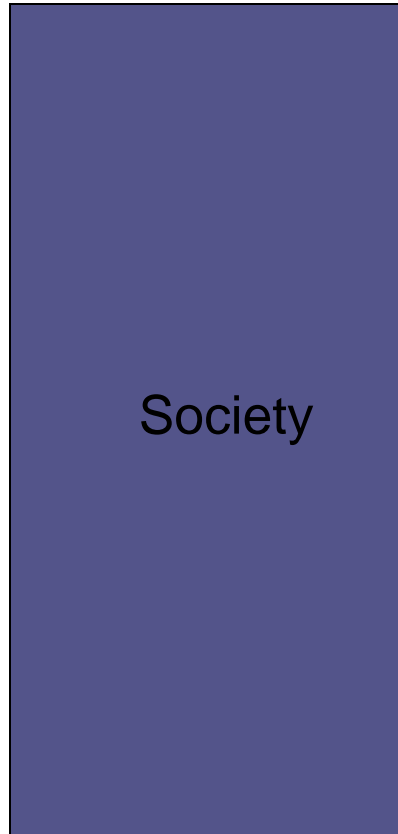
Hydrosphere-
water



Biosphere-
agriculture,
wildlife



Atmosphere-
air



Society

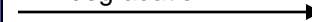
Lithosphere-
solid waste



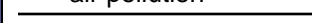
Hydrosphere-
water pollution



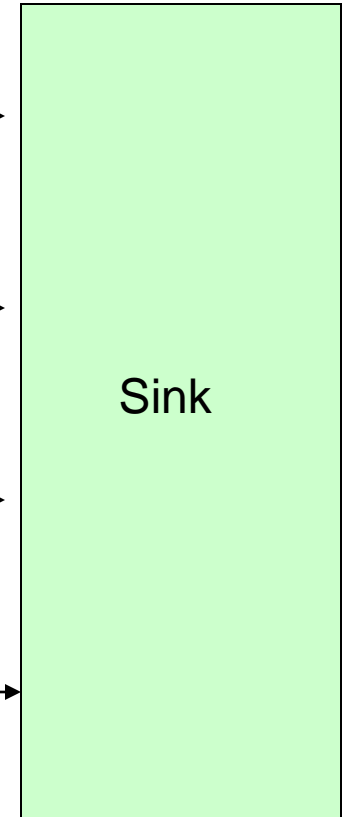
Biosphere-
degradation



Atmosphere-
air pollution



OUTPUT (into
environment)



Sink

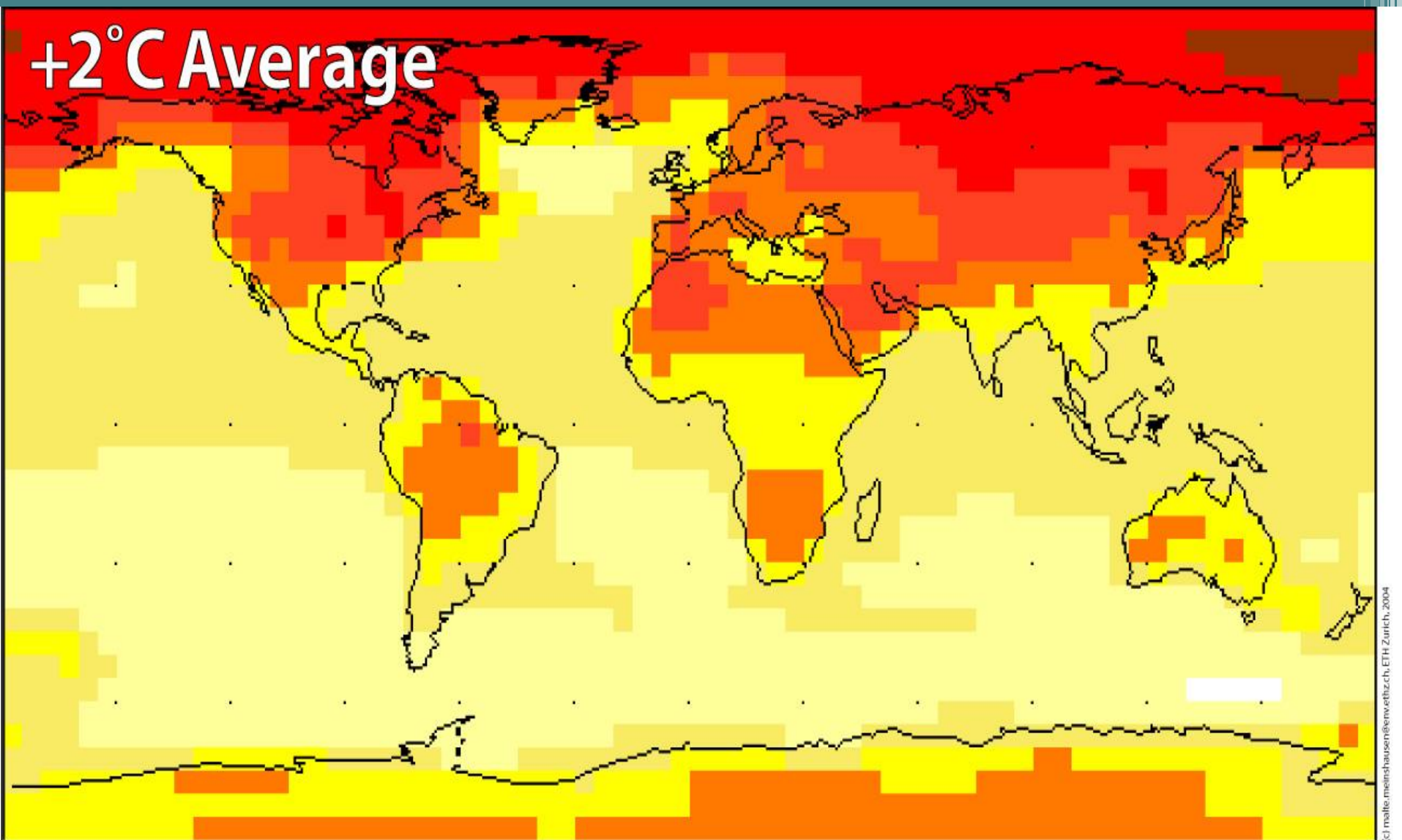
Energy Management

1. Collecting and analysing continuous data.
2. Identify optimizations in equipment schedules, set points and flow rates to improve energy efficiency.
3. Calculate return on investment. Units of energy saved can be metered and calculated just like units of energy delivered.
4. Execute energy optimization solutions.
5. Repeat step two to continue optimizing energy efficiency.

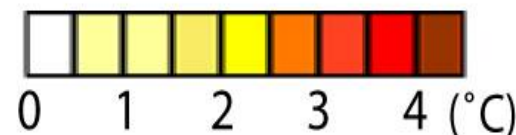
Climate Change

- Climate: the average weather in a certain area over substantial time ranges.
- Climate change: an alteration in climatic patterns, brought about by the combined effect of factors such as water, air, land use, population and natural disasters such as volcanoes, hurricanes. This is a natural, cyclic, self-regulated process.
- So why worry? – the observed ‘climate change’ over the last two decades shows an alarming increase in global temperatures. The rise has been directly linked to the increase in Greenhouse Gas Emissions.

Estimated increase in global temperatures



Approximate annual mean surface temperature distribution for global increase by 2°C



Note: Employed linear pattern scaling method as implemented in the SCENGEN model (by Wigley et al.).

The displayed pattern is the average of the default set of models, namely CSM (1998), ECHAM3 (1995), ECHAM4 (1998), GFDL (1990), HADAM2 (1995), HADAM3 (2000).

The pattern has been derived for a temperature increase of 2°C above 1990 in a transient run with emission scenario IPCC SRES B2. Note that the equilibrium temperature pattern for a 2°C increase above pre-industrial levels will be quantitatively different, although qualitatively similar.

Why we need to study RES?

- The level of development in any nation is a function of harnessed energy resources.
- This is because energy is inevitable for all faces of development, be it social, economic or industrial
- Green living is something wished for by people around the world. To support this idea, scientist and non-governmental organizations are spreading the word of importance on renewable energy resources.

Advantages of RES?

Here are some of advantages of using renewable energy resources, which will help you in knowing their significance:

- Renewable energy is natural source of energy and can replenish itself easily over short period of time. It comes from common sources like solar power, running water, and wind.
- They are limitless and hence one can be dependent on them unlike fossil fuels.
- Renewable sources do not pollute the environment.
- It is quite affordable and can be availed to many people as an alternative for non renewable sources at economical cost.
- Pollution free environment.
- Promotes healthy living.
- Helps in making wise utilization of all available resources.

History of Renewable Energy

Industrial revolution

During the 19th century, some countries started using renewable energy to generate electricity



History of renewable energy

Ancient times

The use of renewable dates back several thousand years



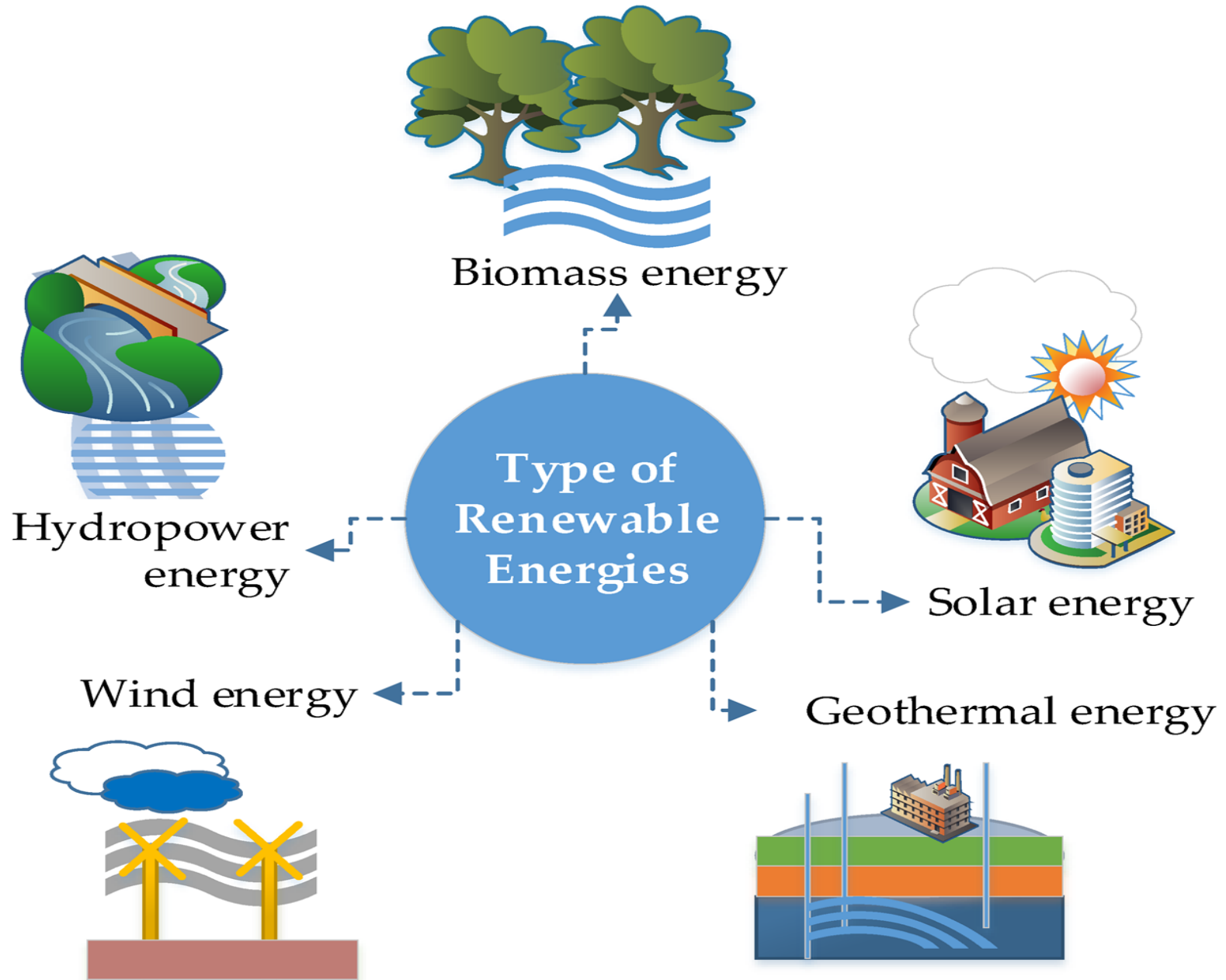
People learned to make fire from wood for light and heat



Crop drying by solar radiation



Farmers harnessed wind energy to power Machinery for grinding and watering crops



What is RES?

The energy resources can be broadly classified into two major categories based on availability and re-formation as

1. Non-Renewable energy sources
2. Renewable energy sources.

Renewable Energy is energy that is derived

“from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth.”

Energy Conservation

- Energy conservation means reducing the consumption of energy by producing or using less of it.
- Energy conservation is “the prevention of the wasteful use of energy, especially in order to ensure its continuing availability”.
- Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms.
- Energy conservation can be the result of several processes or developments, such as productivity increase or technological progress.
- Energy conservation and Energy Efficiency are separate, but related concepts.
- Energy Conservation is the deliberate practice or an attempt to save electricity, fuel oil or gas or any other combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money.

Non-Renewable Energy Sources

- These are the energy sources, once depleted cannot be reformed such as petroleum crude, coal, natural gas, nuclear.
- For transport and domestic purpose these are utilised in different form. utility of these energy sources is enormously increasing as a result of which they are getting depleted at a faster rate.
- We have to look ahead for best and efficient utilization of renewable energy sources available

Renewable energy sources

Hydro

Solar

Wind

Biomass

These energy resources have enormous potential to meet the growing energy needs of the rural areas in the developing world, while offering sustainable solutions to the global threats to climate changes.

Prospects of Renewable Energy Sources

Growing interest in renewable energy is driven by the following facts among others:

- It contributes to poverty reduction in developing countries
- It meets the energy needs at all times, without the requirement of expensive conversion devices
- It can deliver energy in all forms that people need (solid, liquid and gaseous fuels, heat and electricity)
- It is carbon dioxide-neutral and can even act as carbon sink
- It helps to restore unproductive and degraded lands, increasing biodiversity, soil fertility and water retention capability

Environmental concerns

The major Environmental problems related to energy production distribution and consumption in developing countries are:

- **Deforestation**
- **Air pollution**
- **Land pollution**
- **Flooding , Etc**

Hydrogen Energy

- Hydrogen fuel cells produce electricity by combining hydrogen and oxygen atoms. The hydrogen reacts with oxygen across an electrochemical cell similar to that of a battery to produce electricity, water and small amounts of heat.
- Hydrogen is an energy carrier that can be used to store, move and deliver energy produced from other sources.
- Hydrogen is a clean fuel that, when consumed in a fuel cell, produces only water.

Advantages of Hydrogen Energy

1. **Hydrogen is renewable**
2. **Hydrogen is a clean energy source**
3. **Hydrogen energy is not toxic**
4. **Hydrogen energy is highly efficient**

Disadvantages of Hydrogen Energy

1. **Hydrogen is volatile**
2. **Hydrogen energy is expensive to produce**
3. **Hydrogen energy is difficult to store**
4. **Hydrogen can be dangerous**

Solar energy

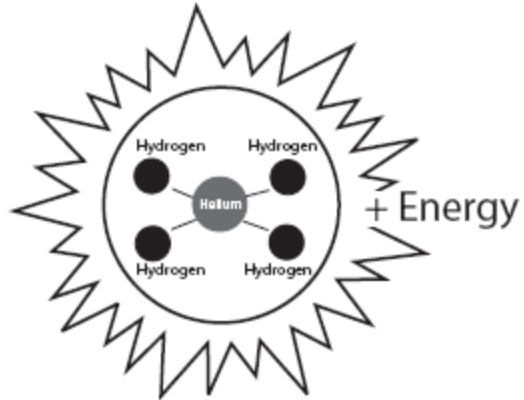


SOLAR ENERGY

What is Solar Energy?

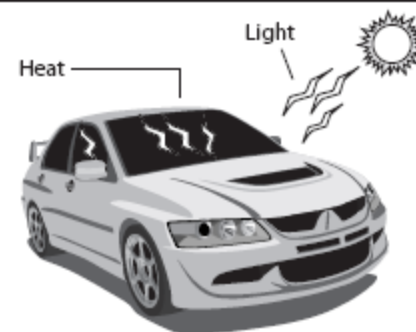
- Every day, the sun radiates (sends out) an enormous amount of energy—called **solar energy**. **It radiates more energy in one second than the world has used since time began. This energy comes from within the sun itself.**
- Like most stars, the sun is a big gas ball made up mostly of hydrogen and helium gas. The sun makes energy in its inner core in a process called **nuclear fusion**.

FUSION



During a process called FUSION, four hydrogen atoms combine to form one helium atom, with a conversion of matter. This matter is emitted as radiant energy.

SOLAR COLLECTOR



On a sunny day, a closed car becomes a solar collector. Light energy passes through the window glass, is absorbed by the car's interior and converted into heat energy. The heat energy becomes trapped inside.

SOLAR WATER HEATER



SOLAR PANELS



SOLAR THERMAL ELECTRICITY



Applications of energy services

Energy services are the desired and useful processes that result from the use of energy like :-

- Lighting
- Provision of air conditioned indoor climate, refrigerated storage
- Transportation
- Appropriate temperatures for cooking etc

Advantages of Solar Energy

1. Solar energy is freely available.
2. It does not produce ash, fumes and noise pollution hence it is clean, noiseless and environment friendly.
3. It saves money in long run.
4. It is renewable form of energy
5. Non polluting. No wastes created by its use.
6. Has lot of domestic applications. Hence advantageous for huge Indian population.

Disadvantages of Solar Energy

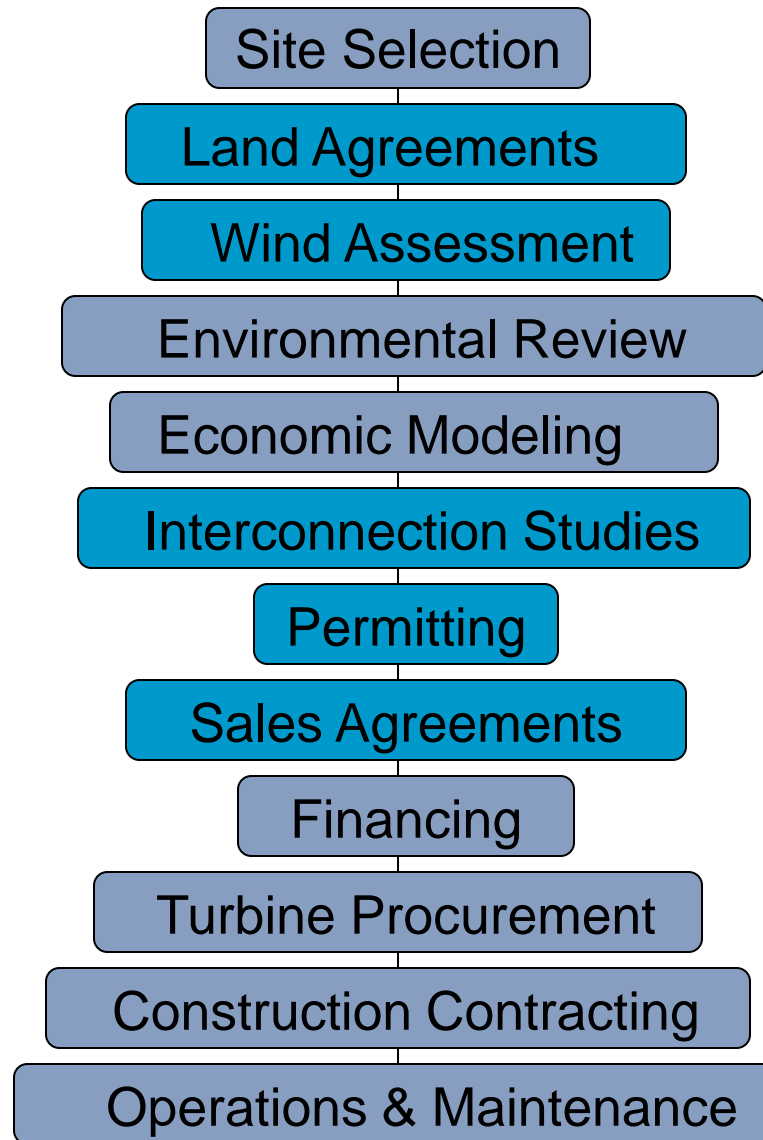
1. Initial cost is very large.
2. Energy should be stored in batteries.
3. Large space is needed for installation.
4. Energy generated is dependent on solar intensity
5. High temperatures cannot be achieved ($> 40^{\circ}\text{C}$). Efficiency of collector goes down with increase in temperature.
6. Clouds affect the amount and quality (efficiency). Hence may not be available when required.

WIND ENERGY



- Wind Resource
- Financing and Ownership Structure
- Taxes and Policy Incentives
- Plant Size: equipment, installation and O&M economies of scale
- Turbine size, model, and tower height
- Green field or site expansion
- What is included: land, transmission, ancillary services





Ocean Thermal Energy Conversion (OTEC)

- Ocean thermal energy conversion (OTEC) is a source of renewable energy.
- Ocean Thermal Energy Conversion (OTEC) makes use of the naturally occurring thermal gradient of the oceans.
- The warm water acts as a heat source whilst the cold water at about 1000 m acts as a heat sink. This creates a thermal power cycle which can be used to generate electricity.
- The minimum difference required between the heat source and the heat sink is 20 °C.
- The efficiency of OTEC is very low (< 4 %) but the enormous magnitude of this potential energy resource merits its investigation.

Advantages of OTEC System

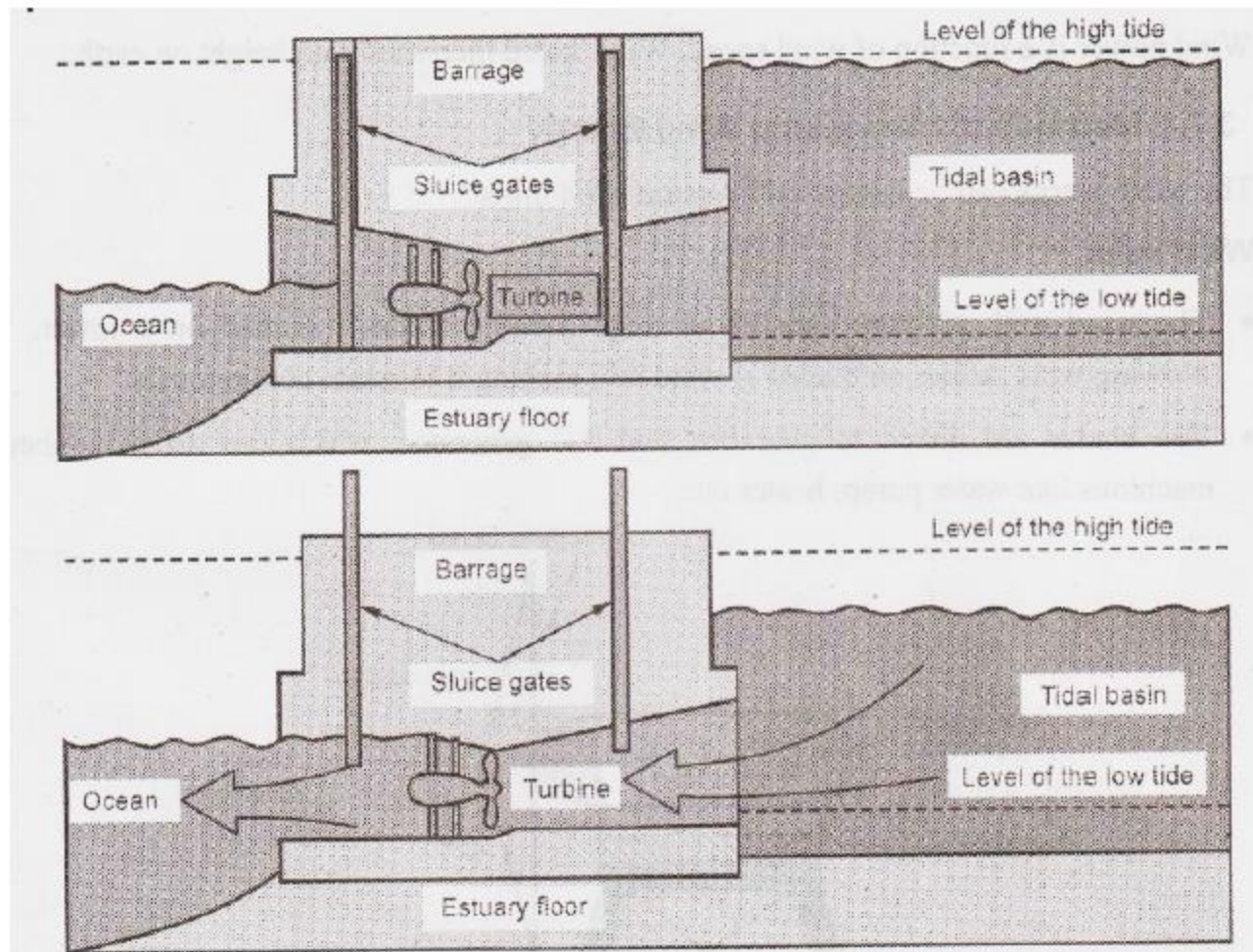
1. Power from OTEC is continuous, renewable and pollution free.
2. Unlike other forms of solar energy, output of OTEC shows very little daily or seasonal variation.
3. Drawing of warm and cold sea water and returning of the sea water, close to the thermocline, could be accomplished with minimum environment impact.
4. Electric power generated by OTEC could be used to produce hydrogen.
5. Tropical and sub-tropical island sites could be made free from pollution caused by conventional fuels for electricity generation.
6. OTEC system might help in enrichment of fishing grounds due to the nutrients from the unproductive deep waters to the warmer surface waters.
7. A floating OTEC plant can generate power even at mid sea and can be used to provide power for off shore mining and processing of manganese nodules.

Limitations of OTEC System

1. Capital investment is very high.
2. Due to small temperature difference in between the surface water and deep water, conversion efficiency is very low about 3-4 %.
3. Low efficiency of these plants coupled with high capital cost and maintenance cost makes them uneconomical for small plants.

Tidal Energy

- Tides are caused by the interaction of the gravitational effects of the sun and moon and the Earth's rotation. The relative motions of these bodies produce a range of different tide cycles.



Advantages of tidal energy :

1. It is a renewal form of energy.
2. It does not required fuel.
3. It does not produce ash and fume hence clean.

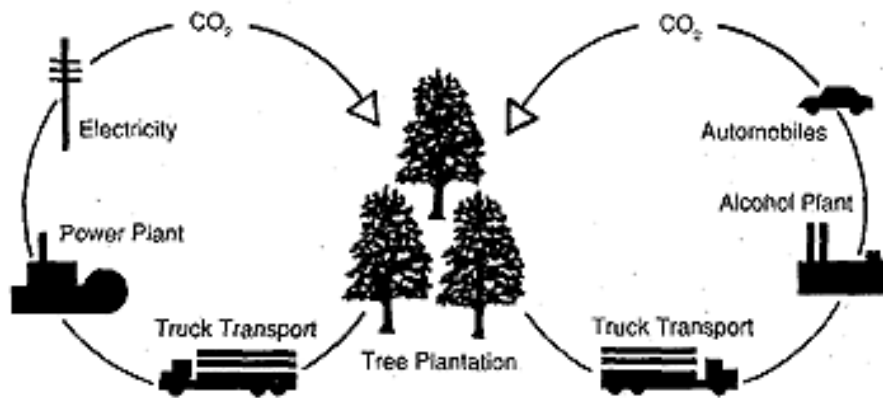
Disadvantages of tidal energy:

1. It requires huge investment for construction.
2. Possibility of damaging equipments frequently.

BIO-ENERGY

- **Definition:** Bioenergy comes from any fuel that is derived from biomass - recently living organisms or their metabolic byproducts.
- Biomass can include matter such as cow manure. Unlike other natural resources such as petroleum, coal and nuclear fuels, bioenergy is a renewable energy source.
- Like all methods used to generate energy, the combustion of biomass generates pollution as a by-product.
- However, because the carbon in biofuels was recently extracted from atmospheric carbon dioxide by growing plants, the combustion of a biofuel does not result in a net increase of carbon dioxide in the Earth's atmosphere.

Biomass-Biopower



Burning biomass directly, or converting it into fuel or, to generate electricity.



Biomass-Biofuels



Converting biomass into liquid fuels for transportation



Animal Waste

- Most common are manure's from pigs, chickens and cattle (feed lots)
- Convert waste via anaerobic digestion into biogas



Forestry crops

- Fast-growing and coppicing.
- Residues are generated by thinning, clearing for roads, extracting stem wood for pulp and timber, sawdust, off-cuts, bark and woodchip



Industrial waste

- Solid waste-peelings from fruits and veggies, substandard food, filter sludge's and coffee grounds
- Liquid waste-washing meats, fruits and veggies pre-cooking, wine making



Municipal waste

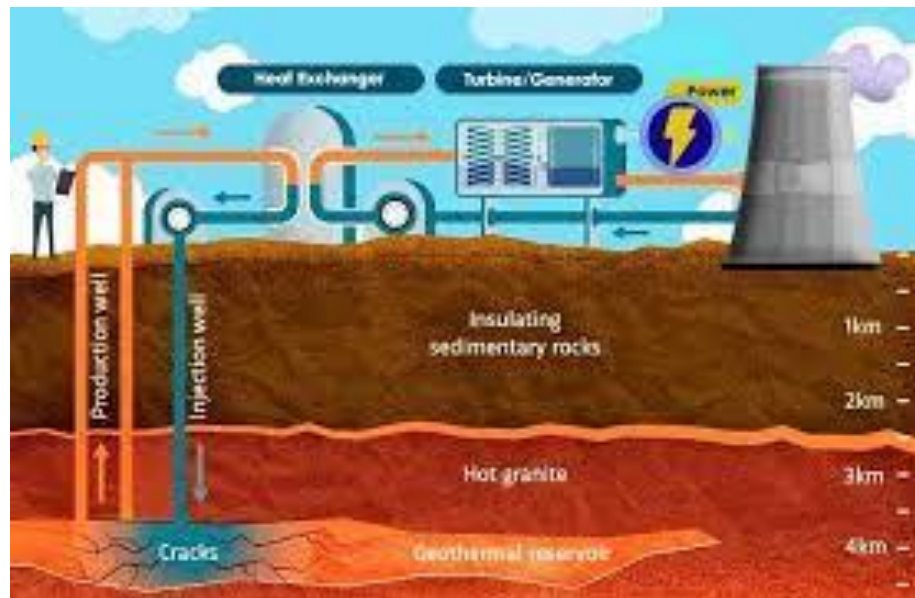
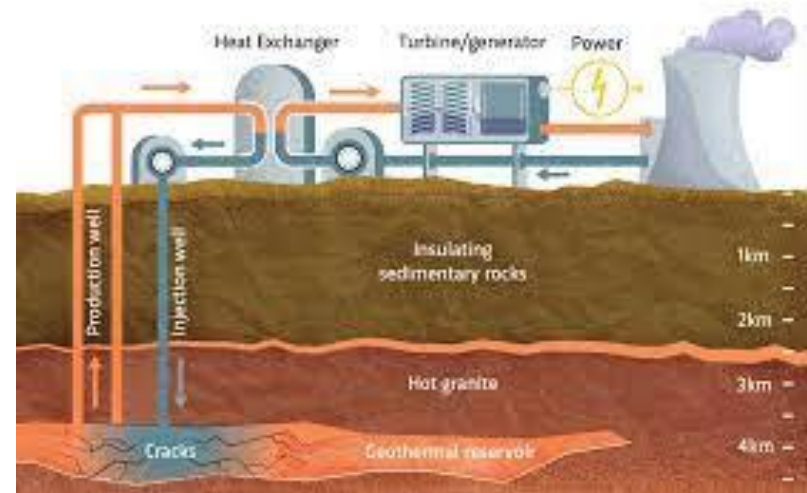
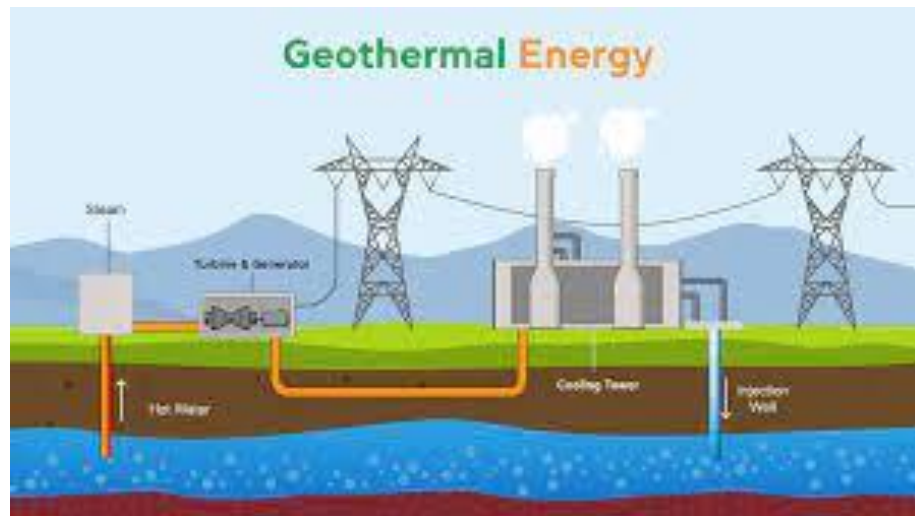
- Millions of ton(s) into landfills
- Converted into energy by direct combustion or anaerobic digestion, with gas collected from the stored material
- Sewage-Biogas production



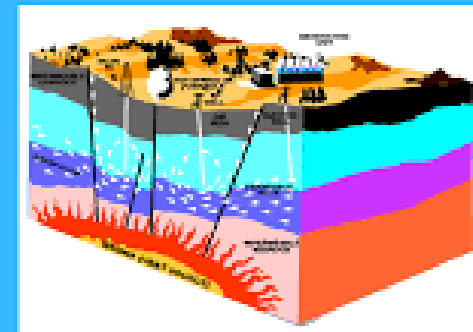
Problems

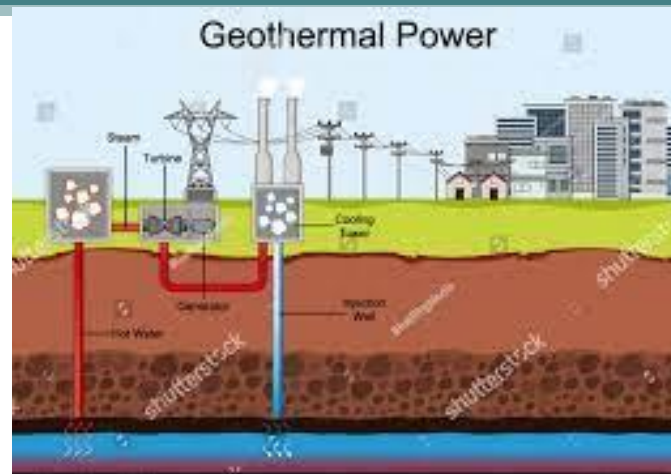
- Biomass has low energy density-transportation
- Incomplete combustion-localized air pollution
- Biomass-combustion-pollution
- Deforestation
- Conflict of land use for other uses,-farming
- Not fully competitive
- Takes energy to make energy
- Exotics
- Increased need for pesticides and fertilizers
- While landfill space is saved, may destroy resources that could be recycled or reused
- Waste products, wood, tires, sewage can contain contaminants

GEO THERMAL ENERGY



Geothermal Energy

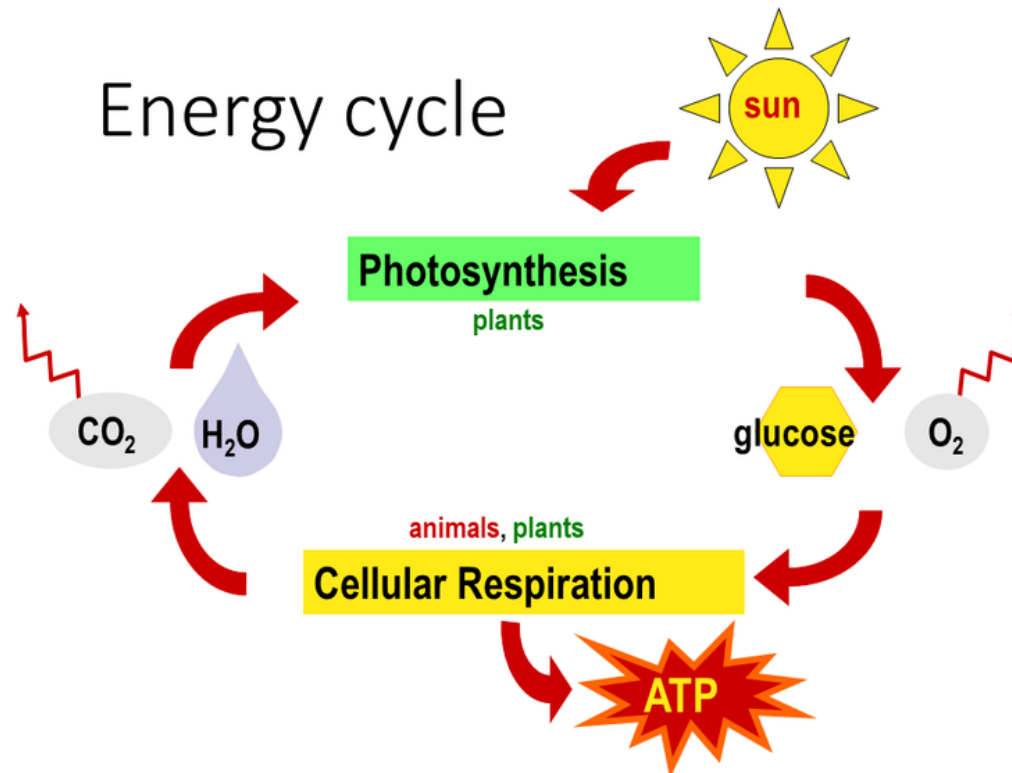




Advantages	Disadvantages
Geothermal energy sourcing is good for the environment.	The extraction of geothermal energy causes greenhouse emissions.
Geothermal energy is a reliable source of renewable energy.	There is a possibility of depletion in geothermal sources.
Geothermal systems have high efficiency.	There is a high-cost investment needed for geothermal systems.
There is no too little geothermal system maintenance needed.	It is hard to implement geothermal systems in big cities.
There is an unlimited supply of geothermal energy.	Geothermal reservoirs cannot easily be found.

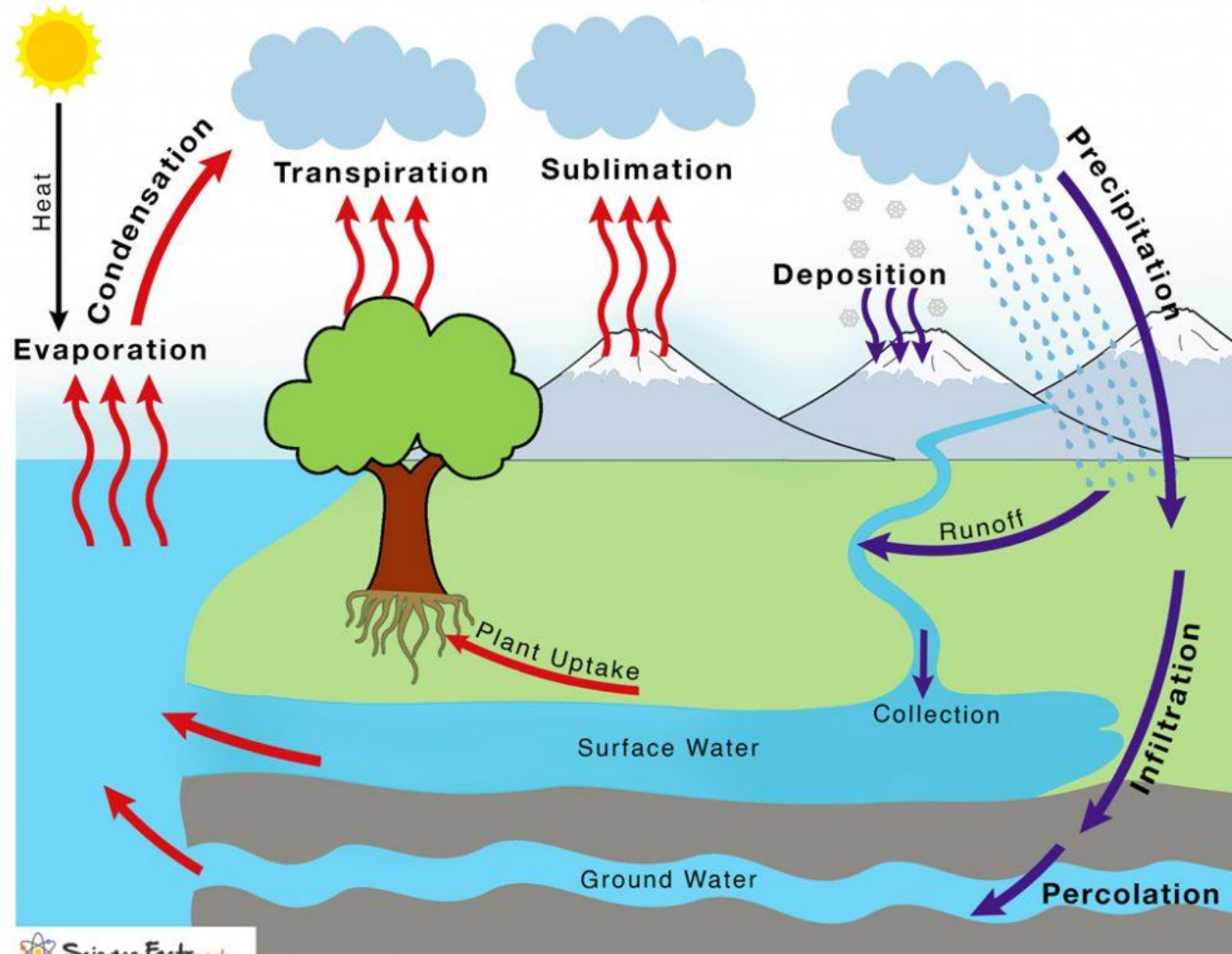
ENERGY CYCLES

The energy cycle is based on the flow of energy through the ecosystem. The energy from sunlight is converted by plants into growing new plants material which include the flowers, fruits, branches, trunks and roots of the plants. Since plants can grow by converting the sun energy directly into their tissues. They are known as producer in the ecosystem.

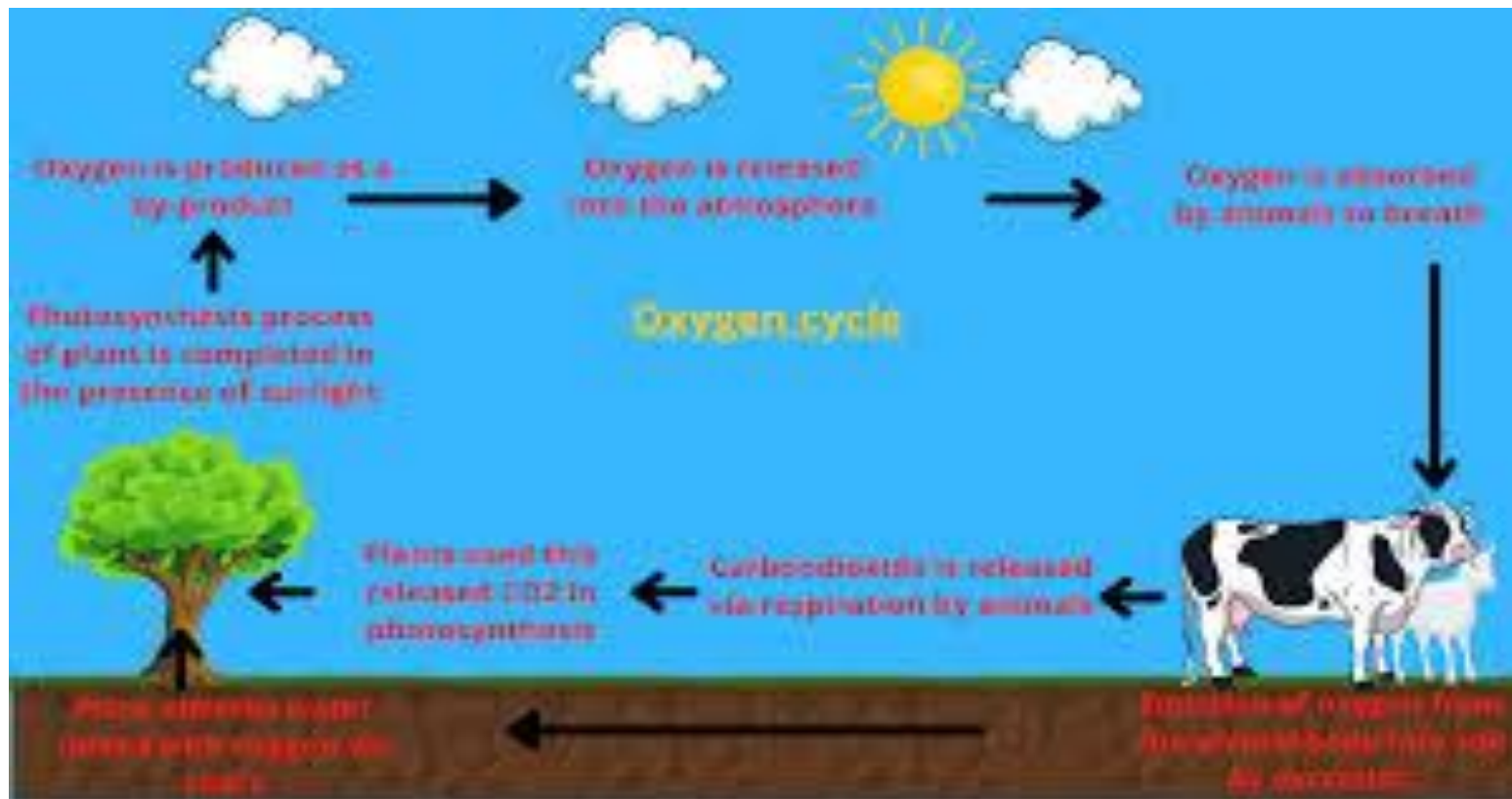
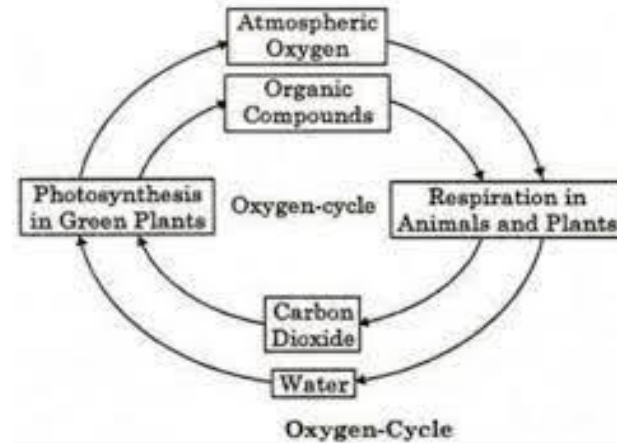


WATER CYCLE

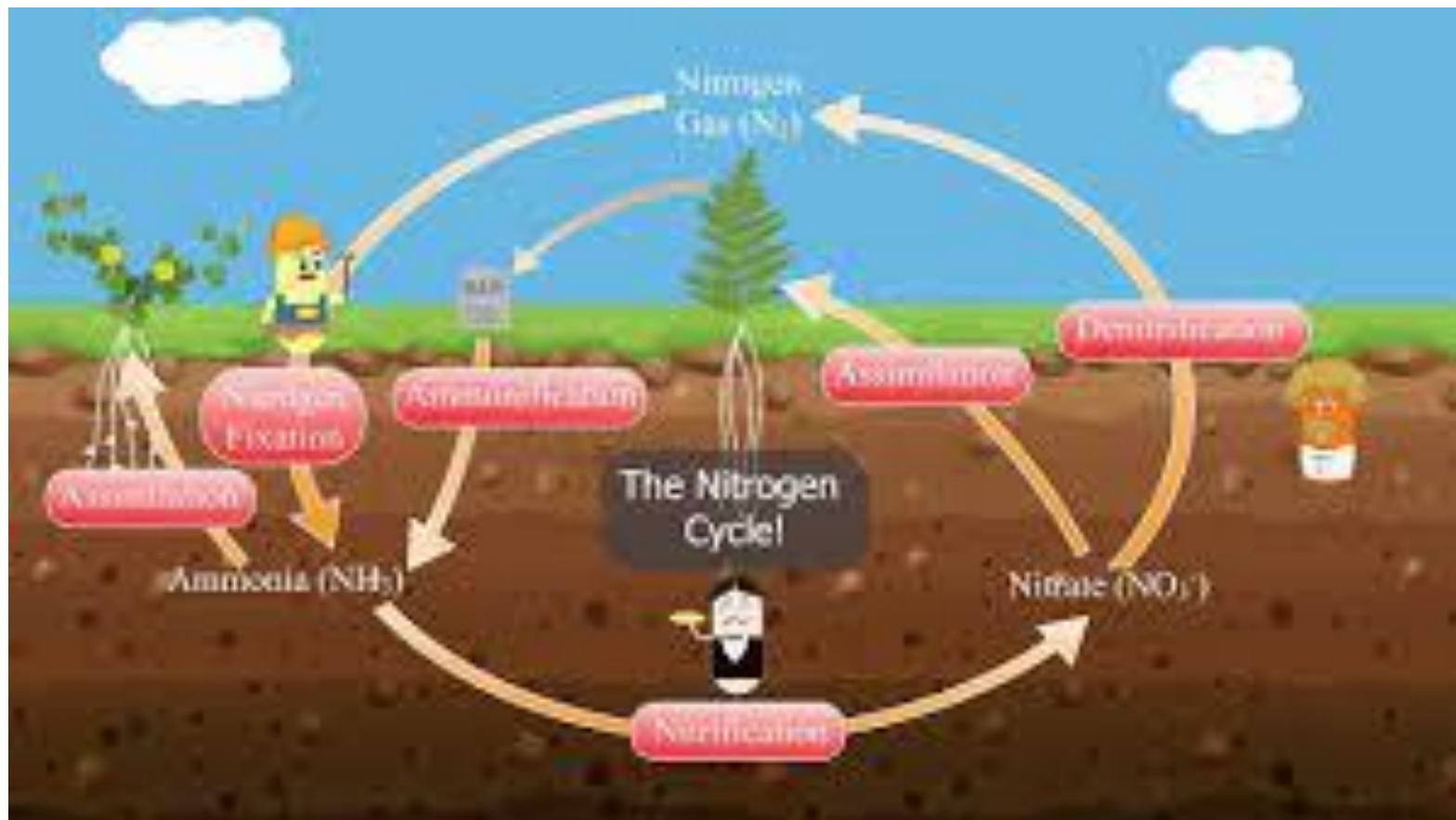
Water Cycle



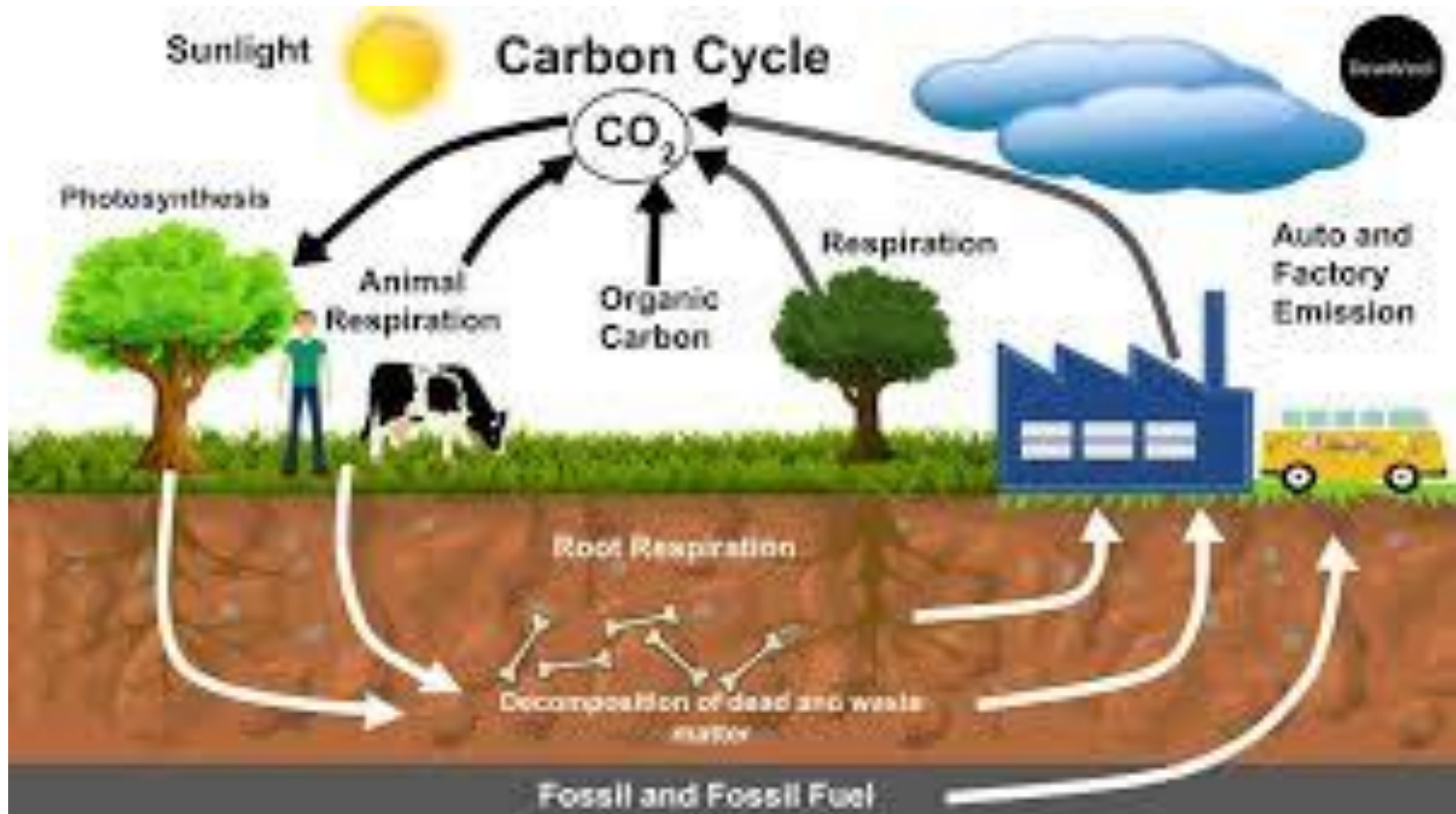
OXYGEN CYCLE



NITROGEN CYCLE

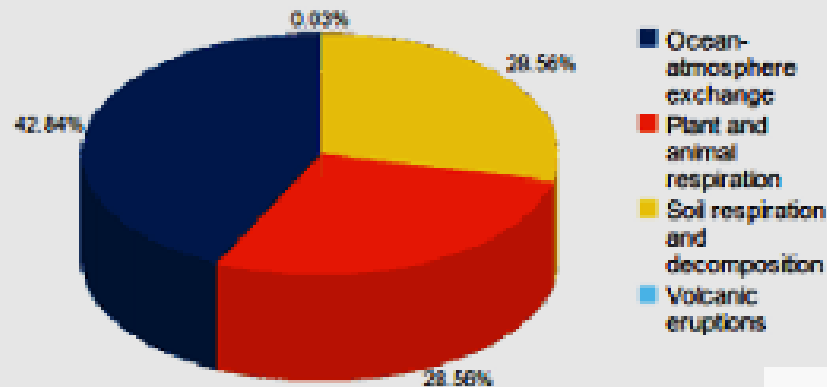


CARBON CYCLE



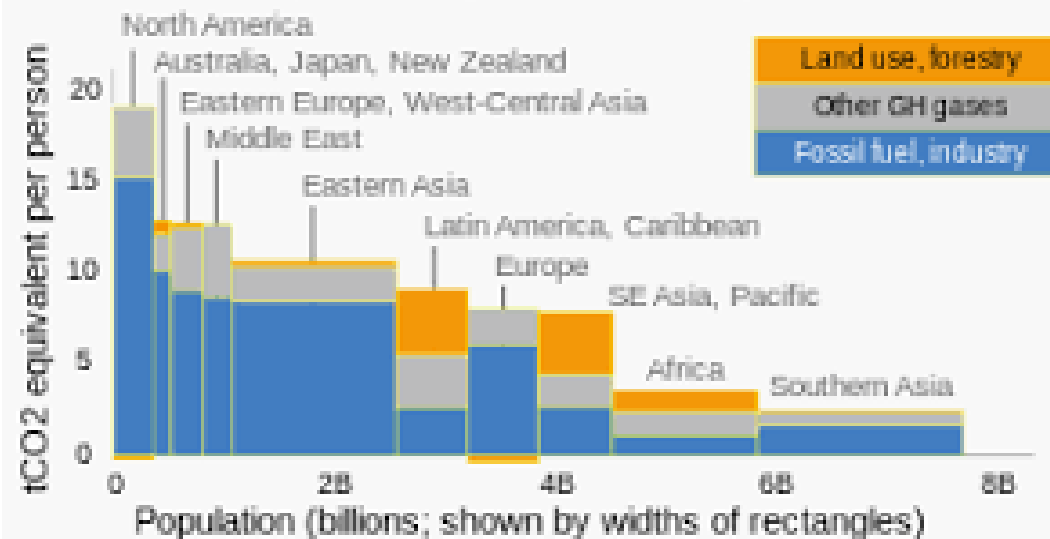
CARBON EMISSION

Natural sources of carbon dioxide

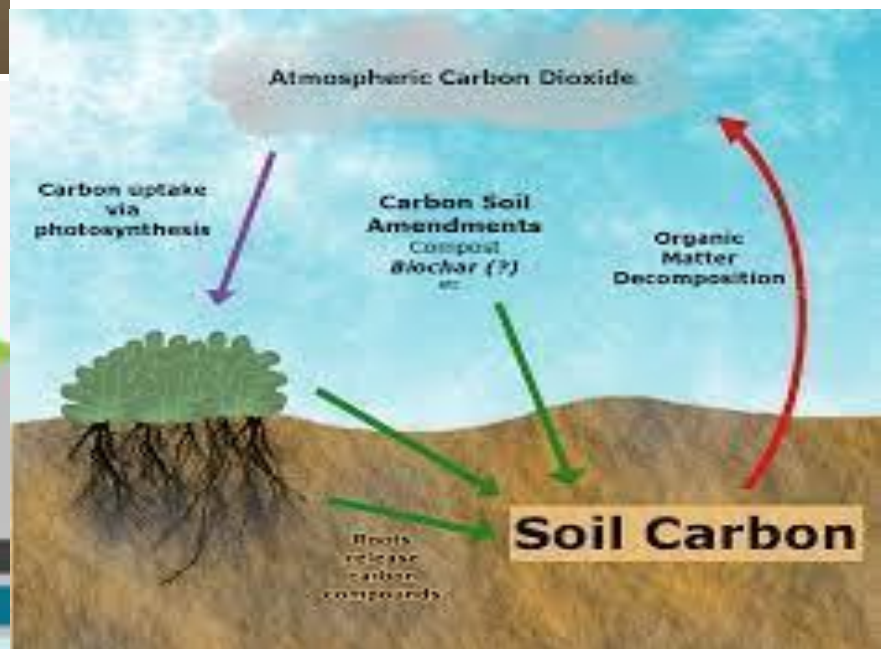
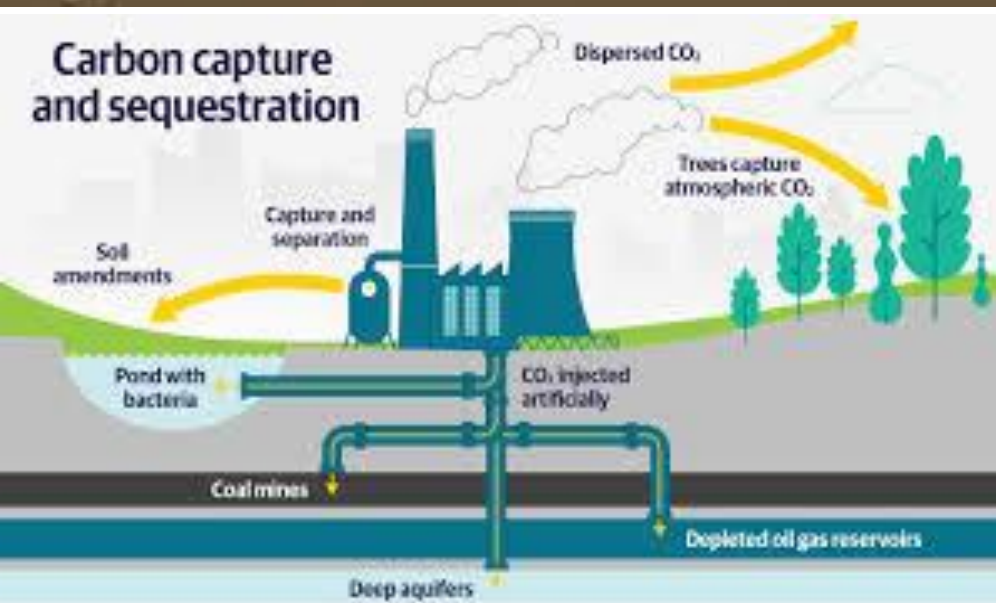
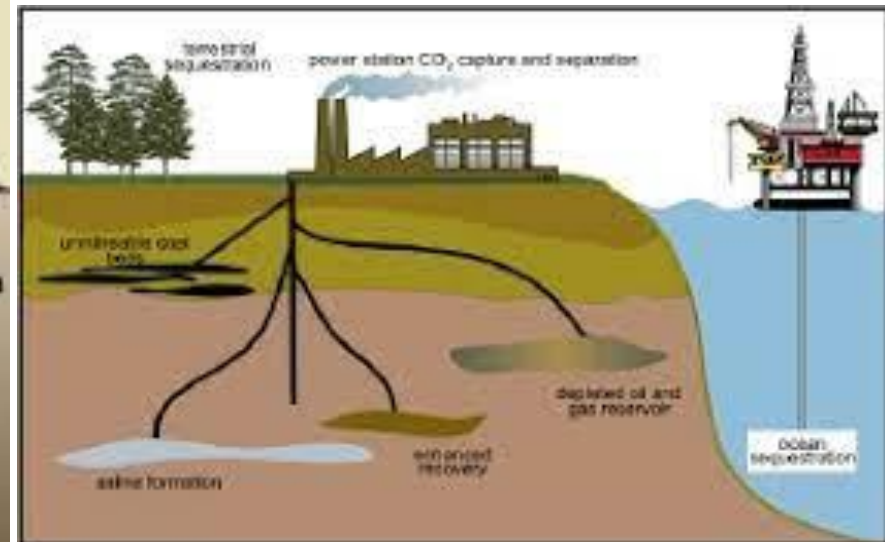


Greenhouse gas emissions per person

(Areas of rectangles show total emissions)

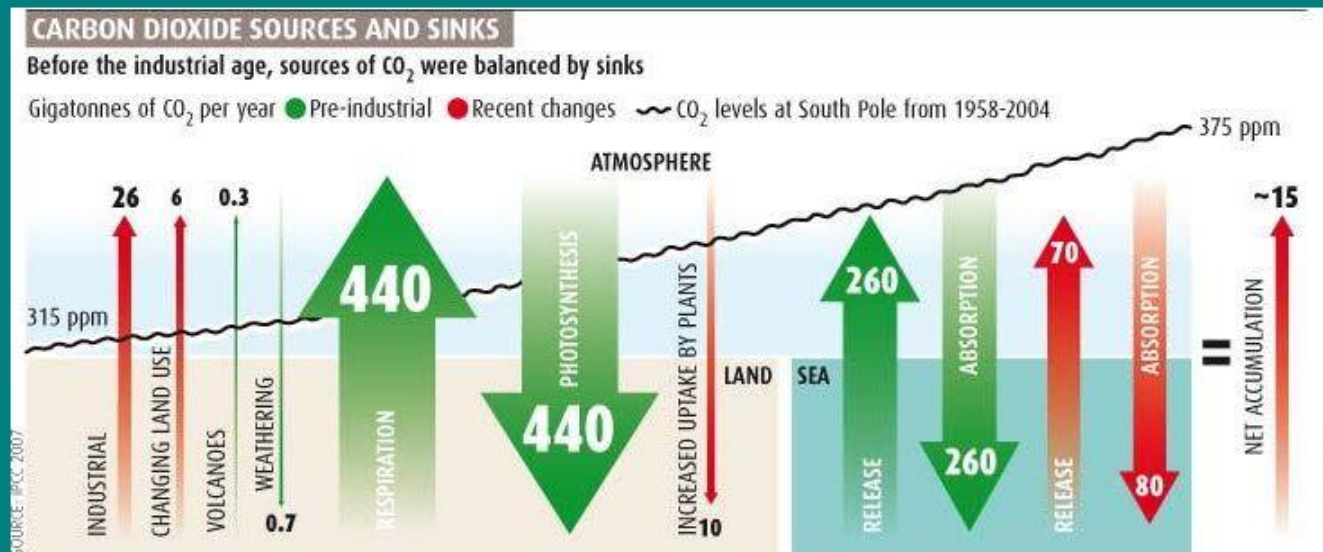


Carbon Sequestration Options



Sources and Sinks

- Carbon Sinks are where carbon is stored
 - For example: in trees, the ocean, limestone, and underground as fossil fuels
- Carbon sources are processes that release carbon back into the atmosphere
 - For example: burning trees, volcanic activity, and burning fossil fuels



GREEN ENGINEERING

Four approaches of Green Engineering:

1. Waste reduction
2. Materials management
3. Pollution prevention
4. Product enhancement

Green engineering processes and products:

- Holistically use systems analysis and integrate environmental impact assessment tools.
- Conserve and improve natural ecosystems while protecting human health and well-being.
- Use life-cycle thinking in all engineering activities.
- Ensure that all material and energy inputs and outputs are as inherently safe and benign as possible.
- Minimize depletion of natural resources.
- Strive to prevent waste.

Principles of Green Engineering

- Use of non-hazardous resources
- Prevention of waste
- Easy separation
- Durability of products
- Design for need
- Maximum efficiency
- Renewable rather than depleting
- Holistic approach
- Think beyond

SUSTAINABLE URBANIZATION



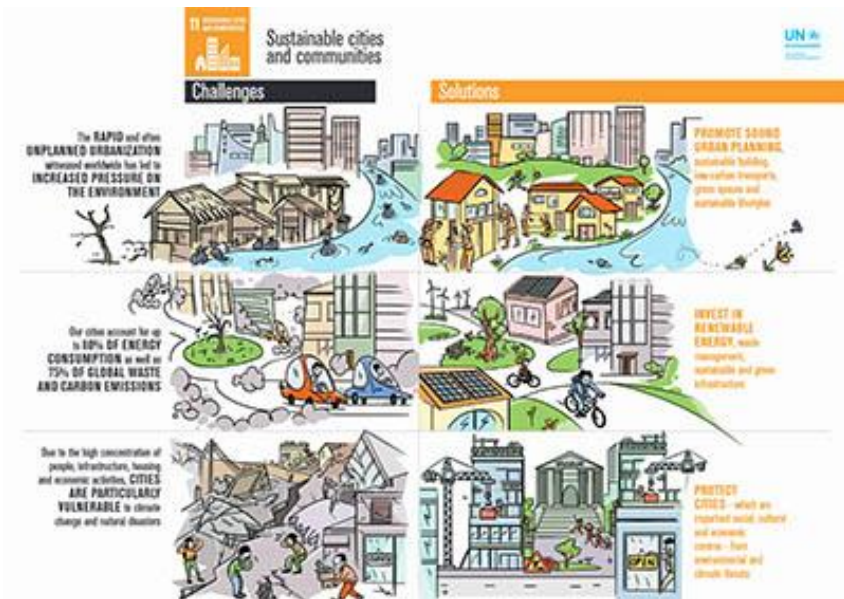
Objectives of Sustainable urban projects

Sustainable urban development project:

1. The conservation of identity, strengthening of neighbourhood and encouragement of its cultural diversity and distinctiveness;
2. The expansion of public transport its interconnection with existing and new developments;
3. The wise use of resources, minimising additional land take up, and the encouragement of moderate degrees of urban density;
4. Safeguarding and interconnecting green spaces with networks working towards quality standards and the conservation of public spaces;
5. The assurance of social harmony and advancement of social and functional interaction;
6. Safeguarding existing jobs and creating new and innovative ones;
7. Advancing a culture of discourse;
8. Creating long term partnerships between the community, and the public and private sectors;
9. Participation in lifelong learning processes, seeing urban life in its wider context.

Benefits of sustainable urban development

SUSTAINABLE CITIES





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