

Module 3, Renewable energy

Solar energy - Solar energy is the radiation from the Sun capable of producing heat, causing chemical reactions, or generating electricity. Once the sunlight passes through the earth's atmosphere, most of it is in the form of visible light and infrared radiation. Solar cell panels are used to convert this energy into electricity.



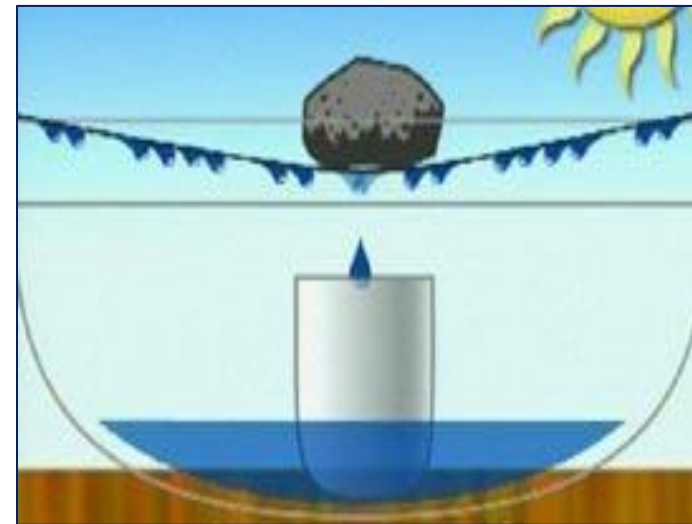
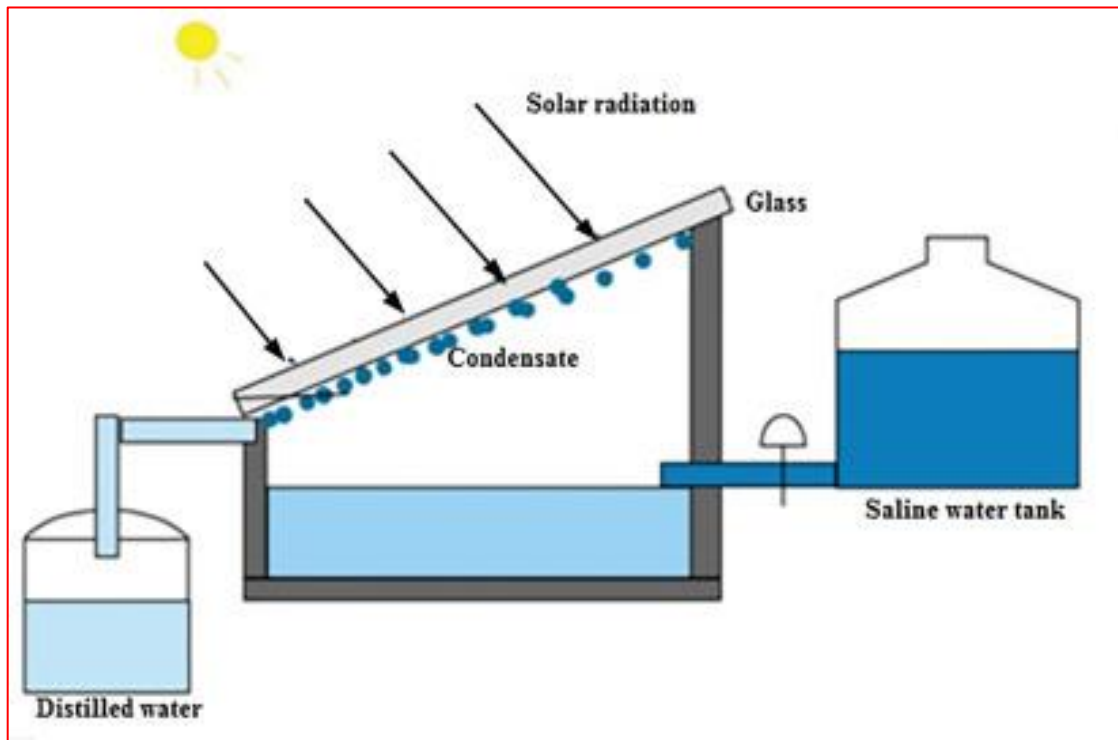
In the flat-plate solar collectors the Sun heats a dark flat surface, which collect as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use.



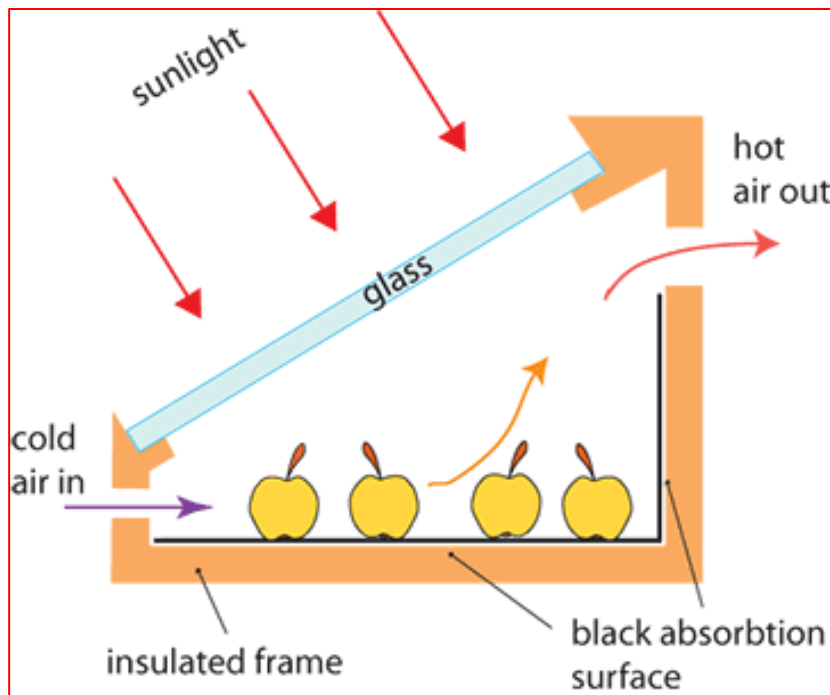
Coating in Solar Panel - The new technology of coating on solar panels helps to improve their self-cleaning, anti-reflection, anti-fogging and energy transmittance properties. An anti-reflective coating for solar panels is a nano coating which reduces the reflection and glare produced by an uncoated solar panel. It does this by reducing the difference in refractive index between air and glass.



Solar Still - This technology is based on the simple evaporation-condensation principle. A solar still distills water with substances dissolved in it by using the heat of the Sun. The evaporated water is cooled and collected, thereby purifying it.

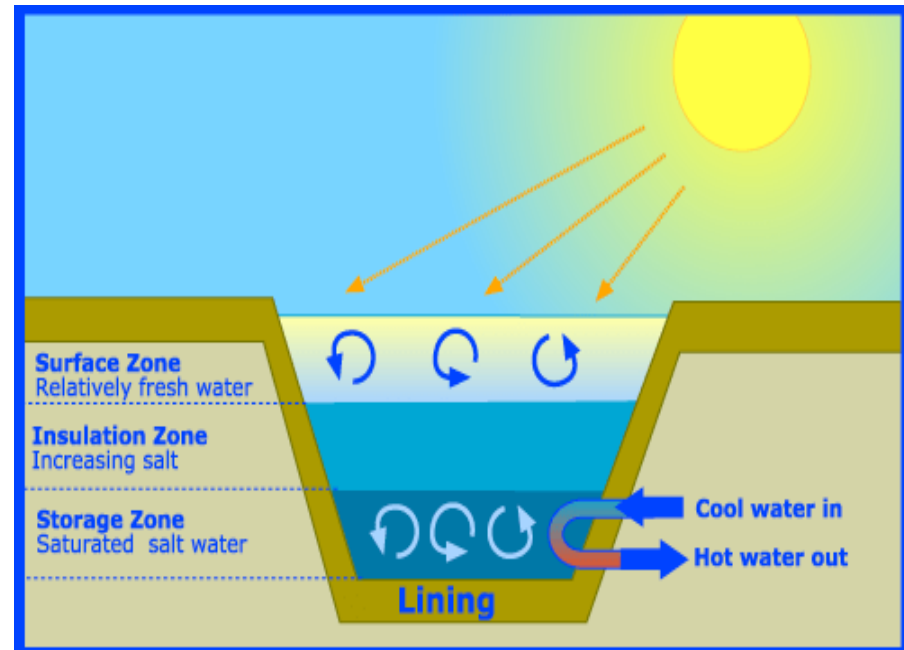


Solar dryer - Solar dryers are devices that use solar energy to dry substances, especially food. A solar dryer has a black absorbing surface which collects the light and converts it to heat. The substance to be dried is placed directly on this surface. These driers may have enclosures, glass covers and/or vents to in order to increase efficiency



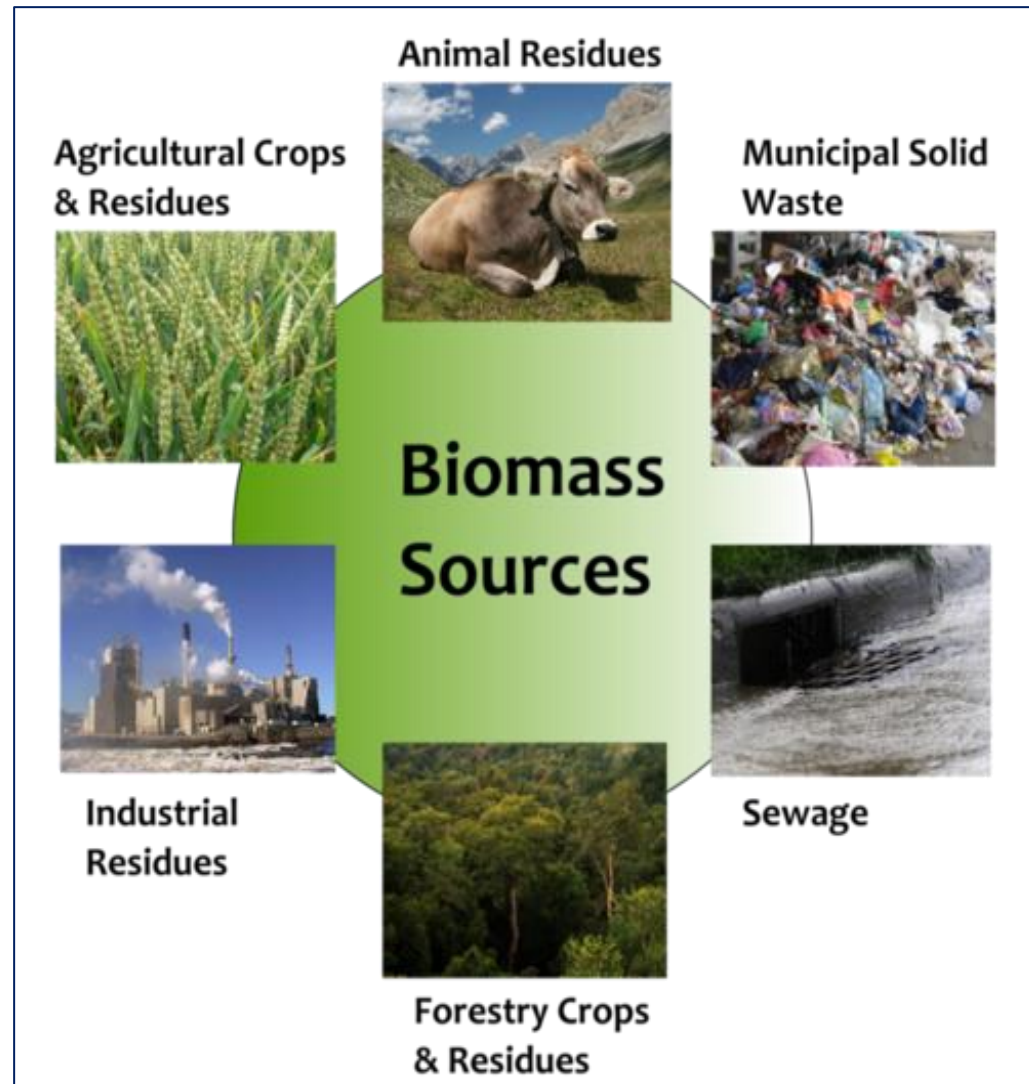
Solar Pond - A solar pond is a pool of saltwater which collects and stores solar thermal energy. Salt is added to the water until the lower layers of water become completely saturated. High-salinity water at the bottom of the pond does not mix readily with the low-salinity water above it due to the difference in density. So when the bottom layer of water is heated by the sunlight, convection occurs separately in the bottom and top layers, with only mild mixing between the two.

The hot, salty water at the bottom layer can then be pumped away for use in electricity generation, through a turbine or as a source of thermal energy.



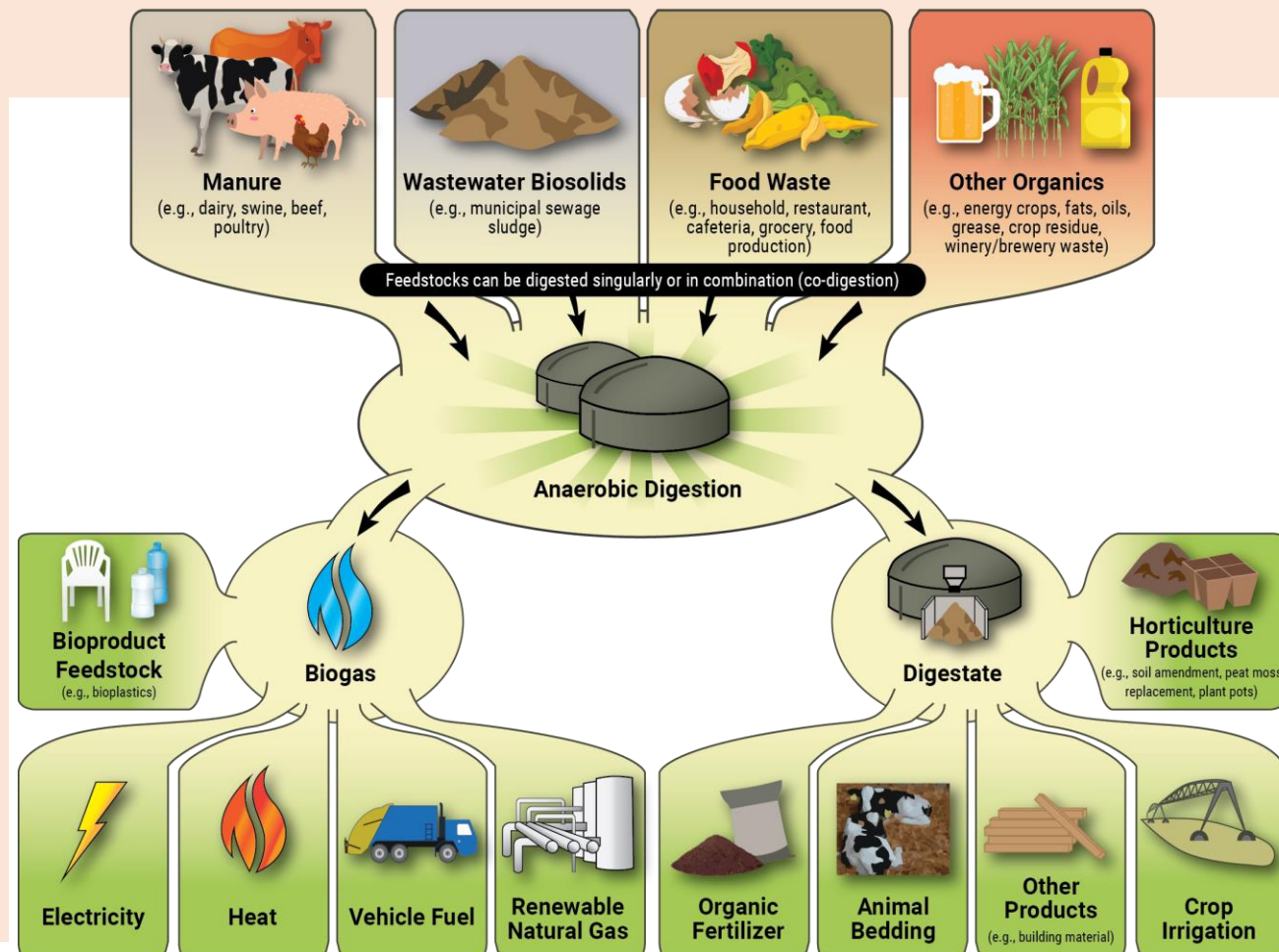
Biomass is renewable organic material that comes from plants and animals. Examples are wood and wood residues, energy crops, agricultural residues, manure, and some garbage.

Thermal characteristics of biomass depend on heat value, moisture level, chemical composition, size and density of the fuel, ash content, susceptibility to slagging and fouling, and volatiles content.

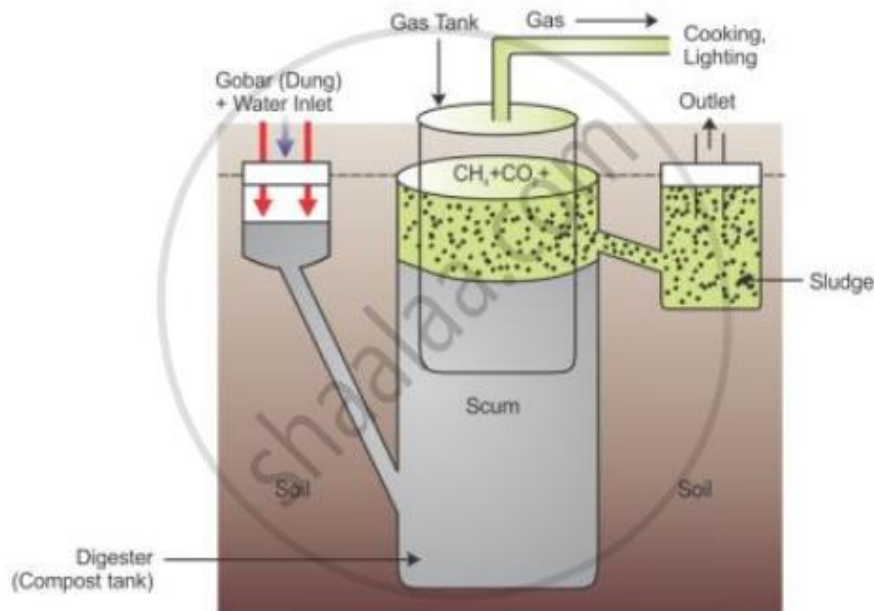


Anaerobic digestion is a method of converting biomass into energy. In this process, organic material is broken down by bacteria, in the absence of oxygen, to create methane-rich biogas. The Anaerobic digestion process begins when biomass is put inside a sealed tank or digester.

Naturally occurring micro-organisms digest the biomass, which releases the biogas that can be used to generate renewable heat and power



Biogas is produced when bacteria digest organic matter (biomass) in the absence of oxygen. The whole biogas production process can be divided into three steps: hydrolysis, acidification, and methane formation. Many microorganisms take part in this complex transformation with the main role given to 3 types of methane-producing bacteria. Biogas is a combination of two-thirds of methane and the rest is mostly carbon dioxide with traces of hydrogen sulfide.



Biogas is environment friendly and is used for cooking, heating and indoor illumination. Biogas can be stored directly in the tank that produced it, or relieved out to an external tank. Storing the gas externally allows to regulate the pressure of the gas for a consistent flow. To make biogas suitable for cooking application it is compressed up to 4 bar after purification, moisture removal and filled in LPG cylinder.



Wind power or wind energy is mostly the use of wind turbines to generate electricity. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels.

Wind power generation capacity in India has significantly increased in recent years. As of 30 November 2021, the total installed wind power capacity was 40 GW, the fourth largest installed wind power capacity in the world. Wind power capacity is mainly spread across the Southern, Western and Northern regions



Progress of wind energy production in India

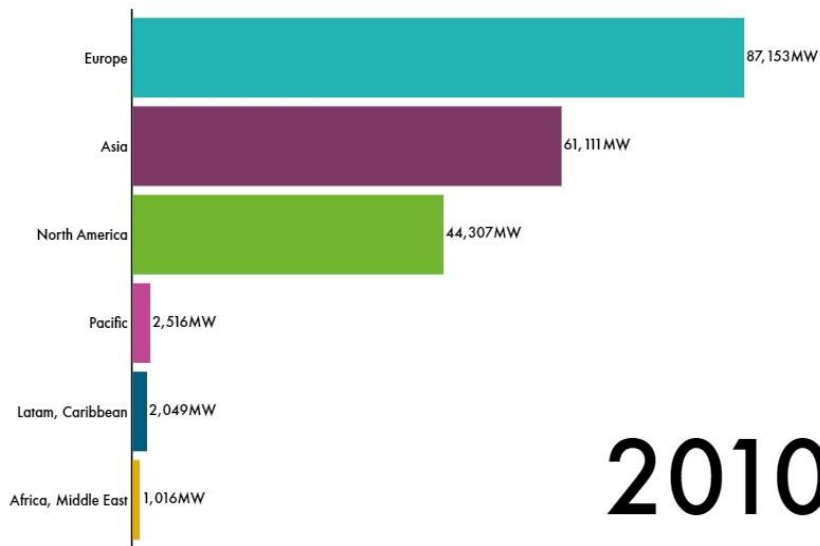
Year	Capacity (in MW)
2015	26,769
2016	32,280
2017	34,046
2018	35,626
2019	37,669
2020	38,785

Major countries of wind energy producers

Country	Capacity (in MW)
China	281,993
USA	117,744
Germany	62,184
India	38,785
Spain	27,089

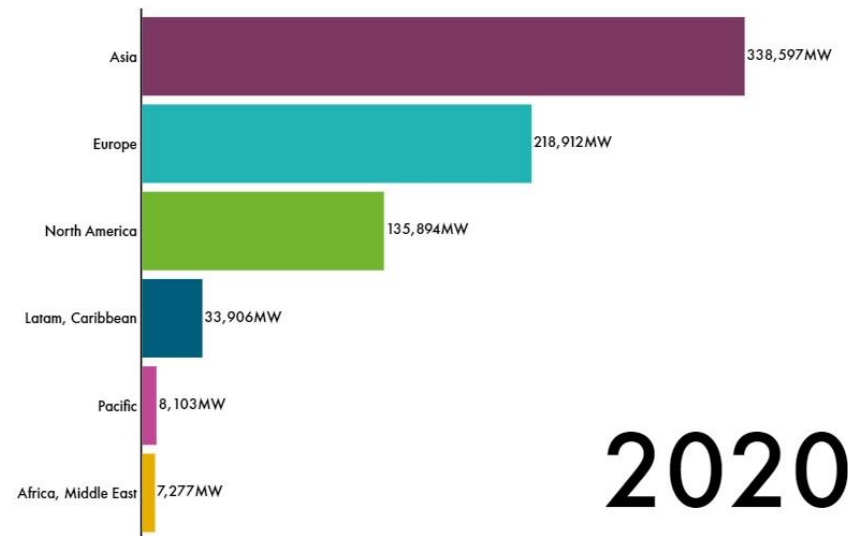
World wide wind energy production in 2010 and 2020 (Region wise)

over last decade by region



2010

over last decade by region



2020

Today, there is now 743 GW of wind power capacity worldwide, helping to avoid over 1.1 billion tonnes of CO₂ globally

Environmental benefits of wind energy

Wind energy is a source of renewable energy. It does not contaminate, it is inexhaustible and reduces the use of fossil fuels, which are the origin of greenhouse gasses that cause global warming. Major benefits of wind energy are,

1. Renewable energy
2. Inexhaustible
3. Not pollutant
4. Reduces the use of fossil fuels
5. Reduces energy imports
6. Creates wealth and local employment
7. Contributes to sustainable development.

Disadvantages of wind energy

- **Unpredictable** - Perhaps the biggest disadvantage to wind energy is that it cannot be produced consistently.
- **Noise** - Turbines might cause noise.
- **Aesthetic pollution** - Cause visual impacts to the landscape.
- **Wind resource development might not be the most profitable use of the land**
- **Location limitations** - Good land-based wind sites are often located in remote locations, far from cities where the electricity is needed
- **Wind plants can impact local wildlife** - Birds have been killed by flying into spinning turbine blades.

Need for new sources

1. Generating energy that produces no greenhouse gas emissions.
2. Reduces air pollution.
3. Diversifying energy supply
4. Reducing dependence on imported fuels.
5. Creating economic development.

Our current level of dependence on fossil fuels puts us on track for a rapid depletion of these finite materials.

Alternative energy is any amount of energy derived from non-fossil fuel sources.

New energy sources-

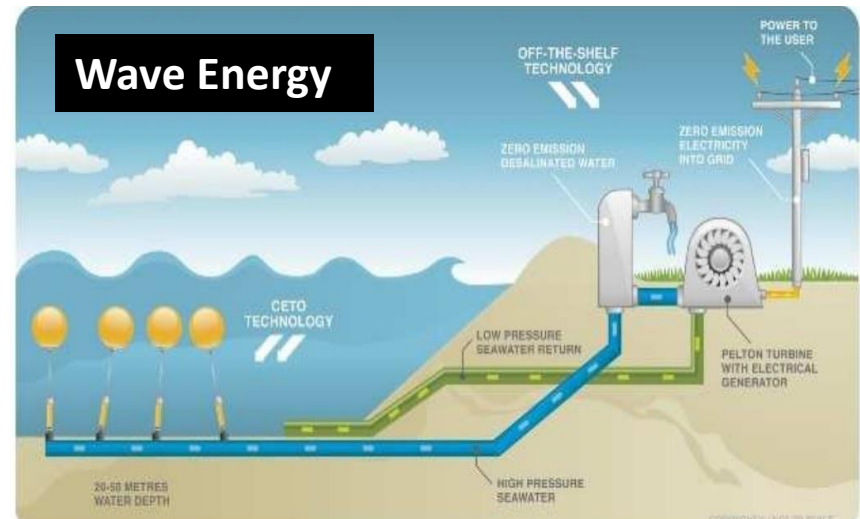
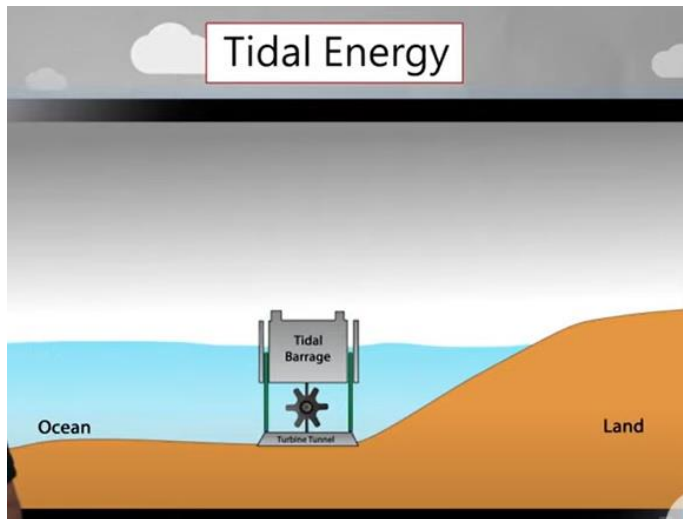
- 1. Wind Energy**
- 2. Solar energy**
- 3. Hydroelectric energy**
- 4. Bioenergy**
- 5. Nuclear energy**
- 6. Ocean energy-**
 - a) Tidal energy –**
 - b) Wave energy-**
 - c) Ocean thermal energy-**
- 7. Geothermal energy -**
- 8. Hydrogen energy -**

New energy sources-

Ocean energy-

a) **Tidal energy** - Tidal energy is a form of power produced by the natural rise and fall of tides caused by the gravitational interaction between Earth, the sun, and the moon.

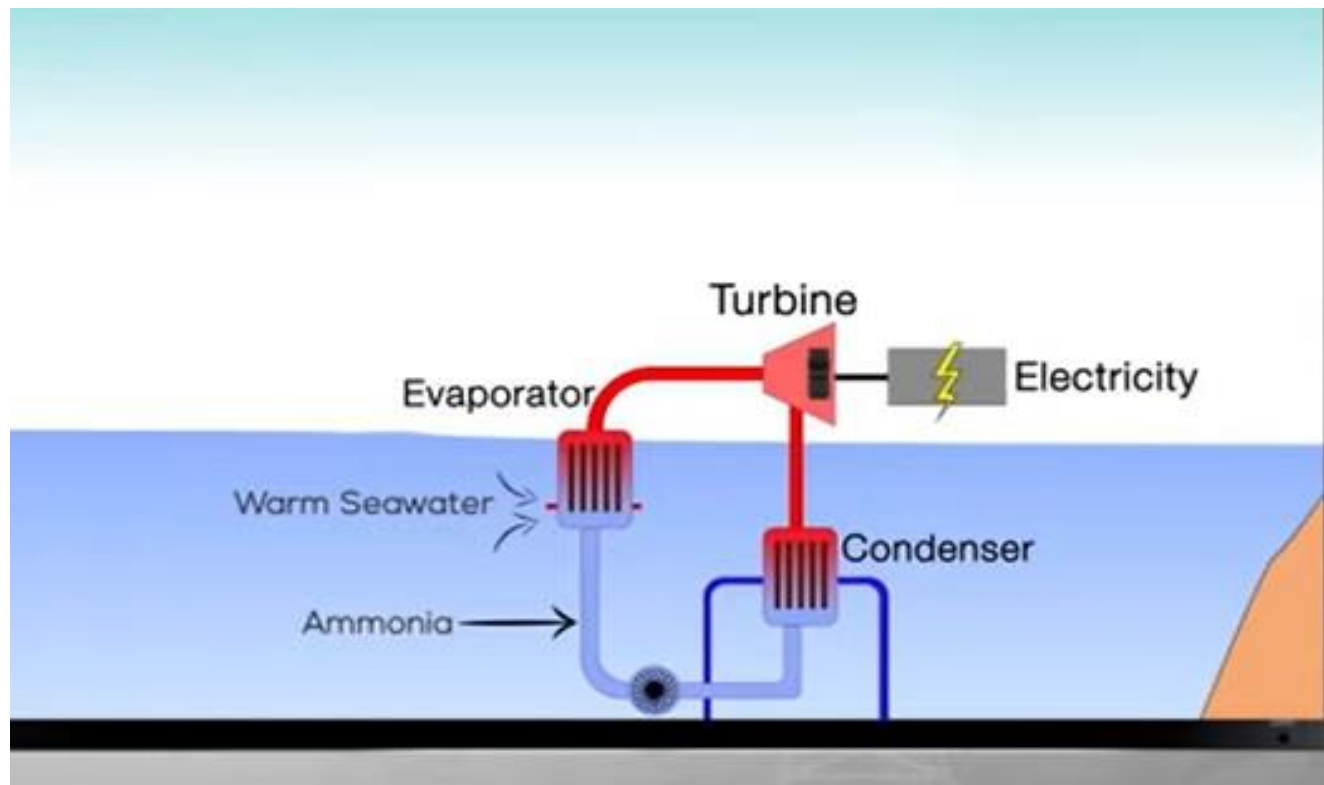
b) **Wave energy**- Description. Wave energy (or wave power) is the transport and capture of energy by ocean surface waves. The energy captured is then used for all different kinds of useful work, including electricity generation, water desalination, and pumping of water.



New energy sources

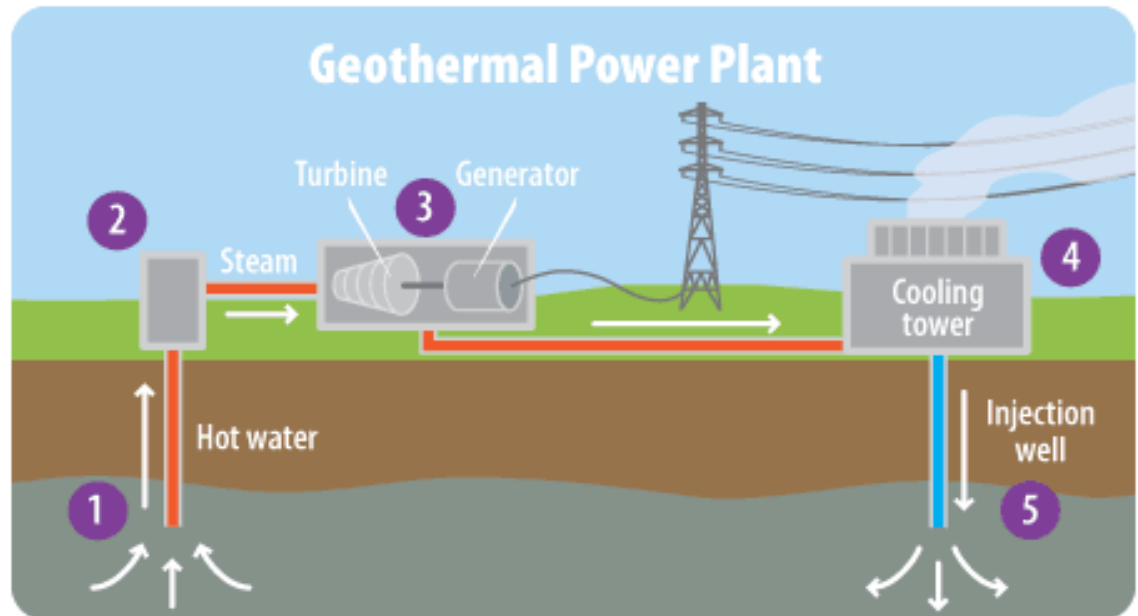
c) **Ocean thermal energy-**

Ocean Thermal Energy Conversion is a process that can produce electricity by using the temperature difference between deep cold ocean water and warm tropical surface waters.



New energy sources

Geothermal energy - Geothermal energy is the thermal energy generated and stored inside the Earth's crust. When underground water comes in contact with the hot spot of the earth crust, steam is generated. Sometimes this hot water formed region finds outlets at the surface. When this hot water gushes out of one of these outlets, it is called hot springs. Hot water or steam from the hot springs can be used for generating electricity.



Geothermal Power Plants in India

- Tattapani in Chhattisgarh.
- Puga in Jammu & Kashmir.
- Cambay Graben in Gujarat.
- Manikaran in Himachal Pradesh.
- Surajkund in Jharkhand.
- Chhumathang in Jammu & Kashmir.



The largest geothermal plant in the world is called the **Geyzers Geothermal Complex**, located in the United States, with a capacity of 900 megawatts.



Hydrogen energy - Hydrogen energy involves the use of hydrogen and/or hydrogen-containing compounds to generate energy to be supplied to all practical uses. Hydrogen is a clean fuel that, when consumed in a fuel cell, produces only water.

Hydrogen can be produced from a variety of domestic resources, such as natural gas, nuclear power, biomass, and renewable power like solar and wind. Hydrogen can be used in cars, in houses, for portable power, and in many more applications.

