UNIT- I V

Renewable Energy Resources

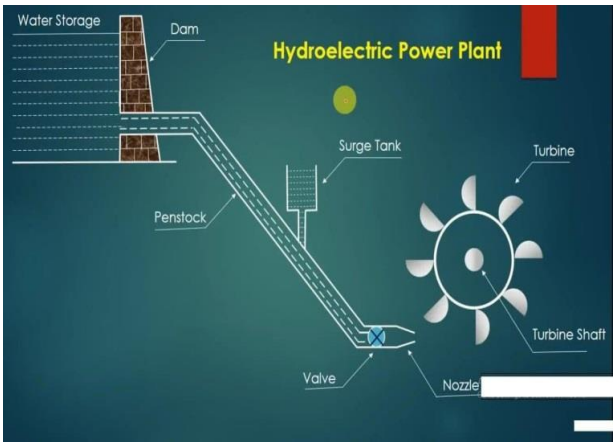
Introduction-Design, working, schematic diagram, advantages and disadvantages hydropower, geothermal power, tidal and wave power, ocean thermal energy conversion.

Solar Energy: Introduction- greenhouse effect-causes, consequences, and remedies, harnessing of solar energy, thermal conversion-solar water heater, parabolic dish parabolic trough and solar tower, solar power plant-construction and working, photo voltaic conversion- construction and working of Photo voltaic cell, applications of solar energy.

Introduction: A renewable resource is a resource of which there is an endless supply because it can be replenished. The sun, the wind, and geothermal heat are considered inexhaustible and therefore are examples of renewable resources. Water is also considered a renewable natural resource, as long as there is precipitation. Changing climate patterns have shown the need for conservation efforts to protect water supplies. Other natural resources are considered renewable even though some time and effort must go into their renewal. In addition, most precious metals are considered renewable because they're reusable. Since they are not destroyed during their extraction and use, they can be recycled. Unlike renewable resources, once a non-renewable resource is depleted, it cannot be recovered. As the human population continues to grow and finite resources become increasingly scarce, the demand for renewable resources increases.

HYDROELECTRIC POWER PLANT

Hydropower is the leading source of renewable energy. It relies on rainfall (and snowmelt) that drains into rivers and flows to dams downstream. Their water is channeled to turn a turbine, producing energy in a generator the amount being determined by the flow or drop of the water.



Construction

1. Reservoir: water harvested from the catchment area is stored in the reservoir which is thenused to generate the electricity.
2. Dam: it is made in the path of the river to make the reservoir to hold the rain water.
3. Spillways: Spillways are made to make the dam safe. When level of water is exceedssome defined point, it will discharge through these spillways.
4. Fore bay: when there is sudden change in the turbine load, in such cases there is need of temporary storage of water. This temporary storage of water near turbine is called as fore bay.
5. Surge tank: surge tank is built in between dam and the valve house. It is used to take careof the system load fluctuations.
6. Penstock: it is water pipeline carrying water from dam to turbine.

7. Prime mover or turbine: it is the main part of the power station. It is coupled with the generator. Turbine is rotated by the flow of water. As it is coupled with the generator, generator also rotates which produces electricity.
8. Powerhouse: it consists of turbine, alternator and electrical equipment.
9. Tail races: outlet water of the turbine is discharged to the river trough tail races.

Working: Hydro Power Plant Electricity produced from generators driven by water turbines that convert the energy in falling or fast-flowing water to mechanical energy. Water at a higher elevation flows downward through large pipes or tunnels (penstocks). The falling water rotates turbines, which drive the generators, which convert the turbines' mechanical energy into electricity. The advantages of hydroelectric power over such other sources as fossil fuels and nuclear fission are that it is continually renewable and produces no pollution. There are now three types of hydroelectric installations: storage, run-of-river, and pumped-storage facilities. **Advantages of Hydroelectric Energy**

1. It is a non-polluting source of energy.
2. It has lower operational cost compared to fossil fuel-based generation plants.
3. Can be easily transmitted through wires to long distances.
4. Dams made for generation of Hydroelectricity also help in irrigation projects.

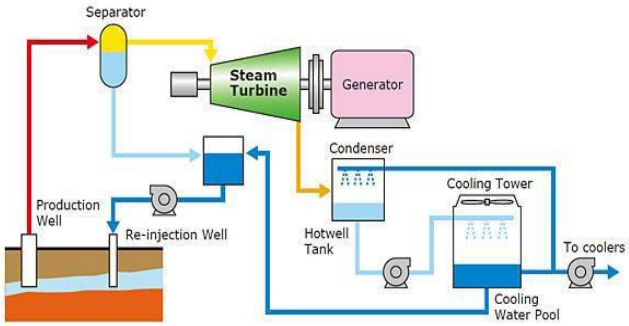
Disadvantages of Hydroelectric Energy

1. It can be generated only in areas with heavy rainfall and sufficient supply of water.
2. Hydro power generation stations are to be located in hilly mountainous terrains where waterfalls as well as ideal sites for dams are located. In a region/country without hills hydel power generation is not possible.
3. Loss during transmission is very high, sometimes up to 30%.
4. Dams are expensive to build.
5. Building a dam affects the environment and wildlife of adjoining areas. Nearby low-lying areas are always under the threat of floods.

GEO THERMAL POWER PLANT

Geothermal energy is the energy obtained from the earth (geo) from the hot rocks present inside the earth. Geothermal energy is a renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

Construction & Working



A geothermal power plant uses steam obtained from these geothermal reservoirs to generate electricity. Wells are drilled at the appropriate locations to bring this geothermal energy up to the surface. A mixture of steam and water is collected from the production well. Steam separators are employed to separate the steam and use it to operate turbines. The further process is quite similar to a thermal power plant - steam turbines run the generators and, hence, electricity is generated. The condensed steam and the water collected from the production well are injected back into the reservoir through the injection well.

Advantages of Geothermal Energy

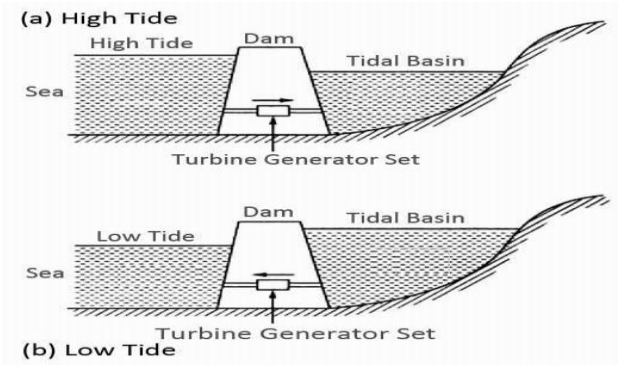
1. It is a renewable source of energy.
2. By far, it is non-polluting and environment friendly.
3. There is no wastage or generation of by-products.
4. Geothermal energy can be used directly. In ancient times, people used this source ofenergy for heating homes, cooking, etc.
5. Maintenance cost of geothermal power plants is very less.

Disadvantages of Geothermal Energy

1. Only few sites have the potential of Geothermal Energy.
2. Most of the sites, where geothermal energy is produced, are far from markets or cities, where it needs to be consumed.
3. Total generation potential of this source is too small.
4. There is always a danger of eruption of volcano.
5. Installation cost of steam power plant is very high.

TIDAL/WAVE POWER PLANT

Construction & Working



Tides are the waves caused due to the gravitational pull of the moon and also sun (though its pull is very low). The rise is called high tide and fall is called low tide. This building up and receding of waves happens twice a day and causes enormous movement of water. It is so powerful that it has caused many mishaps and resulted in sinking of ships. Thus tidal energy forms a large source of energy and can be harnessed in some of the coastal areas of the world. Tidal dams are built near shores for this purpose. During high tide, the water flows into the dam and during low tide, water flows out which result in turning the turbine.

Advantages of Tidal Energy

1. It is an inexhaustible source of energy.
2. Tidal energy is environment friendly energy and doesn't produce greenhouse gases.
3. As 71% of Earth's surface is covered by water, there is scope to generate this energy onlarge scale.
4. We can predict the rise and fall of tides as they follow cyclic fashion.
5. Efficiency of tidal power is far greater as compared to coal, solar or wind energy. Its efficiency is around 80%.

Disadvantages of Tidal Energy

1. Cost of construction of tidal power plant is high.
2. There are very few ideal locations for construction of plant and they too are localized tocoastal regions only.
3. Intensity of sea waves is unpredictable and there can be damage to power generation units.
4. Influences aquatic life adversely and can disrupt migration of fish.
5. The actual generation is for a short period of time. The tides only happen twice a day soelectricity can be produced only for that time.

OCEAN THERMAL ENERGY CONSERVATION

Ocean thermal energy conservation is a process that can produce electricity by using the temperature difference between cold ocean water and warm tropical surface water. Ocean Thermal Energy Conversion (OTEC) is to turn the solar energy trapped by the ocean into useable energy. This kind of energy is found in tropical oceans where the water temperature differs from surface to deeper into the sea. OTEC generates electricity by using the temperature difference of 20°C(36°F) or more than that exists between the warm tropical waters at the sun warmed surface, and cold water drawn from the depth of 1000 meters. To convert this thermal gradient into electrical energy, the warm water can be used to heat and vaporize a liquid. The working fluid develops pressure as it is caused to evaporate. This expanding vapor runs through a turbine generator and is then condensed back into a liquid by cold water brought up from depth and the cycle is repeated.

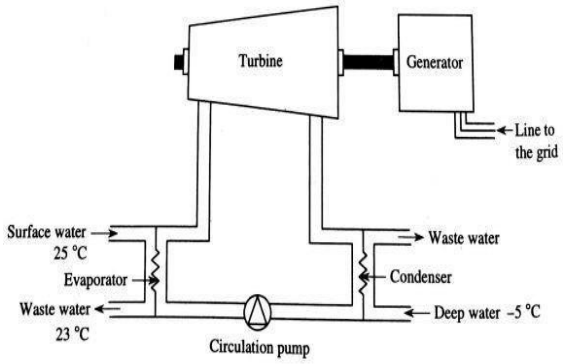


Diagram of closed cycle OTEC plant

CLOSED CYCLE OTEC

Construction & Working

Closed Cycle OTEC employs a low-boiling-point liquid like propane or ammonia (B.P=-33℃) as an intermediate fluid. In OTEC plant first warm surface sea water is pumped through a heat exchanger to vaporize the fluid. The expanded vapor turns the turbo generator. Cold water pumped through a second heat exchanger condenses the vapor into a liquid which is thenrecycled. The first closed cycle OTEC.

OPEN CYCLE OTEC

Construction & Working

Open cycle OTEC uses warm surface water directly to make electricity. The warm sea water is first pumped into a low pressure container, which causes it to boil. In some processes, the expanding steam drives low pressure turbine attached to an electrical generator. The steam leaves its salt and contaminants in the low

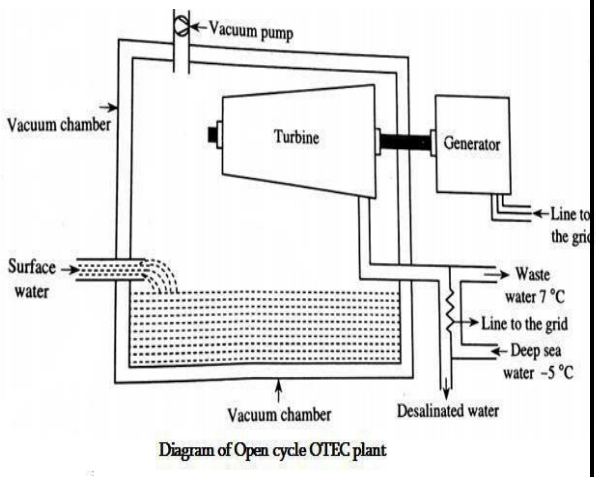


Diagram of Open cycle OTEC plant

pressure container to give pure fresh water. It is condensed toa liquid by exposure to cold temperatures from deep–ocean water. This method produces desalinated fresh water, suitable for drinking, irrigation and agriculture.

Advantages of OTEC

1. Warm surface sea water and cold water from the ocean from the ocean depths replace fossilfuels to produce electricity.
2. OTEC plants will produce little or no carbon dioxide or other polluting chemical
3. OTEC systems can produce fresh water as well as electricity. A lot of fish & other nutritioussea-food will be collected in outlet flow.
4. OTEC can also be used to produce, ammonia, hydrogen, aluminum chlorine and other chemicals.

Disadvantages of OTEC

1. OTEC produced electricity at present would cost more than electricity generated from fossilsfuels at their current costs.
2. No energy company put money in this project because it only had been tested in a very smallscale.
3. Construction of OTEC plants and lying of pipes in coastal waters may cause localized damageto reefs and near-shore marine ecosystem.

SOLAR ENERGY

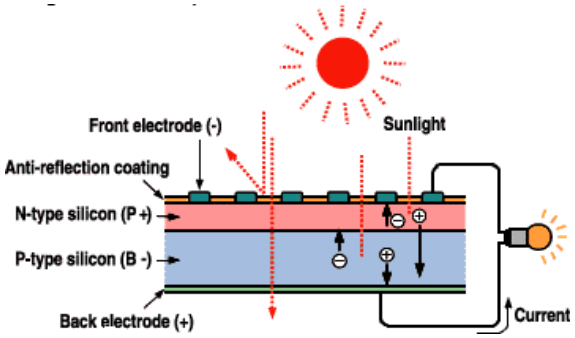
Introduction: Solar energy is the most readily available source of energy. It is also the most important of the non-conventional sources of energy because it is non-polluting and, therefore, helps in lessening the greenhouse effect. When we hang out our clothes to dry in the sun, we use the energy of the sun. In the same way, solar panels absorb the energy of the sun to provide heat for cooking and for heating water.

PHOTOVOLTAIC(PV) CELL (OR) SOLAR CELL

Construction and Working

A photovoltaic cell, commonly called a solar cell or PV, is the technology used to convert solar energy directly into electrical power.

A photovoltaic cell is a non-mechanical



device usuallymade from silicon alloys. When photons strike a photovoltaic cell, only the absorbed photons provide energy to generate electricity. When enough Sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms, Special treatment of the material surface during manufacturing makes the front surface of the cell more receptiveto free electrons, so the electrons naturally migrate to the surface. When the electrons leave their position, holes are formed. When many electrons, each carrying a negative charge, travel toward the front surface of the cell, the resulting imbalance of charge between the cell's front and back surfaces creates a voltage potential like the negative and positive terminals of a battery. Whenthe two surfaces are connected through an external load, such as an appliance, electricity flows.

The photovoltaic cell is the basic building block of a photovoltaic system. Individual cells can vary in size from about 0.5 inches to about 4 inches across. However, one cell only produces 1 or 2 watts. To increase power output, cells are electrically connected into a packaged weather-tight module. Modules can be further connected to form an array. Array is made up of one or several thousand modules. Most modern modules are about 10% efficient in converting Sunlight. Furtherresearch is being conducted to raise this efficiency to 20%.

Some advantages of photovoltaic systems are:

I. Conversion from Sunlight to electricity is direct, so that bulky mechanical generator systems are unnecessary.

2. PV arrays can be installed quickly and in any size.

3. The environmental impact is minimal.

4. Requiring no water for system cooling.

5. Generating no by-products

SPV can be used for a number of applications such as:

1. Domestic lighting and street lighting.

2. Village electrification.

3. Water pumping.

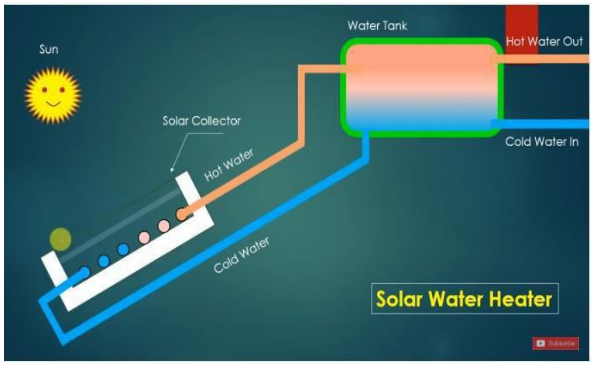
4. Desalination of salty water.

5. Powering of remote telecommunication repeater stations.

6. Railway signals.

SOLAR WATER HEATER

Construction and Working

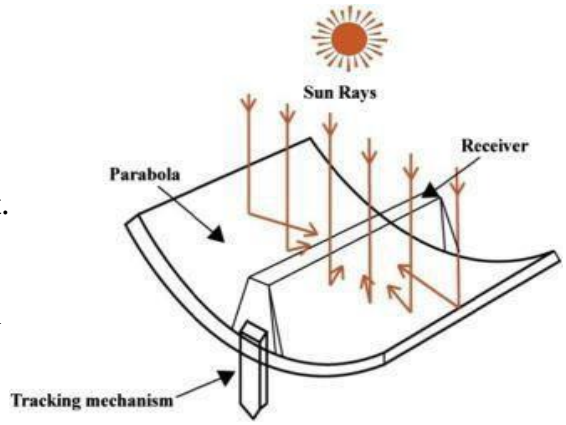


Construction: A typical domestic solar water heater consists of a hot water storage tank and one or more flat plate collectors. Inlet and outlet pipes are connected to water tank which is insulated to avoid heat loss. Material of construction of tube is copper in side collector. Glass cover is provided on the collector. Water is place on the metal structure at the top and flat plate collectorsare the bottom facing the sun.

Working: The collectors are glazed on the sun facing side to allow solar radiation to come in. A black absorbing surface (absorber) inside the flat plate collectors absorbs solar radiation and transfers the energy to water flowing through it. A black surface heats up when left in the sun, by absorption of solar radiation; the good absorption property of black surfaces is used to improve solar energy absorption in a solar heater Heated water is collected in the tank which is insulated to prevent heat loss. Circulation of water from the tank through the collectors and back to the tank continues automatically due to density difference between hot and cold water (thermosiphon effect).

PARABOLIC TROUGH

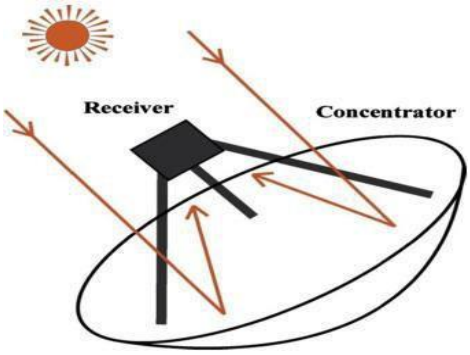
It is a type of solar thermal energy collector.



It is constructed as a long parabolic mirror (usually coated silver or polished aluminum) with a Dewar tube running its length at the focal point. Sunlight is reflected by the mirror and concentrated on the Dewar tube. The trough is usually aligned on a north-south axis, and rotated to track the sun as it moves across the sky each day. Heat transfer fluid (usually oil) runs through the tube to absorb the concentrated sunlight. This increases the temperature of the fluid to some 400°C. The heat transfer fluid is then used to heat steam in a standard turbine generator. The temperature of the heat transfer fluid quickly reaches 750 degrees as the sun's energy is captured by the Parabolic Troughs. The overall

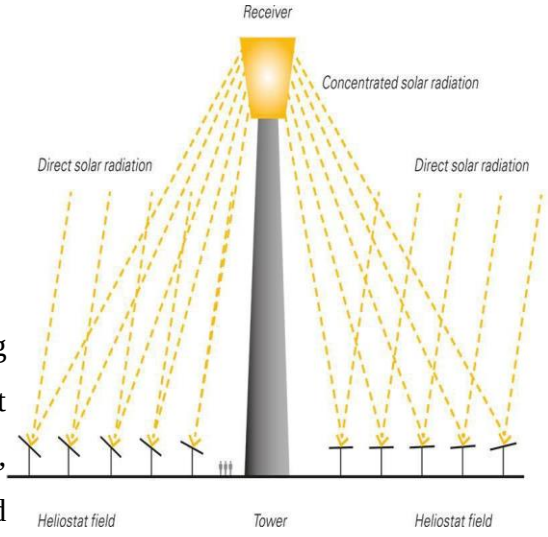
process is very economical and thermal efficiency ranges from about 60% to as high as 80%.

PARABOLIC DISH SYSTEMS



Parabolic dish systems consist of a parabolic-shaped point focus concentrator in the form of a dish that reflects solar radiation onto a receiver mounted at the focal point. These concentrators are mounted on a structure with a two-axis tracking system to follow the sun. The collected heat is typically utilized directly by a heat engine mounted on the receiver moving with the dish structure.

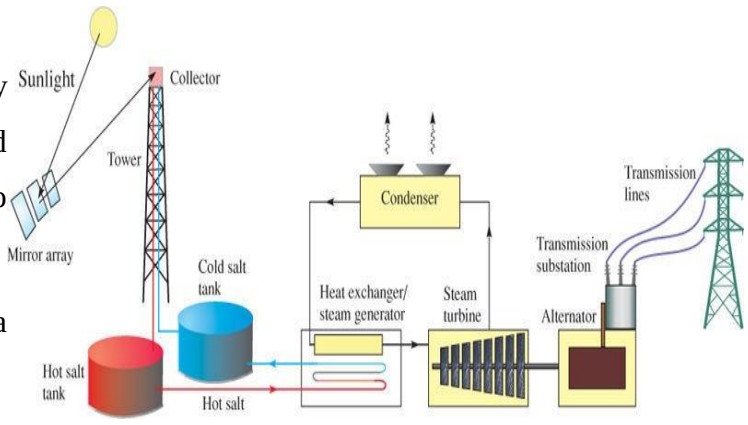
SOLAR POWER TOWER



Solar power towers generate electric power from sunlight by focusing concentrated solar radiation on a tower-mounted heat exchanger (receiver).

The system uses hundreds to thousands of sun-tracking mirrors called heliostats to reflect the incident sunlight onto the receiver. In a molten-salt solar power tower, liquid salt at 290ºC (554ºF) is pumped from a cold storage tank through the receiver where it is heated to 565ºC (1,049ºF) and then on to a hot tank for storage. When power is needed from the plant, hot salt is pumped to a steam generating system that produces superheated steam for a conventional Rankine- cycle turbine/generator system. From the steam generator, the salt is returned to the cold tank where it is stored and eventually reheatedin the receiver.

SOLAR THERMAL POWER PLANT



It uses the Sun‘s rays to heat a fluid to very high temperatures. The fluid is then circulated through pipes so it can transfer its heat to water produce steam. The steam, in turn, is converted into mechanical energy in a

turbine and into electricity by a conventional generator coupled to the turbine. The three main types of solar thermal power systems are:

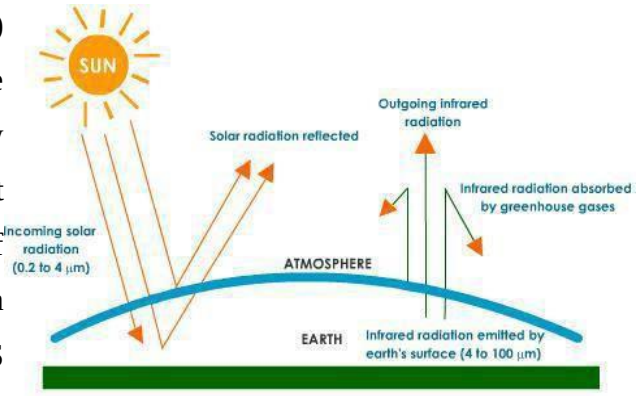
1. Parabolic trough (the most common type of plant).
2. Solar dish.
3. Solar power tower.

Process of solar thermal power generation:

- Concentrating solar radiation by means of a collector system, increasing radiation flux density(i.e. concentrating of the solar radiation onto a receiver).
- Absorption of the solar radiation (i.e. conversion of the radiation energy into thermal energy(i.e. heat) inside the receiver).
- Transfer of thermal energy to an energy conversion unit.
- Conversion of thermal energy into mechanical energy using a thermal engine (e.g. steamturbine).
- Conversion of mechanical energy into electrical energy using a generator.

GREEN HOUSE EFFECT, CONSEQUENCES OF GLOBAL WARMING AND REMEDIES TO CONTROL GLOBAL WARMING

The process of heating of globe is called "Global warming". This phenomenon is similar to that of green house or glass house in which glass roof allows solar radiation inside but prevents the escape of the terrestrial radiation (heat) generated inside the green house. As a result, inside temperature of the green house will rise and allow tropical plants to grow on temperature soils without any discomfort hence; it takes the name of "greenhouse effect". J.FOURIER – a French scientist first recognized in 1827. But ANTHES differ to use the name greenhouse effect as there was no perfect analogy between CO_2 and glass. They preferred to call atmospheric effect to greenhouse effect'. *The earth's surface partly absorbs sun rays, while emits long wave infrared radiation. CO_2 and water vapor in the atmosphere strongly absorb infrared*



radiation and effectively block a large fraction of the earth's emitted radiation. The radiation thus absorbed by carbon dioxide and water vapor is partly returned to the earth's surface. The net result is that the earth's surface gets heated and the phenomenon is known as Greenhouse effect. The gases which are cause for the global warming are known greenhouse gases. Surface of the earth is about 15°C; this is about 33° C higher than it would be in absence of greenhouse effect. Without this background temperature, our earth would have remained as any other lifeless cold planetwith -18°C.

Carbon dioxide (CO_2): It is the most important greenhouse gas. It contributes more than 60 per cent to the warming of the globe. It stays in the atmosphere, on average, for about 500 years. Prior to industrial revolution, the CO_2 concentration in the earth's atmosphere was 280 ppm and by 1994 it was 358 ppm with an annual increase of 1.5 ppm. If the same trend continues it is estimated that by the end of the 21st century the carbon dioxide concentrations may cross 600 ppm mark.

Methane (CH_4): It is estimated that domestic cow can produce 73,000 liters of methane per year. Its concentration is around 1 .7 ppm and increasing at a rate of 1.1% each year. Though onemolecule of Methane is 25 times as effective as CO_2 molecule at trapping heat, it contributes around 15% of the total global warming. It stays in the troposphere for7- 10 years.

Nitrous oxide (N_2O): Unlike other oxides of nitrogen N_2O has longer life span (140 – 190 years)and its concentration in the atmosphere is 380 pp is rising at a rate of about 0.3 % per year, because of the increased use of fossil fuels and chemical fertilizers. One molecule of N2O is 250 times as effective as CO_2 molecule at trapping heat. It accounts for 4% of the total global warming.

Chlorofluorocarbons (CFCs): These are man-made, long-lived, stable and inert wonder chemicals, which are responsible for the majority of the modern man's comforts. Now these are mainly blamed for the destruction of protective ozone layer in the stratosphere. In addition to this, they can act as GHGs and can bring about 11% of total global warming. They are rising at the rate of 5% in the atmosphere. One molecule of CFC is 20,000 times as effective as CO_2 molecule at trapping heat.

Troposphere ozone (0_3): It is produced through photochemical reactions involving Hydrocarbons and Nitrogen oxides that are coming from automobile exhaust gases. It

concentration in the atmosphere is about 0.02 ppm. It is 2000 times as effective as CO_2, in heat retention property. This gas along with water vapor and other gases may contribute 9% of the total global warming effect.

Consequences of global warming:

1. Melting of polar ice caps, glaciers.
2. Sea level rise, submergence of low lying areas — sinks coastal cities and islands. Maldivesmay vanish by the end of this century.
3. By the year 2080, Manhattan and Shanghai could be underwater.
4. Salt water inundation, intrusion into fresh water aquifers, Water crisis.
5. Shift in rainfall pattern, Change in cropping pattern.
6. Crop failures, Starvation, hunger deaths.
7. Beach erosion, Loss of biodiversity (species extinction).
8. Corals bleaching.
9. Coastline change-disputes with maritime boundaries.
10. 1°C rise is equal to a change in latitude by 100 km.
11. 2-5 rises is enough to have in Europe the climate of Africa today.
12. Drought, Desertification, Climate change, Severe storms, floods, winters, heat waves,

Green solutions to control global warming:

1. Greening of the globe can save the planet and its life: 600 million forests are necessary toprevent global warming.
2. Enriching oceans with iron could help to absorb phytoplankton more carbon dioxide.
3. Locking carbon in tropical forest biomass is the only cost effective remedy. Seriously thinkabout Carbon capturing and Carbon burying.
4. Switching over to carbon free fuels. Carpooling, Mass transport, Cycle and recycle. Createmarket to C02. Carbon trading
5. Adopting low carbon lifestyles and economies. Promote Veg. diets, No car days, No-carincentives, No night time crickets.
6. Alternative energy sources or Renewable energy.
7. Solar and Nuclear power rather than thermal power.
8. Less Carbon intensity of fossil fuels.
9. Installing fluorescent lights or natural skylights. Development of new technologies,

such ashydrogen cars, may reduce the consumption of petroleum and emissions of carbon dioxide.

10. Increased use of bio-fuels (such as ethanol fuel and biodiesel.
11. New buildings can be constructed using passive solar building design, using renewable heatsources.
12. Reforestation and avoided deforestation.