New Energy Sources

3.2 Need for new energy sources

Fossil fuels and nuclear energy are the important resources use to meet most of our energy needs today. They are expected to be widely used in the near future However, fossil and nuclear energy resources are non-renewable and will someday be exhausted, while their continued use possess environmental risks related to air pollution, global climate change, land use and waste disposal. These issues have stimulated the search for new energy sources for producing and using energy.

- Solar thermal;
- Solar photovoltaics;
- Wind power generation and water pumping;
- Biomass combustion/co-generation;
- Small, mini, and micro hydro power;
- Solar power;
- Utilization of biomass–gasifiers, briquetting, biogas, improved *chulha* (cook-stove);
- Geothermal for heat applications;
- Power generation/energy recovery from urban, municipal and industrial wastes;
- Tidal power generation;
- Chemical sources of energy;
- Fuel cells;
- Alternative fuel for surface transportation and hydrogen energy, etc.

3.2.1 Hydrogen

The fuel that has potential of being widely used in the future is hydrogen gas (H2). Like natural gashydrogen can be burned to heat buildings, cook food and produce electricity in power plants. Hydrogen can be produced by **thermal dissociation** or **photolysis** or **electrolysis** of water. Hydrogen possess high calorific value. It is non-polluting, because the combustion product is water.

$2H_2 + O_2 \longrightarrow 2H_2O + 150kJ$

H_2 gas can be compressed in a fuel tank and used to power cars and buses.

Sources of Hydrogen

(i) Plentiful hydrogen is available from water (H20). Water can be split intogaseous H_2 and O_2 by an electrolysis process.

(ii) Hydrogen can also be produced from natural gas and biomass resources.

(iii) Ethanol reacts with high-temperature steam to produce hydrogen.

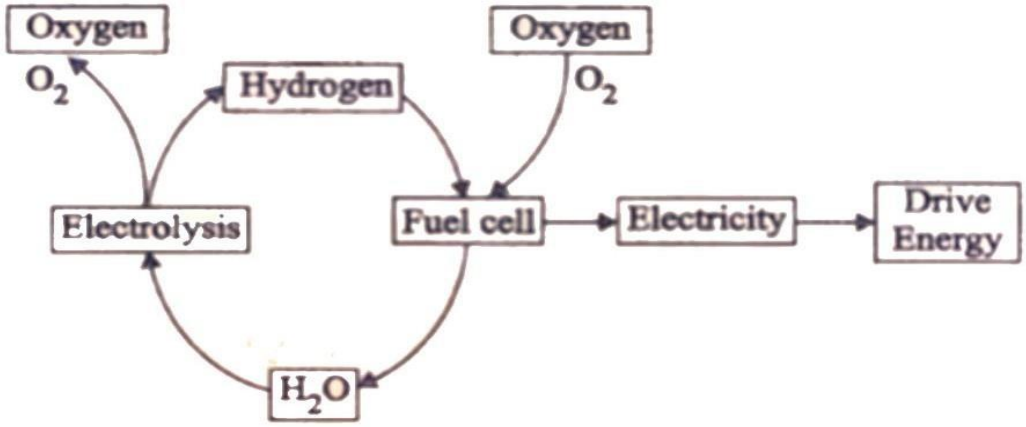
(iv) Biomass is converted into sugar-rich feed stocks that can be fermented to produce hydrogen.

(v) Microbes such as green algae, consume water in the presence of sun light and produce hydrogen as a by-product.

Hydrogen Fuel cell

Hydrogen can be used in fuel cells. The electrons in hydrogen atoms generate electricity in the fuel cell. Thecombination of H_2 and O_2 creates water and heat from the reaction. The heat may be used to produce electricity.

At anode, hydrogen is split into protons and electrons. The electrons moves to cathode and generates electricity.



Hydrogen Fuel Cell Technology

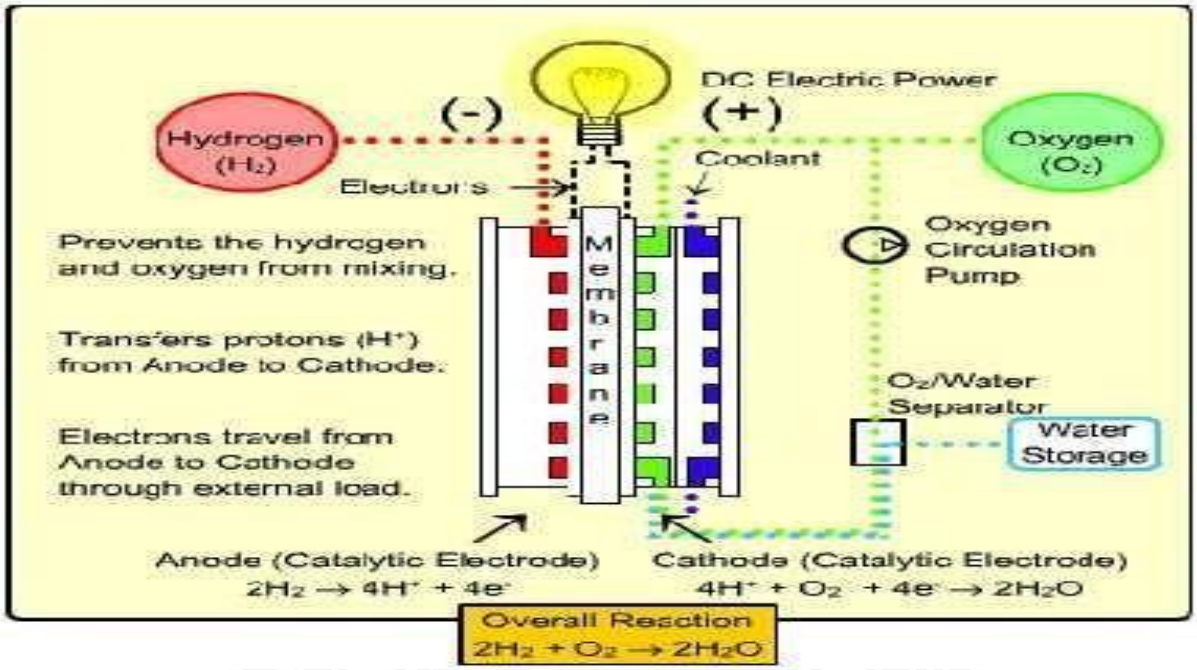


Fig. Hydrogen fuel cell

Electrical power plants can be built using large banks of fuel cells, but small groups of cells provideelectricity for individual home and commercial buildings.

Disadvantages of hydrogen fuel

- Hydrogen is highly inflammable and explosive in nature
- Safe handling is required
- It is difficult to store and transport.
- Difficulties in storing enough hydrogen for motor vehicles to run long distances.
- Infrastructure to refuel these vehicles.

3.2.2 Ocean thermal Energy (OTE)

There is often large temperature difference between the surface level and deeper level of the tropicaloceans.

This temperature difference can be utilized to generate electricity.

The energy available due to the difference in temperature of water is called oceanthermal energy.

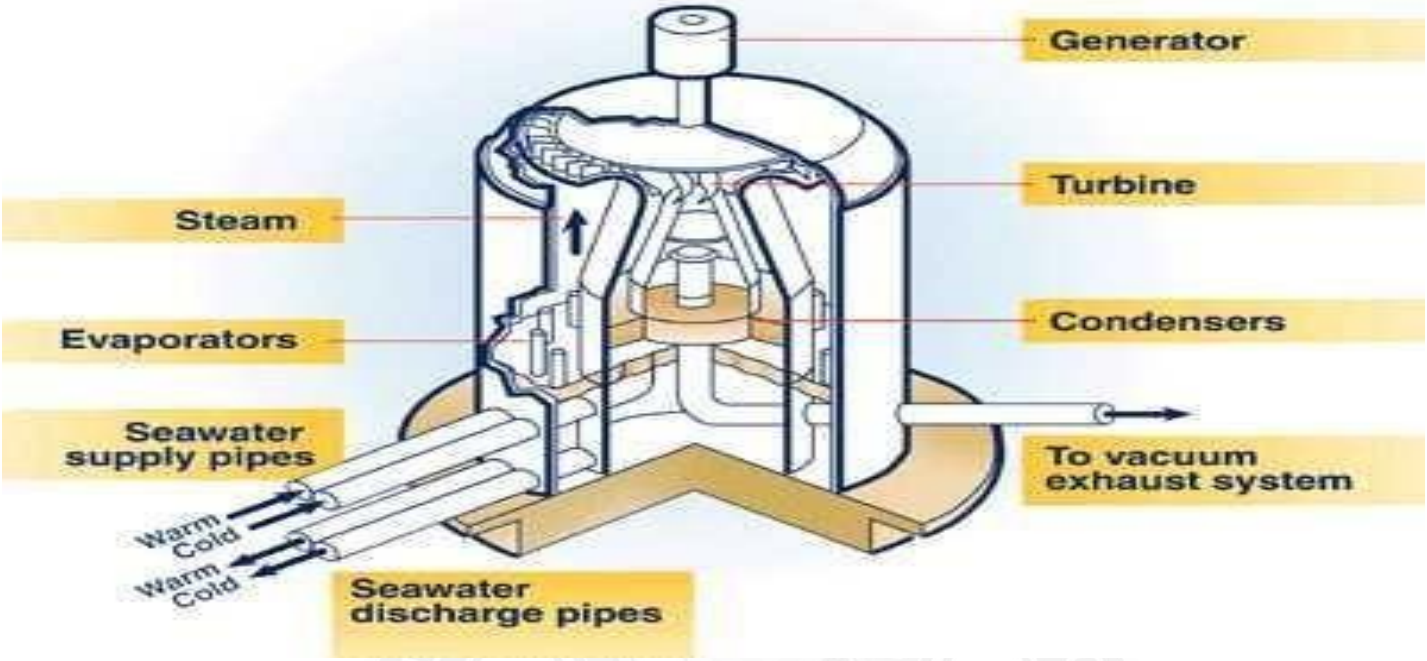


Fig. Ocean thermal energy

Condition

The temperature difference should be of 20^0C or more is required between surfacewater and deeper water.

Process

- The warm surface water of ocean is used to boil a low boiling liquid like ammonia.
- The high vapour pressure of the liquid, formed by boiling is then to turn the turbine of thegenerator and generates electricity.
- The cold water from the deeper ocean is pumped to cool and condense the vapour into liquid.

There is often large temperature difference between the surface level and deeper level of the tropical oceans.This temperature difference can be utilized to generate electricity. The energy available due to the differencein temperature of water is called ocean thermal energy.

Significance of OTE

OTE is continuous, renewable and pollution free.

The use of cold deep water, as the chiller fluid in air-conditioning, has also been proposed

Electric power generated by OTE can be used to produce hydrogen.

3.2.3 Tidal energy (or) Tidal power

Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy.

The “high tide” and “low tide” refer to the rise and fall of water in the oceans.

The tidal energy can be harnessed by constructing a tidal barrage.

During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which intern produces electricity by rotating the generators.

During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed toflow into the sea and again rotates the turbine.

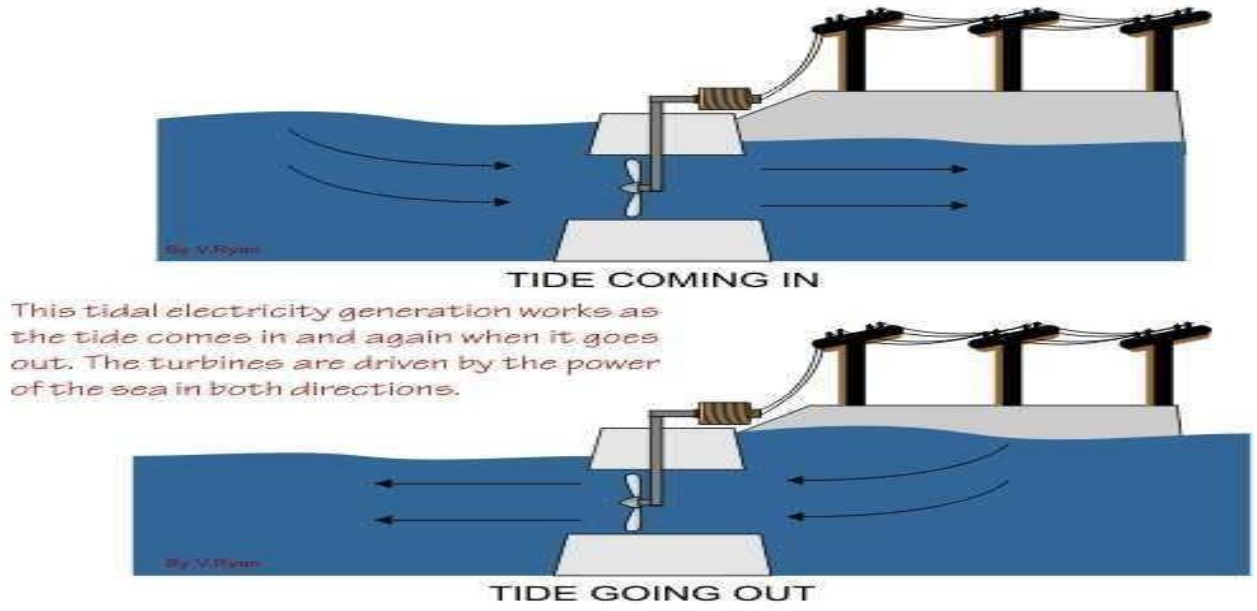


Fig. Tidal energy

Tidal energy is· a renewable energy powered by the natural rise and fall of ocean tides and currents.

Significance of Tidal Energy

Tidal power plants do not require large areas of valuable lands as they are on the bays (or) estuaries.

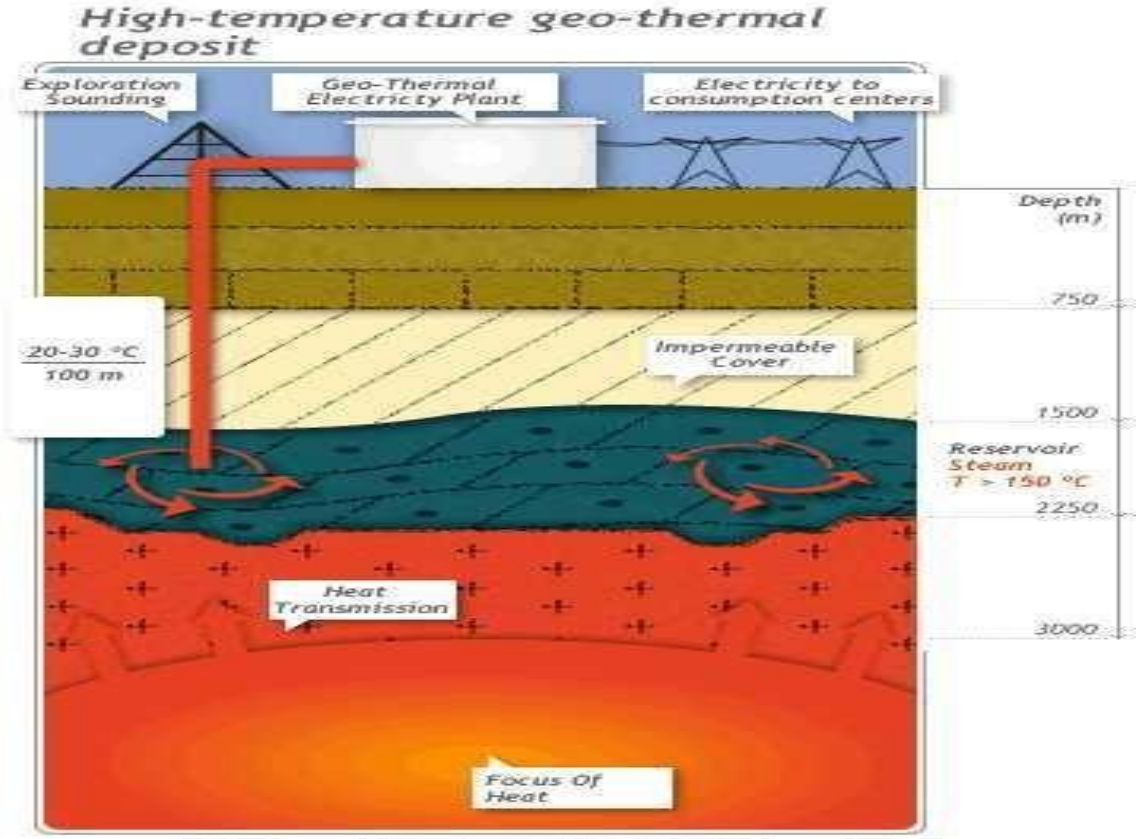


Fig. Geothermal energy

As the sea water is inexhaustible, it is completely independent of the uncertainty of precipitation

It is pollution-free energy source, as it does not use any fuel and also does not produce any wastes.

3.2.4 Geo Thermal Energy

The heat produced deep in the Earth's core is called Geothermal energy. The energy harnessed from thehigh temperature present inside the earth can be used to produce electricity. Temperature of the earth increases at a rate of 20-75^{0}C per km, when we move down the earth surface.

High temperature and high pressure steam fields exists below the earth's surface in many places.

The energy harnessed from the high temperature present inside the earth is called geothermal energy.

Natural geysers

In some places, the hot water (or) steam comes out of the ground through cracks naturally in the form.

Artificial geysers

In some places, we can artificially drill a hole up to the hot region and by sending a pipe in it, we can makethe hot water or steam to rush out through the pipe with very high pressure.

Thus, the hot water (or) steam coming out from the natural (or) artificial geysers is allowed to rotate theturbine of a generator to produce electricity.

Significance of geothermal energy

The power generation level is higher for geothermal than for solar and wind energies.

Geothermal power plants can be brought on line more quickly than most other energy sources.

GTE is effectively and efficiently used for direct uses such as hot water bath, resorts, aquaculture, greenhouses.

3.2.4 Solar Energy

Solar cells (or) photovoltaic cells (or) PV cells

Solar cells consist of a p-type semiconductor (such as Si doped with B) and n-type semi-conductor (Si doped with P).

They are in close contact with each other.

When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.

There by potential difference between two layers is created, which causes flow of electrons (i.e., an electric current)

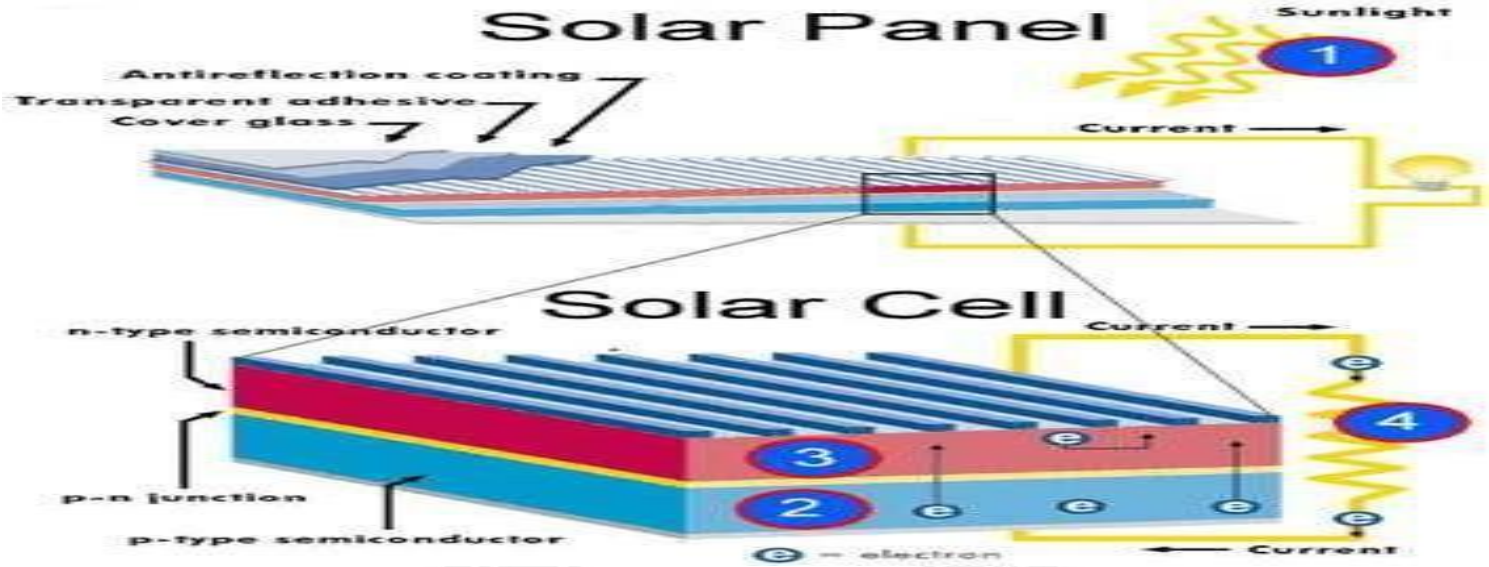


Fig. Solar cell

Uses

Used in calculators, electronic watches. Street lights, water pumps to run radios and TVs.

Solar Battery

When a large number of solar cells are connected in series it forms a solar battery.

Solar battery produces more electricity which is enough to run water pump, to run street-light, etc.,

They are used in remote areas where conventional electricity supply is a problem.

Solar heat collectors

Solar heat collectors consist of natural materials like stones, bricks, (or) materials like glass, which can absorb heat during the day time and release it slowly at night.

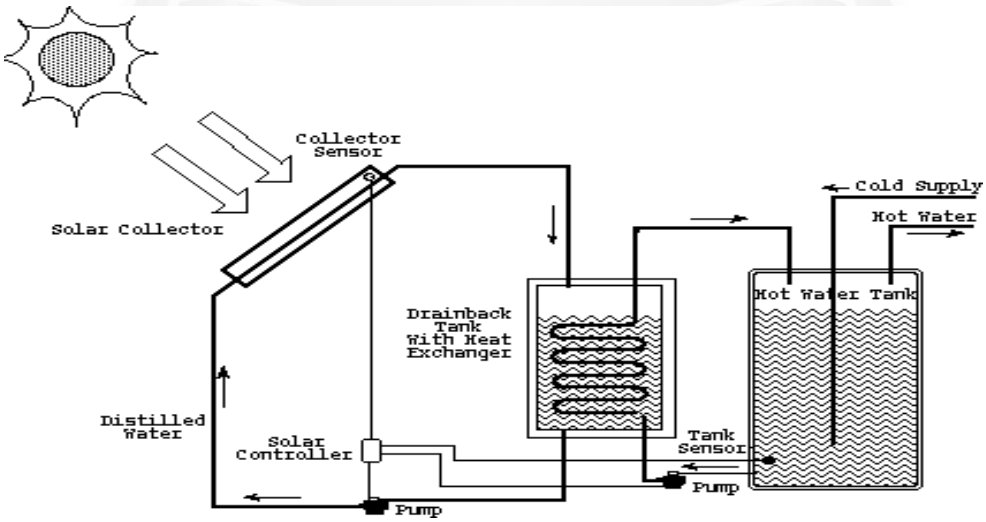


Fig. Solar heat collector

Uses

Used in cold places, where houses are kept in hot condition using solar heat collectors.

Significance of Solar Energy

Solar cells are noise and pollution free.

Solar water heaters, cookers, require neither fuel nor attention while cooking food.

Solar cells can be used in remote and isolated areas, forests, hilly regions.

3.2.6 Wind Energy

Moving air is called wind.

Energy recovered from the force of the wind is called wind energy.

The energy possessed by wind is because of its high speed.

The wind energy is harnessed by making use of wind mills.

Harvesting of wind energy

Wind Mills

The strike of blowing wind on the blades of the wind mill makes it rotating continuously.

The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.

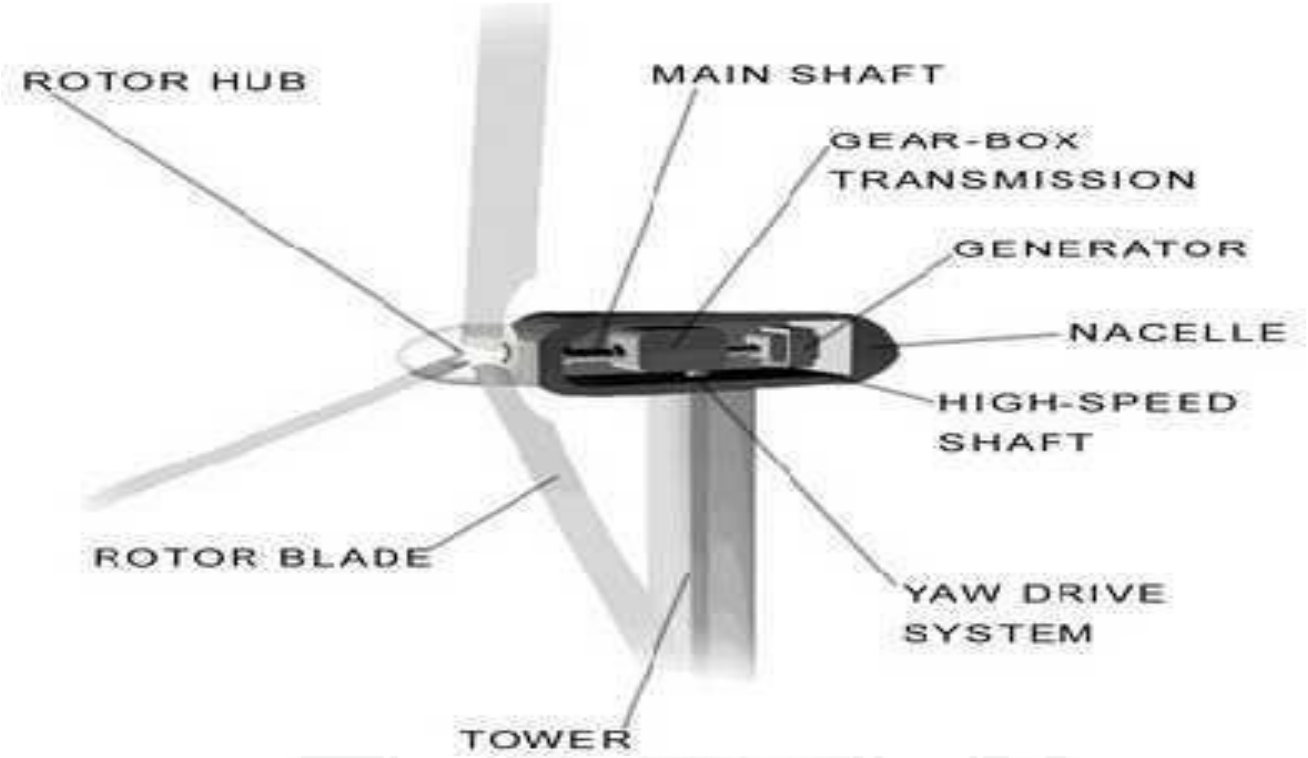


Fig. Wind mill

Wind farms

When a large number of wind mills are installed and joined together in a definite pattern it forms a windfarm.

The wind farms produce a large amount of electricity.

Conditions

The minimum speed required for satisfactory working of a wind generator is 15km/hr.

Advantages

It does not cause any air pollution

It is very cheap.

Significance of Wind Energy

The generation period of wind energy is low and power generation starts from commissioning.

It is recommended to broaden the nation's energy options for new energy sources.

It is made available easily in many off-shore, on-shore and remote areas.

3.2.7 Bio-Mass energy

Biomass is the organic matter, produced by plants or animals, used as sources of energy. Most of thebiomass is burned directly for heating, cooling and industrial purposes.

E.g.: Wood, crop residues, seeds, cattle dung, sewage, agricultural wastes.

Biogas

Mixture of methane, carbon dioxide, hydrogen sulphide, etc. It contains about 65% of methane gas as a major constituent.

Biogas is obtained by the **anaerobic fermentation** of animal dung or plant wastes in the presence of water.

Bio fuels

Biofuels are the fuels, obtained by the fermentation of biomass. Eg: Ethanol, Methanol

Ethanol

Ethanol can be easily produced from the **sugarcane**. Its calorific value is less when compared to petrol, andproduces much less heat than petrol.

Methanol

Methanol can be easily obtained from **ethanol or sugar**-containing plants.
Its calorific value is also too low when compared to gasoline and diesel.

Gasohol

Gasohol is a mixture of **ethanol and gasoline**.

- In India trial is being carried out to use Gasohol in cars and buses.
- Gasohol is common fuel in Brazil and Zimbabwe for running cars and buses.
- Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Due to its highcalorific value, hydrogen can serve as an excellent fuel.
- Moreover, it is non-polluting and can be easily produced.
- Presently H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

Significance of bio-mass energy

- The cost of obtaining bio-energy through bio-gas plant is less than the cost of obtaining Energy from fossil fuels.
- Biomass consumes more CO_2 than is released during combustion of biomass.
- It provides a stored form of energy and in many cases in a form suitable for vehicle propulsion.

3.2.8 Artificial intelligence (AI) in the energy sector

Artificial intelligence (AI) is used to forecast demand and manage the distribution of resources, to ensure that power is available at the time and place it's needed with a minimum of waste. AI plays an essential role in the world's transition to clean energy. Artificial intelligence is particularly important in the renewable energy industry, where it often can't be stored for long periods of time and has to be used close to the time and location where it is generated.

Distributed Energy Storage System

A distributed energy storage system (DESS) is a packaged solution that stores energy for use at a later time. The system is provided with two main components.

(i) DC charged batteries and

(ii) Bi-directional inverter.

Its major role is to prevent power fluctuation and power quality problems.

Grid Integration

Grid integration is the practice of developing efficient ways to deliver variable renewable energy tothe grid.

Space technologies

Space-based energy technologies like

Harvesting hydrogen from the moon to power fuel cell on earth,

Orbiting solar rays that absorb around-the-clock direct sunlight and send the energy back down to stations on the ground via radio (or) microwaves, are being developed as the new energy technology.

Norwegian crystals

Low carbon mono crystalline silicon ingots, is a type of crystal, used for high performance

photovoltaic devices.

Gallium-doped ingots, that increases the lifetime of the solar cells.

Through this, Norwegian crystals controls the carbon footprint of solar panel components at ultra-low levels.

Algal bio-fuels

Algae is ·an alternative to liquid fossil fuels. It offers huge commercial potential. Like fossil fuel, algae fuel releases CO_2 when burnt. But unlike fossil fuel the CO_2 released by algae fuel is removed from the atmosphere via, photosynthesis as the algae (or) plant grew.

The impact of algal bio-fuels on the atmosphere is much lower. Algal fuel production has a minimal impact on land and water resources. It can be produced using seawater (or) even grey waste water.

Body heat

The body heat, liberated by humans in the crowded area like central station, market place, is channel led through the station's vent system. Then it is used to warm up water in underground tanks and pumped through the heating system.

3.2.9 Applications of Hydrogen Energy

Hydrogen is a reagent, used in many industries, including chemicals, textile fiber manufacturing, glass, electronics and metallurgy.

It is also used as a fuel for rocket launchers.

In electronics, hydrogen is used as a carrier gas, for the manufacture of electronic components.

Hydrogen is used in industries for many applications.

Examples

(i) It combines with nitrogen to produce ammonia, a base for fertilizers.

(ii) It is a good reagent for textile fibers like nylon, polyurethane foam.

Hydrogen is used in metallurgy for heat treatment Process to produce mechanical parts (or) to alter their properties.

Hydrogen is used during fuel refining to remove this Sulphur via a process of desulphurization.

A mixture of hydrogen and nitrogen is used to prevent oxidation in flat glass production.

As an efficient reducing and f etching agent, hydrogen is used ·to create semiconductors, L E D s, displays.

Hydrogen gas is used as a therapeutic gas for a number of different diseases.

Hydrogen fuel cell

Hydrogen fuel cell uses hydrogen as a fuel in a chemical process that combines H2 and O2 to produce electrical energy with water and heat as the only product.

Two main applications of fuel cells are,

(i) Stationary power stores

(a) These are used to power office buildings, data centers, grocery stores and off-grid telecommunicationtowers.

(b) It is used as a part of uninterruptible power supply (UPS) system, where continuous uptime is critical.

(ii) Hydrogen fuel cell vehicles (FCVs)

- The heat produced by the hydrogen fuel cell can be used for space and water heating (or) industrialprocess.
- Hydrogen fuel cells power clean trucks, fork lifts, etc.,
- Hydrogen power is being considered for transportation applications including hydrogen fuel cellbuses.
- Hydrogen fuel cell trains have now appeared.
- Hydrogen offers versatile options for mobile power generation. Some of the hydrogen fuel cells weredeveloped by NASA to provide electricity for rockets and shuttles in space.
- Hydrogen fuel cells have found a number of marine applications (used in boats and submarines).

Advantages and disadvantages of hydrogen fuel cells

Advantages

- Hydrogen is readily available.
- It does not produce harmful emissions.

- It is environmentally friendly.
- It can be used as fuel in rocket.
- It is energy efficient and more powerful than fossil fuels.
- It is renewable.
- It reduces carbon foot prints.
- Charging times is fast.
- It does not make noise and visual pollution.
- It can be used for long time.

Disadvantages

- It is expensive.
- It is difficult to store.
- It is highly inflammable.
- Infra-structure.
- Regulatory issues.

3.2.10 Applications of ocean energy Resources

Tidal energy (or) tidal power is a form of ocean energy that is harnessed by converting tide energy into useful forms of power. Tidal energy is obtained from the rise and fall of tides. Tidal barrages and dams are constructed across a narrow opening to the sea. Water rushes into the dam when the sea level rises which moves the blade of the turbines which helps in the generation of electricity. Below are some important applications of ocean energy.

1. Ocean waves

Potential energy associated with ocean waves can be harnessed using modular technologies.

2. Temperature gradients

Difference in thermal energy between sea surface and Deep water can be harnessed by Ocean Thermal Energy Conversion (OTEC) process.

3.Salinity gradient

At the mouth of rivers, where fresh water mixes with salt water, energy associated with the salinity gradient can be harnessed using pressure retarded reverse osmosis process and associated conversion technologies.

4. Ocean wave energy converters

These are the technology used to trap the mechanical energy of the wave to convert it to electrical power.

5. Oscillation bodies

Oscillating waves uses hydraulic motors (or) electrical generators as a power take-off system.

6. Overlapping wave energy converters

The overtopping wave energy convertors (or) terminators, using the low head hydraulic turbines, convertsthe potential energy formed by the height of accumulated water over the wave surface to electrical power.

7. Ocean thermal Energy (OTE)

The temperature difference, between the surface level and deeper level of the tropical oceans, can be utilizedto generate electricity.

Advantages and disadvantages of ocean energyAdvantages

- Ocean energy is cheaper and efficient.
- It is environment - friendly.
- The source of ocean energy is inexhaustible
- Operational and maintenance costs are low.
- Tidal energy sources can last for decades.
- It protects coastal flooding's due to the stability of rock armor.

Disadvantages

- Construction of tidal power plant is expensive and requires high capital investment.
- Maintenance and equipment repairing is a challenge.

- Negative influence on marine life forms.
- Storage capacity is required.
- Environmental problems like habitat change arises.

3.2.11 APPLICATIONS OF TIDAL ENERGY CONVERSION

- Electricity can be generated from the tidal energy.
- Tidal energy is used in grinning mills for the mechanical crushing of grains.
- Tidal energy is used to rotate a turbine.
- Tidal energy is used to store energy in a hydroelectric dam, acting as large energy storage.
- Tidal barrages and reservoirs can be modified to store energy.
- Tidal barrages are capable of preventing damages to the coast during high storms.
- Tidal barrages also help to create easy transport between the two arms of an estuary (or) a bay.

Advantages (or) Merits

- It is environment friendly.
- It is cheaper and efficient.
- Low operating and maintenance costs.
- The source of energy is inexhaustible.
- Protects coastal flooding.
- Tidal energy sources can last for decades.
- Power output is highly predictable.

Disadvantages

- Construction of tidal power plants is expensive and requires high capital investment.
- Equipment repairing and maintenance is difficult.
- Environment problems, like habitat change, arises
- Storage capacity is required.
- Negative influence on marine life forms.
- Location limited.