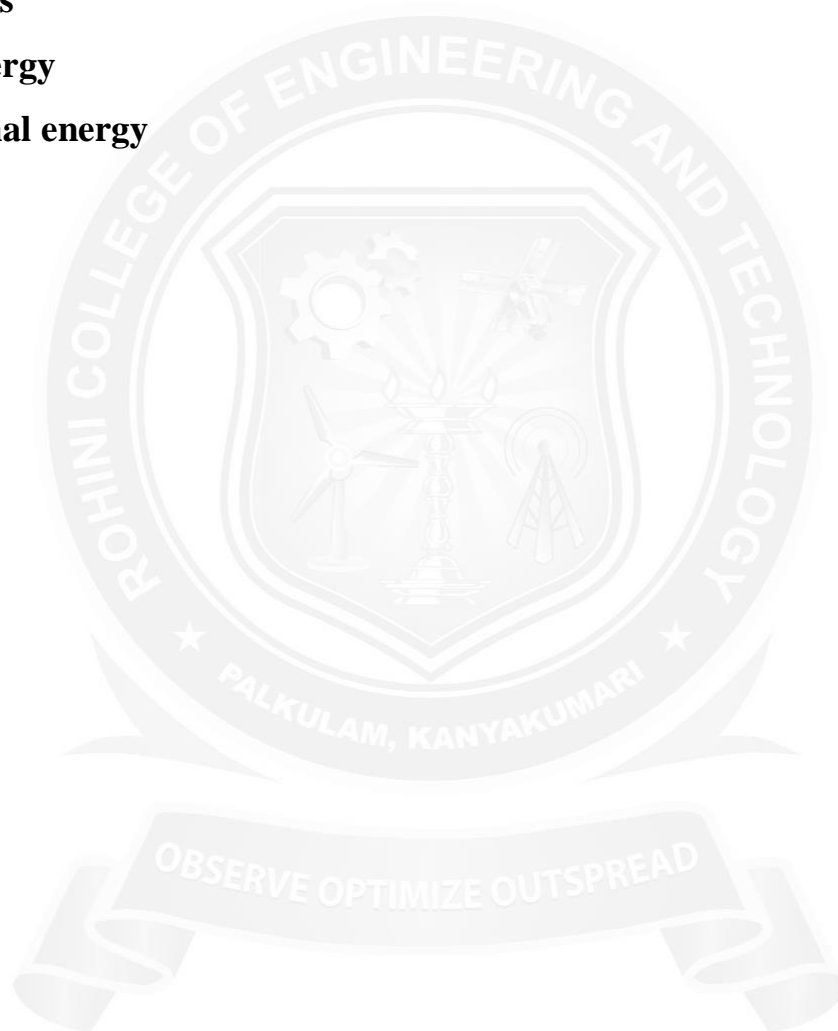


MODULE -V
ENERGY SOURCES & STORAGE DEVICES

5.3 Solar Cells

5.4 Wind Energy

5.5 Geothermal energy



5.3 Solar Cells

- Solar energy is the most abundant and renewable source of energy available on the earth. To utilize this energy, various types of technologies are used, that converts solar energy into heat and electricity.
- The use of solar cells or photovoltaic cells (PV) is one of the most prominent and widely used methods to utilize solar energy.
- Devices that convert solar energy into electrical energy are known as solar cells.
- Solar cells are the electronic components that produce electricity when exposed to sunlight using the photovoltaic effect. They make use of photovoltaic effect.
 - So solar cells can be otherwise called as photovoltaic cells.
 - The phenomenon of the generation of electric current or voltage in a circuit when it is exposed to light is known as the photovoltaic effect.

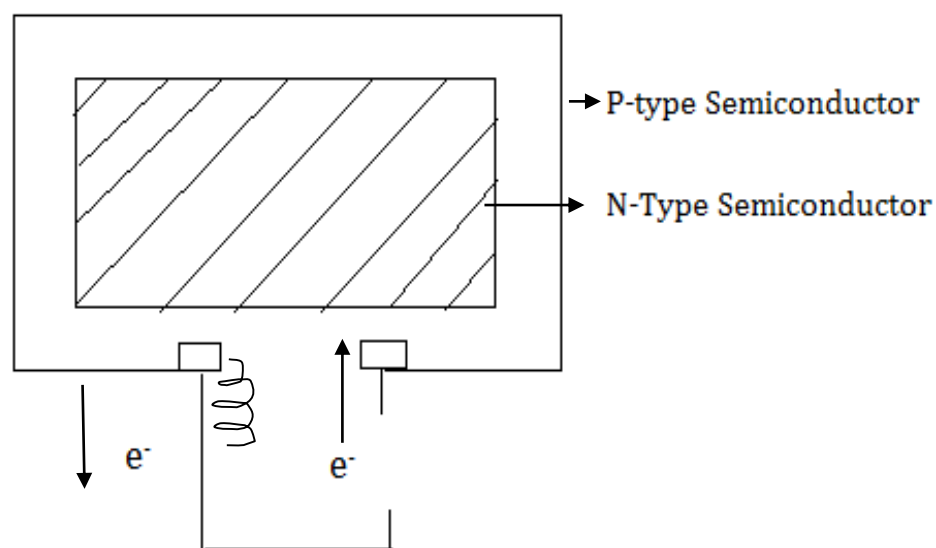


Fig:1-Solar cell

Source: physical chemistry by Arun paul

Description

- ❖ Solar cells consist of a p-type semiconductor and n-type semiconductor kept in close contact with each other. The surface is coating with anti reflection coating to avoid the loss of incident light energy due to reflection.
- ❖ When solar rays fall on the p-type semiconductor the electrons jumps from valance band to conduction band.
- ❖ Thus they cross the p-n junction and go to the n-type semiconductor.
- ❖ This causes a potential difference , which causes the flow of electrons (Electricity) make the lamp light up.

Uses

- ❖ Solar cells are used in calculator , electronics watches etc,
- ❖ Solar Batteries are used to run street lights, water pumps , radio and television.

Advantages of Solar cell

- It is clean and non polluting
- It is renewable energy
- Can be powered for remote locations.
- Its free ,limitless and environmentally friendly
- Solar cells do not produce any noise
- They require very little maintenance
- They have long life time
- There are no fuel costs or fuel supply problems.

Disadvantages of Solar cell

- Solar cells or solar panels are very expensive
- Energy has not be stored in batteries.
- Air pollution and whether can affect the production of electricity
- They need large area of land to produce more efficient power supply.

- Sun does not shine consistently
- Less efficient and costly equipment
- Reliability depends on location

Application of solar energy

- Domestic power supply
- Electric power generation in space
- Drying agricultural products
- Solar pumps used for water supply
- Water heating
- Generating Electrical power
- To providing electrical power to satalites.

Recent Developments in solar energy materials

A typical solar cell consists of semiconducting materials such as p- and n-type silicon with a layered p-n junction connected to an external circuit. Sunlight illumination on the panels causes electron ejection from silicon. The ejected electrons under an internal electric field create a flow through the p-n junction and the external circuit, resulting in a current (electricity). With a swiftly growing market and the development of creative applications, R&D on innovative solar energy materials is at its peak to achieve maximum [solar-to-electricity efficiency](#) at low cost. Three types of highly investigated semiconducting materials of today are crystalline Si, thin films, and the next-generation perovskite solar cells (PSCs).

Use of photovoltaic cells for solar power generation are now **replaced by semiconductor materials** which is having a limited shape and size for the same power generation. Now a days they are used in space applications.

Artificial intelligence-based maximum power point tracking algorithms are the future of solar-based circuits. Fabrication of transparent solar cells that have the potential to be used for a vast number of applications, solar cells with more than one layer of light capturing materials.

Solar Panel Developments

- Passivated emitter rear cell (PERC)
- Heterojunction technology (HJT)
- Half-cell technology. ...
- Bifacial solar panels.
- Building-integrated photovoltaics (BIPV)
- Concentration photovoltaic cell (CPV) ...
- Multi-junction solar cells.
- Perovskite solar cells.

5.4 Wind Energy

- ❖ Air in motion is called wind. Energy got from the force of wind is called Wind energy.
- ❖ Wind energy is collected by using Wind mills.

Working of Wind mill

Principle:

It is defined as the system in which the kinetic energy of the wind is converted to mechanical energy which in turn is used to generate electrical energy.

- ❖ An Anemometer is a device used to measure the velocity and direction of the wind giving us an idea of the amount of wind energy available at a particular location.
- ❖ The blowing wind strikes the blades of the windmill and makes it to rotate.

- ❖ Wind turbines convert the kinetic energy in the wind into mechanical power..
- ❖ This mechanical power can be used for specific tasks such as grinding grain or pumping water, or can be converted into electricity by a generator.
- ❖ This generated energy can be utilized to meet the energy needs of both households and businesses. Wind turbines are usually built close together to make wind farms.
- ❖ Not only is wind an abundant and inexhaustible resource, but it also provides electricity without burning any fuel or polluting the air.

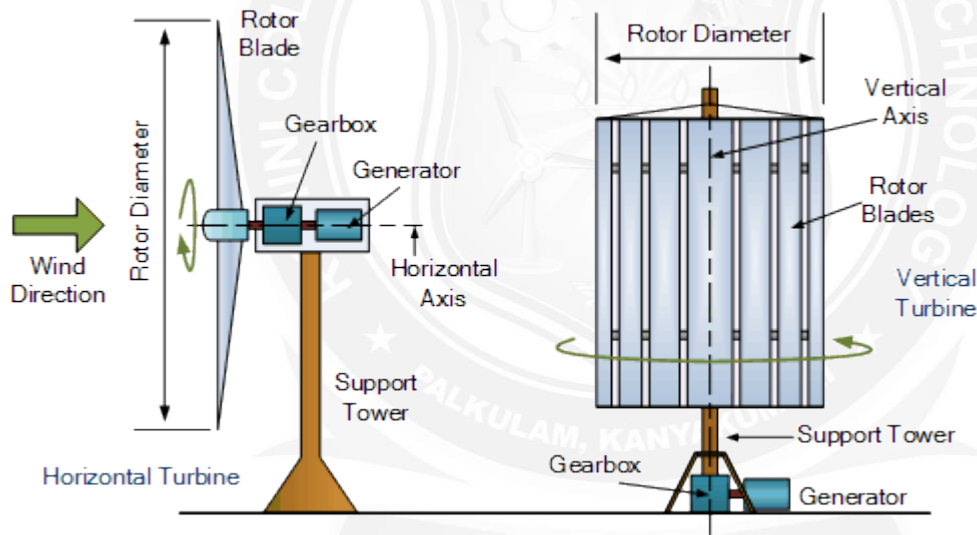


Fig:2-Wind mill

Source: online sources

Advantages of wind power

- Environmental benefits
- Economic development benefits
- Fuel diversity
- Cost stability

Advantages

- A serious obstacle for birds.

- Noise pollution
- Cost of wind turbine
- Threats to wildlife
- Suitable to particular region

5.5 GEOTHERMAL ENERGY

The word geothermal comes from the Greek words geo (earth) and thermal (heat). So, geothermal energy is heat from within the earth. We can use the steam and hot water produced inside the earth to heat buildings or generate electricity. Geothermal energy is a clean, renewable resource that can be harnessed for use as heat and electricity, because the water is replenished by rainfall and the heat is continuously produced inside the earth. It is a renewable resource that can be harvested for human use.

In order to harness the geothermal energy, a hydrothermal convection system is used. In this process, a hole is drilled deep under the earth, through which a pipe is inserted. The steam trapped in the rocks is routed through this pipe to the surface of the earth. This steam is then used to turn the blades of a turbine of an electric generator. In another method, the steam is used to heat water from an external source which is then used to rotate the turbine.

Applications

1.Generation of electricity: Geothermal power plants are usually installed within a two-mile radius of the geothermal reserve. The steam from these reserves is either directly used to rotate the turbines of an electrical generator or is used to heat water which then produces steam for the process.

2.Farming: In cold countries, geothermal energy is used to heat greenhouses or to heat water that is used for irrigation.

3.Industry: Geothermal energy is used in industries for the purpose of food dehydration, milk pasteurizing, gold mining, etc.

4.Heating: Geothermal energy is used to heat buildings through district heating systems in which hot water through springs is directly transported to the buildings through pipelines.

Advantages

- **Renewable resource:** Geothermal energy is free and abundant. The constant flow of heat from the Earth makes this resource inexhaustible and limitless to an estimated time span of 4 billion years.
- **Green energy:** Geothermal energy is non-polluting and environment-friendly as no harmful gases are evolved with the use of geothermal energy unlike the use of fossil fuels. Also, no residue or by-product is generated.
- **Generation of employment:** Geothermal power plants are highly sophisticated and involve large scale research before installation. This generates employment for skilled and unskilled laborers at a very large scale at each stage of production and management.
- **Can be used directly:** In cold countries, the geothermal energy is used directly for the melting of ice on the roads, heating houses in winters, greenhouses, public baths, etc. Although the initial cost of installation is very high, the cost for maintenance and repair is negligible.

Disadvantages

- **Transportation and transmission:** Unlike fossil fuels, geothermal energy cannot be transported easily. Once the tapped energy is harnessed it can only be used

efficiently in the nearby areas. Also, with the transmission, there are chances of emission of toxic gases getting released into the atmosphere.

- **High installation cost:** The installation of geothermal power plants to get steam from deep under the Earth requires a huge investment in terms of material and human resources.
- **Intensive research required:** Before setting up a plant, extensive research is required, as the sites can run out of steam over a period of time due to a drop in the temperature as a result of excessive or irregular supply of inlet water.
- **Limited to particular regions:** The source of geothermal energy is available in limited regions, some of which are highly inaccessible such as high rise mountains and rocky terrains, which renders the process economically infeasible in many of the cases.
- **Impact on the environment:** Geothermal sites are present deep under the earth, so the process of drilling may result in the release of highly toxic gases into the environment near these sites, which sometimes prove fatal to the workforce involved in the process.

