Energy:

Energy is defined as the ability to produce change or do work, and that work can be divided into several main tasks we easily recognize

Energy produces light. Energy produces heat. Energy produces motion. Energy produces sound. Energy produces growth.

What is energy?

Energy makes change it does things for us. It moves cars along the road and boats over the water keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work. People have learned how to change energy from one form to another so that we can do work more easily and live more comfortably

Forms of Energy is found in different forms, such as light, heat, sound and motion. There are many forms of energy, but they can all be put into two categories: kinetic and potential.

First law of Thermodynamics :

“Heat and work are mutually convertible but since energy can neither be created nor destroyed, the total energy associated with an energy conversion remains constant". Let us review the statements of the first law of thermodynamics.

1. Energy exists in many forms, e.g. electrical energy, thermal energy, mechanical energy, chemical energy.

2. In an energy conversion process one form of energy is transformed to another.

3. Energy cannot be created newly, Energy cannot be destroyed.

4. In a closed system, total energy remains unchanged. This is the principle of conservation of Energy

Mechanical Energy:

Mechanical energy is energy that results from movement or the location of an object. Mechanical energy is the sum of kinetic energy and potential energy.

Examples: An object possessing mechanical energy has both kinetic and potential energy, A moving car has kinetic energy. If you move the car up a mountain, it has kinetic and potential energy. A book sitting on a table has potential energy.

Thermal Energy:

Thermal energy or heat energy reflects the temperature difference between two systems.

Example: A cup of hot coffee has thermal energy. You generate heat and have thermal energy with respect to your environment.

Nuclear Energy:

Nuclear energy is energy resulting from changes in the atomic nuclei or from nuclear reactions.

Example: Nuclear fission, nuclear fusion, and nuclear decay are examples of nuclear energy. An atomic detonation or power from a nuclear plant are specific examples of this type of energy.

Chemical Energy:

Chemical energy results from chemical reactions between atoms or molecules. There are different types of chemical energy, such as electrochemical energy.

Example: A good example of chemical energy is an electrochemical cell or battery.

Electromagnetic Energy:

Electromagnetic energy (or radiant energy) is energy from light or electromagnetic waves.

Example: Any form of light has electromagnetic energy, including parts of the spectrum we can't see. Radio, gamma rays, x-rays, microwaves, and ultraviolet light are some examples of electromagnetic energy.

Sonic Energy:

Sonic energy is the energy of sound waves. Sound waves travel through the air or another medium.

Example: A sonic boom, a song played on a stereo ,your voice.

Gravitational Energy:

Energy associated with gravity involves the attraction between two objects based on their mass. It can serve as a basis for mechanical energy, such as the potential energy of an object placed on a shelf or the kinetic energy of the Moon in orbit around the Earth.

Example: Gravitational energy holds the atmosphere to the Earth.

Kinetic Energy:

Kinetic energy is the energy of motion of a body.

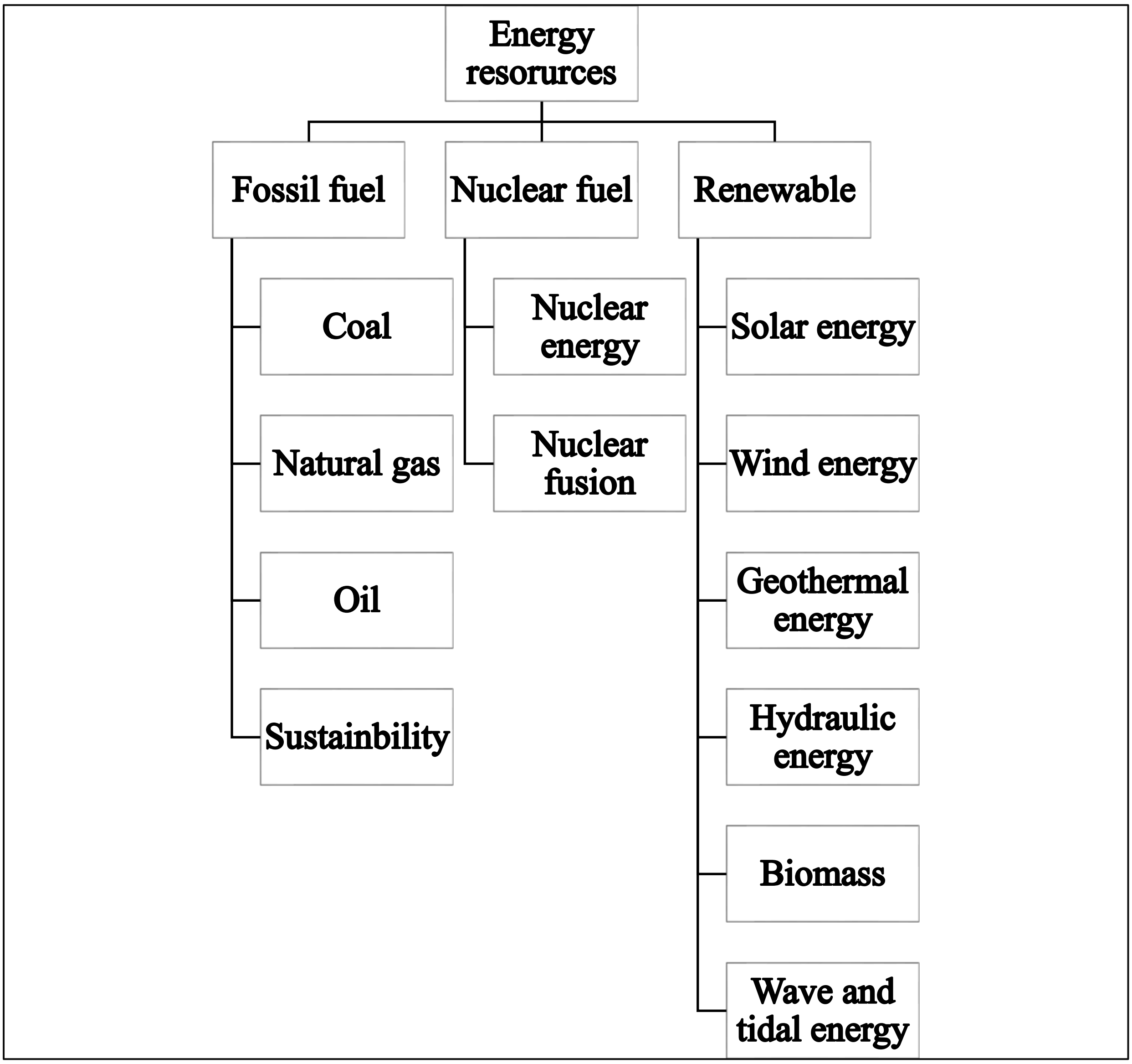
Example: An example is a child swinging on a swing. No matter whether the swing is moving forward or backward.

Potential Energy:

Potential energy is the energy of an object's position.

Energy resources:

World energy resources are the estimated maximum capacity for energy production given all available resources on Earth. They can be divided by type into **fossil fuel**, **nuclear fuel** and **renewable** resources.



What are fossil fuels:

Fossil fuels are called “fossil” because, just like rock fossils, they are made from dead plants and animals. Those plants and animals lived a very long time ago, even before dinosaurs. After they died, they were buried under layers of rock. The heat and pressure of being so far under the earth changed them until they became coal, oil and gas. We burn these three types of fuels to make light and heat, or to create other energy, such as electricity.

Oil:

Oil is a sticky, black liquid made from tiny, one-celled sea plants and animals called plankton. To get to it, you drill a narrow hole deep into the earth and pump it back to the surface using suction. Oil gets turned into petrol / diesel to make your car go, tar for paving roads and chemicals that make plastics.

Coal:

Coal is black, rocklike stuff that was created from dead plants in swamps. There is more of it than any other fossil fuel. Coal can be found near the surface of the earth or further underground. To reach it, coal needs to be mined. 40% of the electricity in the world is made from burning coal; its heat turns water into steam, which turns turbines -- big wheels -- that make the electricity.

Natural Gas:

Anywhere you find oil, you will find natural gas. Just like with oil, you drill to reach it and pump it into pipe lines. Then it has to be cleaned, which means everything but the methane gas is removed. Methane doesn't have any smell, so a chemical is added to make it stink so you can tell when you're around it.

It's highly flammable and is used for cooking, heating and making electricity. It's cleaner than oil or coal and burns hotter as well, so it produces more electricity.

Interesting Fossil Fuel Facts:

- -Fossil Fuels take millions of years for fossil fuels to develop.
- -The fossil fuels we use today began forming during the Carboniferous Period which was before dinosaurs ruled the Earth.
- - Oil, also called petroleum, is pumped from underground and can be turned into products such as gasoline and electricity.
- -If your house uses natural gas for cooking and heating, this is a form of a fossil fuel that lies underground usually above oil.
- -Coal is another fossil fuel used to generate electricity and is found closer to the Earth's surface.

- -Although fossil fuels are mainly used to make electricity, they are also used to power machines such as cars and planes.
- -Fossil fuels are non-renewable which means they cannot be made by humans.
- -Fossil fuels in their natural form must first be burned to be used as electricity.
- -When fossil fuels are burned, they release unhealthy toxins into the air we breathe.
- -Around 90% of our energy comes from fossil fuels.
- -The energy stored in fossil fuels comes from the sun.
- -The main component of natural gas is methane which is highly flammable.
- -Natural gas has no smell so a chemical called mercaptan is added so that it can easily be detected.
- -Natural gas is pumped to houses by way of underground pipelines that connect directly to the natural gas source.
- -Although renewable sources of energy are better than non-renewable sources of energy, we continue to use non-renewable sources because they are easier to obtain.

Advantages of using fossil fuels:

1-Very large amounts of electricity can be generated in one place using coal, fairly cheaply.

2- -Transporting oil and gas to the power stations is easy

3-Gas-fired power stations are very efficient.

4 - A fossil-fuelled power station can be built almost anywhere, as

long as you can get large quantities of fuel to it.

Disadvantages of using fossil fuels:

1-Fossil fuels are non-renewable energy resources. Their supply is limited, and will eventually run out. Fossil fuels do not renew themselves, while fuels such as wood can be renewed endlessly.

2- Fossil fuels release carbon dioxide when they burn, which adds to the greenhouse effect and increases global warming. Of the three fossil fuels, for a given amount of energy released, coal produces the most carbon dioxide and natural gas produces the least.

3- Coal and oil release sulphur dioxide gas when they burn, which causes breathing problems for living creatures and contributes to acid rain.

4- Mining coal can be difficult and dangerous. It can also destroy large areas of landscape.

5- Coal-fired power stations need huge amounts of fuel, which means train-loads of coal almost constantly. To cope with changing demands for power, the station needs reserves.

This means covering a large area of countryside next to the power station with piles of coal.

Nuclear energy :

Electricity can be generated in different ways. For example, it can be made using solar panels, by burning coal, or by capturing the heat from atoms that split apart. When the electricity is made from atoms splitting apart, it's called nuclear energy. “Thermal” power plants convert heat into electricity using steam. At nuclear power plants, the heat to make the steam is created when atoms split apart — called fission. When atoms split apart, they release heat. When the process is repeated over and over, it is called a chain reaction. In a nuclear power plant, uranium is the material used in the fission process. The heat from fission boils water and creates steam to turn a turbine. As the turbine spins, the generator turns and its magnetic field produces electricity. The electricity can then be carried to your home, so you can work on the computer, watch television or make toast! About 20 percent of the electricity in the U.S. comes from nuclear energy. That means one out of every five homes in this country can turn on their lights due to the atom! The U.S. Nuclear Regulatory Commission, also called the NRC, regulates nuclear power plants. We make sure they are safe for people who work there and live nearby, and for the environment. Nuclear Reactors Nuclear power plants are very complex. There are many different buildings at the site and many different systems. Some of the systems work directly to make electricity. Some of the systems work to keep the plant working correctly and safely. All nuclear power plants have a "containment structure" that holds the reactor. And all plants have deep pools where the nuclear fuel when it is no longer being used can be cooled and stored.

How Energy Works:

Nuclear energy originates from the splitting of uranium atoms – a process called **fission.** This generates heat to produce steam, which is used by a turbine generator to generate electricity. Because nuclear power plants do not burn fuel, they do not produce greenhouse gas emissions.

What is the process of nuclear energy?

Nuclear energy is a form of energy released from the nucleus, the core of atoms, made up of protons and neutrons. This source of energy can be produced in two ways: fission – when nuclei of atoms split into several parts – or fusion – when nuclei fuse together

Pros and cons of nuclear power:

Proses of nuclear energy	cons of nuclear energy
Carbon-free electricity	Uranium is technically non-renewable
Small land footprint	Very high upfront costs
High power output	Nuclear waste
Reliable energy source	Malfunctions can be catastrophic

Disadvantages of Nuclear Energy:

- Raw material. Safety measures needed to prevent the harmful levels of radiation from uranium.
- Fuel Availability. ...
- High Cost. ...
- Nuclear Waste. ...
- Risk of Shutdown Reactors. ...
- Impact on Human Life. ...
- Nuclear Power a Non Renewable Resource. ...
- National Risks.
- Risk of Accident. ...
- Radioactive Waste. ...
- Limited Fuel Supply. ...
- Impact on the Environment.

dvantages of Nuclear Energy:

- First and foremost, nuclear energy is clean and it provides pollution-free power with no greenhouse gas emissions. Contrary to what many believe, cooling towers in nuclear plants only emit water vapour and are thus, not releasing any pollutant or radioactive substance into the atmosphere. Compared to all the energy alternatives we currently have on hand, many experts believe that nuclear energy is indeed one of the cleanest sources.
- being among the countries that recorded the fastest decline in carbon intensity and experienced a clean energy transition by building nuclear reactors and hydroelectric dams
- Earlier this year, the European Commission took a clear stance on nuclear power by labelling it a green source of energy in its classification system establishing a list of environmentally sustainable economic activities. While nuclear energy may be clean and its production emission-free, experts highlight a hidden danger of this power: nuclear waste. The highly radioactive and toxic byproduct from nuclear reactors can remain radioactive for tens of thousands of years.

- Clean Energy Source. Nuclear is the largest source of clean power in the United States. ...
- Creates Jobs. The nuclear industry supports nearly half a million jobs in the United States

What is renewable energy and are there other names for it?

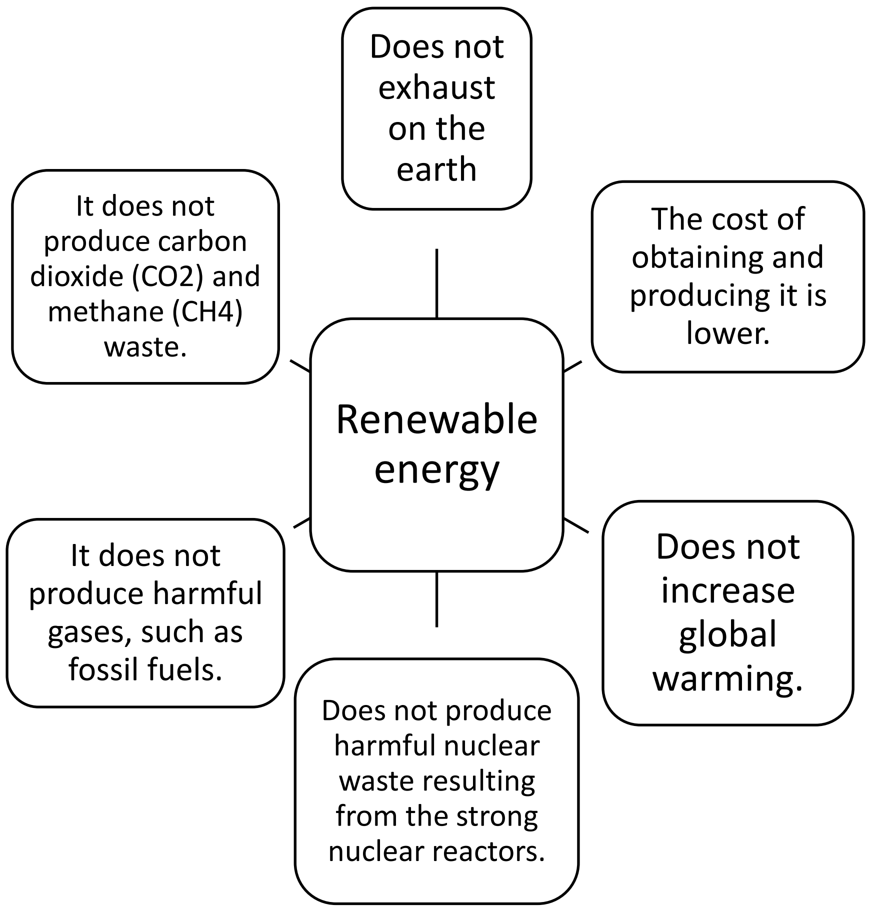
- Renewable energy is energy that is derived from natural resources, which are constantly renewed and that is not exhausted.
- It is also called sustainable energy, as it is a permanent source of life on the planet and its sources do not need an extraction, mining or mechanized processes, they are 100% natural.

Sometimes it is called alternative energy (here it should be noted that this designation is more general, as it includes sources that are used instead of fossil energy sources or produce fuel like the fuel produced by fossil energy). But not all alternative energy sources are renewable. For example, nuclear energy is considered an alternative energy for fossil fuels, but it is considered exhausted

Why focus on renewable energy?

- Increasing the percentage of carbon dioxide in the atmosphere leads to an increase in the temperatures while increasing methane emissions increase the acid rain.

- Radiation and nuclear waste, which is produced by nuclear reactors that produce energy. Although nuclear energy formed a few decades ago, an ideal solution and an important source of energy, the accumulation of its products from dangerous waste on the life of creatures made it undesirable. The resulting waste is more harmful and more expensive to dispose of.



Solar Energy:

The Sun:

Solar energy is one of the energies derived from natural and non-depleting sources available in nature. This energy is considered one of the most important sources of renewable energy, as it comes from light and heat emitted from the sun. The sun is a sphere of intensely hot gaseous matter with a diameter of (1.39×10^9) m . thermal radiation travels with the speed of light in a vacuum (300,000 km/s), after leaving the sun solar energy reaches our planet in 8 min and 20 s. As observed from the earth, the sun disk forms .The solar constant is defined as the amount of energy incident per unit of time on a unit area perpendicular to the solar ray solar constant was estimated at (1353 W / m^2).

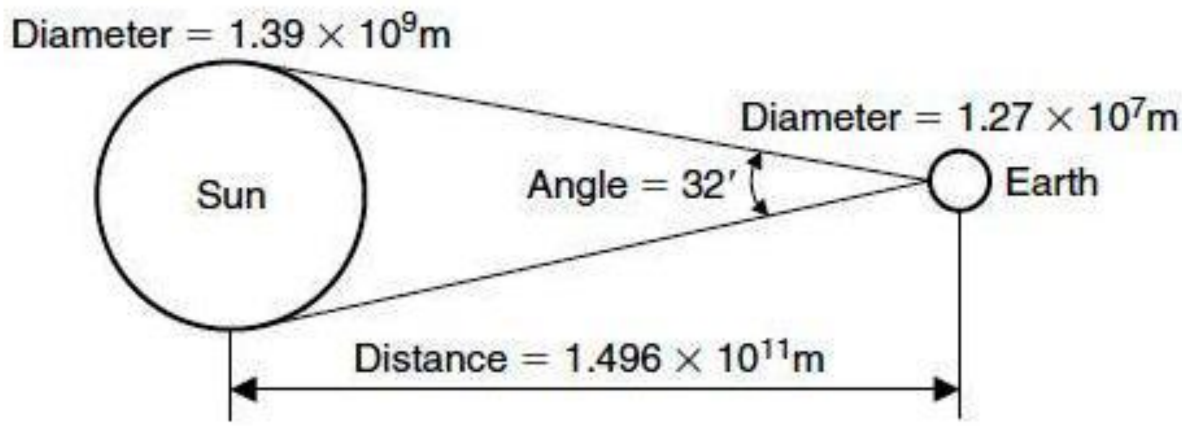


Fig. 1.1 Sun-earth relationship.

Advantage of Solar Energy:

A- Solar energy is continuous and inexhaustible energy.

B - The absence of solar energy from environmental pollutants.

C- Solar energy is free energy that exists in most parts of the earth directly reaching the consumer.

D - East Iraq enjoys its geographical location, as it is located within the hot regions and solar energy is available in large quantities throughout the seasons of the year.

E- Reducing dependence on fossil energy due to the possibility of its depletion in the near future

Solar Radiation:

The Earth obtains solar energy through solar radiation, and this radiant energy comes to us by means of tiny, weightless particles called photons, and photons behave like (electromagnetic) waves.

1. Direct Radiation: radiation from the sun that reaches the earth without scattering

2. Diffuse Radiation: Diffuse Radiation that is scattered by the atmosphere and clouds

Solar Energy Collectors:

Solar Energy Collectors are special kinds of heat exchangers that transform solar radiation energy to internal energy of the transport medium. This is a device that absorbs the incoming solar radiation, converts it into heat, and transfers the heat to a fluid (usually air, water, or oil) flowing through the collector.

There are basically two types of solar collectors:

1- non-concentrating collectors

2- concentrating collectors.

A non-concentrating collector has the same area for intercepting and absorbing solar radiation, whereas a sun-tracking concentrating solar collector usually has concave reflecting surfaces to intercept and focus the sun's beam radiation to a smaller receiving area, thereby increasing the radiation flux. Concentrating collectors are suitable for high-temperature applications. Solar collectors can also be distinguished by the type of heat transfer liquid used (water, non-freezing liquid, air, or heat transfer oil). There are basically their types non-concentrating collectors.

1. Flat-plate collectors (FPCs)
2. Stationary compound parabolic collectors (CPCs).
3. Evacuated tube collectors (ETCs).

Flat-Plate Collectors:

A typical flat-plate solar collector is shown in Figure 2.1. When solar radiation passes through a transparent cover and impinges on the blackened absorber surface of high absorptivity, a large portion of this energy is absorbed by the plate and transferred to the transport medium in the fluid tubes, to be carried away for storage or use. The underside of the absorber plate and the two sides are well insulated to reduce conduction losses.

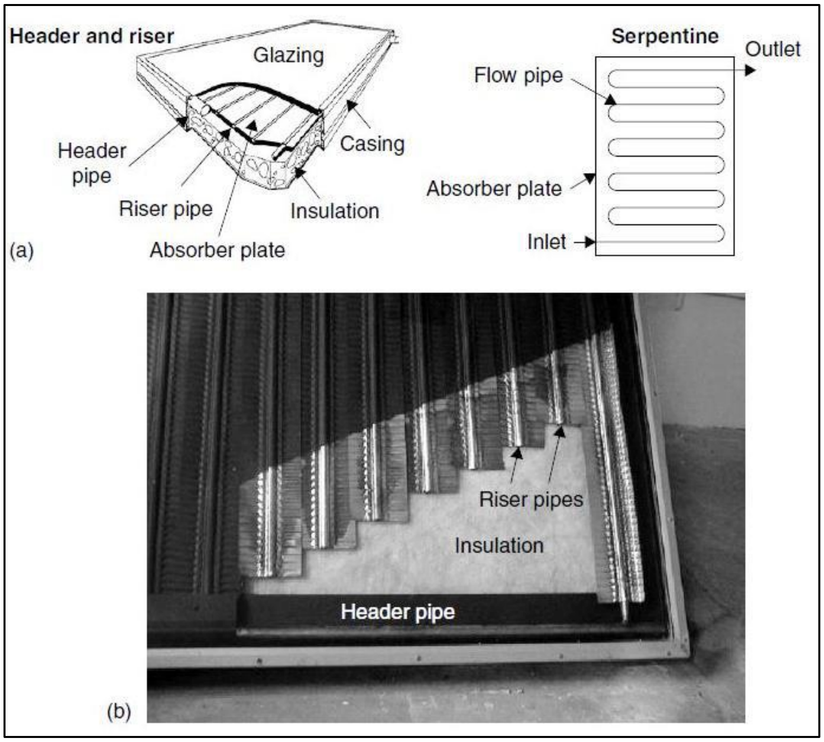


Fig. 2.1flat-plate solar collector

The main components of a flat-plate collector, as shown in Figure 2.2 are the following:

1. Cover: One or more sheets of glass or other radiation-transmitting material.
2. Heat removal fluid passageways: Tubes, fins, or passages that conduct or direct the heat transfer fluid from the inlet to the outlet.
3. Absorber plate: Flat, corrugated, or grooved plates, to which the tubes, fins or passages are attached.
4. Headers or manifolds: Pipes and ducts to admit and discharge the fluid.

5. Insulation: Used to minimize the heat loss from the back and sides of the collector.
6. Container: The casing surrounds the aforementioned components and protects them from dust, moisture, and any other material

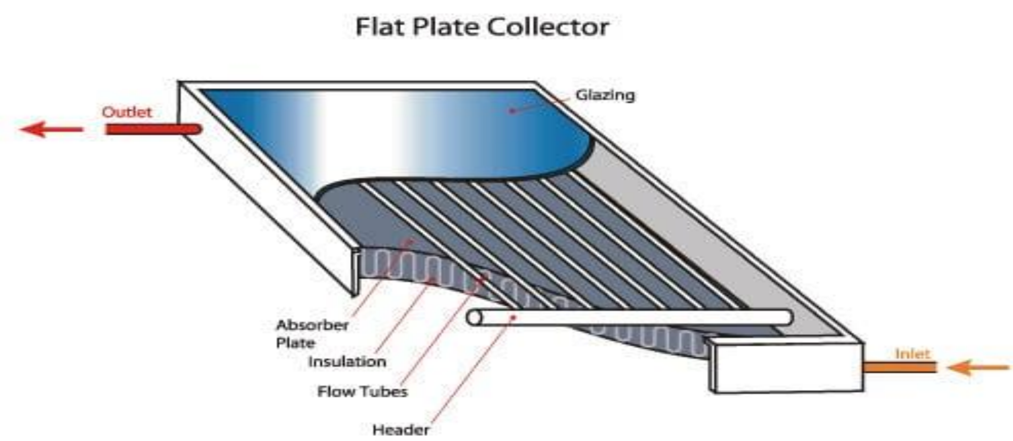


Fig. 2.2 The main components of a flat-plate collector

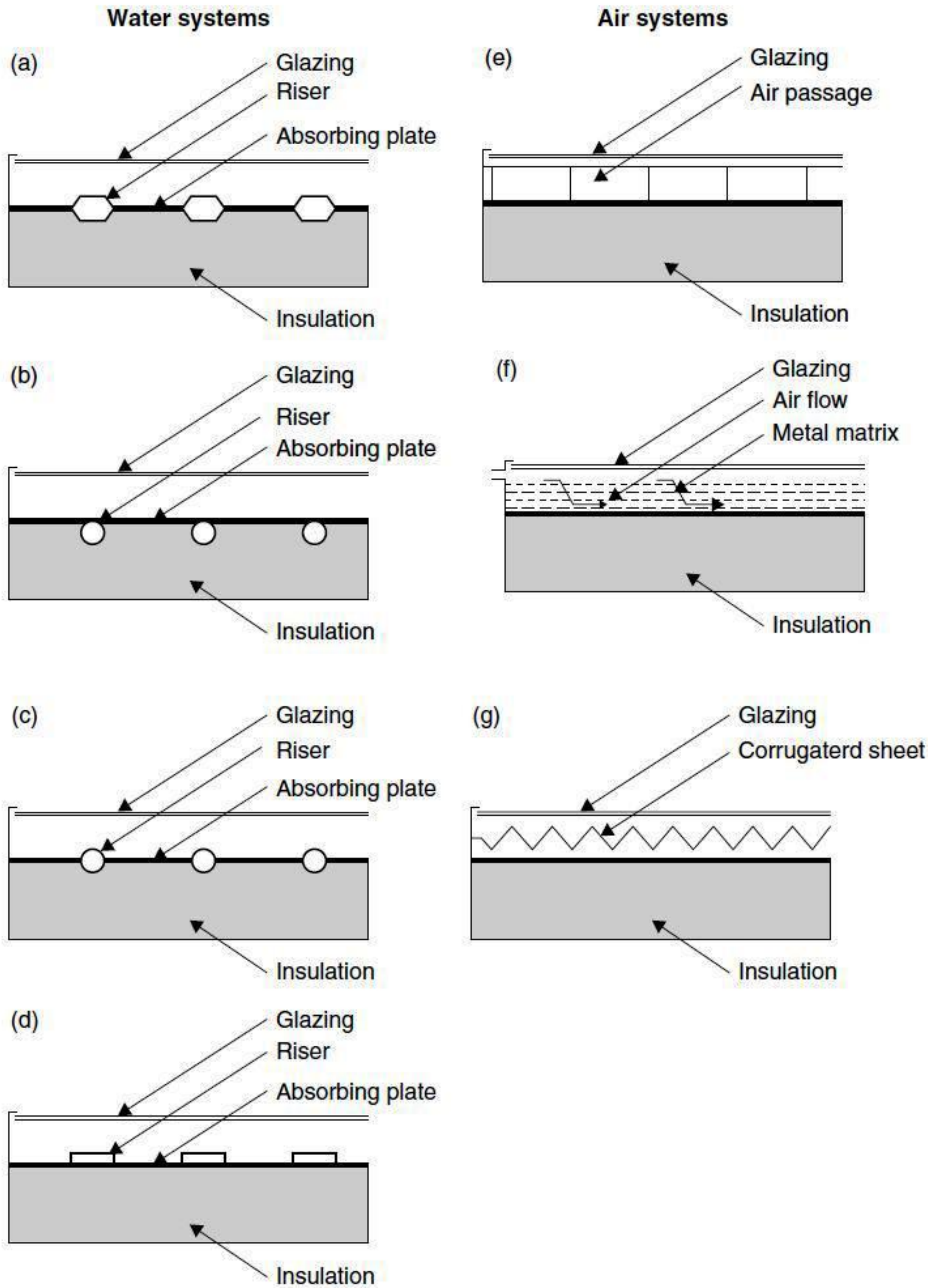


Fig. 2.3 Type components of absorber flat-plate collector configuration for water and air

Compound Parabolic Collectors (CPCs):

Compound parabolic collectors (CPCs) are non-imaging concentrators. They have the capability of reflecting to the absorber all of the incident radiation within wide limits. The necessity of moving the concentrator to accommodate the changing solar orientation can be reduced by using a trough with two sections of a parabola facing each other,

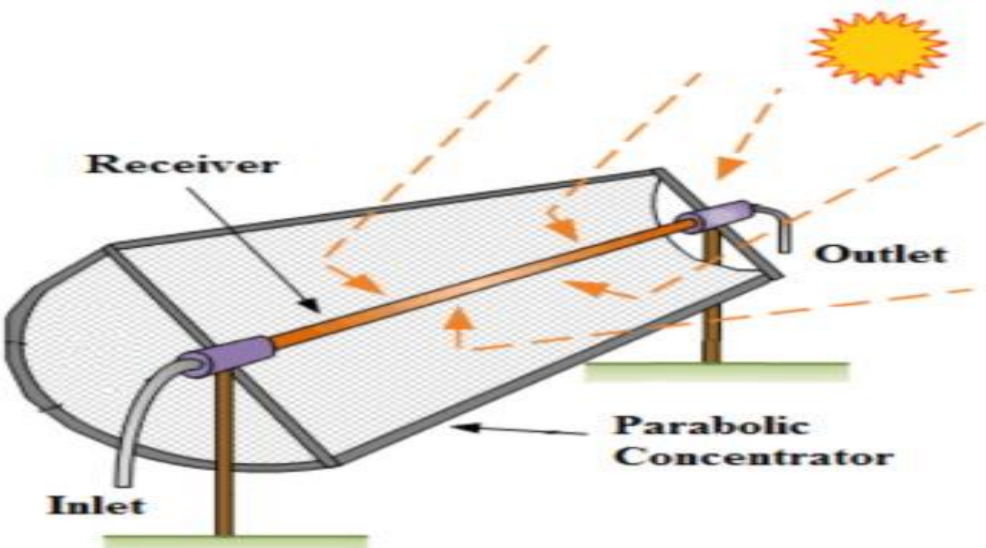


Fig. 2.4 Compound Parabolic Collectors

Evacuated Tube Collectors:

Evacuated heat pipe solar collectors (tubes) operate differently than the other collectors. These solar collectors consist of a heat pipe inside a vacuum-sealed tube, as (ETCs) are relatively expensive. the cost effectiveness of these collectors can be improved by reducing the number of tube and sung reflectors to concentrate the solar radiation on to the tube. the system also presents a 10 % increase in energy collection over a full day because of incidence angles.

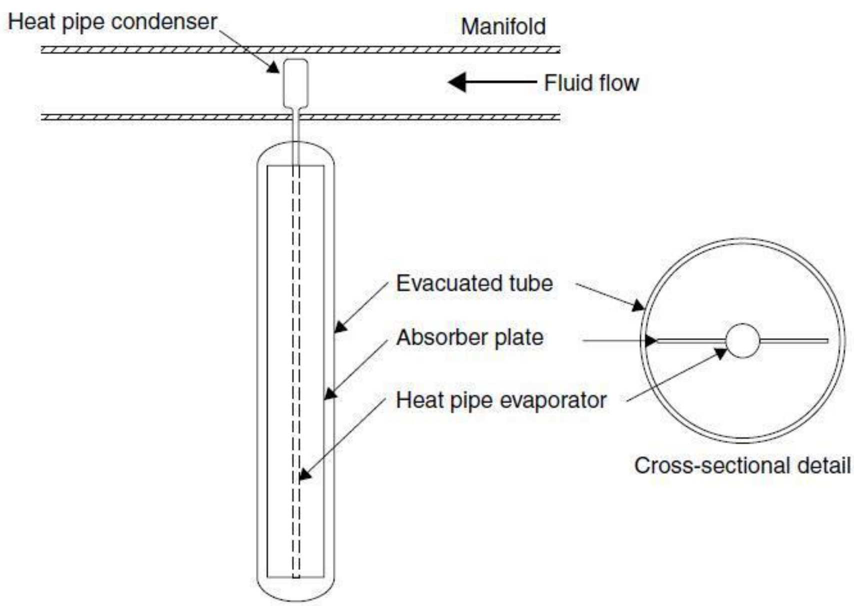
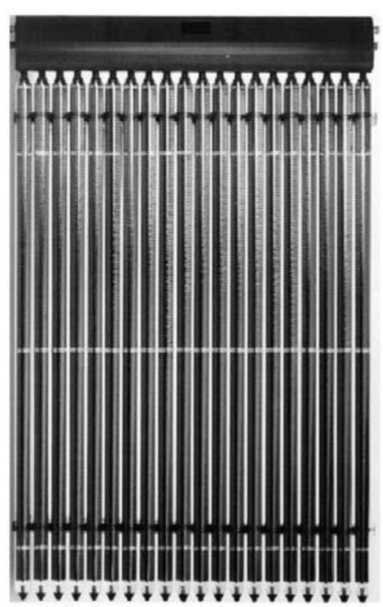


Fig. 2.5 Schematic diagram of an evacuated tube collector.



Wind energy:

Wind energy is the kinetic energy of air in motion, also called wind. Wind power is converted to electrical energy by wind turbines. Several different factors influence the potential wind resource in an area. The three main factors that influence power output are: wind speed, air density, and blade radius. Total wind energy flowing through an imaginary surface with area A is:

$$E_w = 1/2 \rho A v^3$$

where ρ is the density of air Kg/m^3; v is the wind speed m/s; A is the volume of air passing through A m^2 (which is considered perpendicular to the direction of the wind); therefore, the mass m passing through "A". ½ ρv^2 is the kinetic energy of the moving air per unit volume.

Ex: Find the electrical energy generated by an air fan the area of blades is $20m^2$ if the air density is $0.1kg/m^3$, and the wind speed is 7m/s?

$E_w = 1/2 \rho A v 3$

$1/2 * 0.1 * 20 * 7^3 \approx 343\ Watt$

Wind turbine:

Wind turbines operate by transforming the kinetic energy in wind into mechanical power which is used to generate electricity by spinning a generator. These turbines can be on land or can be offshore wind turbines. There are two main types of wind turbines, horizontal and vertical axis. A wind turbine applicable for urban settings was also studied. All types of wind turbines have varying designs, and different advantages and disadvantages.

Horizontal axis:

Horizontal axis wind turbines are the most common type used (see figure 1). All the components (blades, shaft, generator) are on top of a tall tower, and the blades face into the wind. The shaft is horizontal to the ground. The wind hits the blades of the turbine that are connected to a shaft causing rotation. The shaft has a gear on the end which turns a generator. The generator produces electricity and sends the electricity into the power grid. The wind turbine also has some key elements that adds to efficiency. Inside the Nacelle (or head) is an anemometer, wind vane, and controller that read the speed and direction of the wind. As the wind changes direction, a motor (yaw motor) turns the nacelle so the blades are always facing the wind. The power source also comes with a safety feature. In case of extreme winds, the turbine has a break that can slow the shaft speed. This is to inhibit any damage to the turbine in extreme conditions.

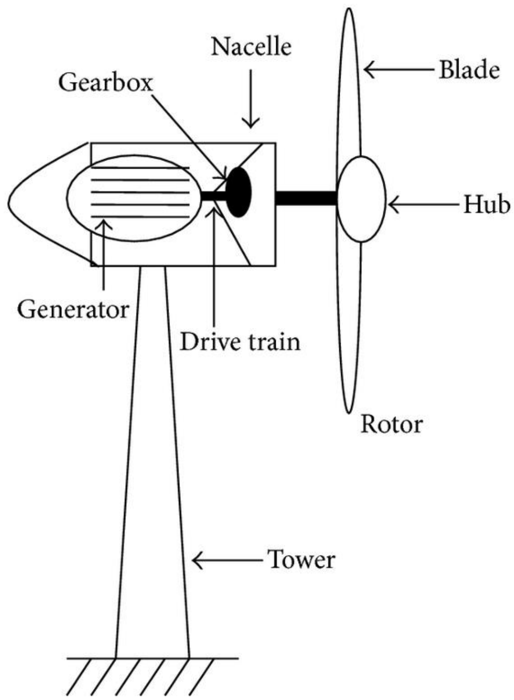


Fig. 3.1 Horizontal axis wind turbine

Advantages

- Blades are to the side of the turbines center of gravity, helping stability
- Ability to wing warp, which gives the turbine blades the best angle of attack
- Ability to pitch the rotor blades in a storm to minimize damage
- Tall tower allows access to stronger wind in sites with wind shear
- Tall tower allows placement on uneven land or in offshore locations
- Can be sited in forest above tree-line
- Most are self-starting

Disadvantages

- Difficulty operating in near ground winds
- Difficult to transport (20% of equipment costs)
- Difficult to install (require tall cranes and skilled operators)
- Effect radar in proximity
- Local opposition to aesthetics
- Difficult maintenance

Vertical axis

In vertical axis turbines the shaft the blades are connected to is vertical to the ground (see figure 2). All the main components are close to the ground. Also, the wind turbine itself is near the ground, unlike horizontal where everything is on a tower. There are two types of vertical axis wind turbines; lift based and drag based. Lift based designs are generally much more efficient than drag, or ‘paddle’ designs.

Tidal Energy Generators

There are currently three different ways to get tidal energy: tidal streams, barrages, and tidal lagoons.

For most tidal energy generators, turbines are placed in tidal streams. A tidal stream is a fast-flowing body of water created by tides. A turbine is a machine that takes energy from a flow of fluid. That fluid can be air (wind) or liquid (water). Because water is much denser than air, tidal energy is more powerful than wind energy. Unlike wind, tides are predictable and stable. Where tidal generators are used, they produce a steady, reliable stream of electricity. Underwater turbines will be more expensive to install than wind farm turbines, and the turbine blades might injure aquatic species. If those problems can be corrected, tidal energy and related wave energy offer a long-term renewable form of energy.

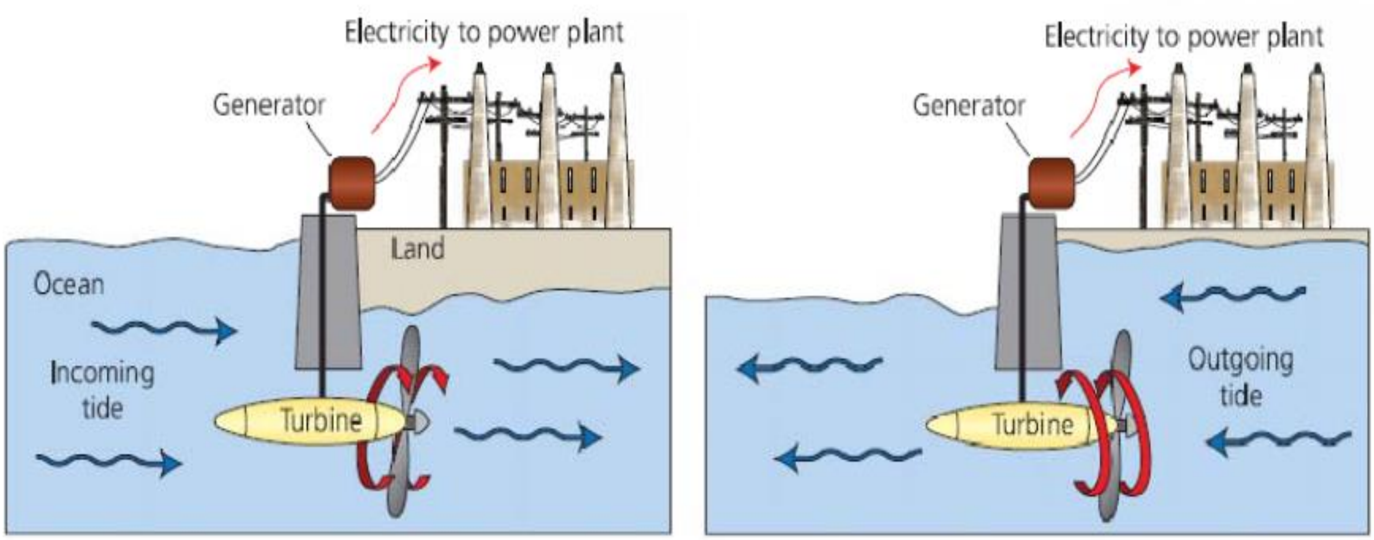


Fig. 6.2 Tidal Energy Generators

Wave Energy

Wave energy, also known as ocean energy or sea wave energy, is energy harnessed from the ocean or sea waves. When the wind blows across the sea surface, it transfers the energy to the waves. They are powerful sources of energy. The energy output is measured by wave speed, wave height, wavelength and water density.

Wave energy is, essentially, a condensed form of solar power produced by the wind action blowing across the ocean water surface, which can then be utilized as an energy source. When the intense sun rays hit the atmosphere, they get it warmed up. The intensity of sun rays hitting the earth's atmosphere varies considerably in different parts of the world. This disparity of atmospheric temperature around the world causes the atmospheric air to travel from hotter to cooler regions, giving rise to winds.

As the wind glides over the ocean surface, a fraction of the kinetic energy from the wind is shifted to the water beneath, resulting in waves. As a matter of fact, the ocean could be seen as a gigantic energy storehouse collector conveyed by the sun rays to the oceans, with the waves transporting the conveyed kinetic energy across the ocean surface. With that in mind, we can safely conclude that waves are a form of energy and it's the same energy, not water that glides over the surface of the ocean.

The Wave Energy Converter (WEC)

The Wave energy hitting the shore is converted into electricity using a wave energy converter (WEC), essentially, a power station. The operating principle of this power station is both simple and ingenious. It's an enclosed chamber with an opening under the sea, which allows strong sea waves to flow into the chamber and back.

The water level in the chamber rises and falls with the rhythm of the wave, and so air is forced forwards and backward via the turbines joined to an upper opening in the chamber. The compressed and decompressed air has enough power to propel the turbines. The turbine is propelled in the same direction by the back and forth airflow through the turbine. The propelling turbine turns a shaft connected to a generator. The generator produces electricity, which is transported to electrical grids and later supplied to demand centers and distribution lines that connect individual homes and industries. The advantage of this wave energy converter is that even considerably low wave motions can produce sufficient airflow to maintain the movement of the turbine to generate energy.

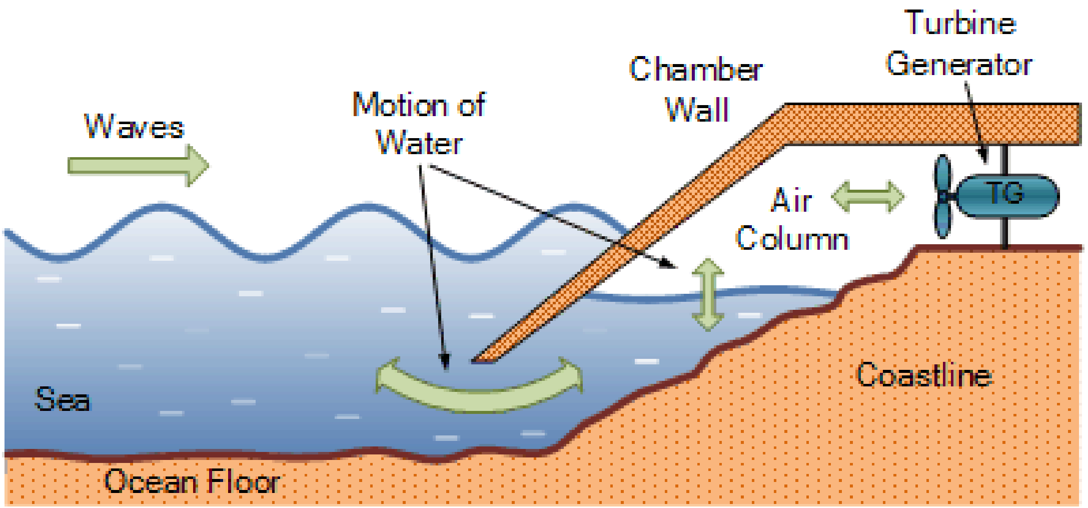


Fig. 6.3 The Wave Energy Converter (WEC)

Advantages of Wave Energy

1. It’s highly predictable
2. It’s a renewable form of energy
3. Wave energy is eco-friendly
4. Creation of green jobs
5. The exponential growth of remote areas
6. Security of energy supply
7. Land remains undamaged

Disadvantages of Wave Energy

1. High upfront capital costs
2. Variability in wave magnitude can damage equipment
3. Damage to sea life ecosystem
4. Disadvantage of location
5. Environmental concerns