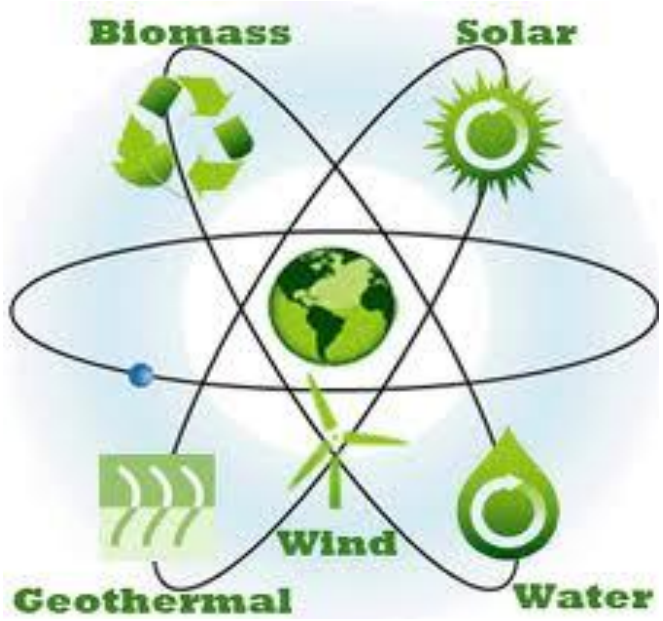
Lect.-1
Classification of energy sources, contribution of these sources in agricultural sector.



By
Er. J. K. Gaur
M-9414264790

Energy:

Energy is defined via work, i.e capacity of doing work.

the SI (Standard International) unit for **energy** is the same as the unit of work – the joule (J),

named in honor of James Prescott Joule.

1 joule is .equal to 1 Newton- metre. (**N·m)**

One Newton is the force needed to accelerate one kilogram of mass at the rate of one metre per second squared in the direction of the applied force.

$F=m \cdot a$ *or* $N=1\ kg \cdot 1\ m/s^2$

- The energy unit used for electricity, is the kilowatt- hour(kWh);

One kWh is equivalent to 3.6×10^6 J (3600 kJ or 3.6 MJ).

In Food industry the unit of energy is calorie.

1 calorie = 4.184 J

Basically energy can be classified into two types:

Potential Energy and Kinetic Energy

Potential Energy

Potential energy is stored energy and the energy of position (gravitational). It exists in various forms.

Kinetic Energy

Kinetic energy is energy in motion- the motion of waves, electrons, atoms, molecules and substances. It exists in various forms.

Various Forms of Energy

(i) Chemical Energy

Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy.

(ii) Nuclear Energy

Nuclear energy is the energy stored in the nucleus of an atom - the energy that holds the nucleus together. The nucleus of a uranium atom is an example of nuclear energy.

It is not a renewable energy source, but because it is a technology not based on fossil fuels many people think nuclear power plants could play an important role in reducing carbon emissions and battling climate change.

(iii) Stored Mechanical Energy

Stored mechanical energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of stored mechanical energy.

(iv) Gravitational Energy

Gravitational energy is the energy of place or position. Water in a reservoir behind a hydropower dam is an example of gravitational energy. When the water is released to spin turbines, it becomes rotational energy.

(v) Radiant Energy

Radiant energy is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Solar energy is an example of radiant energy.

(vi) Thermal Energy

Thermal energy (or heat) is the internal energy in substances- the vibration and movement of atoms and molecules within substances. Geothermal energy is an example of thermal energy.

(vii) Electrical Energy

Electrical energy is the movement of electrons. Lightning and electricity are examples of electrical energy.

(viii) Energy in Motion

The movement of objects or substances from one place to another is motion. Wind and hydropower are examples of motion.

(ix) Sound Energy

Sound is the movement of energy through substances in longitudinal (compression/rarefaction) waves.

(x) Light Energy

Light energy is a type of wave motion. That is, light is a form of energy caused by light waves. It enables us to see, as objects are only visible when they reflect light into our eyes.

Classification of Energy Resources on the basis of availability:

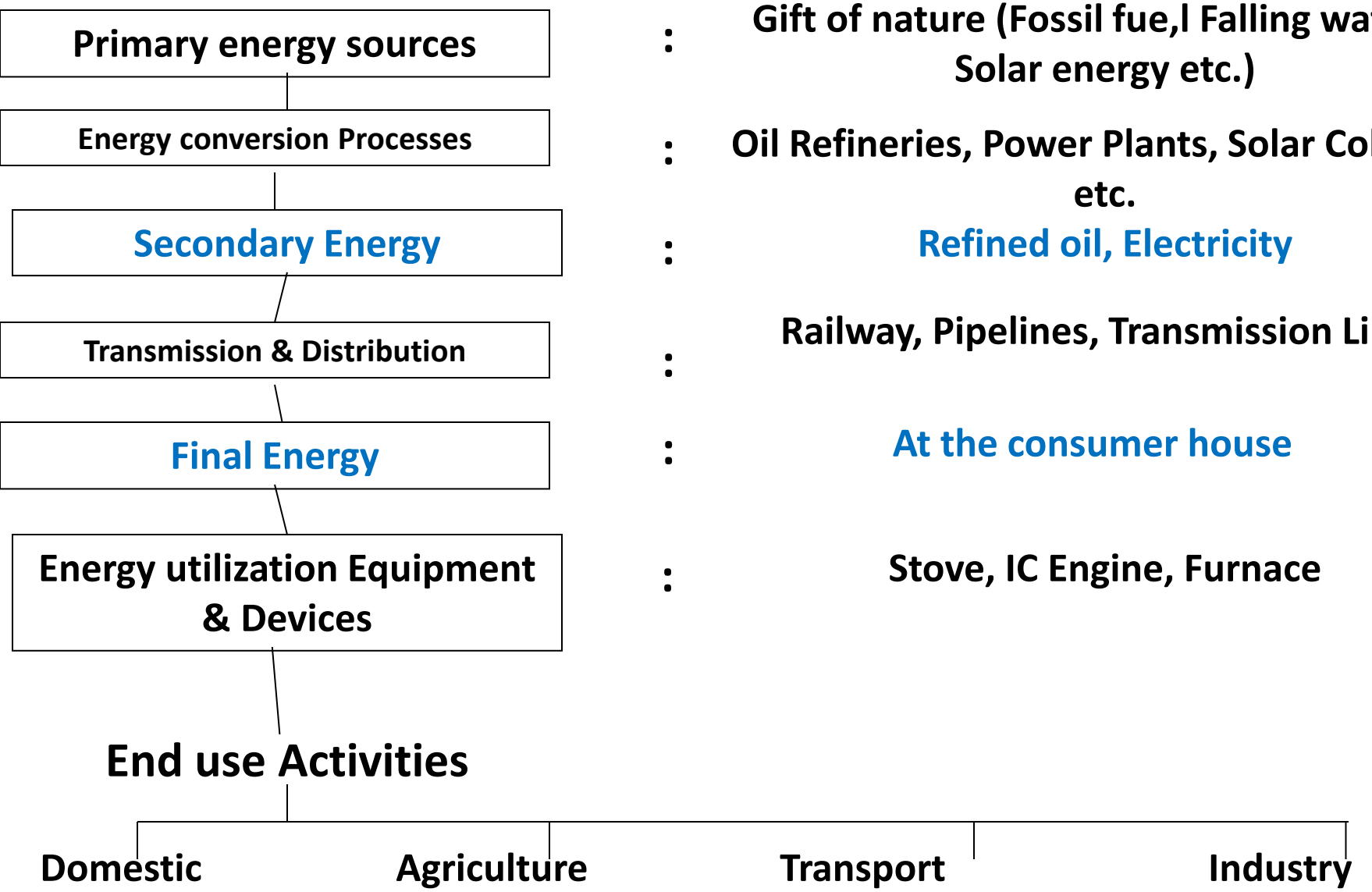
Primary energy resources:

1. Fossil fuels such as coal natural gas etc.
2. Nuclear fuels such as Uranium, Thorium etc.
3. Hydro energy
4. Solar energy
5. Wind energy
6. Geothermal energy
7. Ocean energy such as tidal energy, wave energy
8. Hydrogen energy

Secondary energy resources:

1. Petrol, diesel, kerosene oil.
2. CNG and LPG
3. Electrical energy based on coal, diesel gas.

Energy flow Pattern in Present Context



Classification of Energy Sources

Energy sources can be classified on the basis of three features:

(a) Conventional and Non Conventional Energy sources.

(b) Renewable and Non Renewable Energy sources.

(c) Commercial and Non Commercial Energy sources.

Conventional and Non Conventional Energy sources.

- Based on conventionality in deriving energy, energy sources can be classified as conventional (coal, oil, hydro, nuclear, etc.) and non - conventional (solar, wind, tidal, geothermal, biogas, etc.) sources.
- Fossil fuels(coal, oil and petroleum products, natural gas) are conventional energy sources.
- Fossil fuels are formed by the decomposition of the remains of dead plants and animals buried under the earth long ago.
- Hydro power is also conventional source of energy. The watercourses created by precipitation of rain and snows and flowing from higher level to a lower level can be used for generation of electricity.

Flowing water → Turbine → Generator → Electricity

Potential energy to kinetic energy – Mechanical energy to electrical energy

Hydro Electric Energy

Hydro power is the cleanest, cheapest & best source of electricity generation. It falls under the conventional energy resource. Energy is derived from fast flowing water. Hydropower converts power of the falling water to electric power which can be transmitted to long distances through wires & cables. It can be stored for future use also. Hydropower is generated by using hydraulic machine, called turbines. Now high dams are built to obtain a substantial amount of hydrostatic pressure.

It has the main advantage over all the other forms of alternative energy production , that is, its greater reliability as compared to the other forms of alternative energy sources.

Coal:

- Normally found under the crest of earth trapped in rocks.
- Mostly (about 71%) Used in thermal power plant as fuel.
- Depending upon the carbon contents of coal these are classified as;

(i)Peat- 60% carbon

(ii) Lignite – (soft coal) 70% carbon

(iii) Bituminous- (household coal) 80% carbon

(iv) Anthracite- (Hard coal) -90% carbon

Crude Petroleum can be heated at various temperatures to get following useful products:

(i) Petroleum gas – LPG (Below 40^0C)

(ii) Petrol- 40 to 170^0C

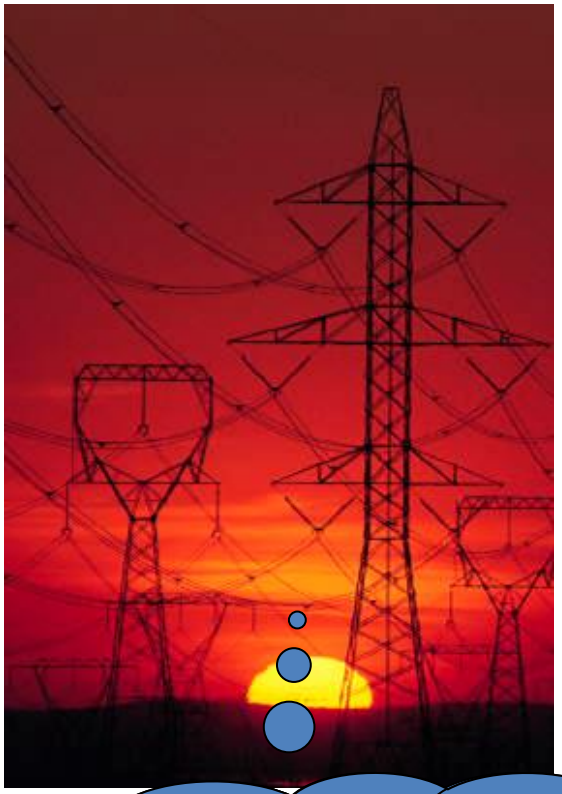
(iii) Kerosene- 170 to 250^0C

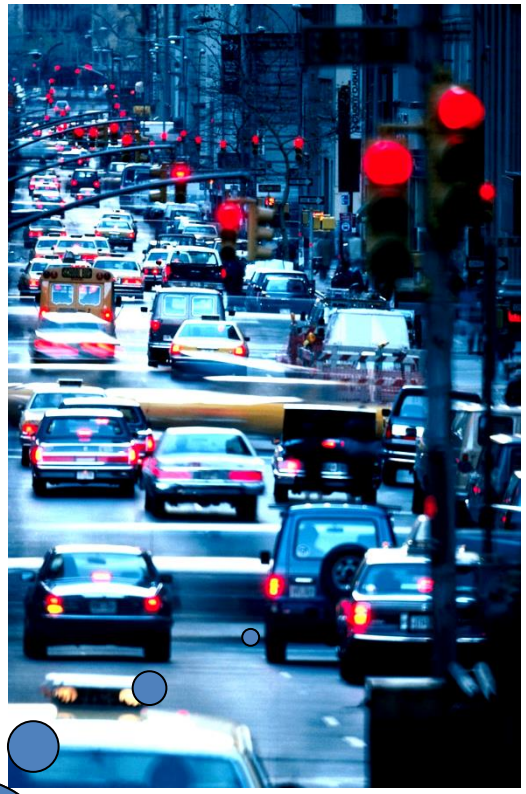
(iv) Diesel – 250-350 ^{0}C

(v) Lubricating oil, paraffin wax – above 400 ^{0}C

Natural gas- it consists of about 95% methane, and rest ethane and propane.

Burning of Fossil Fuels





Pollution from coal, natural gas, and oil

The conventional sources can produce energy irrespective of weather conditions.

Conventional Energy Sources

Disadvantages of Conventional Energy Sources

- Petroleum, gas and coal are non renewable energy sources which means that they will eventually run out.
- These energy sources also release greenhouse gases like carbon dioxide into the atmosphere which contribute to global warming.
- Other pollutants released include sulfur and nitrogen oxide, which can lead to acid rain and mercury, which is harmful to humans when ingested.

Non conventional energy sources:

These sources are obtained from the earth atmosphere and have no shortage as far as their quantum is concerned.

- Solar
- Wind
- Biomass
- Tidal
- Geothermal
- Ocean energy.

Commercial and Non Commercial Energy sources.

On the nature of their transaction, the energy sources can be classified as commercial and noncommercial sources of energy .

All energy resources, particularly the commercial ones, are natural. Coal, oil and nuclear sources constitute commercial sources,

While firewood, biomass and animal dung constitute non- commercial sources.

Non Renewable and Renewable Sources of Energy Sources

Non Renewable Energy Sources:

These energy sources are nature gifted resources being accumulated in nature for a very long time and can't be replaced if exhausted. Once these natural resources are used up, they are gone forever, hence called non- renewable.

Example: coal, petroleum, natural gas, thermal power, hydro power and nuclear power are the main conventional sources of energy.

Uranium is a non-renewable source, but it is not a fossil fuel. Uranium is converted to a fuel and used in nuclear power plants.

Renewable Energy Sources

Energy sources, which are continuously and freely produced in the nature and are not exhaustible, are known as the renewable sources of energy.

Renewable energy is captured from an energy resource that is replaced rapidly by a natural process.

Example: solar energy, biomass and wood energy, geo thermal energy, wind energy, tidal energy and ocean energy.

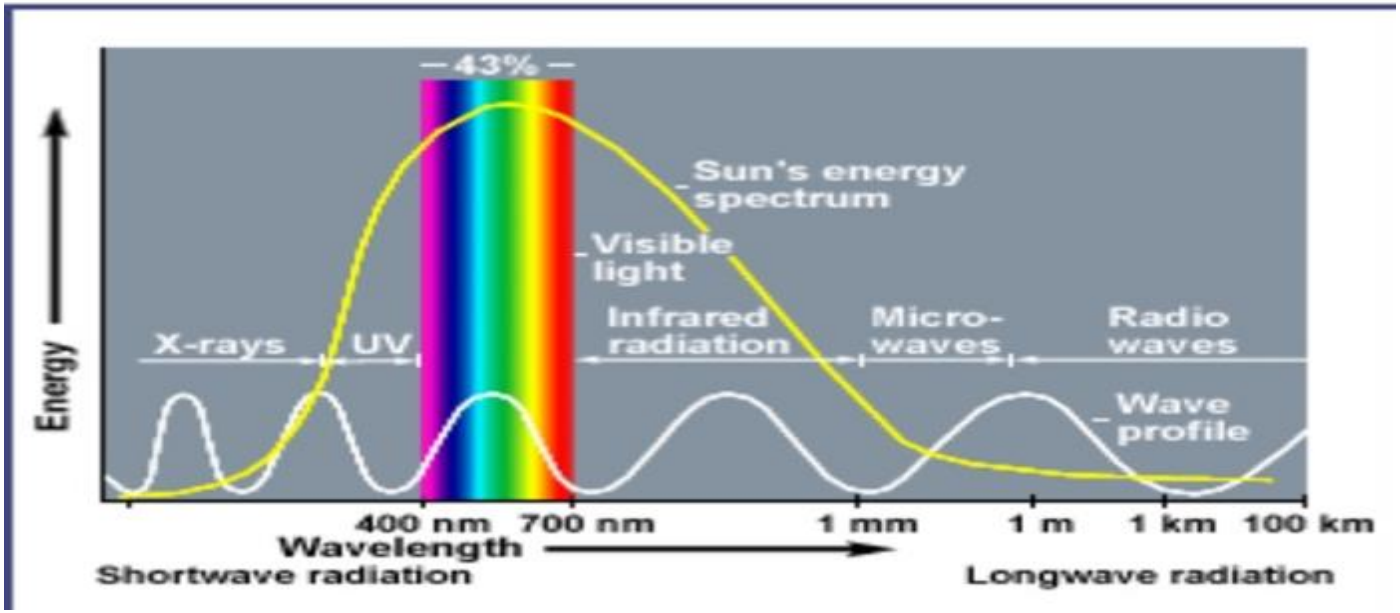
But main attention has to be directed to the following sources of renewable namely, a) solar photovoltaic, b) wind, and c) hydrogen fuel cell.

Renewable energy

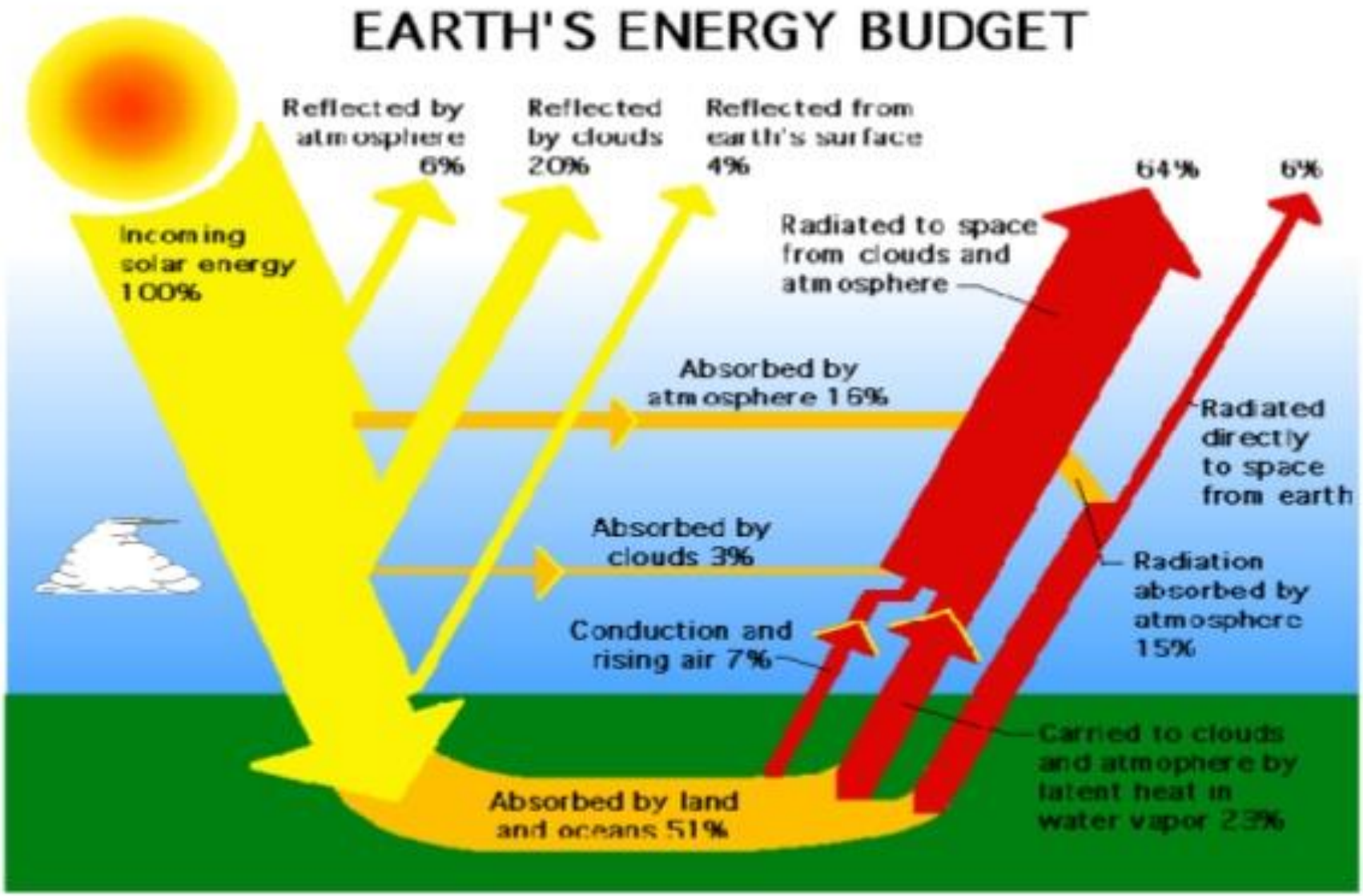
- **Renewable energy** is energy that is collected from renewable sources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy often provides energy in four important areas:
- Electricity generation,
- Air and water heating/cooling,
- Transportation and
- Rural (off grid) energy services.

Solar Energy

Solar energy is the energy received from the sun. This energy is in the form of solar radiation, which may be used directly for thermal applications like drying, heating etc. and can also be used to produce electricity by using solar PV cells.



Solar Power


EARTH'S ENERGY BUDGET
Reflected by atmosphere 6%
Reflected by clouds 20%
Reflected from earth's surface 4%
64%
6%
Incoming solar energy 100%
Radiated to space from clouds and atmosphere
Absorbed by atmosphere 16%
Radiated directly to space from earth
Absorbed by clouds 3%
Radiation absorbed by atmosphere 15%
Conduction and rising air 7%
Carried to clouds and atmophere by latent heat in water vapor 23%
Absorbed by land and oceans 51%

Use of solar energy

Thermal mode and photovoltaic mode

(A) In domestic sector

- Cooking
- Water heating
- Lightening
- Operating electrical appliances
- Solar distillation
- Drying

(B) In Agriculture sector

- Pumping of irrigation water
- Drying of farm produce
- Winnowing
- Soil solarisation

USAGE OF SOLAR POWER

Agricultural Usage:

Agriculture seeks to optimize the capture of solar energy in order to optimize the productivity of plants. Sunlight is generally considered a plentiful resource, the exceptions highlight the importance of solar energy to agriculture.

Greenhouses convert solar light to heat, enabling year-round production and the growth o specialty crops and other plants not naturally suited to the local climate.

Drying

- For safe storage
- For off season use of the product
- The important factor is to preserve the nutritive value and the colour

Protection from birds, no effect of rain, wind storm etc.

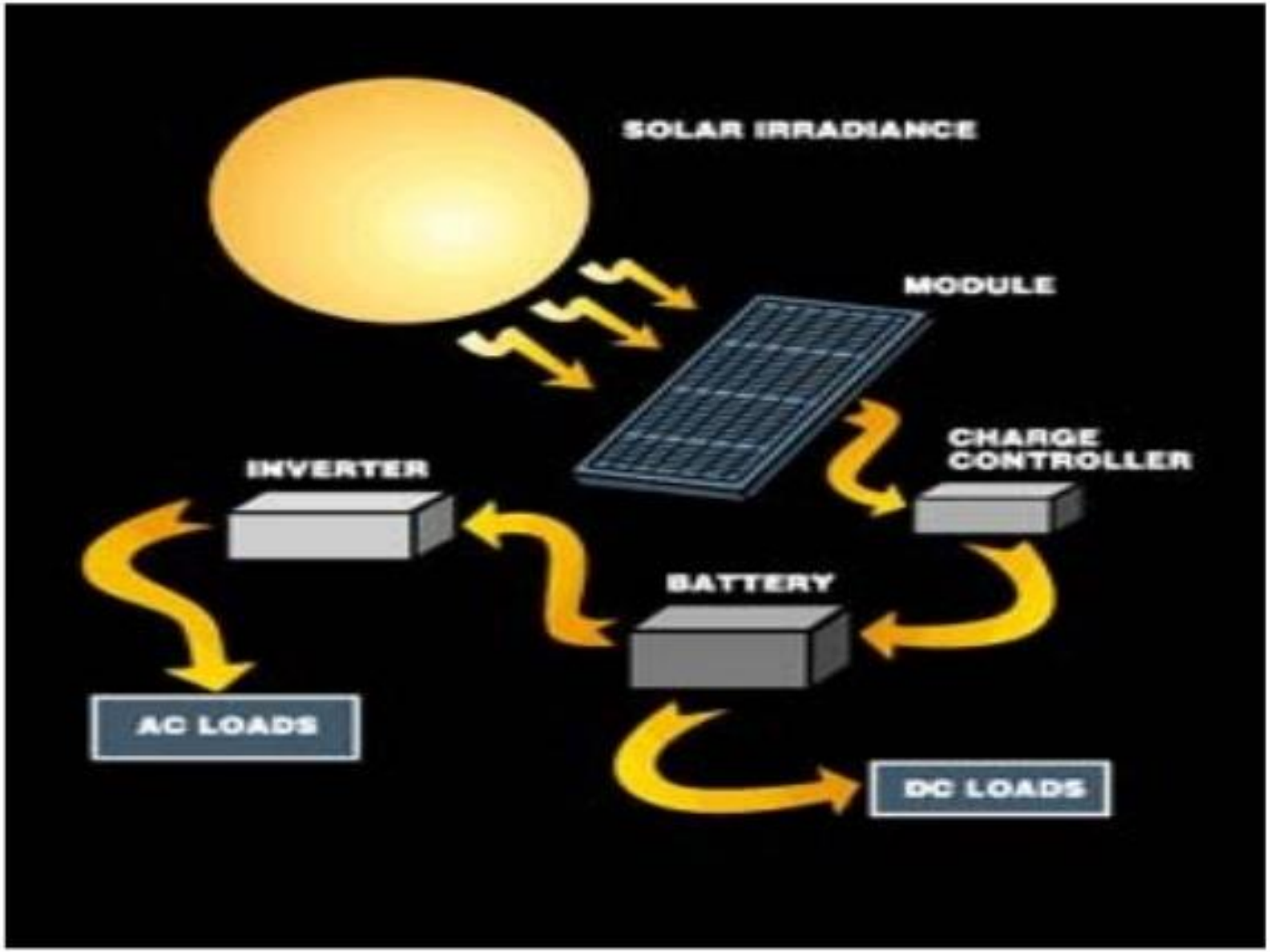
Solar dryers

In direct heating

Direct heating

Solar steam generator and steam engine that operates with a high efficiency for pumping water

Solar PV pump for irrigation



Electricity generation from solar energy

Photovoltaic pumping system specifications

Motor pump/ Configuration	**Output (m^3.day)**	**Head (m)**	**Solar Array (Wp)**
Submerged borehole motor pump	40 25	20 20	1200 800
Surface motor/ submerged pump	60	7	840
Reciprocating positive displacement pump	6	100	1200
Floating motor/pumpset	100 10	3 3	530 85
Surface suction pump	40	4	350

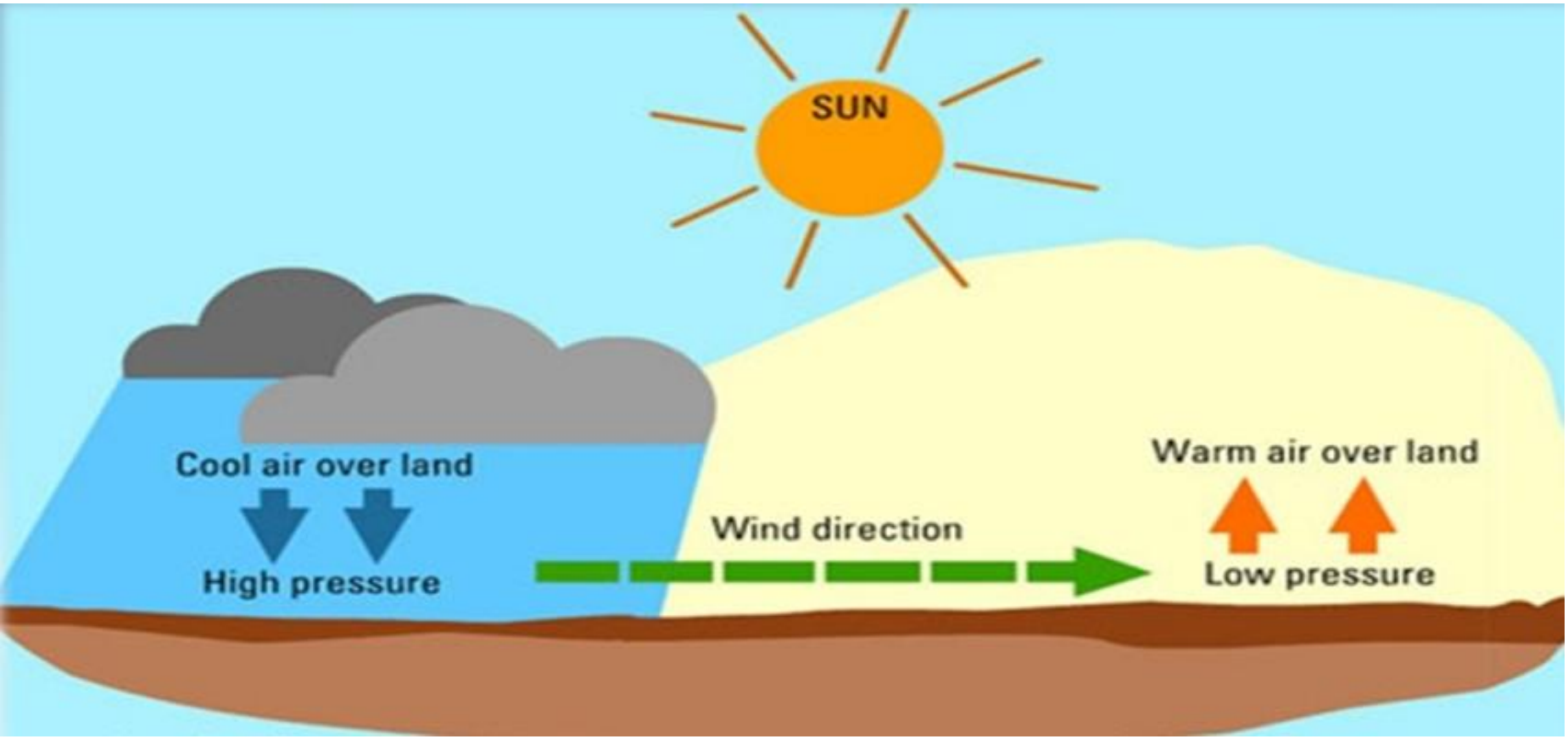
View of SOLAR PHOTOVOLTAICS pump with Sun tracker for 900 Wp SPV Panel in Operation

Wind Energy

Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth.

Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover.

This wind flow or energy in wind motion, can be harnessed by windmills for pumping, grinding etc. or by modern wind turbines to generate electricity.

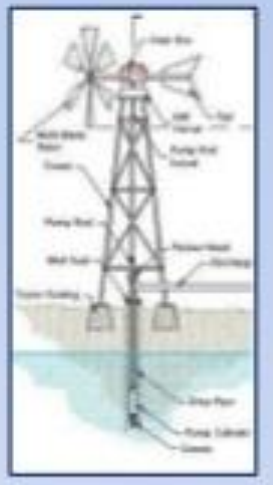


This behaviour of warm gases or liquids moving upward and being replaced by cooler particles is called Convection. The energy moving during convection is called convectional current.

The wind energy is kinetic energy from the wind.

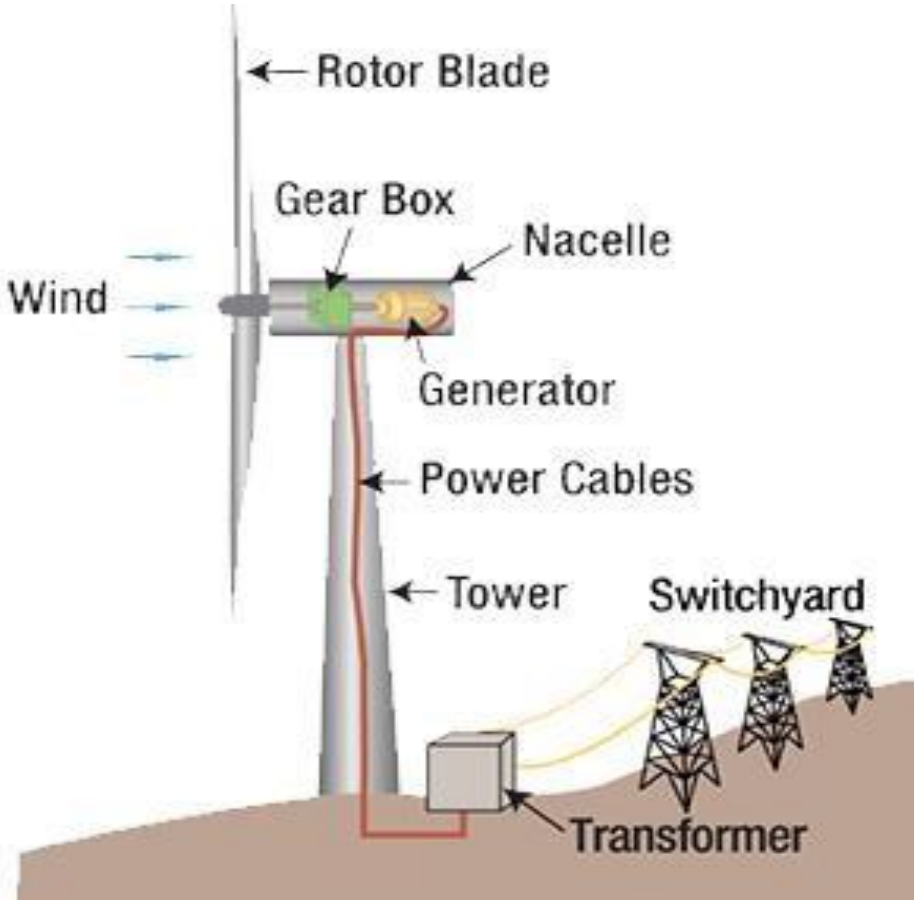
Wind turbines: how do they work? (1)

- 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 a generator can convert this mechanical power into **electricity**.
- A wind turbine works the opposite of a fan.
- Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity.



Wind turbine

The wind turbines use the kinetic energy of the wind and convert that energy into mechanical energy, which in turn can be converted into electricity by means of a generator.



The new windmills, also known as wind turbines, appeared in Denmark as early as 1890.

Power in the Wind (W/m2)

- The power in the wind is:

$$\text{Power} = \tfrac{1}{2}\,\rho\,A\,V^3$$

= 1/2 x air density x swept rotor area x (wind speed)^3

ρ

Density = P/(RxT)

P - pressure (Pa)
R - specific gas constant (287 J/kgK)
T - air temperature (K)

kg/m^3

A

Area = $\pi\ r^2$

m^2

V^3

Instantaneous Speed
(not mean speed)

m/s

- Using the density of air at sea level:

Power = 0.6125 AV^3 (metric)

Types of wind machines

Fan Mill Horizontal Axis

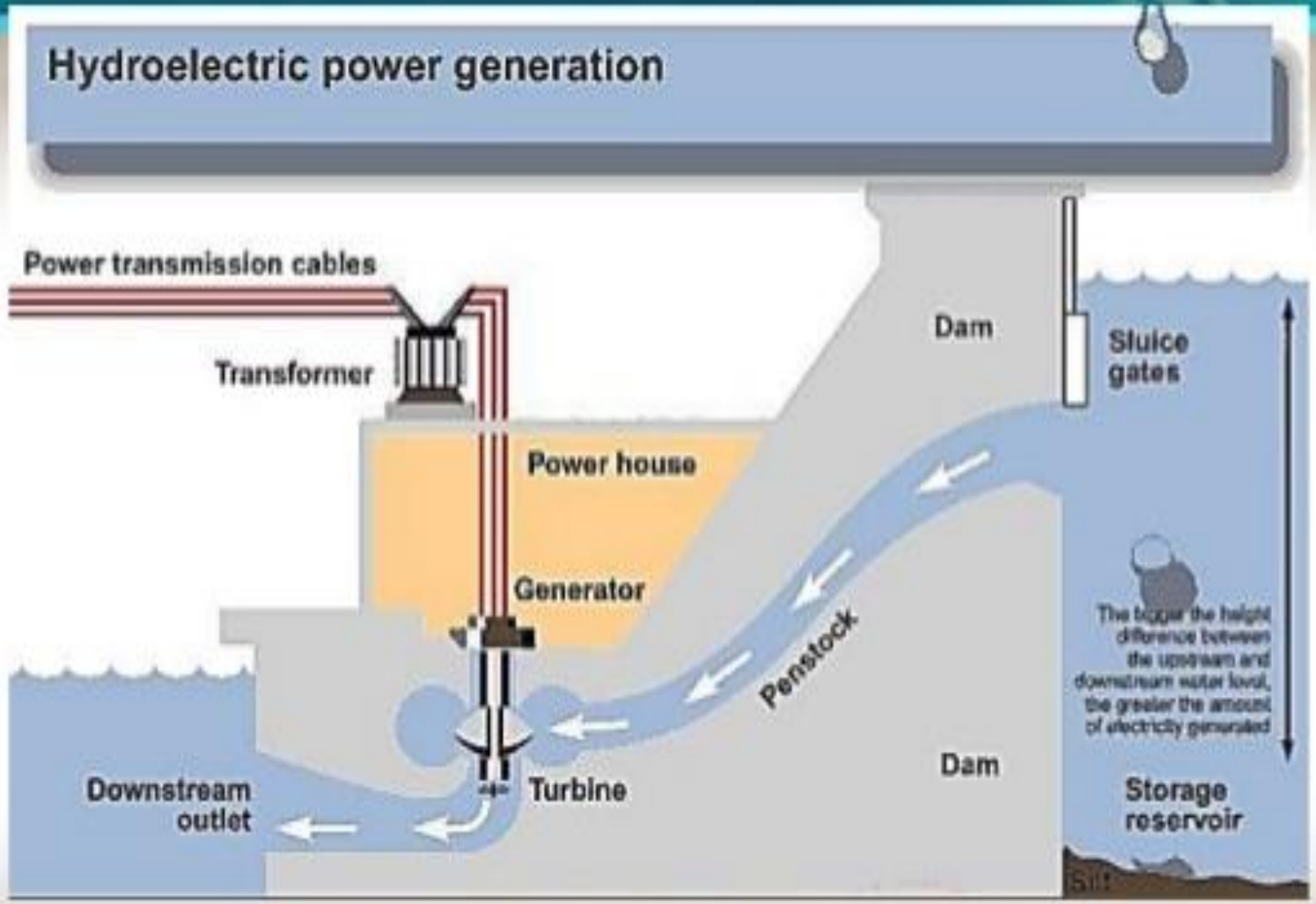
Darrieus Vertical Axis

Hydropower

Harvesting energy from water is possible due to the gravitational potential energy stored in water. As water flows from a high potential energy (high ground) to lower potential energy (lower ground), the potential energy difference thereby created can be partially converted into kinetic, and in this case electric energy through the use of a generator.

There are essentially two major designs in use that utilize water to produce electricity: the hydroelectric dam, and the pumped-storage plant.

Hydropower


Hydroelectric power generation
Power transmission cables
Transformer
Power house
Generator
Penstock
Turbine
Downstream outlet
Dam
Sluice gates
Dam
Storage reservoir
Silt

Principle :

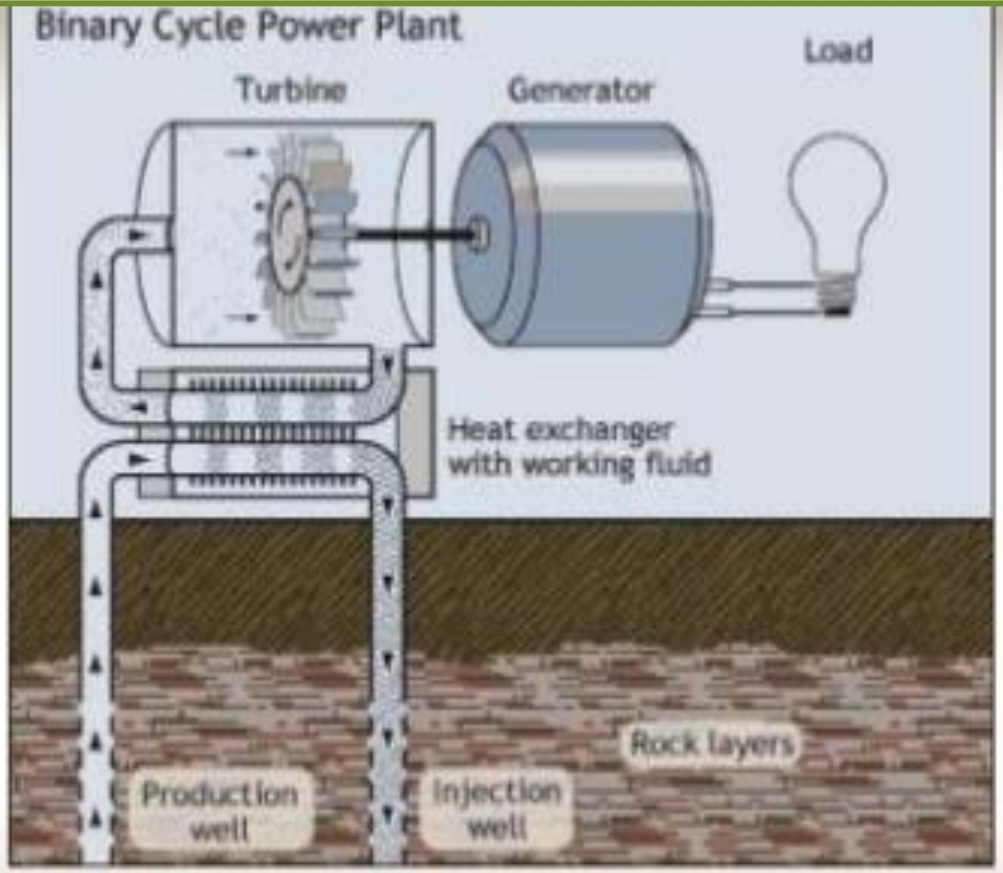
The force of the water being released from the reservoir through the penstock of the dam spins the blades of a turbine. The turbine is connected to the generator that produces electricity. After passing through the turbine, the water reenters the river on the downstream side of the dam.

A pumped-storage plant is very similar to the hydroelectric dam, the main difference being that the pumped-storage plant uses two reservoirs, one being considerably higher than the other. The advantage of this design is that during periods of low demand for electricity, such as nights and weekends, energy is stored by reversing the turbines and pumping water from the lower to the upper reservoir. The stored water can later be released to turn the turbines and generate electricity as it flows back into the lower reservoir.

Geothermal energy

It is one of the only renewable energy sources not dependent on the Sun. Instead, it relies on heat produced under the surface of the Earth.

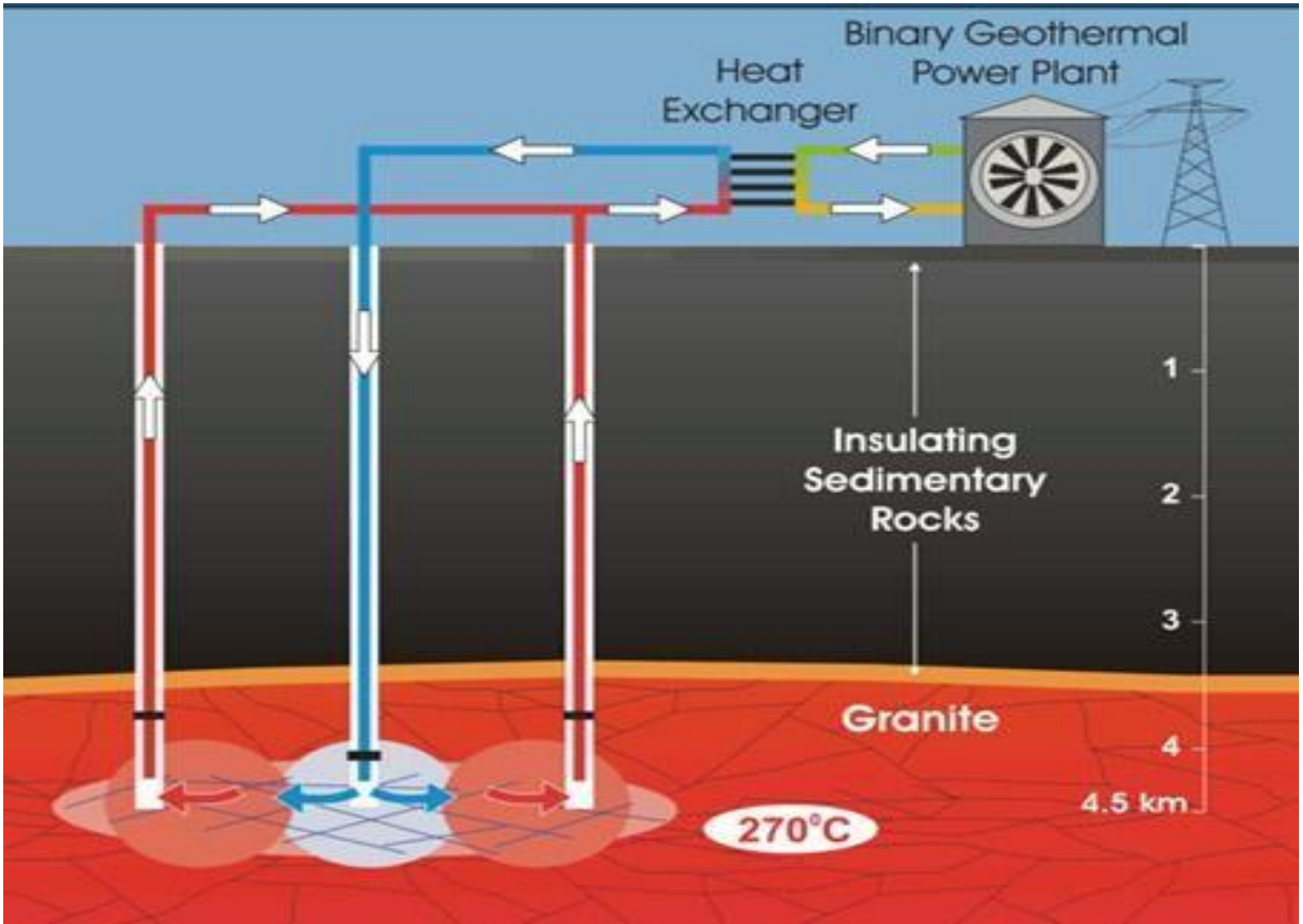
- Geothermal energy is energy obtained by tapping the heat of the earth itself, both from kilometers deep into the Earth's crust in volcanically active locations of the globe or from shallow depths, as in geothermal heat pumps in most locations of the planet. It is expensive to build a power station but operating costs are low resulting in low energy costs for suitable sites. Ultimately, this energy derives from heat in the Earth's core.



Geothermal energy

- Three types of power plants are used to generate power from geothermal energy: dry steam, flash, and binary.
- Dry steam plants take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator.
- Flash plants take hot water, usually at temperatures over 200 °C, out of the ground, and allows it to boil as it rises to the surface then separates the steam phase in steam/water separators and then runs the steam through a turbine.
- In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine. The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat.
- The geothermal energy from the core of the Earth is closer to the surface in some areas than in others. Where hot underground steam or water can be tapped and brought to the surface it may be used to generate electricity.

Binary Geothermal Power Plant



Problems with Geothermal energy use

Some problems that geothermal energy faces are depletion of both water and heat in geothermal areas.

- The first problem has been partially addressed by re-injecting water into reservoirs, thus sustaining the plant's ability to operate.
- Water re-injection can cause small earthquakes, which raises the question of whether the plants should be liable for the damages caused.

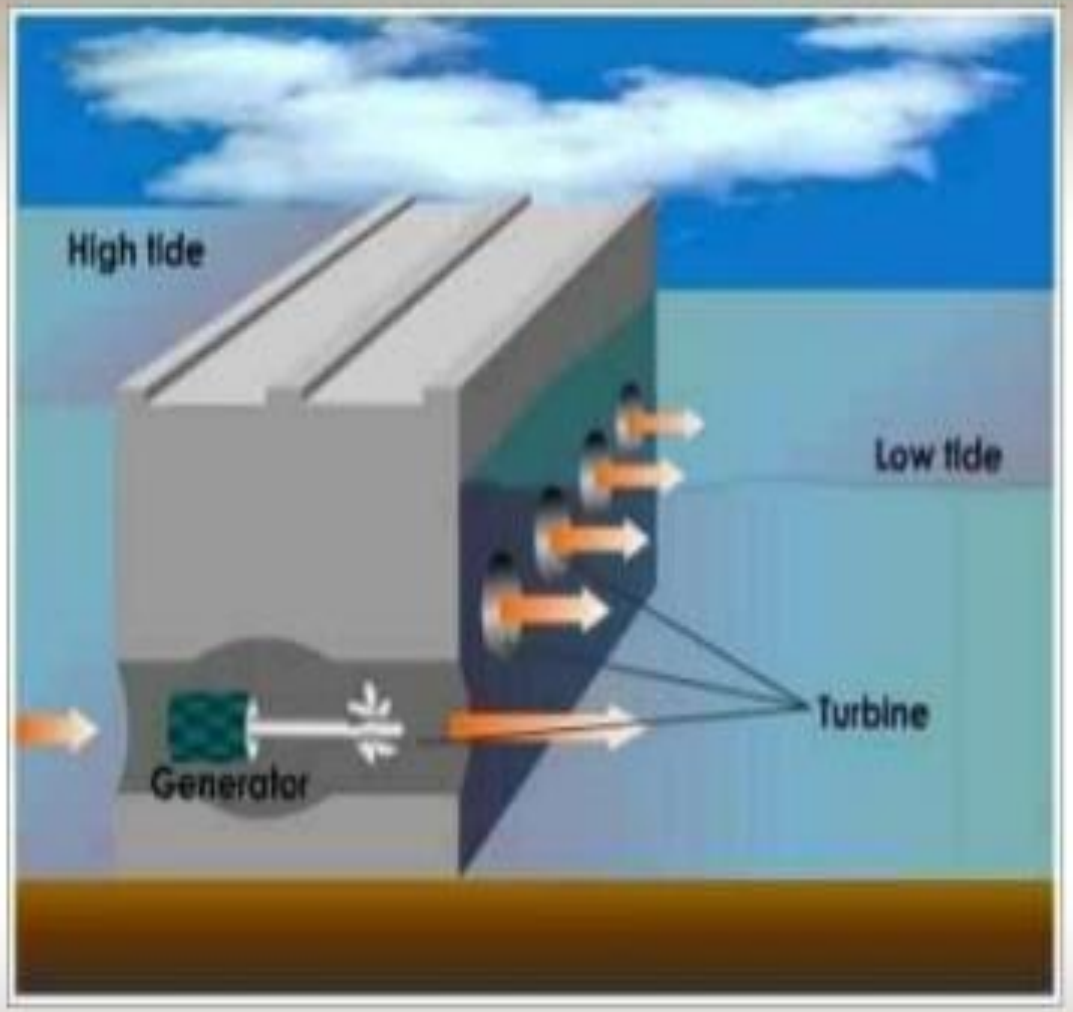
Ocean Energy

Nearly seventy percent of the Earth's surface is covered by oceans, which have the potential to supply humans with an enormous amount of renewable energy. Humans have exploited the vast energy potential of Earth's oceans by taking advantage of wave movement, tides, ocean currents, and ocean thermal energy.

Wave farm: This technology is based on the principle of rolling waves flowing through joints in a large cylindrical pipe, which pushes high pressure oil through hydraulic motors to generate electricity- which is in turn fed to an onshore grid through an underwater cable. Thus wave energy can be converted to electricity. One square kilometer of ocean interspersed with the devices would produce about 30 MW of electricity, which could power 20,000 homes.

Tidal Energy

- This is another unlimited and inexhaustible source of energy. The Gulfs of Kutch is preferably suited to build up electricity from the energy produced by high and lofty tides entering into slender creeks.



Ebb generation

Ebb generation means, at high tide, water flows in through openings (gates) in the barrage, or dam up to the normal level, spinning turbines to generate electricity. The water is retained behind the barrage until low tide, when it flows out again, once again spinning the turbines and generating electricity.

The predictability of tides makes tidal power a reliable energy source, though it can only produce electricity at certain times of day: during high and low tides.

BIOMASS ENERGY

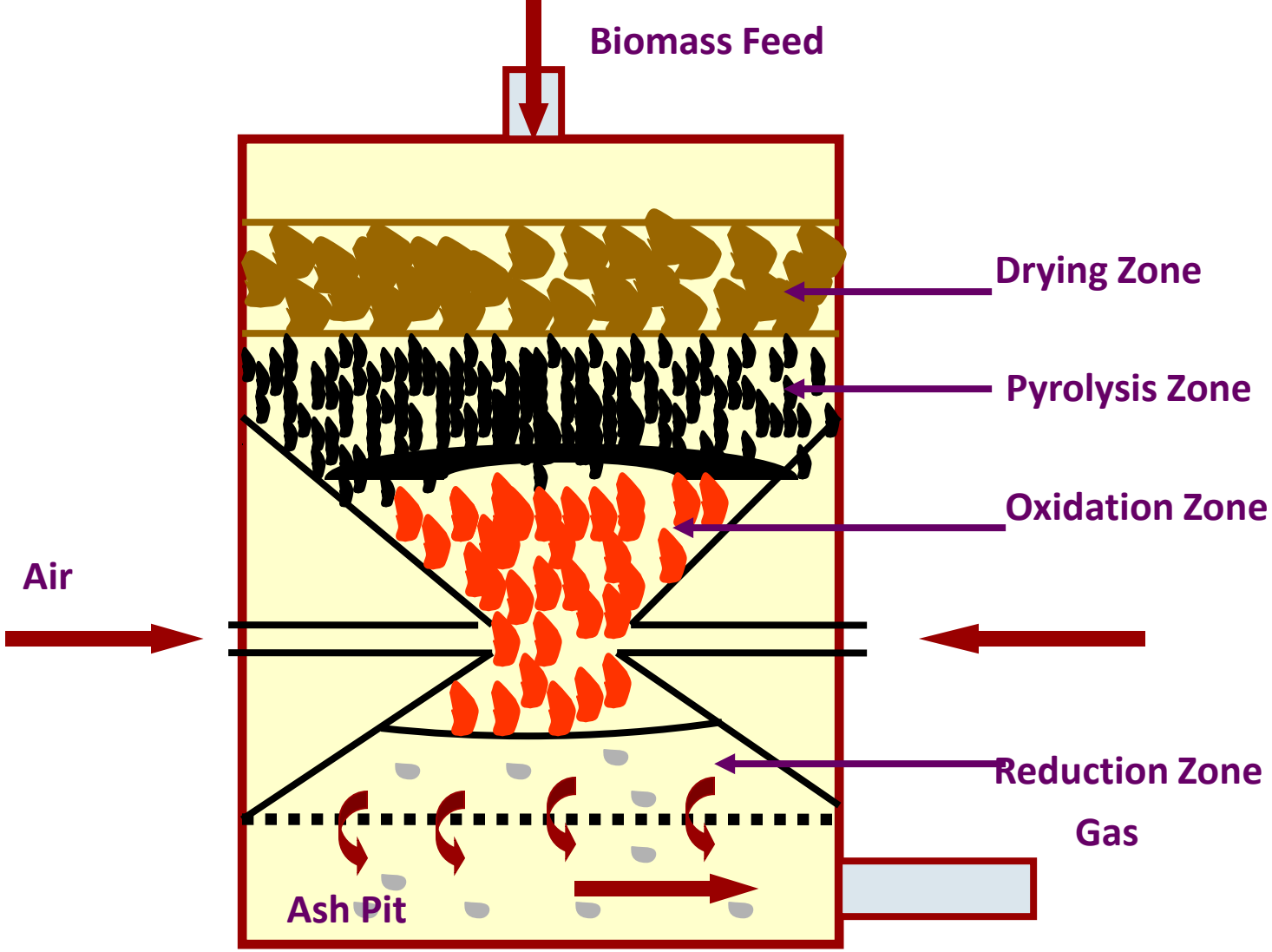
Biomass, a renewable energy source, is biological material derived from living, or recently living organisms, such as wood, waste, and alcohol fuels.

Biomass

Biomass can be converted into fuels through a number of different processes, including solid fuel combustion, digestion, pyrolysis, and fermentation and catalyzed reactions.

Electricity is generated in many places through solid fuel combustion.

- **Pyrolysis** creates a product much like charcoal, with double the energy density of the original biomass, making the fuel highly transportable and more efficient.
- The most widely used alternative fuel, ethanol, is created through fermentation of organic materials.



Biomass wastes based Gasifier for thermal and power generation

Ethanol

Ethanol, also known as ethyl alcohol or grain alcohol, is a colorless, clear liquid. The chemical formula is **CH_3CH_2OH.** Fuel-quality ethanol goes through more processes than do alcoholic beverages, in order to make it unfit for human consumption and to increase the purity so as to avoid separation when mixed with gasoline.

- Ethanol is not used by itself to fuel vehicles. Instead, it's mixed with gasoline. The two most common blends are E10 and E85. The number refers to the percentage of ethanol in the blend. E10 is a blend of ten percent ethanol and ninety percent gasoline. E85, the most mainstream alternative fuel, is eighty-five percent ethanol and fifteen percent gasoline.

- Using ethanol increases the octane rating and decreases the amount of damaging emissions associated with fuel consumption. It is for this second reason that ethanol use is so strongly recommended.
- Increase in use of ethanol as fuel will benefit farmers economically. The majority of ethanol used today comes from corn.
- The variety of other feedstock that can be used today includes barley, wheat, cornstalks, rice straw, sugarcane bagasse, pulpwood, switch grass and even municipal solid waste.

Biogas Production from Organic Waste

- Biogas is produced when bacteria degrade organic matter in the absence of air.
- Biogas contains around 55-65% of methane, 30-40% of carbon dioxide and small quantities of hydrogen, nitrogen, carbon monoxide, oxygen and hydrogen sulphide.
- The calorific value of biogas is appreciably high (around 4700 kcal or 20 MJ: at around 55% methane content).
- The biogas can effectively be utilized for generation of power through a biogas based power generation system after dewatering and cleaning of the gas.
- The slurry produced in the process provides valuable organic manure for farming.

FAMILY SIZE BIOGAS PLANT

Advantages of Renewable Energy

Renewable Energy	Non-renewable Energy
Continuous supply.	Limited supply.
Can be replenished within a short period time.	It takes a longer time (millions of years) to be replenished.
Most of the resources are fairly non-polluting and available locally.	Cause pollution and global warming.

Disadvantages of Renewable energy sources

A common disadvantage to all is that it is difficult to produce the large quantities of electricity their counterpart the fossil fuels are able to. Since they are also new technologies, the cost of initiating them is high.

- wind : turbines are expensive. Wind doesn't blow all the time, so they have to be part of a larger plan.
- Solar :panels are expensive, Not all climates are suitable for solar panels.
- waves : different technologies are being tried around the world. Scientists are still waiting for the killer product.
- tides : barrages (dams) across river mouths are expensive to build and disrupt shipping. Smaller turbines are cheaper and easier to install.

Disadvantages of Renewable energy sources

- Rivers : Dams are expensive to build and disrupt the environment. They have also caused earthquakes.
- Geothermal : Difficult to drill two or three kilometers down into the earth.
- Biofuel : Often uses crop lands and crops (like corn) to produce the bio-alcohol. This means that more land has to be cleared to grow crops, or there is not enough food, or that food becomes more expensive.

- Renewable energy in India comes under the purview of the Ministry of New and Renewable Energy (MNRE). India was the first country in the world to set up a ministry of non-conventional energy resources, in the early 1980s.
- Solar Energy Corporation of India is responsible for the development of solar energy industry in India.
- Hydroelectricity is administered separately by the Ministry of Power and not included in MNRE targets.

Contribution of Energy Sources in Agriculture Sector

In agriculture sector the following operations are generally performed:

1. Land preparation
2. Sowing or transplanting
3. Water pumping
4. Weeding
5. Spraying & dusting
6. Harvesting
7. Drying
8. Transportation
9. Processing of products
10. Packaging
11. Long time storage in cold stores.

For all these activities, energy is required which can be obtained by different energy sources like diesel, electricity, biomass, cattle dung , solar and wind along with the power of human and animals .

Thank You