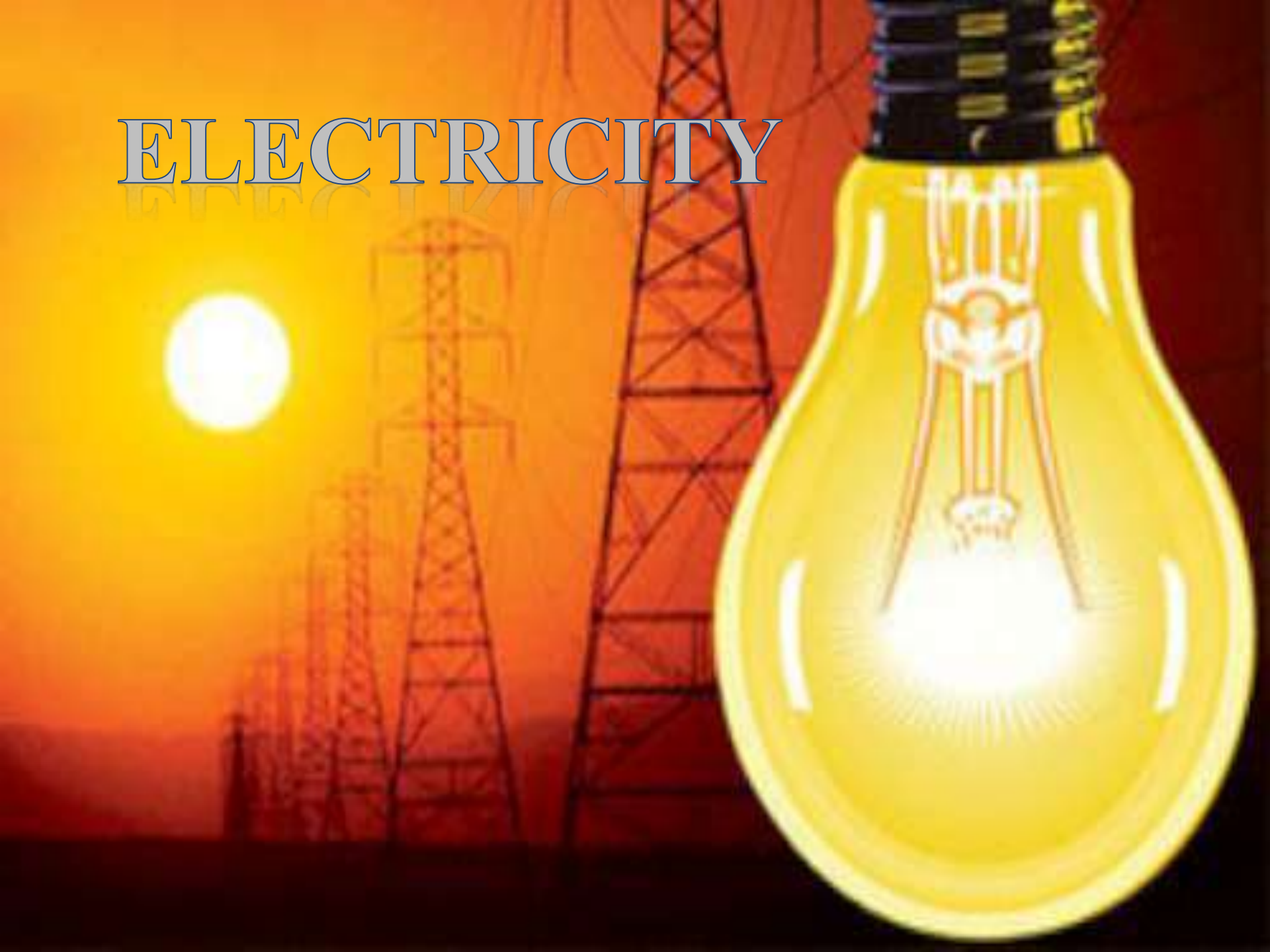
ELECTRICITY



WHAT IS ELECTRICITY

- Electricity is a form of energy that can be easily changed to other form
- Or
- Flow of current

What is current ?

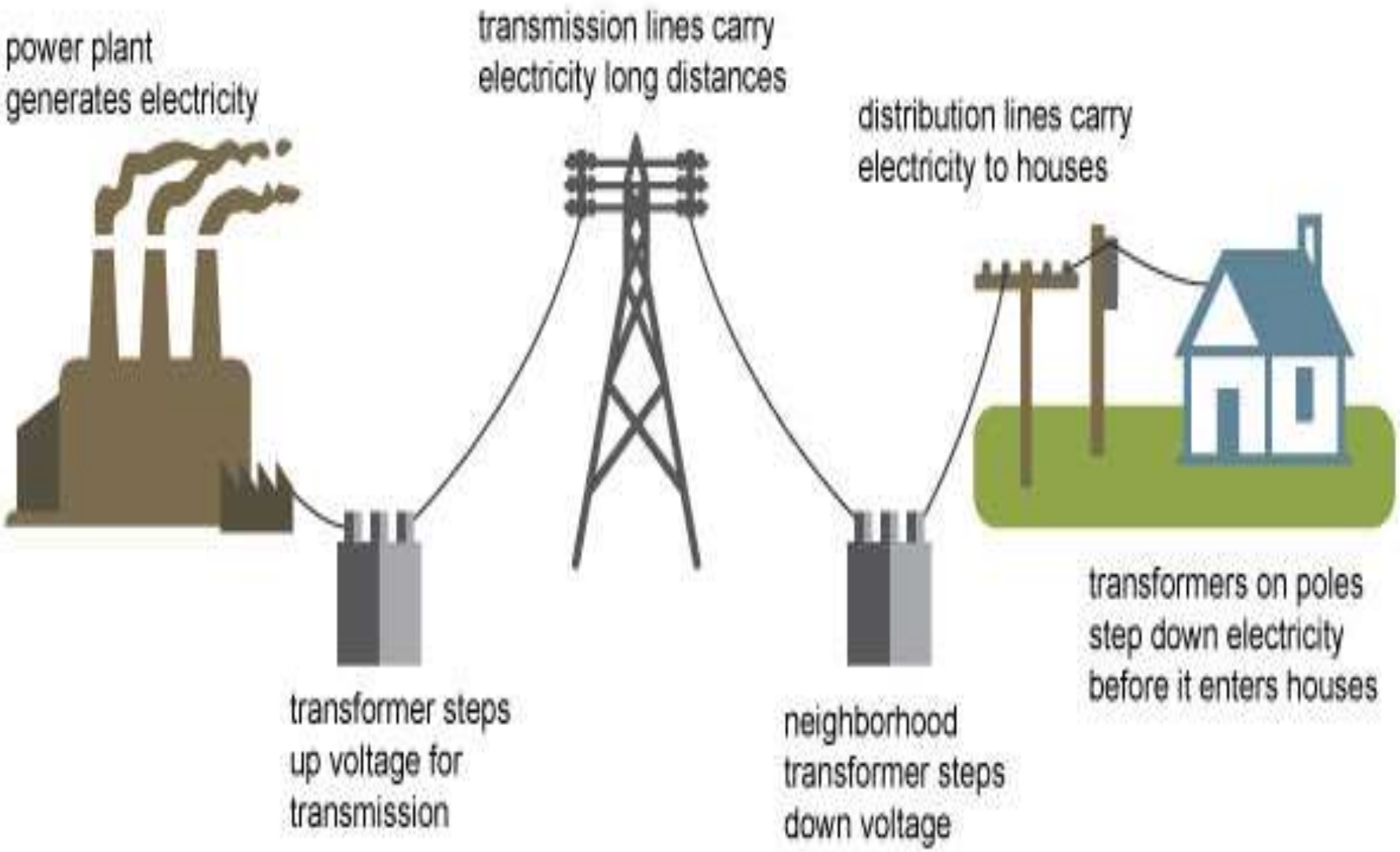
- Current is the flow of charge
  Or
- Flow of electrical charge is referred to as electrical current

How we get current to building ?

- There is three main process

1. Generation
2. Transmission
3. distribution

Electricity generation, transmission, and distribution



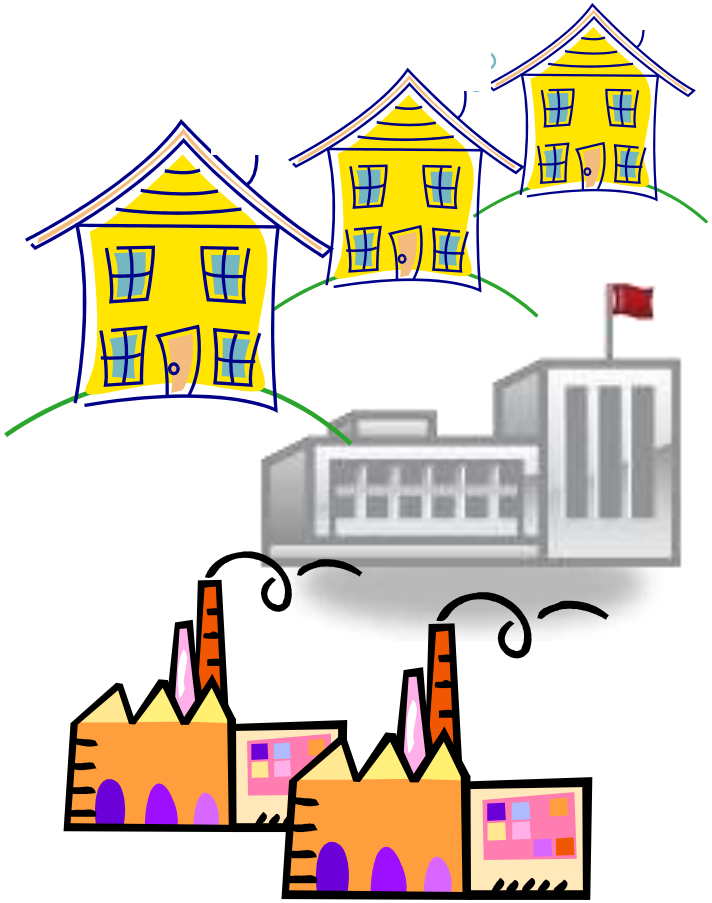
Source: Adapted from National Energy Education Development Project (public domain)

Factories, homes and schools need huge amounts of energy

- Generators in power stations supply electricity to factories, homes and schools.

- These generators are in **power stations**

and are huge!

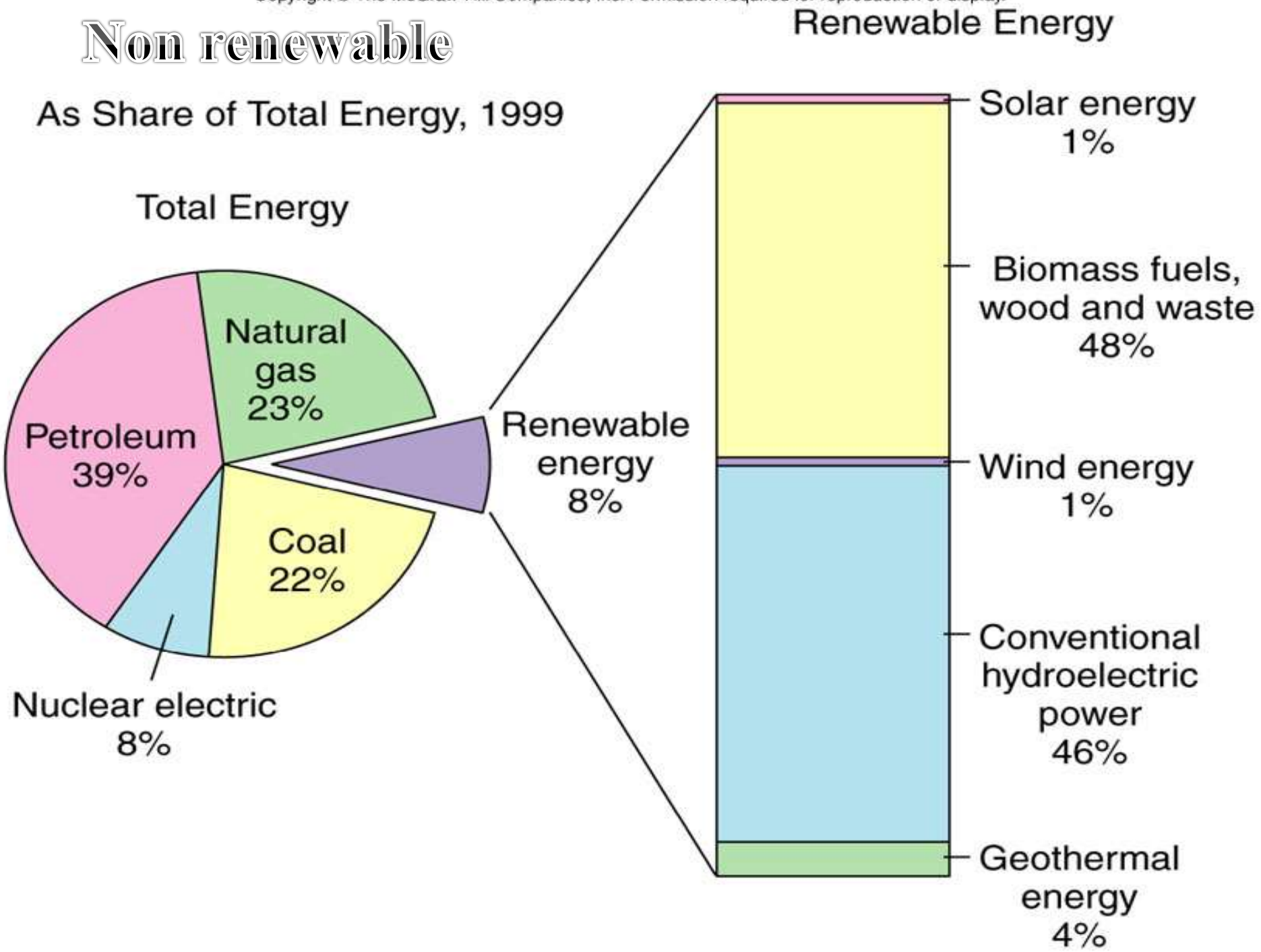


GENERATION

- There are basic types of sources used to generate electricity and are further divided into two categories;

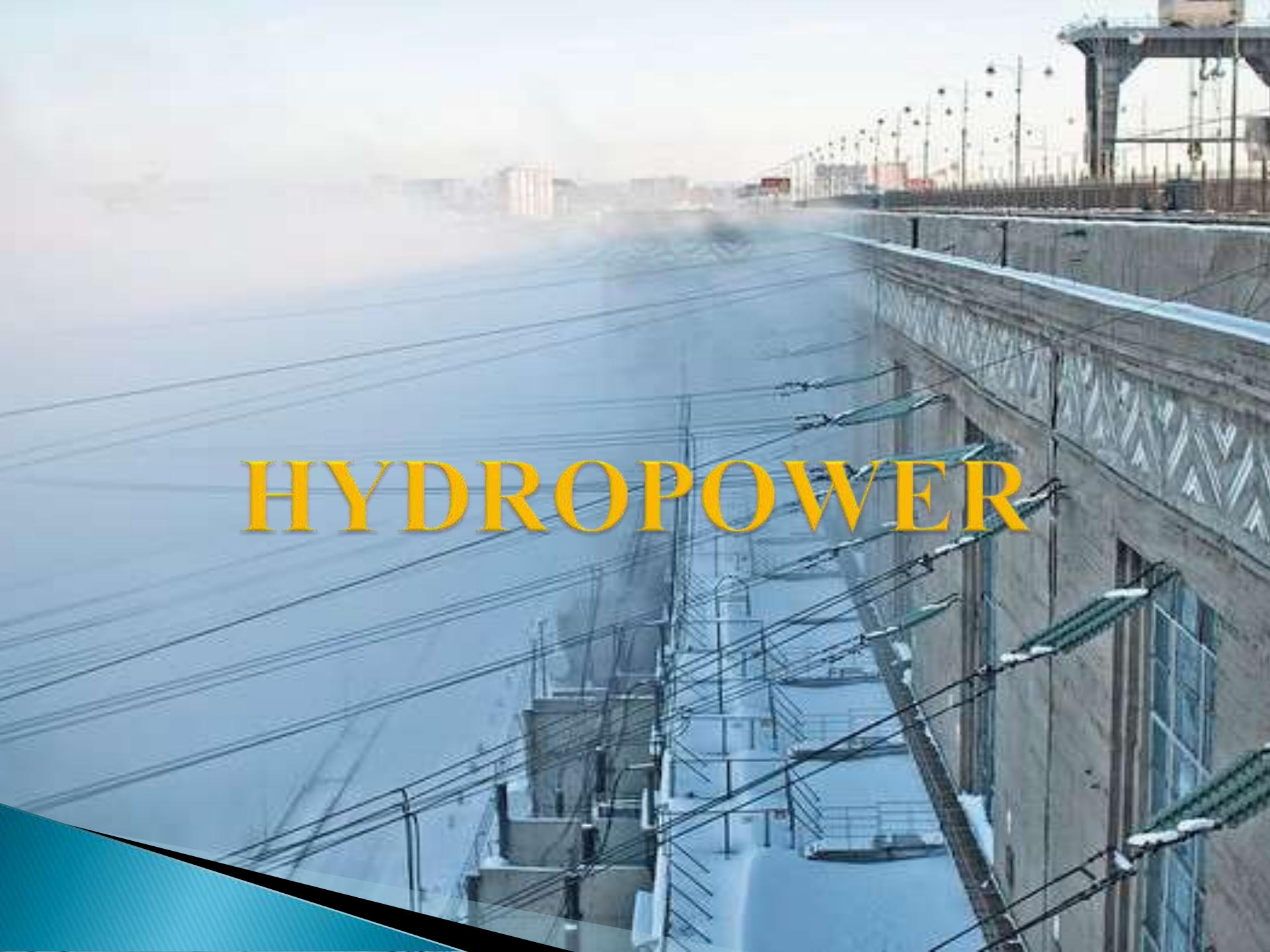
1. renewable
2. non-renewable sources.

Non renewable



Renewable energy

- Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the earth.
- **Hydropower**
- **Wind power**
- **Solar energy**
- **Geothermal energy**
- **Bio energy**


HYDROPOWER

Generators in power stations are very, very big

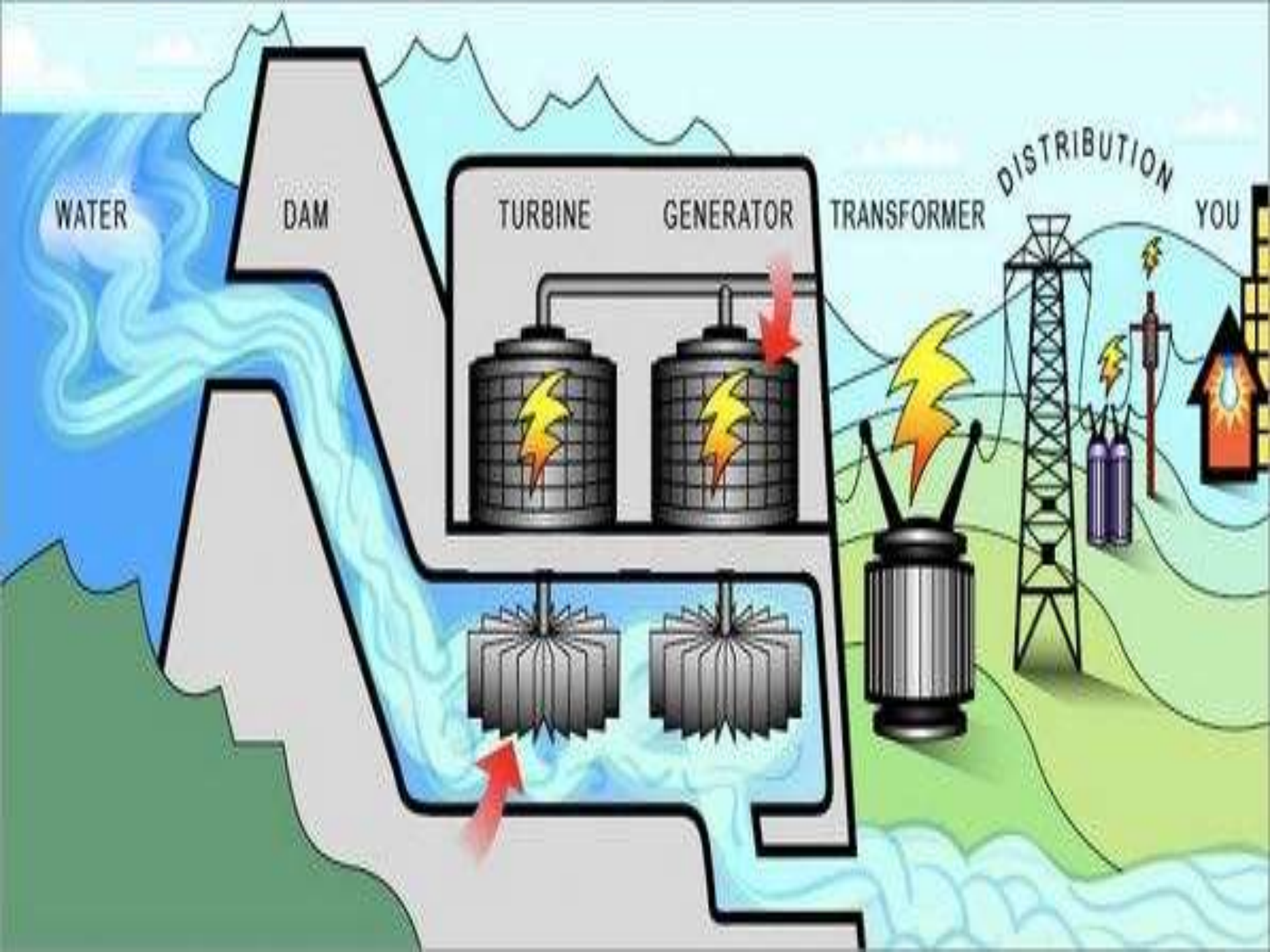
- Huge generators need huge amounts of energy.
- The energy turns the generators.
- The electric current carries the energy to where it is needed.

- Hydroelectric power system convert the kinetic energy in flowing water into electrical energy
- Falling or flowing water turns a propeller like piece called a turbine
- The turbine turns a metal shaft in an electricity

WORKING

- Flowing water is directed at a turbine
- The flowing water causes the turbine to rotate ,converting the waters KE into ME
- The ME produced by the turbine is converted into electrical energy using a turbine generator
- Inside the generator the shaft of the turbine spins a magnet inside coil of copper wire
- It is a fact of nature that moving a magnet inside coil of copper wire

- It is a fact of nature that moving a magnet near a conductor causes an electrical current


WATER
DAM
TURBINE
GENERATOR
TRANSFORMER
DISTRIBUTION
YOU

ADVANTAGE

- No fuel required
- No air pollution
- Can easily work during high peak daily load
- Prevents floods

DISADVANTAGE

- Disrupts the aquatic ecosystems
- Disruption of surrounding area
- requires large area


Wind power

- Wind is a form of **solar 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 motion energy, when "harvested" by modern **wind turbines**, can be used to generate **electricity**.

- Installed wind capacity by state as of 31 March 2018

StateTotal	Capacity (MW)
Tamil Nadu	8,197
Gujarat	5,613
Maharashtra	4,784
Karnataka	4,509
Rajasthan	4,298
Andhra Pradesh	3,963
MadhyaPradesh	2,520
Telangana	101
Kerala	53
Others	4

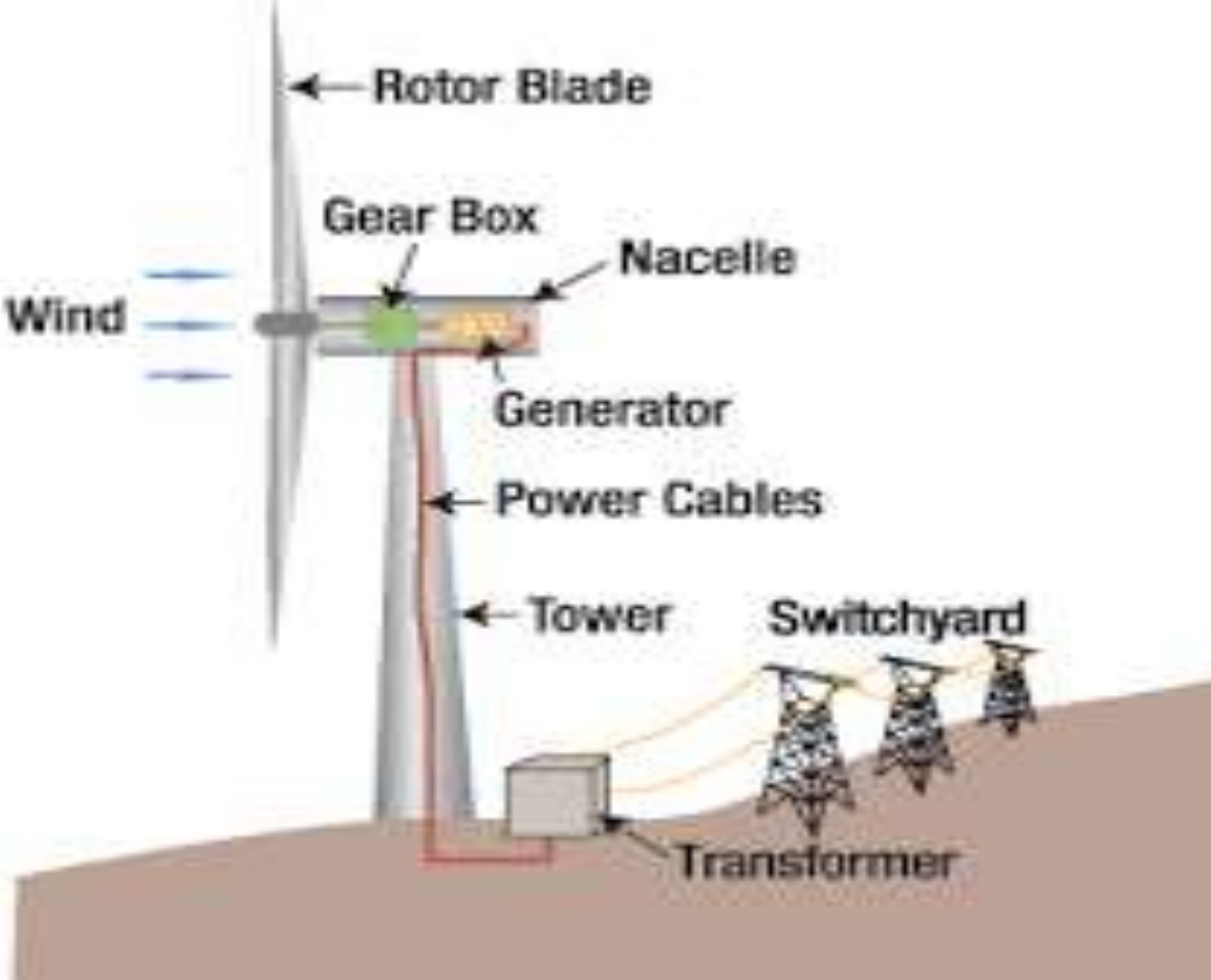
working

- Wind (moving air that contains kinetic energy) blows toward the turbine's rotor blades.
- The rotors spin around, capturing some of the kinetic energy from the wind, and turning the central drive shaft that supports them. Although the outer edges of the rotor blades move very fast, the central axle (drive shaft) they're connected to turns quite slowly.

- In most large modern turbines, the rotor blades can swivel on the hub at the front so they meet the wind at the best angle (or "pitch") for harvesting energy. This is called the pitch control mechanism. On big turbines, small electric motors or hydraulic rams swivel the blades back and forth under precise electronic control. On smaller turbines, the pitch control is often completely mechanical. However, many turbines have fixed rotors and no pitch control at all.
- Inside the nacelle (the main body of the turbine sitting on top of the tower and behind the blades), the gearbox converts the low-speed rotation of the drive shaft (perhaps, 16 revolutions per minute, rpm) into high-speed (perhaps, 1600 rpm) rotation fast enough to drive the generator efficiently.

- The generator, immediately behind the gearbox, takes kinetic energy from the spinning drive shaft and turns it into electrical energy. Running at maximum capacity, a typical 2MW turbine generator will produce 2 million watts of power at about 700 volts.
- Anemometers (automatic speed measuring devices) and wind vanes on the back of the nacelle provide measurements of the wind speed and direction.
- Using these measurements, the entire top part of the turbine (the rotors and nacelle) can be rotated by a yaw motor, mounted between the nacelle and the tower, so it faces directly into the oncoming wind and captures the maximum amount of energy. If it's too windy or turbulent, brakes are applied to stop the rotors from turning (for safety reasons). The brakes are also applied during routine maintenance

- The electric current produced by the generator flows through a cable running down through the inside of the turbine tower.
- A step-up transformer converts the electricity to about 50 times higher voltage so it can be transmitted efficiently to the power grid (or to nearby buildings or communities). If the electricity is flowing to the grid, it's converted to an even higher voltage (130,000 volts or more) by a substation nearby, which services many turbines.
- Homes enjoy clean, green energy: the turbine has produced no greenhouse gas emissions or pollution as it operates.
- Wind carries on blowing past the turbine, but with less speed and energy (for reasons explained below) and more turbulence (since the turbine has disrupted its flow).


Rotor Blade
Gear Box
Nacelle
Wind
Generator
Power Cables
Tower
Switchyard
Transformer


WIND
WINDMILLS
TURBINE
GENERATOR
TRANSFORMER
DISTRIBUTION
YOU

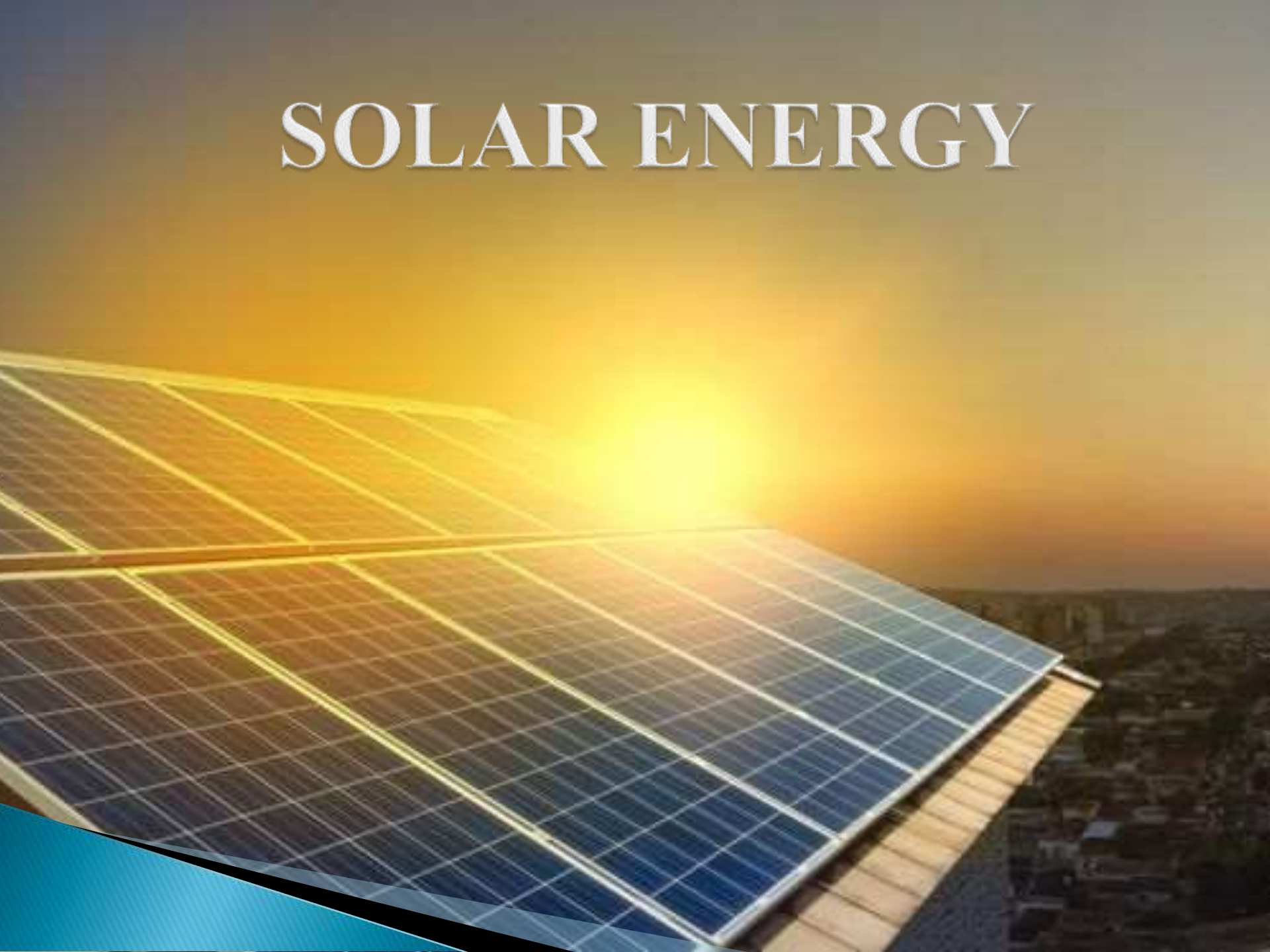
ADVANTAGE

- 1) Wind Energy is an inexhaustible source of energy and is virtually a limitless resource.
  2) Energy is generated without polluting environment.
  3) This source of energy has tremendous potential to generate energy on large scale.
  4) Like solar energy and hydropower, wind power taps a natural physical resource.
  5) Windmill generators **don't** emit any emissions that can lead to acid rain or greenhouse effect.
  6) Wind Energy can be used directly as mechanical energy.
  7) In remote areas, wind turbines can be used as great resource to generate energy.
  8) In combination with Solar Energy they can be used to provide reliable as well as steady supply of electricity.
  9) Land around wind turbines can be used for other uses, e.g. Farming.

DISADVANTAGE

- 1) Wind energy requires expensive storage during peak production time.
  2) It is unreliable energy source as winds are uncertain and unpredictable.
  3) There is visual and aesthetic impact on region.
  4) Requires large open areas for setting up wind farms.
  5) Noise pollution problem is usually associated with wind mills.
  6) Wind energy can be harnessed only in those areas where wind is strong enough and weather is windy for most parts of the year.
  7) Usually places, where wind power set-up is situated, are away from the places where demand of electricity is there. Transmission from such places increases cost of electricity.
  8) The average efficiency of wind turbine is very less as compared to fossil fuel power plants. We might require many wind turbines to produce similar impact.
  9) It can be a threat to wildlife. Birds do get killed or injured when they fly into turbines.
  10) Maintenance cost of wind turbines is high as they have mechanical parts which undergo wear and tear over the time.

SOLAR ENERGY



Russell Ohl was the fi rst person to come up with a solar cell like the ones used today

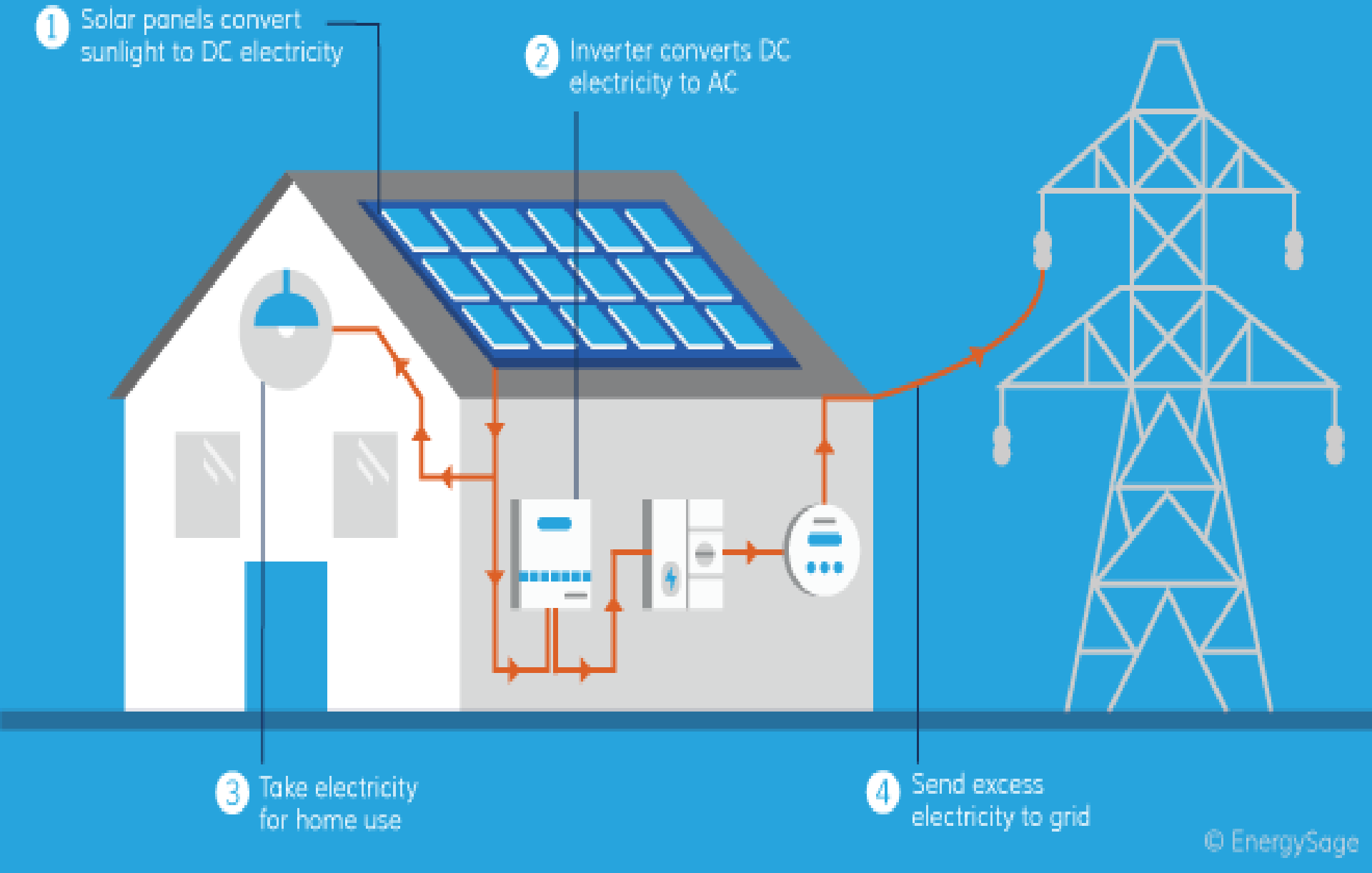
In 1941, American Engineer and Shoe maker -RUSSELL OHL invented and later patented the first

SOLAR CELL

- Energy comes in different forms. Light is a form of energy. So is heat. So is electricity. Often, one form of energy can be turned into another. This fact is very important because it explains how we get electricity, which we use in so many ways. Electricity is used to light streets and buildings, to run computers and TVs, and to run many other machines and appliances at home, at school, and at work.

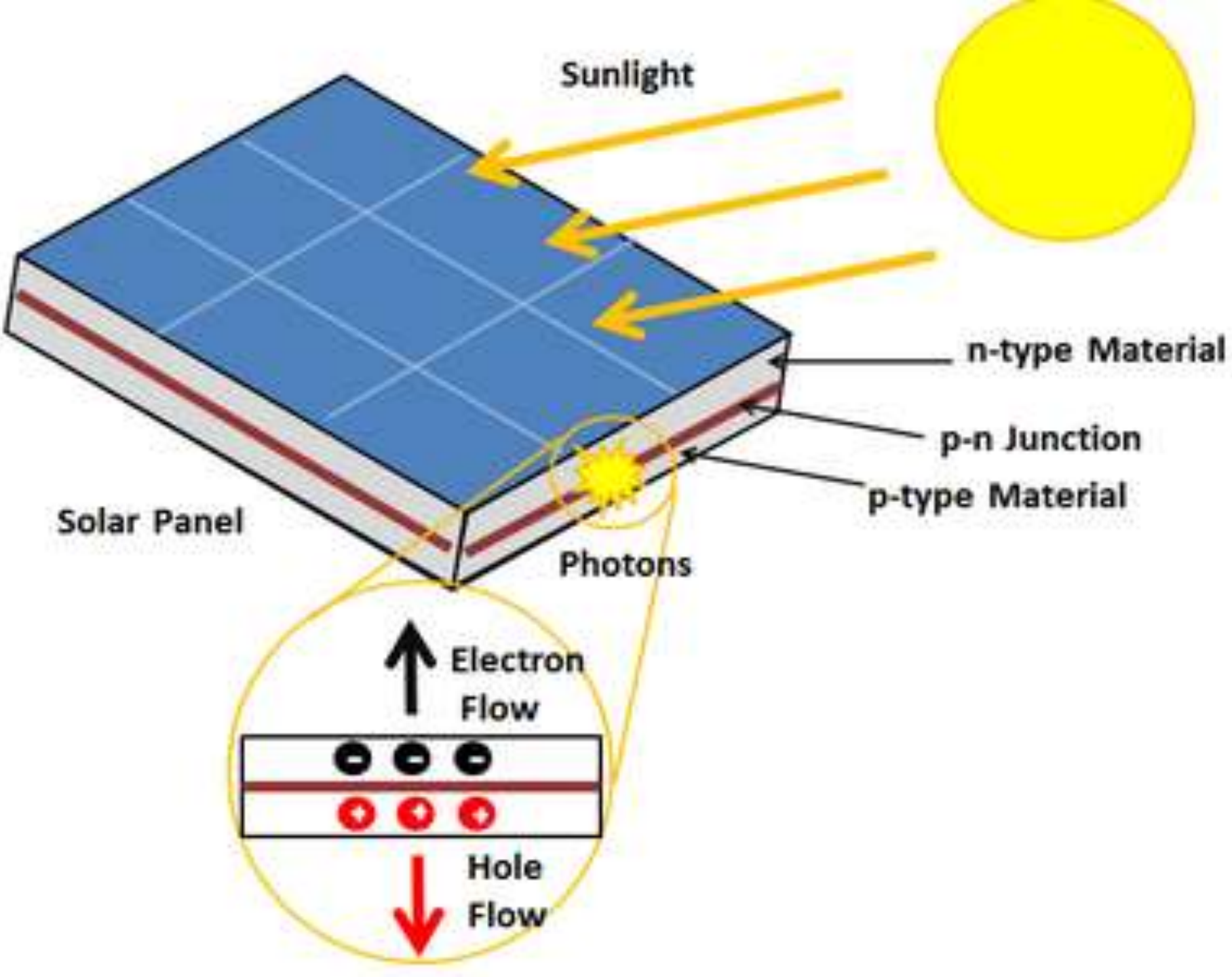
- Solar panels work by absorbing sunlight with photovoltaic cells, generating direct current (DC) energy and then converting it to usable alternating current (AC) energy with the help of inverter technology. AC energy then flows through the home’s electrical panel and is distributed accordingly

Residential solar panels connected to the grid



INSIDE A SOLAR CELL

- Solar cells come in various sizes. Some are tinier than a stamp. Some are 5 inches (12 centimeters) across.
- The cells are made of a type of material known as a semiconductor. Often, they are made of silicon. Semiconductors can conduct, or carry, electricity. They don't do this as well as metals, however. That is why they are called "semi." Because they only "semi" conduct electricity, they can be used to control electric current.
- On their top and bottom they typically have metal contacts through which current can flow.
- A typical simple cell has two layers of silicon. One is known as n-type. The other is p-type. The layers are different from each other.


Sunlight
n-type Material
p-n Junction
p-type Material
Solar Panel
Photons
Electron
Flow
Hole
Flow

How Solar Cells Make Electricity

- The process of making electricity begins when the silicon atoms absorb some light. The light's energy knocks some electrons out of the atoms. The electrons flow between the two layers. The flow makes an electric current. The current can leave the cell through the metal contacts and be used.
- When light hits a solar cell, much of its energy is wasted. Some light bounces off or passes through the cell. Some is turned into heat. Only light with the right wavelengths, or colors, is absorbed and then turned into electricity

Panels on Homes and Other Buildings

- Solar panels for buildings are no different from other panels. They must be able to receive enough sunlight to be useful.
- Often, they are put on a roof that faces the Sun and is not shaded. Sometimes they are simply built on the ground.
- Solar panels come in various colors and designs. They may be put on a wall or roof and blend right in, so you don’t even notice them. Roof shingles and tiles can be made using thin-film panels.

- Usually solar panels and a few wires cannot by themselves supply electricity to a building. More equipment is needed. Solar cells make DC electricity. This is fine for some electronic devices. But home appliances and lights usually run on AC. Houses are generally wired for AC. To change the DC to AC, a device called an inverter is needed.
- Also, if the building is not connected to the public power grid, there has to be some way of storing electricity for use when it is too dark for the solar panels to work. Usually, batteries are used to store the electricity. Batteries can be helpful even in buildings that are connected to the grid. They can serve as a backup if the grid suffers a power loss.

ADVANTAGE

- Solar energy is energy supplied by nature – it is thus free and abundant!
- Solar energy can be made available almost anywhere there is sunlight
- Electricity produced by solar cells is clean and silent. Because they do not use fuel other than sunshine, PV systems do not release any harmful air or water pollution into the environment, deplete natural resources, or endanger animal or human health.

DISADVANTAGE

- High initial costs for material and installation and long ROI
- Needs lots of space as efficiency is not 100% yet
- No solar power at night so there is a need for a large battery bank
- Devices that run on DC power directly are more expensive
- Depending on geographical location the size of the solar panels vary for the same power generation
- Cloudy days do not produce much energy
- Lower production in the winter months

TIDAL POWER PLANT

- **Tidal power** or **tidal energy** is the form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity.

DIESEL ENGINE POWER PLANT SYSTEMS

- The first commercial tidal power station in the World was constructed in France in 1965 across the mouth of La Rance Estuary.
- It has a high capacity of 240 MW. The average tidal range at La Rance is 8.4 m and the dam built across the estuary encloses an area of 22 km^2.

- The diesel engine power plant consists of the following auxiliary systems:
- **1)Fuel Supply System**
- It consists of fuel tank for the storage of fuel, fuel filters and pumps to transfer and inject the fuel. The fuel oil may be supplied at the plant site by trucks, rail, road, tank, cars, etc.

2)Air Intake and Exhaust System

- It consists of pipe for the supply of air and exhaust of the gases.
- Filters are provided to remove dust etc. from the incoming air.
- In the exhaust system silencer is provided to reduce the noise.
- Filters may be of dry type (made up of cloth, felt, glass, wool etc.) or oil bath type.
- In oil bath type of filters the air is swept over or through a bath of oil in order that the particles of dust get coated.
- The duties of the air intake systems are as follows:

- i) To clean the air intake supply.
- ii) To silence the intake air.
- iii)To supply air for super charging.
- The intake system must cause a minimum pressure loss to avoid reducing engine capacity and raising the specific fuel consumption. Filters must be cleaned periodically to prevent pressure losses from clogging. Silencers must be used on some systems to reduce high velocity air noises.

- **3. Cooling Systems**
- This system provides a proper amount of water circulation all around the engines to keep the temperature at reasonable level.
- Pumps are used to discharge the water inside and the hot water leaving the jacket is cooled in cooling ponds or other devices and is recalculated again

- **4. Lubrication System**
- Lubrication is essential to reduce friction and wear of the rubbing parts.
- It includes lubricating oil tank, pumps, filters and lubricating oil cooler.

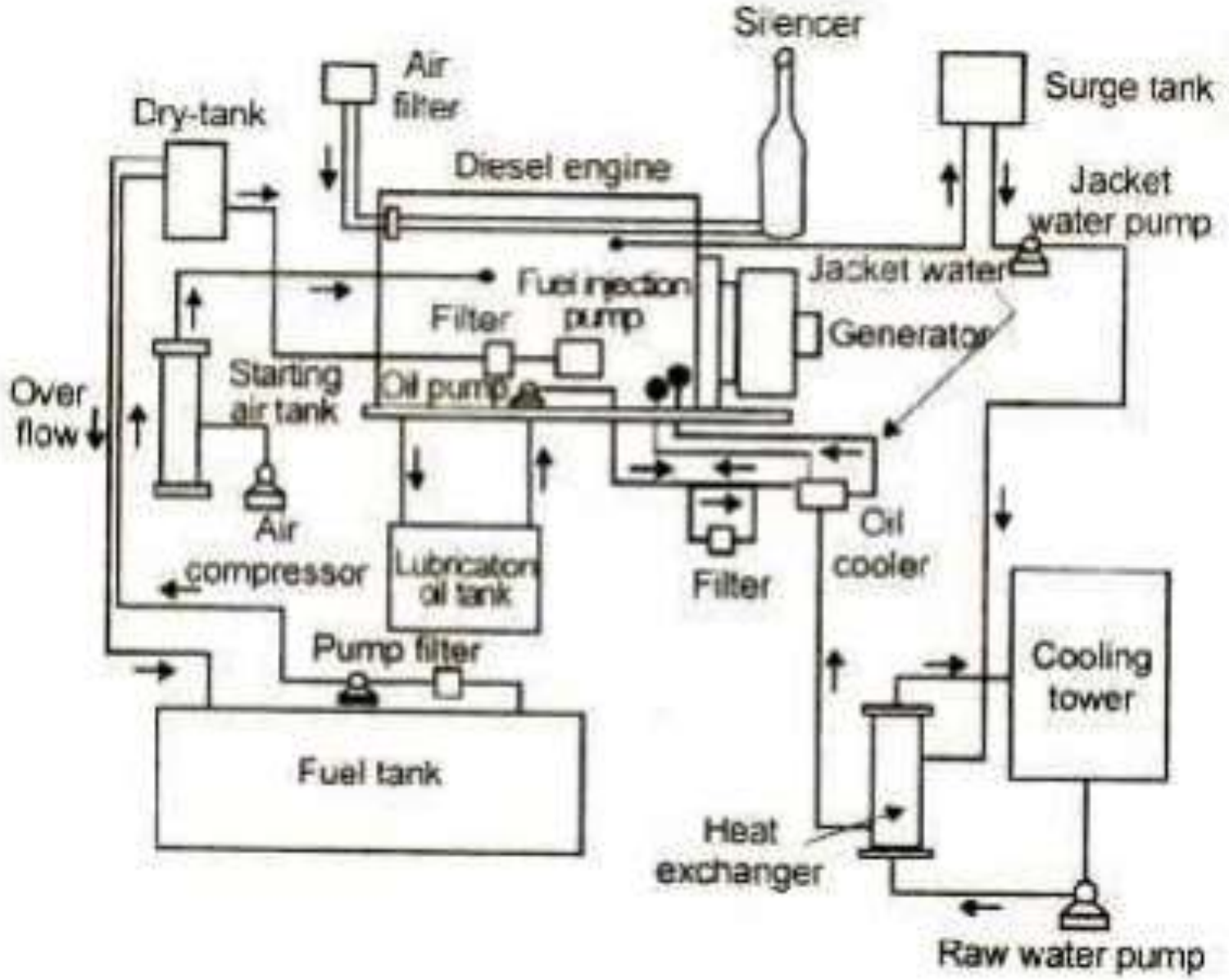


Figure : Schematic representation of a diesel engine power plant.

- **5. Starting System**
- For the initial starting of engine the various devices used are compressed air, battery, electric motor or self-starter.
- The auxiliary equipment of diesel engine power plant.

Advantages:

- Tidal power is completely independent of the precipitation (rain) and its uncertainty besides being inexhaustible.
- Large area of valuable land is not required.
- When a tidal power plant works in combination with thermal or hydro-electric system peak power demand can be effectively met with.
- Tidal power generation is free from pollution.

Limitations:

- Due to variation in tidal range the output is not uniform.
- Since the turbines have to work on a wide range of head variation (due to variable tidal range) the plant efficiency is affected.
- There is a fear of machinery being corroded due to corrosive sea water.
- It is difficult to carry out construction in sea.
- As compared to other sources of energy, the tidal power plant is costly.
- Sedimentation and siltation of basins are the problems associated with tidal power plants.
- The power transmission cost is high because the tidal power plants are located away from load centers.

NON-RENEWABLE SOURCES.

- Non-renewable energy is a **source of energy that will eventually run out**. Most sources of non-renewable energy are fossil fuels, such as coal, gas and oil.

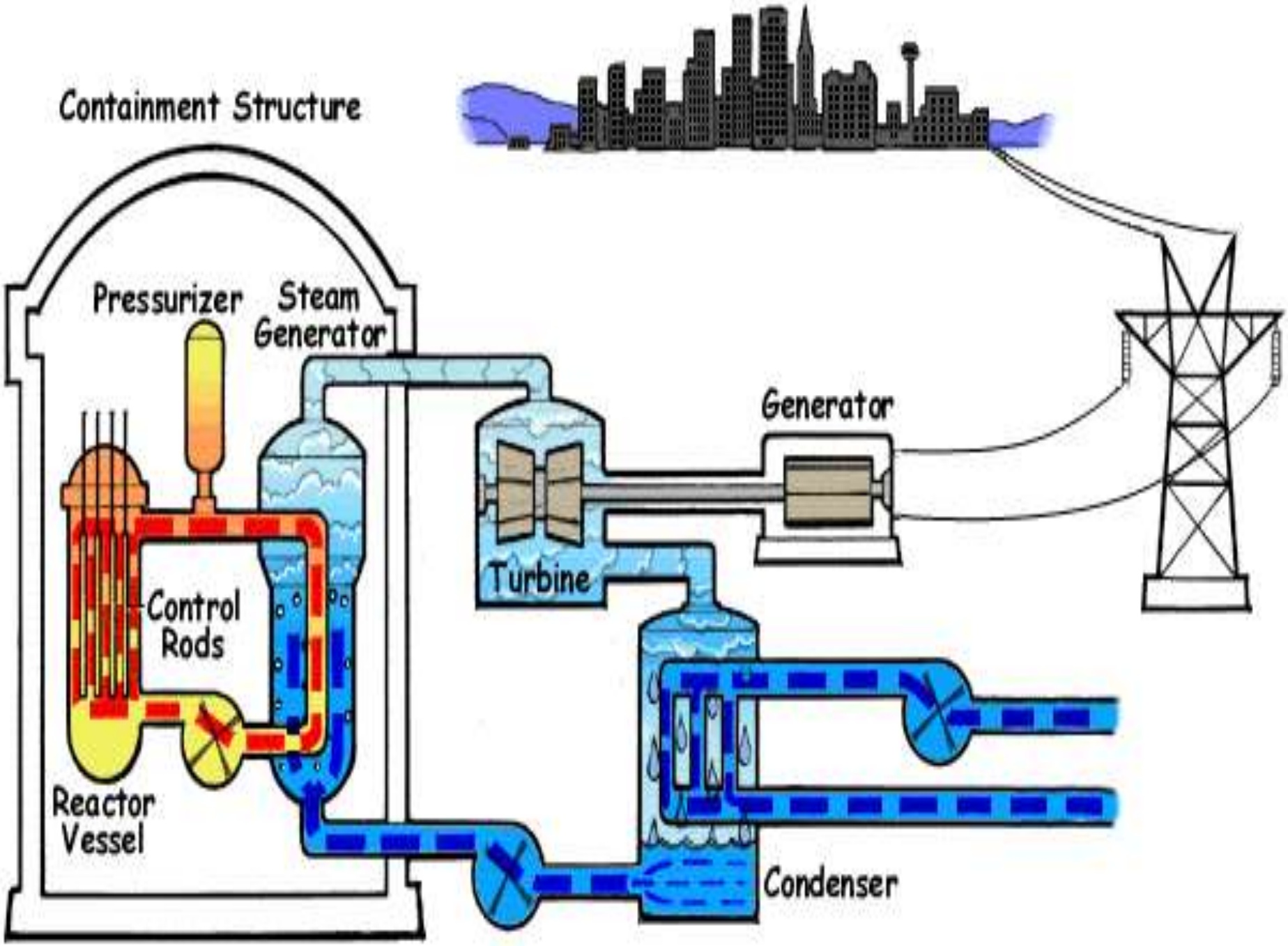
- Nuclear power plants are very complex.
- There are many different buildings at the site and many different systems. Some of the systems work directly to make electricity. Some of the systems work to keep the plant working correctly and safely.
- All nuclear power plants have a "containment structure" 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.

- All nuclear power plants make electricity from the steam created by the heat of splitting atoms. But there are two different ways that steam is used.

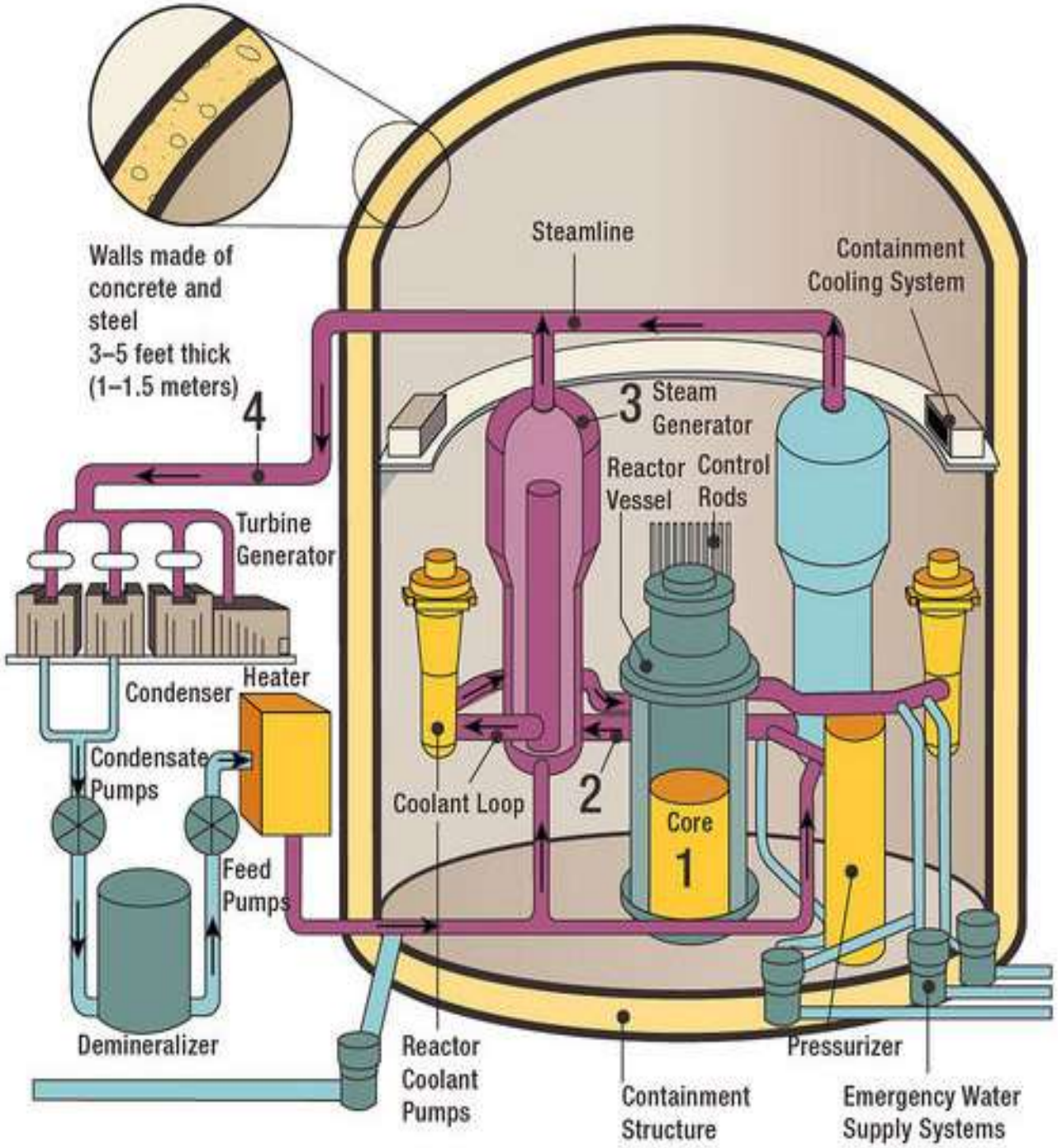
1. Pressurized Water Reactors are known as "PWRs
2. Boiling Water Reactor (BWR)

Pressurized Water Reactors are known as "PWRs

- Pressurized Water Reactors are known as "PWRs." They keep water under pressure so that it heats but does not boil. Water from the reactor and the water that is turned into steam are in separate pipes and never mix.

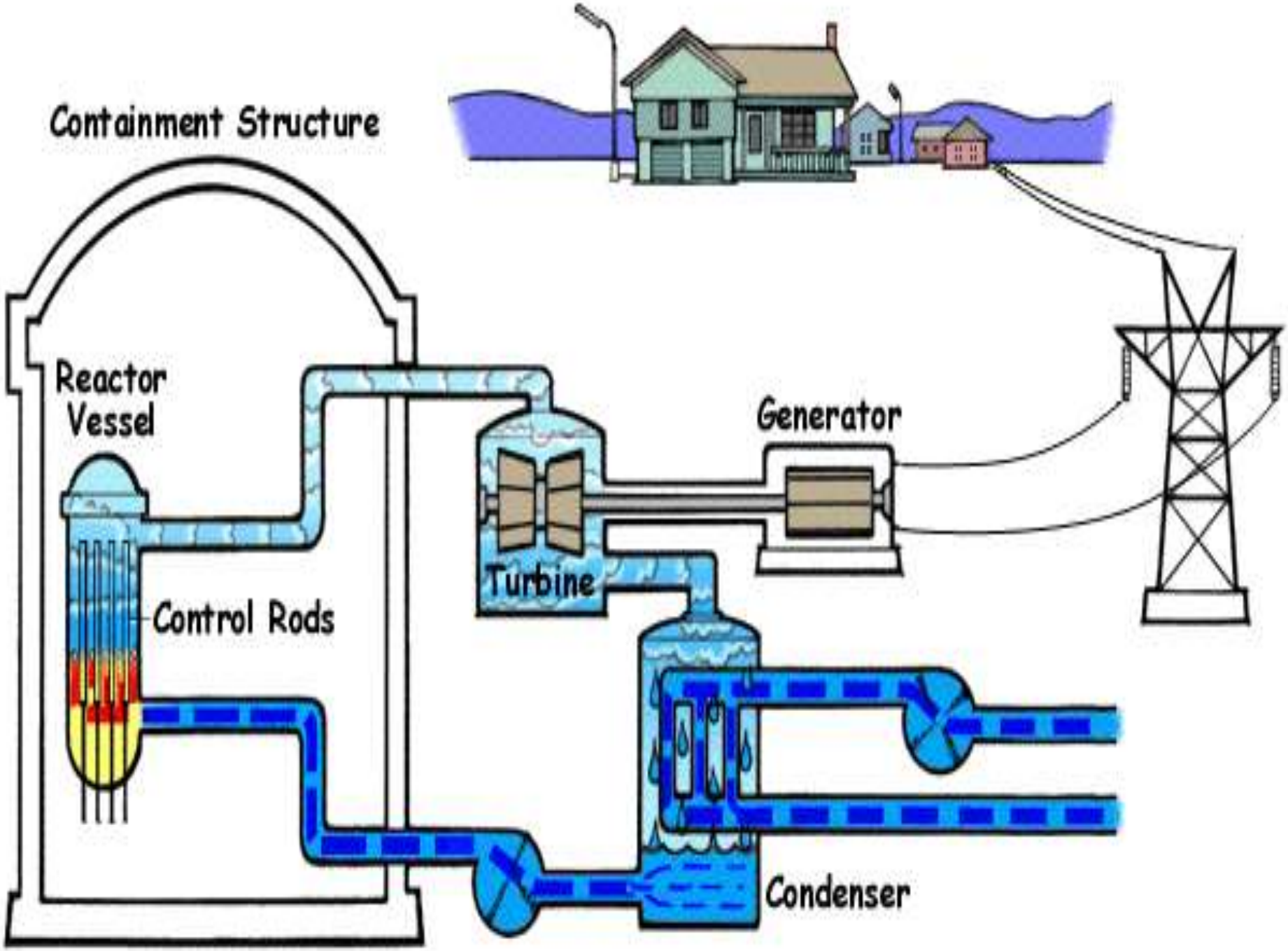

Containment Structure
Pressurizer
Steam Generator
Generator
Turbine
Control Rods
Reactor Vessel
Condenser

- In a typical design concept of a commercial PWR, the following process occurs:
- The core inside the reactor vessel creates heat.
- Pressurized water in the primary coolant loop carries the heat to the steam generator.
- Inside the steam generator, heat from the primary coolant loop vaporizes the water in a secondary loop, producing steam.
- The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.
- The unused steam is exhausted to the condenser, where it is condensed into water.
- The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the steam generator. The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps.
- These pumps and other operating systems in the plant receive their power from the electrical grid.
- If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power.
- PWRs contain between 150-200 fuel assemblies.

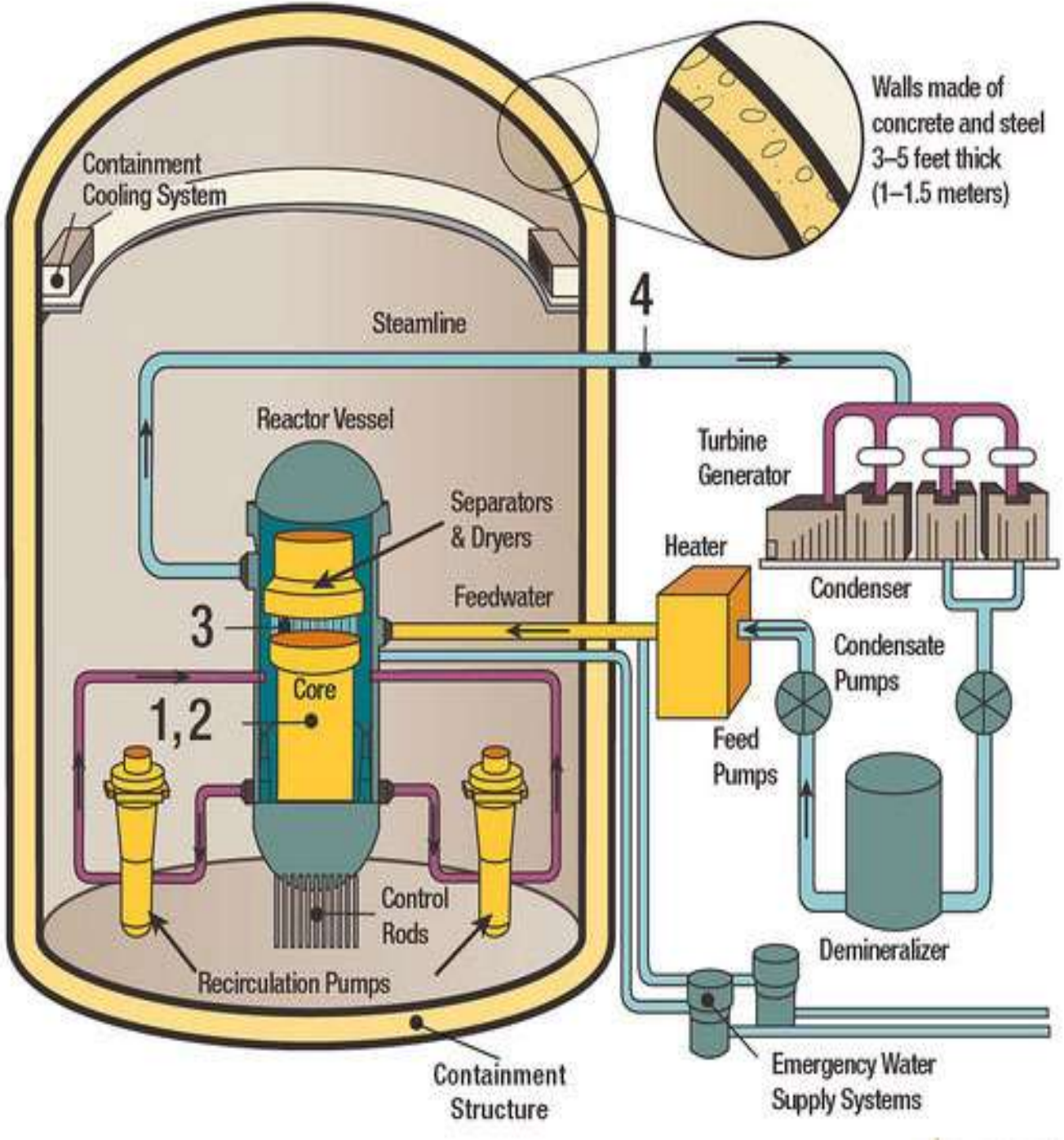

Walls made of concrete and steel 3–5 feet thick (1–1.5 meters)
Steamline
Containment Cooling System
3 Steam Generator
4
Reactor Vessel
Control Rods
Turbine Generator
Condenser
Heater
Condensate Pumps
Coolant Loop
2
Core
1
Feed Pumps
Demineralizer
Reactor Coolant Pumps
Containment Structure
Pressurizer
Emergency Water Supply Systems

Boiling Water Reactor (BWR)

- Boiling Water Reactors are known as "BWRs." In BWRs, the water heated by fission actually boils and turns into steam to turn the generator. In both types of plants, the steam is turned back into water and can be used again in the process.


Containment Structure
Reactor Vessel
Control Rods
Turbine
Generator
Condenser

- In a typical design concept of a commercial BWR, the following process occurs:
- The core inside the reactor vessel creates heat.
- A steam-water mixture is produced when very pure water (reactor coolant) moves upward through the core, absorbing heat.
- The steam-water mixture leaves the top of the core and enters the two stages of moisture separation where water droplets are removed before the steam is allowed to enter the steamline.
- The steamline directs the steam to the main turbine, causing it to turn the turbine generator, which produces electricity.
- The unused steam is exhausted to the condenser, where it is condensed into water. The resulting water is pumped out of the condenser with a series of pumps, reheated, and pumped back to the reactor vessel.
- The reactor's core contains fuel assemblies that are cooled by water circulated using electrically powered pumps.
- These pumps and other operating systems in the plant receive their power from the electrical grid.
- If offsite power is lost, emergency cooling water is supplied by other pumps, which can be powered by onsite diesel generators. Other safety systems, such as the containment cooling system, also need electric power.
- BWRs contain between 370-800 fuel assemblies.


Walls made of concrete and steel 3–5 feet thick (1–1.5 meters)
Containment Cooling System
Steamline
4
Reactor Vessel
Turbine Generator
Separators & Dryers
Heater
Feedwater
Condenser
3
Condensate Pumps
Core
1,2
Feed Pumps
Control Rods
Demineralizer
Recirculation Pumps
Containment Structure
Emergency Water Supply Systems

ADVANTAGE	DISADVANTAGE
Produces no polluting gases.	Waste is radioactive and safe disposal is very difficult and expensive.
Does not contribute to global warming	Local thermal pollution from wastewater affects marine life.
Very low fuel costs	Large-scale accidents can be catastrophic.
High technology research required benefits other industries.	Public perception of nuclear power is negative.
Low fuel quantity reduces mining and transportation effects on environment	Costs of building and safely decommissioning are very high.
Power station has very long lifetime.	Cannot react quickly to changes in electricity demand.