

Electrical Power Systems



By

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Lecture (1) - Part(1)





Course Code: EPE 215

Study Hours: 2 Lect. + 2 Tut + 2 Lab

Assessment:

Final Exam: 90 marks (50%) .

Year Work & Quizzes & Midterm: 60 marks (33.33%).

Oral & Practical: 30 marks (16.67%)

Textbook:

1- M. S. Naidu, High Voltage Engineering, 2009.

2- B. L. Theraja, A textbook of electrical and technology in S. I. System of units, Vol. III

3- Hadi Saadat, Power System Analysis



Syllabus

1

- Introduction.

2

- AC and DC Transmission Systems.

3

- AC and DC Distribution Systems.

4

- Substations and circuit breakers.

5

- Interconnections of power systems.

6

- Electrical and Mechanical Design of Transmission Lines.

7

- Insulators and Voltage Distribution.

8

- Underground Cable Systems.

9

- Overvoltage in Electrical Power Systems.

10

- Protection of individuals, equipment and power system installations.

11

- Protective devices and insulation co-ordination.

Engineering Definition

What is Engineering?

Engineering is the application of math and science by which properties of matter and the sources of energy in nature are made useful.

Engineering Design Definition

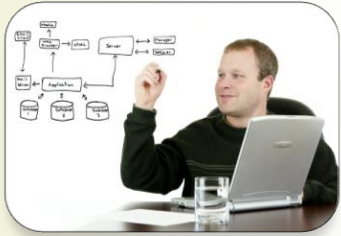
What is Design?

So, Engineering design is.....

Applications & Examples

Why Engineering Design?

Betterment of society through



Design



Manufacturing



Research & Development



Management



Continual Improvement



Logistics

Engineer Definition

Who is Engineer?

Creative

```
graph TD; A[Creative] --> B[Iterative]; B --> C[Integrated]; C --> D["Innovation is the key  
Oven Story!!!!!!!!!!"]
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Iterative

Integrated

**Innovation is the key
Oven Story!!!!!!!!!!**

So, Engineer is.....

Engineering Process Cycle

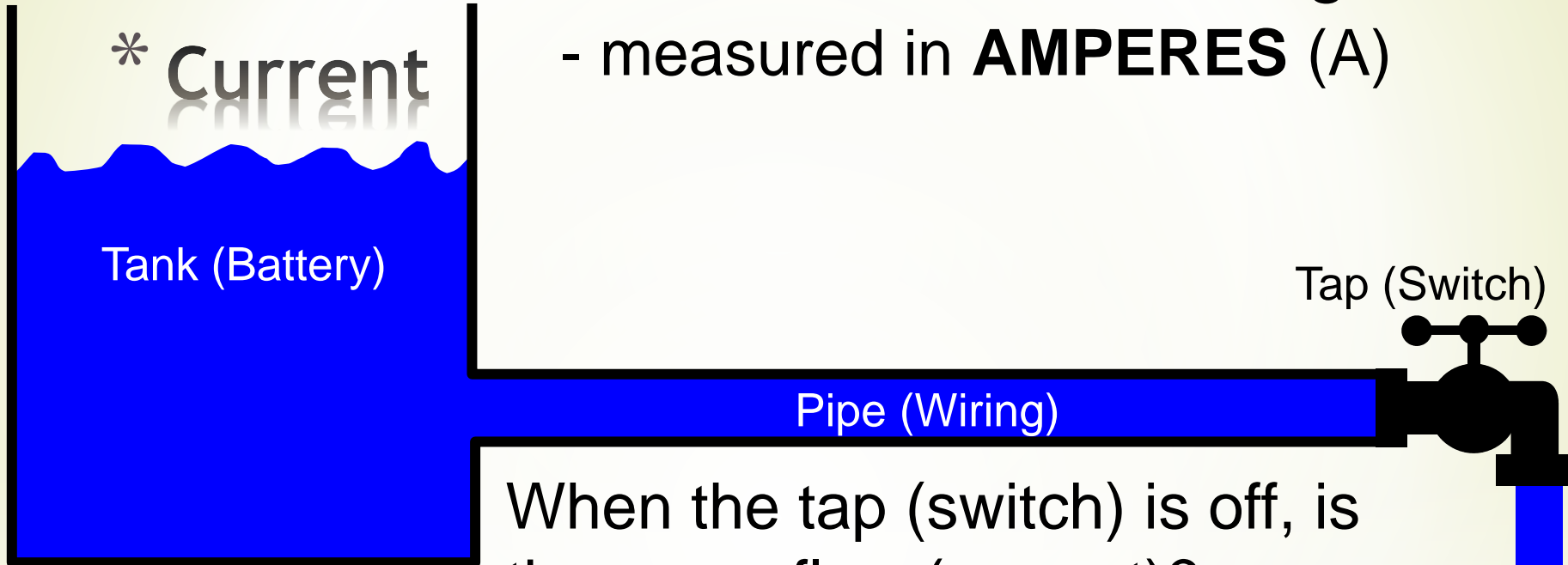
The engineering process cycle is achieved by following 10 stages.

- 1-Identify the problem/product innovation
- 2-Define the working criteria/goals
- 3-Research and gather data
- 4-Brainstorm / generate creative ideas
- 5-Analyze potential solutions
- 6-Develop and test models.
- 7-Make the decision.
- 8-Communication and specify.
- 9-Implement and commercialize.
- 10-Perform post-implementation review and assessment.

What is the electric energy?

*It is one of the most important energy forms; Energy cannot be created or destroyed; In all devices and machines, including electric circuits, energy is transferred from one type to another.

The *flow* of electric charge
- measured in **AMPERES (A)**



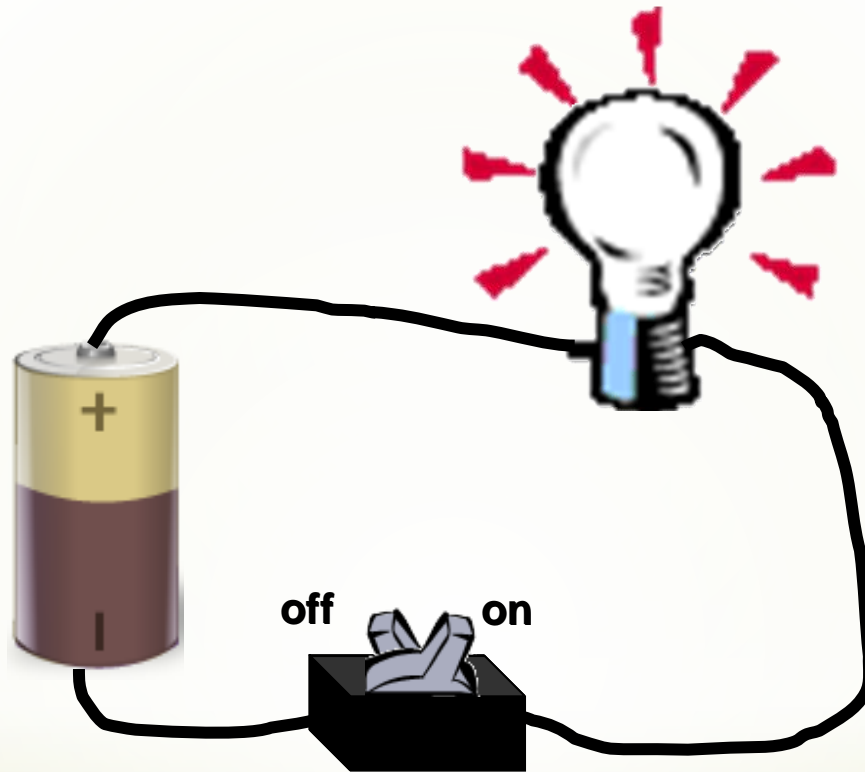
When the tap (switch) is off, is there any flow (current)?

NO

When the tap (switch) is on, is there any flow (current)?

YES

Current in a Circuit



When the switch is off, there is no current.

When the switch is on, there is current.



How do we produce electric energy?

Magnetic field + movable conductor = electricity

*Edison and Swan



Nearly 40 years went by before a really practical DC (Direct Current) generator was built by Thomas Edison. In 1878 Joseph Swan, a British scientist, invented the incandescent filament lamp and within twelve months Edison made a similar discovery in America.

*Edison and Swan...continued

Swan and Edison later set up a joint company to produce the first practical filament lamp. Prior to this, electric lighting had been crude arc lamps.

Edison used his DC generator to provide electricity to light his laboratory and later to illuminate the first New York street to be lit by electric lamps, in September 1882. Edison's successes were not without controversy, however - although he was convinced of the merits of DC for generating electricity, other scientists in Europe and America recognized that DC brought major disadvantages.

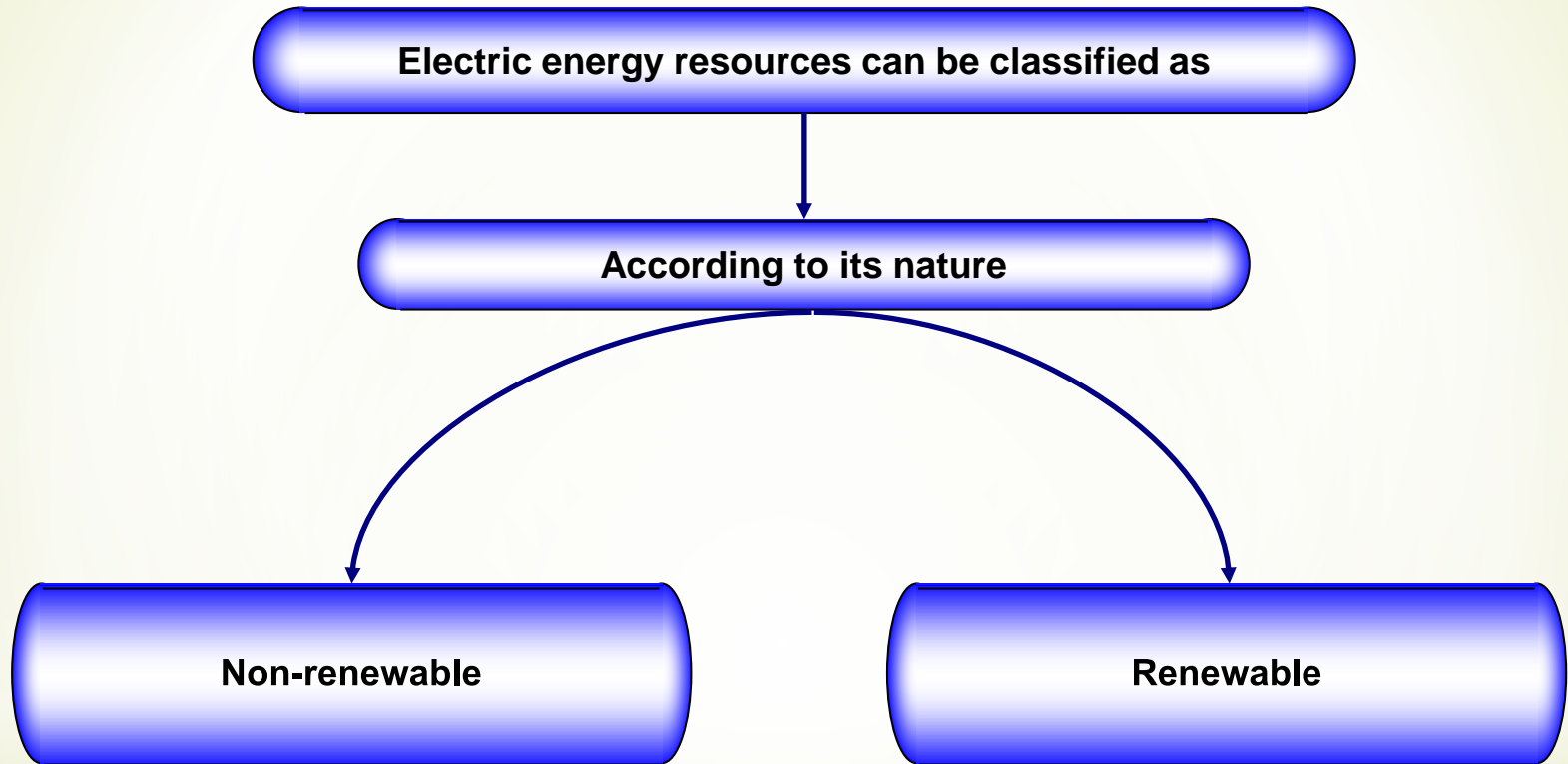
Electric energy changes the life style

** We can say that the electric energy is the source of life*

** Imagine life without electricity!!!!!!!!!!!!*



Classification of electrical energy resources



Most of our electricity comes from the burning of the fossil fuels coal and gas.



Example: Energy Dilemma

The fact
X 2
Energy demand

VS.

The need
÷ 2
Co2 emissions

Result

Frequent power outages

Rising energy prices

Climate change

Conflicts for resource access & control

Proposed Solution

The fact
New and
Renewable
Energy
Production

with

The need
Energy
Control

Result

Result

Productive
& Green

Reliable

Efficient

Safe

Classifications of main drivers behind the focus on renewable energy

Environmental drivers

- ❖ *Limiting green house gas (GHG) emissions*
- ❖ *Avoidance of the construction of new transmission circuits and large generating plants*

Commercial drivers

- ❖ *General uncertainty in electricity markets favours small generation schemes*
- ❖ *DG is a cost effective route to improved power quality and reliability*

National/regulatory drivers

- ❖ *Diversification of energy sources to enhance energy security*
- ❖ *Support for competition policy*

What about the concept of smart grid?

THE SMART GRID



Source: European Technology Platform SmartGrids

Smart Grid Definition

- * A smart grid is a modern electric system.
- * It uses communications, sensors, automation and computers to improve the flexibility, security, reliability, efficiency, and safety of the electricity system.
- * It offers consumers increased choice by facilitating opportunities to control their electricity use and respond to electricity price changes by adjusting their consumption.

What can Edison say about the electricity today?



Electricity
Changes
Life style

Activity (1)

Overview

Electric energy is the most popular form of energy, because it can be transported easily at high efficiency and reasonable cost.

What is a Power System?

Power system includes all parts of an electric system power sources and customers.

What is the function of the system?

The Function of the system is to **generate** power, **transmit** this power and to **distribute** it to customers at voltage levels and reliability that are appropriate to various users.

System Components

What are the main component of a power system?

Generation plants

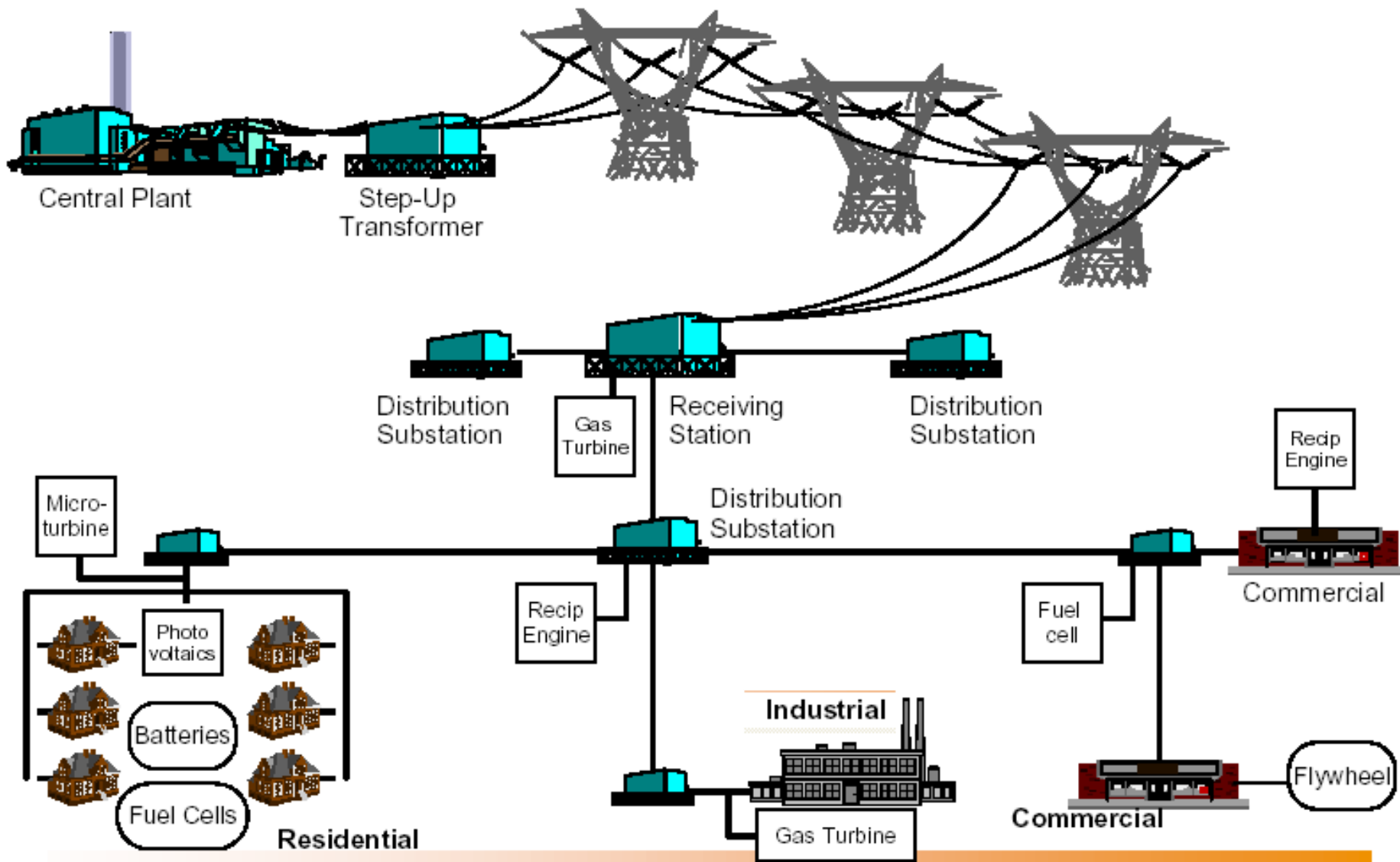
HV Substations

Transmission Lines

Bulk power Substations

Distribution system

Electric Power System Layout



Power System Basics

All power systems have three major components: Generation, Load and Transmission.

Generation: Creates electric power.

Load: Consumes electric power.

Transmission: Transmits electric power from generation to load.

*Power System Components

- **Firstly**: Physical components includes :
 1. (Generation, Transmission, Distributions, Transformer and Load), Also,
 2. (Protection, Controller, Measurements and Communications).
- **Secondly** : Moral Components Includes (Computers).
- **Thirdly**: Human Components Includes (Human Elements).

Types of Generating Stations

The electric energy can be extract from two types of sources: Conventional energy sources and renewable energy sources.

1. Conventional energy sources

➤ Thermal Power Stations

A. Steam Power Stations (water steam by burning Coal, Oil, NG)

B. Nuclear Power Stations (water steam by Uranium or Plutonium fission)

➤ Diesel Power Stations

2. Renewable Energy sources

A. Wind

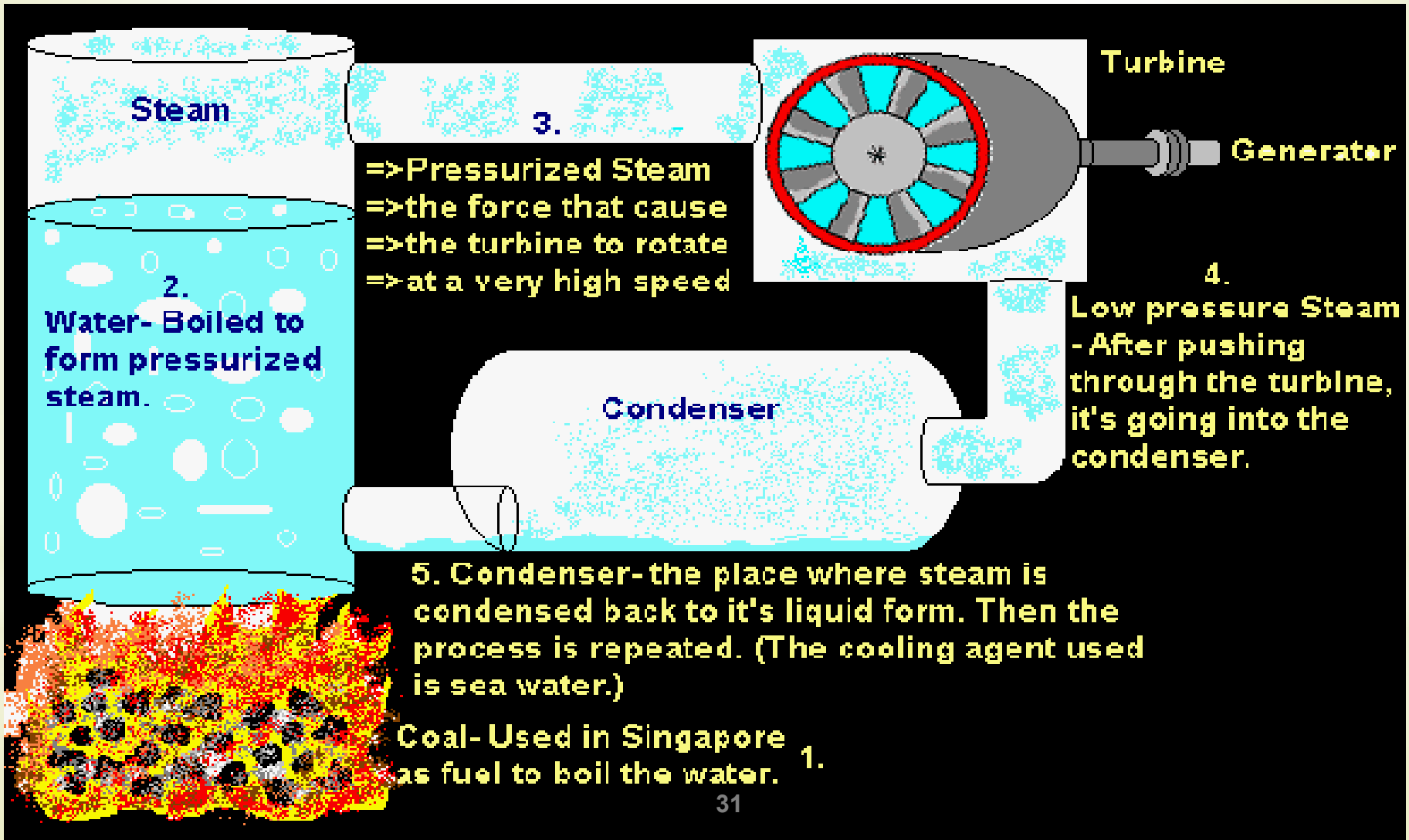
B. Solar

C. Hydroelectric Power Stations (falling water)

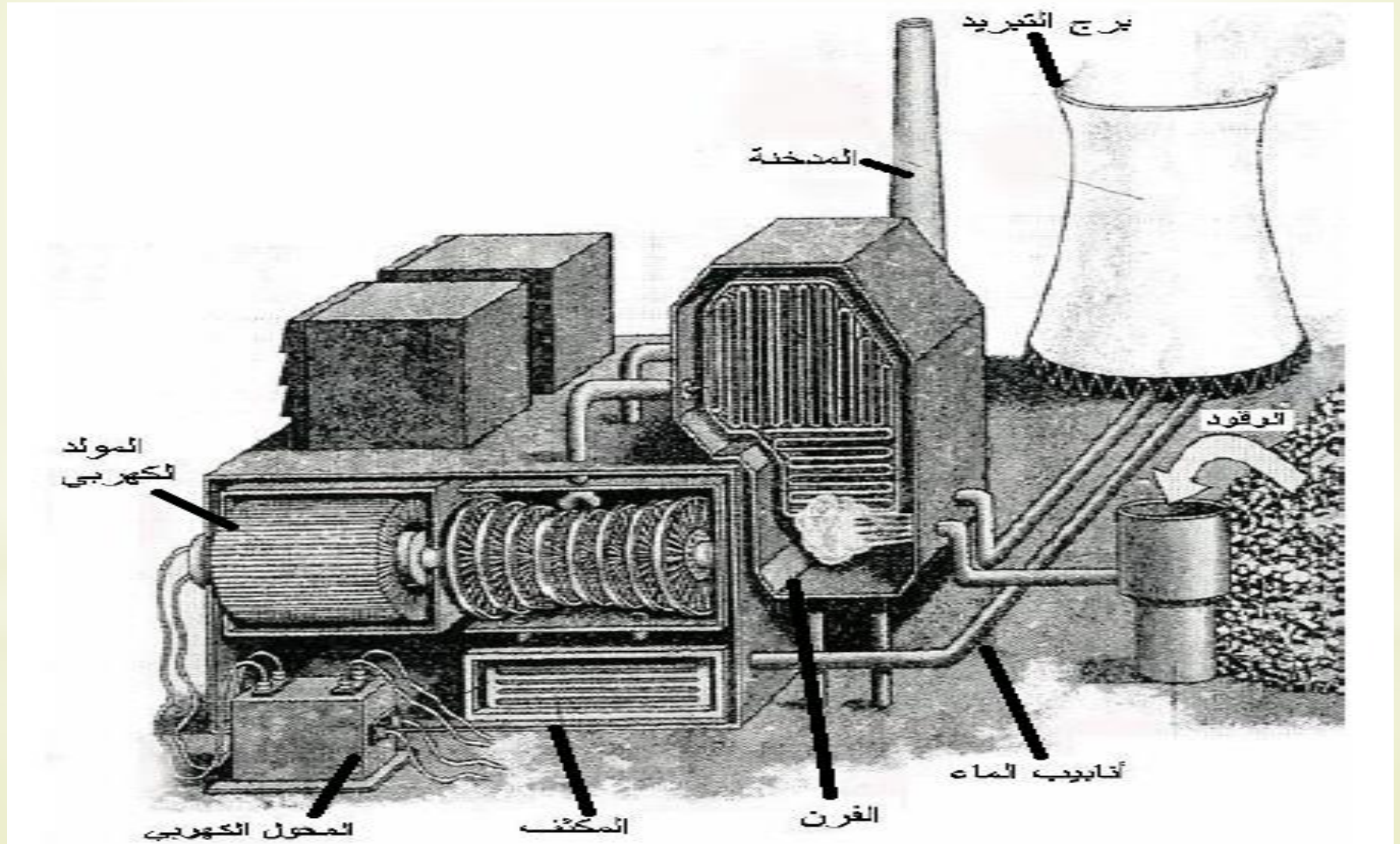
D. Geothermal

E. Biomass

Steam Power Station



Steam Power Station



Steam Power Station



Steam Power Station

1. Advantages of Steam Power Station

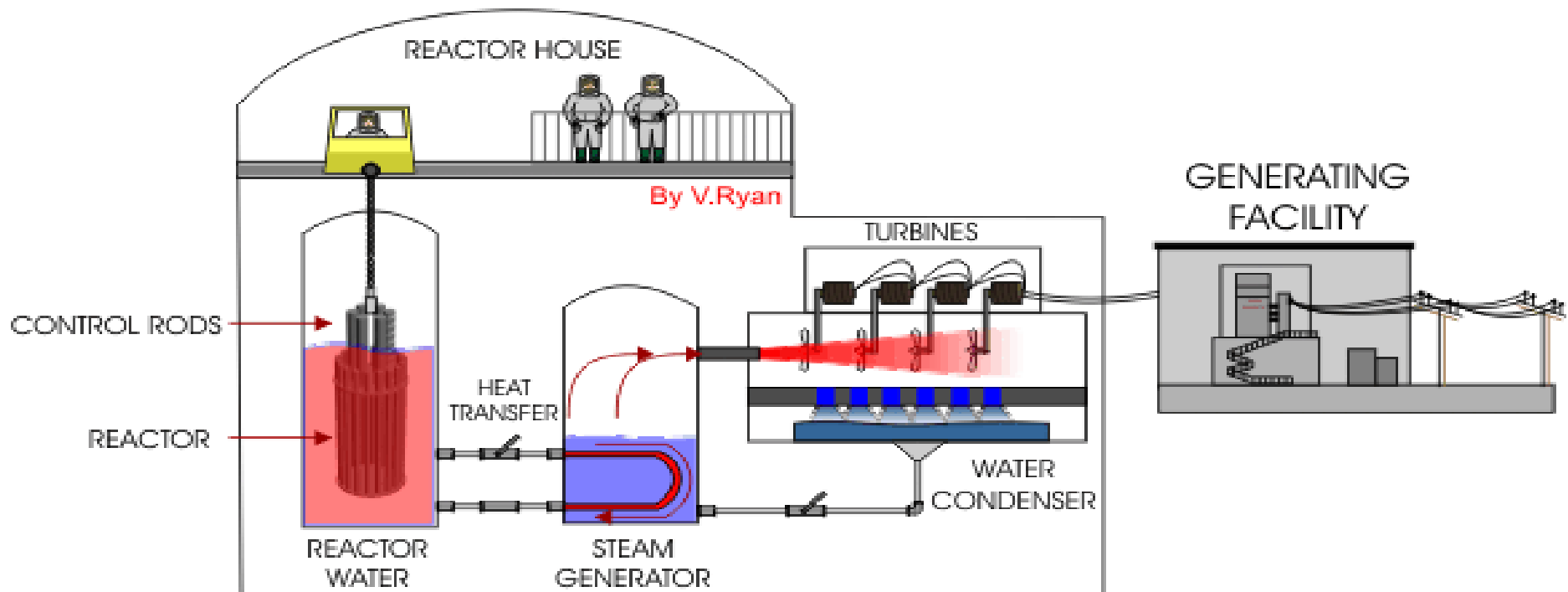
- Steam stations give high electrical power using less fuel than required in gas stations to get the same energy.
- Fuel used in steam stations cheaper than used in the gas and nuclear plants.
- Initial costs less.
- Maintenance costs and Generation are not as high.
- Space required for the plant steam less than those required for water station.

2. Disadvantages of Steam Power Station

- Environmental pollution caused them.
- High operating costs periodic.
- Low efficiency.
- Require large amounts of cooling water.

Nuclear Power Station

Pass water on the heart of a nuclear reactor to cool it, and inside the nuclear reactor uses uranium nuclear fuel uranium and made a series of Nuclear fission give rise to intense heat is evaporating cooling water, which exploits the steam turbine administration.



Nuclear Power Station



Nuclear Power Station

1. Advantages of Nuclear Power Station

- Less wastes
- It is clean
- No carbon dioxide to make greenhouse effect
- The cost run is lower

2. Disadvantages of Nuclear Power Station

- The nuclear power plants easily lead to accidents
- Radioactive wastes are produced that harm our health
- Nuclear power plant needs to use more money to build.

Diesel Power Plants



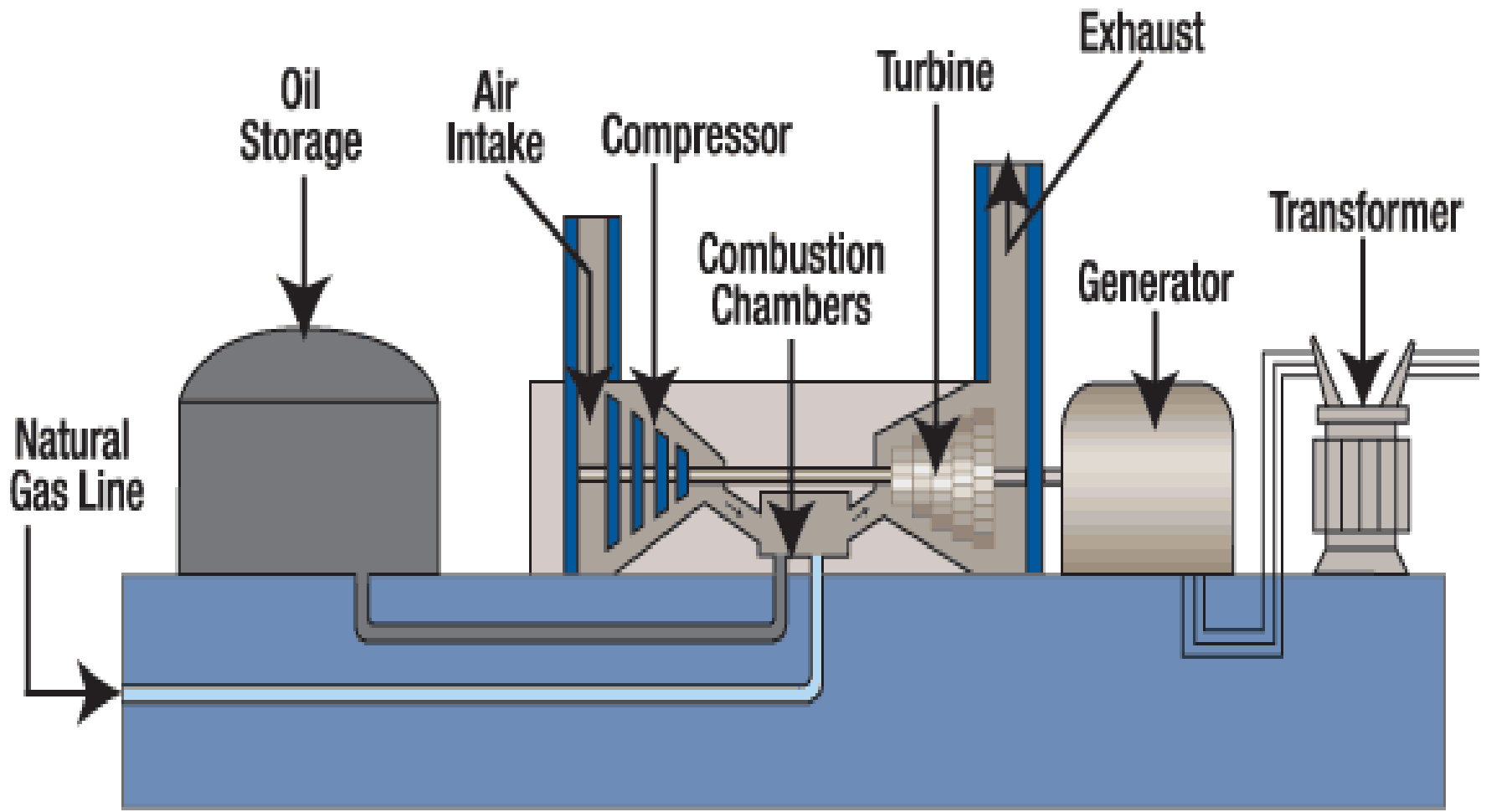
- **Theory of Operation**

Diesel Power Plants

- **Advantages of Diesel Power Plants**
- **Disadvantages of Diesel Power Plants**



Gas Power Station



Gas Power Station

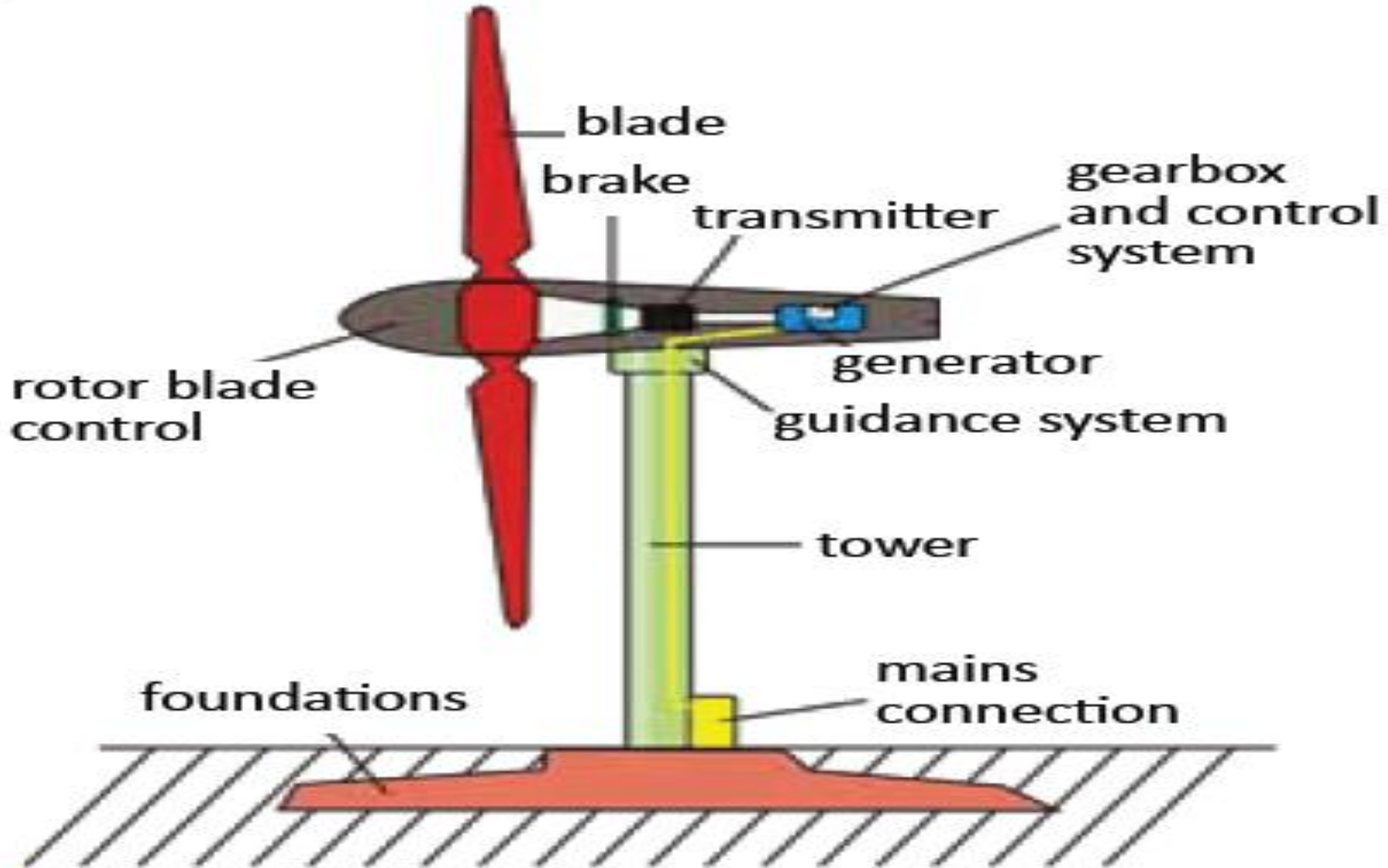
1. Advantages of Gas Power Station

- Construction of the gas station costs less than other stations.
- Can be operated on or off in less time than required for other stations .
- Need for qualified workers with average and a few in the operating.
- Can run at peak times or operating continuously.
- You do not need large amounts of water, so they are used in desert areas

2. Disadvantages of Gas Power Station

- High operating costs because they need large amounts of fuel.
- Give energy is not high.
- Low efficiency.
- Wasting a large amount of thermal energy with the exhaust gases.

Wind Power Station



Wind Power Station



Wind Power Station

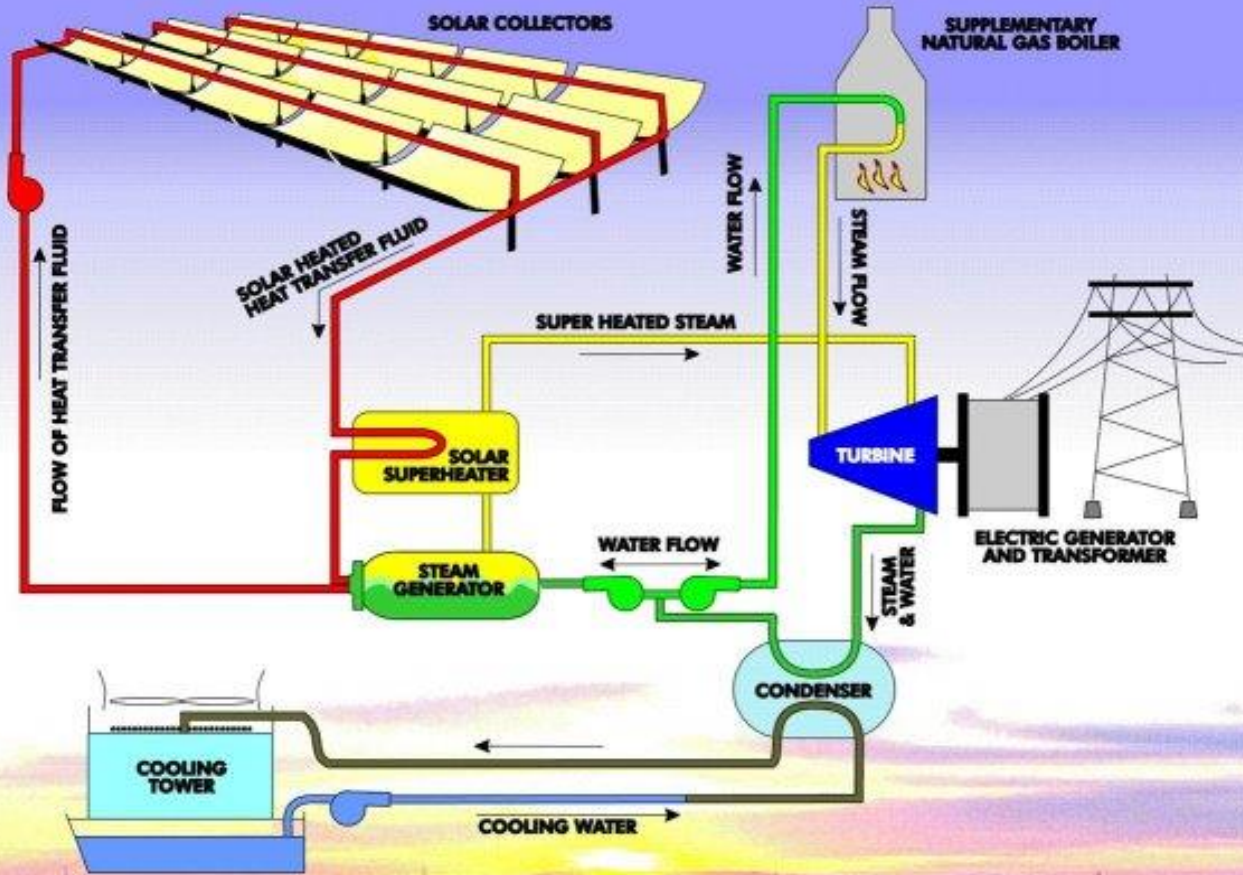
1. Advantages of Wind Power Station

- It is a renewable form of energy, which means it will never run out.
- Wind energy is clean. It causes no pollution.
- The land on which turbines are built can still be used for farming.
- It costs no more than coal energy and is cheaper than nuclear energy.
- Overall wind energy projects are simple, clean and cheap to maintain. Jobs are often created both in the short and long term in the building and maintenance of the turbines.

2. Disadvantages of Wind Power Station

- Some people are concerned about noise, although wind turbines are quieter than many people think.
- Wind turbines do not work in very weak or very strong winds.
- Some people think that wind farms spoil the look of the landscape, although not everyone agrees.

Solar Power Plants



□ Theory of operation

Solar Power Plants

- Advantages of Solar Power Plants
- Disadvantages of Solar Power Plants



Solar Power Station

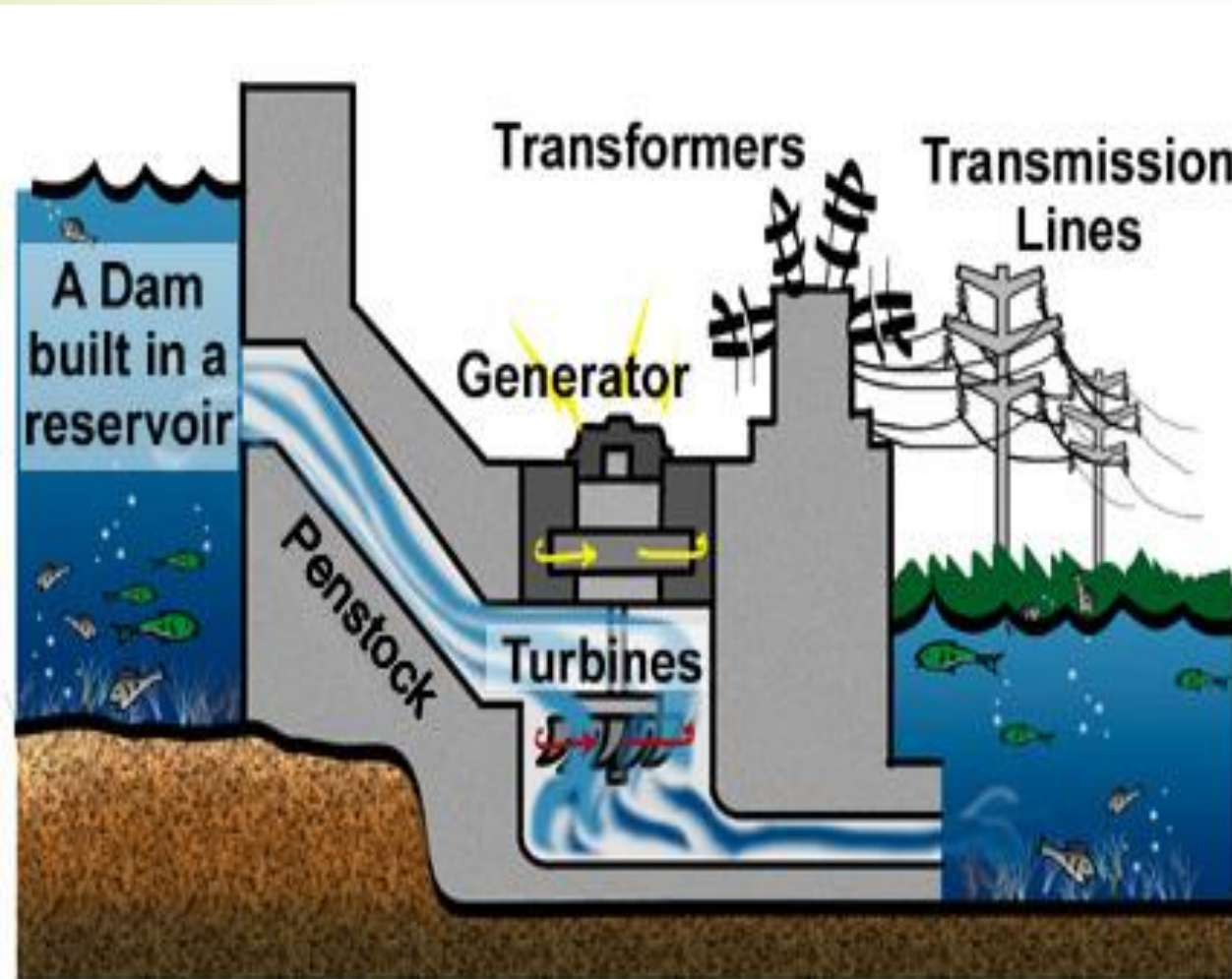
1. Advantages of Solar Power Station

- The sun gives out 'free' power all the time.
- It is silent, causes no pollution and does not harm wildlife.
- PV panels are low maintenance because there are no moving parts to service and can be installed easily because there are hardly any wires.
- It is useful in remote places, and works on a small or large scale.

2. Disadvantages of Solar Power Station

- Solar power does not work at night so electricity needs to be stored.
- At the moment, PV cells are expensive (but getting cheaper).
- Solar panels do not work as well in countries which do not have a lot of sunlight every day.

Hydroelectric Power Plants



□ Theory of Operation

Hydraulic Power Station

1. Advantages of Hydraulic Power Station

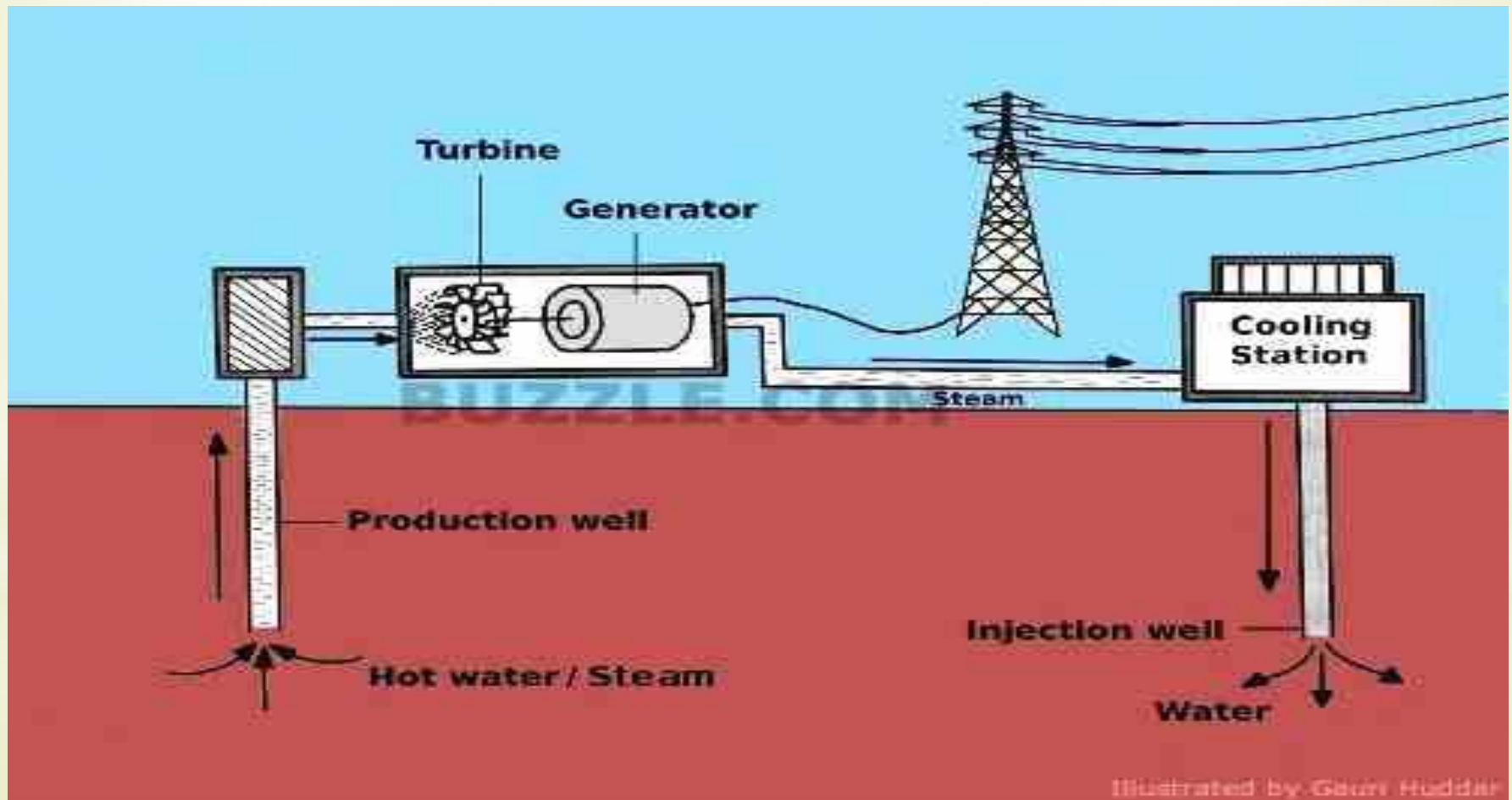
- It need to water as a fuel, which is cheaper fuel
- Clean energy
- Low cost run
- Require less time at the beginning of Operation

2. Disadvantages of Hydraulic Power Station

- Difference in the amount of electrical power from time to time
- High initial costs of building the station
- Difficult to perform maintenance

Geothermal Power Station

Using the temperature of the earth to produce electricity and/or heat, e.g. ground source heat pumps.



Geothermal Power Station

1. Advantages of Geothermal Power Station

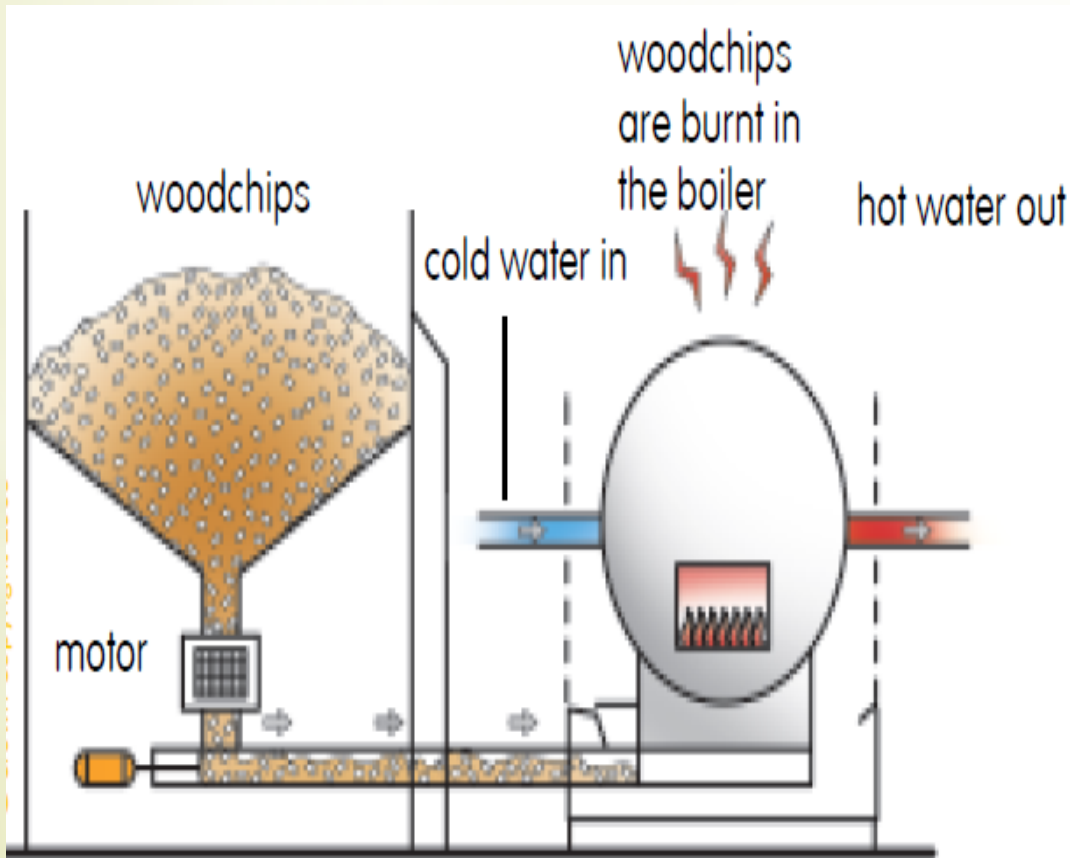
- Geothermal power plants produce renewable energy. No fuel is used
- There is very little pollution.
- Geothermal energy is quiet, and much of the technology needed is hidden underground.

2. Disadvantages of Geothermal Power Station

- It can only be used in some areas around the world, where the earth's crust is thin.
- Sometimes the hot water that is pumped to the surface contains pollutants such as sulphur.

Biomass Power Station

Biomass is plant and animal matter such as straw, sewage, waste food and wood chips. We can burn these natural materials to produce heat and electricity. This is called biomass energy. We can also use them to create fuel called biodiesel which we can use in vehicles instead of petrol and diesel.



The wood chips are burned in a boiler to heat water, which can be used to heat buildings or make electricity. Household waste, animal and factory waste, and straw can also be used as fuel.

Biomass Power Station

1. Advantages of Biomass Power Station

- It does not use up limited resources such as coal.
- It stops landfill gas from going into the air, where it could damage the atmosphere.
- It does not rely on the weather, so it can provide energy all the time.

2. Disadvantages of Biomass Power Station

- Waste materials have to be collected, which can be costly and cause pollution.
- Burning fuels does cause some air pollution.
- Growing crops to use for biomass takes up a lot of land, which could otherwise be used to grow food, and requires a lot of local water. It also decreases biodiversity through loss of habitat.

Activity (2)

**Thank You
For Your Attention**



*Mohamed Ahmed
Ebrahim*