

**The mechanism of electric power supplies
around us and electric power at home**

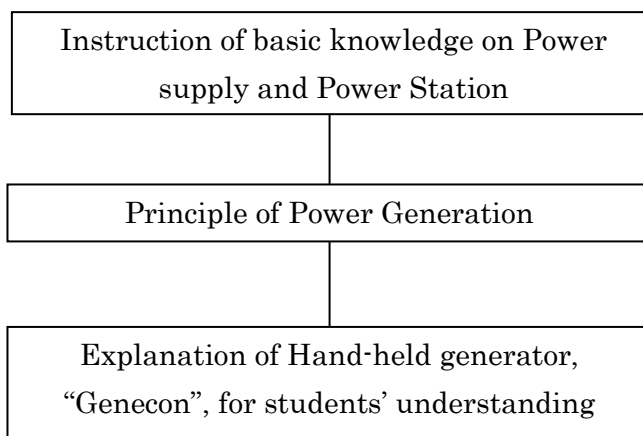
NaRiKa Corporation

1. Learning Outcome

We are living our lives by using various electrical appliances like light, refrigerator, TV, radio, microwave, cell phone, transceiver, flashlight and others. All of us know these electrical appliances require electrical power to be used. Without electrical power and batteries, we would definitely have tremendous inconvenience in our daily life.

In this unit, we are going to guide the students to learn about electrical power supply and generation that are inevitable for our life by going beyond mere textbooks learning. By doing so, students will learn that they are surrounded by power generators, as well as, learn some energy has to be consumed to produce electricity through their own experiment to generate electricity.

2. Learning Flow



3. What's GENECON V3

GENECON V3 (B10-2634-W0) is the hand-held generator, an abbreviated product name for "Hand Generator". By turning the handle, it generates DC of about 3V and shows how users are producing electricity.

Since it generates up to roughly 3V electricity, it is designed to avoid the breakage of miniature bulbs, LED bulbs and "Electrical music box" normally used in science classes in schools. It also alternates those experiment using dry cell batteries such as lighting miniature (LED) bulbs and thermal experiment with electrically heated wire.



GENECON V3 (B10-2634-W0)

GENECON V3 is quite simply and transparently designed to generate electrical power by rotating the built-in motor. The transparent body enables students to recognize the mechanical structure of built-in motor, gears, shafts and handle. It also enables teachers to easily explain to the students that the “motor” and “generator” are alternative and identical to each other.

Connecting adapter of built-in socket for a miniature bulb specially designed for GENECON V3. This adapter is mostly compatible with any type of miniature bulbs. In order to avoid misconnection of lead (cable) in combination with Genecon V3, Narika developed this plug-in type adapter that is easily attached / detached.



Miniature-bulb-adapter
(B10-2634-W2)

4. Background Topic

1. Electric power supply and power plant (station)

We are living our lives by using various electrical appliances like TV, radio, refrigerator, light and others at our homes. As you know these appliances are driven by electric power. Here, let's think about from where electricity used in TV, radio, refrigerator, light and other electric appliances is supplied.

We can use electrical consents in our home and just by plugging the electrical appliance to the electrical consent, every time the electrical appliance will switch on and we can use that appliance conveniently to our needs.

1) Places where electricity is produced

Electricity is being produced at place called power plant. There are many types of power plants: thermal power plant, hydroelectric power plant, wind power plant, solar power plant, nuclear power plant and others. The process of generation of electricity is different depending on the type of the power plant. Depending on the process name of the power plant vary.



Thermal power plant



Hydroelectric power plant



Wind power plant



Geothermal power plant



Nuclear power plant



Solar power plant

[Referenced Material -1]

Electric Power Transmission System

Electricity generated at a power plant is transferred through electrical power transmission lines with the high voltage of 275,000V ~ 66,000V. Also, in order to transfer the electric power to large-scale factories and transportation facilities that demand huge amount of power, the voltage is preliminary reduced to 110,000V ~ 66,000V at primary substation.

Then, the voltage is reduced again at distributing substation to 33,000V ~ 6,600V to deliver the power to each of small-size factories, commercial buildings and condominium buildings.

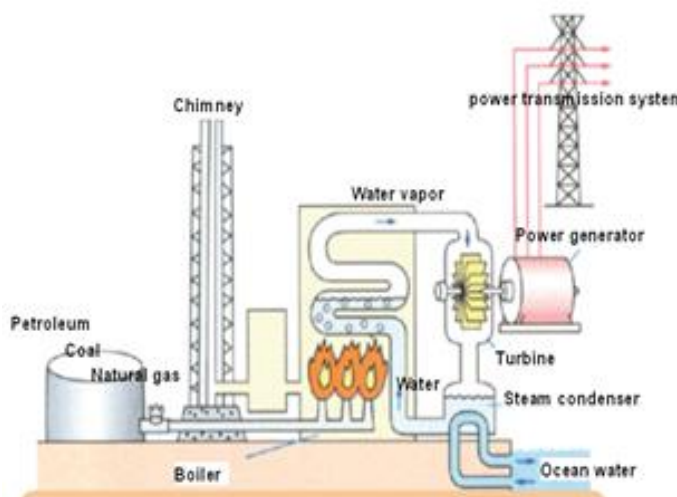
And, finally, the voltage is supplied to each home after being reduced to 240V ~ 100V at the regional transformer. This is the general power transmission system from power station to each home.



[Referenced Material -2]

Mechanism of Thermal Power Generation

At a thermal power plant, boil huge amount of water by burning petroleum, coal or natural gas in the boiler, which produces high pressure steam to turn the turbine connected with the generator producing electric power.

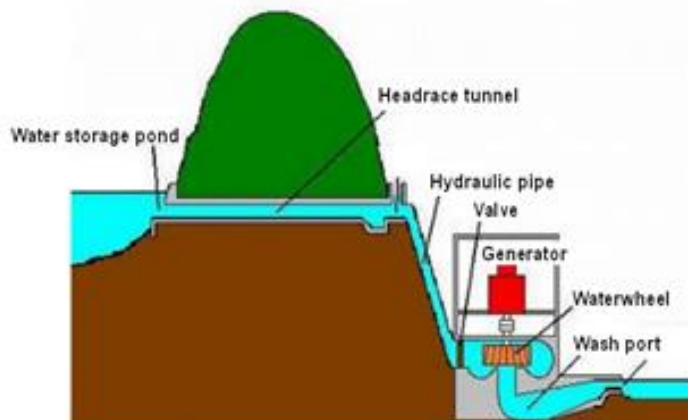


Steam used at the turbine is condensed to water at a steam condenser. The water is returned to the boiler again to produce steam. This method is the mainstream of Thermal Power Generation, which also generate huge amount of carbon dioxide that is the substance responsible for global warming.

[Referenced Material -3]

Mechanism of Hydroelectric Power Generation

The mechanism of Hydroelectric Power Generation is to generate power by rotating waterwheel connected with the generator using the potential energy of water falling down from a high altitude.



Construct a dam or a storage reservoir in the upper course of a river or in a mountain, then, construct a power station at the lower location. Connect the dam or storage reservoir with a headrace channel for the waterfall.

This is regarded as a environment friendly power generation due to the small amount of carbon dioxide to be generated without using fossil fuel. However, the downside is the high cost for the construction.

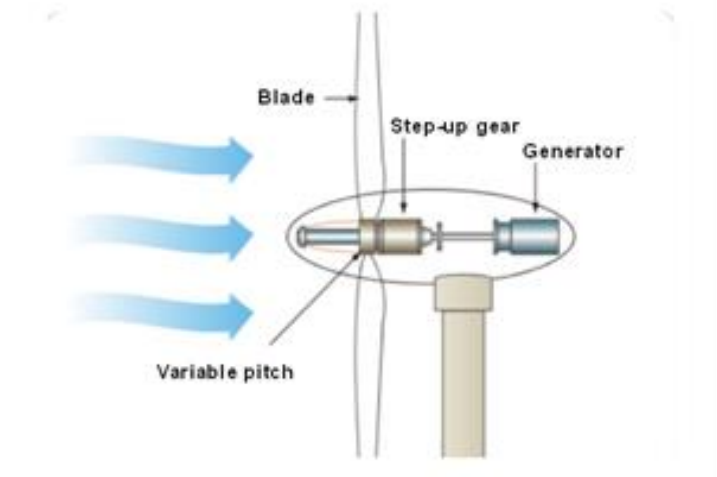
[Reference Material - 4]

Mechanism of Wind Power Generation

Mechanism of Wind Power Generation is to rotate propeller, of which rotating speed is accelerated by the set-up gear, to rotate the shaft of power generator. There are many wind power

stations located in the windy coastline or on the ocean. Also, there are many who expect very much in terms of environment friendliness and lower cost because its power source is natural windy energy.

However, the downside is that the power generation is unstable because wind is not always certain, as well as, the limitation of the good location with enough wind power.

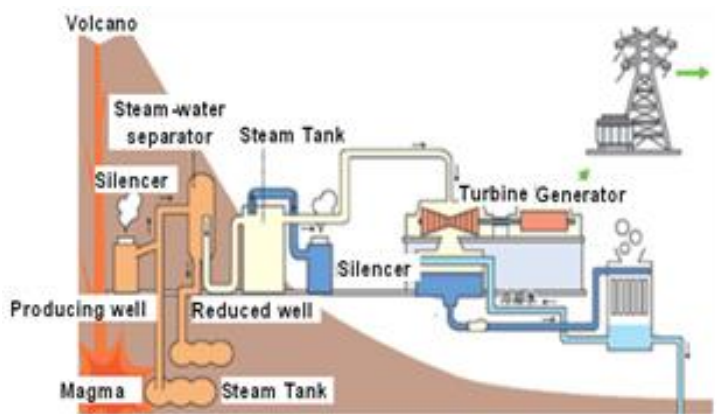


[Reference Material -5]

Mechanism of Geothermal Power Generation

Geothermal utilization power generation that are usually seen at volcanic areas. It is environment friendly due to the utilization of natural energy like Wind Power Generation.

However, the downside is the limitation of the good location, limitation of the power generated, and the cost for investigating earth crust and underground. Also, another downside is that caustic harmful material is contained in the hot water in the ground.

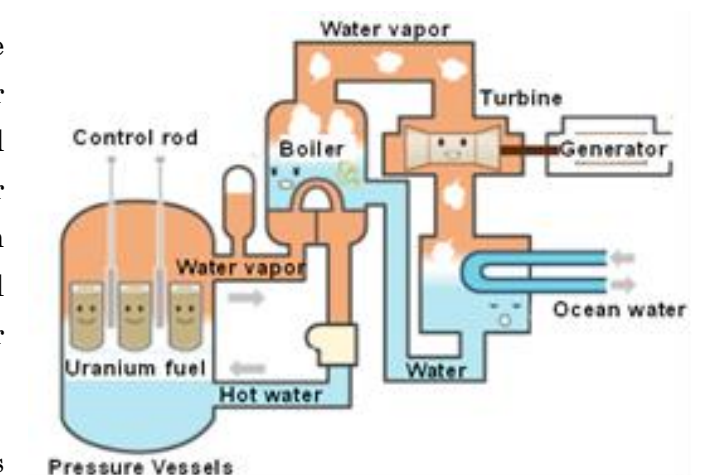


[Reference Material -6]

Mechanism of Nuclear Power Generation

Nuclear power generation is to produce power by rotating turbine producing clear and high-pressure steam at a boiler based on the reaction heat of uranium nuclear fission. The energy gained from uranium nuclear fission is so huge that only small amount of that generates energy enough for power generation.

However, the fission reaction also emits

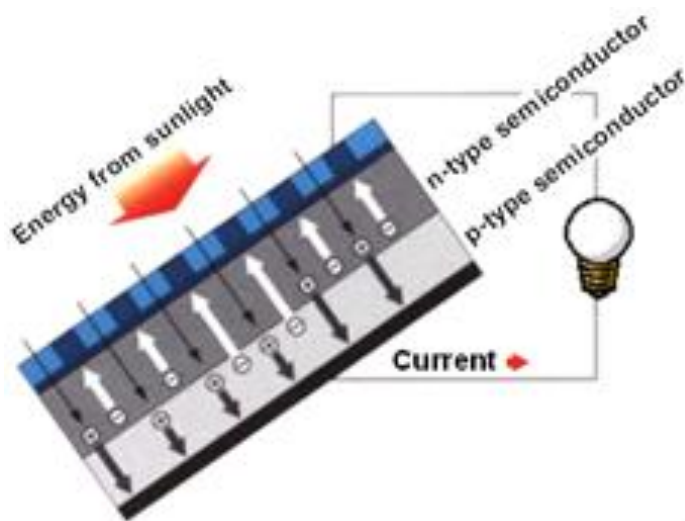


radiation that is pollutive for the nature and human. Hence, the problem of waste disposal (uranium) is getting bigger. Also, it's costly to secure the safety of the nuclear power plant.

[Reference Material -7]

Mechanism of Solar Power Generation

Principle of solar power generation is based on the semiconductor's property of generating electricity when receiving sunlight. Like water or wind power generation, it is environmentally friendly due to the natural power source.



However, the downside is that it only produces power during the daytime, along with the cost, limited lifetime, and inefficiency of power generation, for which improvement and development is underway.

2) Battery types (types of battery)

Portable electrical equipment like radio, flashlight and others are using as a source of energy things called dry cells (batteries). Also, cellular phones and other electrical equipment are using batteries or dry cells which can be recharged. Furthermore, batteries in cars (automotive batteries) are rechargeable as well. And in dry cells or rechargeable batteries the process of making electricity is different that in electric plants. Electricity is made by chemical reaction. Dry cell (batteries) are called primary cells, rechargeable batteries are called secondary cells.



Zinc-carbon batteries
(From the left)

C type, AA type and AAA type batteries



Alkaline batteries

Types of batteries can be divided into 2 types: zinc-carbon batteries and alkaline batteries. Zinc-carbon batteries are most suitable for use in flashlights, radios and others, while alkaline batteries are most suitable for use in equipment like shavers and others where electric motor is used.

Rechargeable batteries are batteries that can be charged of energy and then the stored energy can be used (discharged) all over again. In cellular phones and other equipment, small and safe lithium-ion type or nickel-metal hydride (NiMH) and other types of rechargeable batteries are used. In cars lead-acid batteries using chemical reactions of liquid and metals are used. When charging these types of rechargeable batteries using of appropriate charger is necessary. If you will use charger not designated for charging these types of rechargeable batteries, explosion can occur and injury can happen, therefore extreme carefulness is necessary when charging these types of batteries.



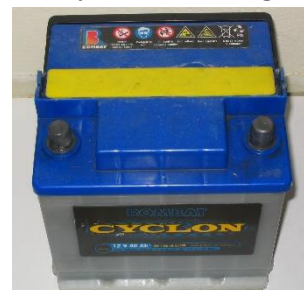
Nickel-cadmium rechargeable battery



Nickel-metal hydride rechargeable battery



Lithium-ion battery



Lead-acid (car) battery

2. Electrical generators around us (dynamo and motor)

1) Typical electrical generator

We can usually see around us small generators used for home purposes. For example: small generators can be used for lighting up outdoors and other things in our homes, or dynamo attached to bicycle wheel used for lighting up the road and others.



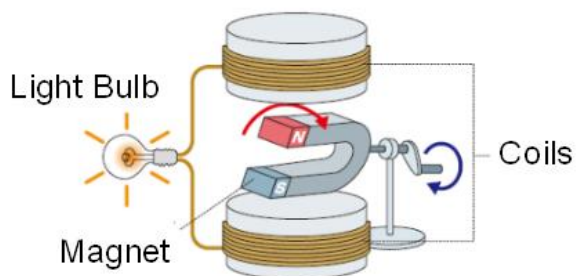
Generator using gasoline as a fuel



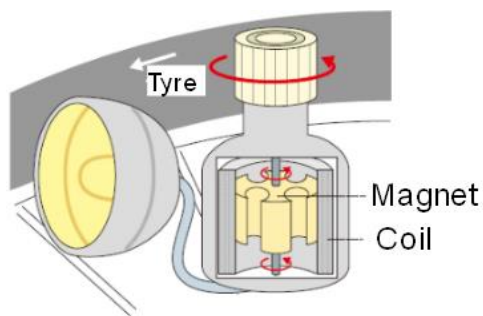
Bicycle with typical dynamo attached (small generator)

2) Mechanism of electric power generation

Mechanism behind generation of energy is utilization of interaction between magnet and coil. By using bar magnet which you put close to the coil and away and by repeating the process electricity will be generated in the coil. This phenomenon is called: electromagnetic induction. On figure below is magnet inserted between 2 coils, if we start rotating the magnet, it will get closer and further away from the coils. As a result of this action, light will be lit by the electricity generated in the coils. This action is called Fleming's right-hand rule.



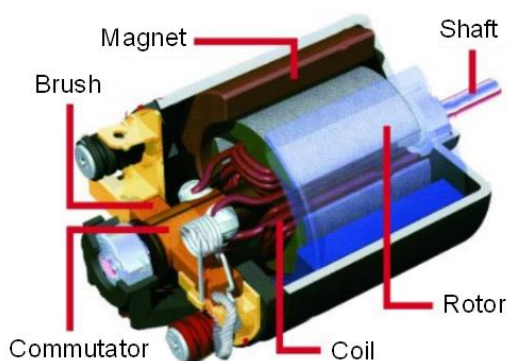
Mechanism of electric power generation



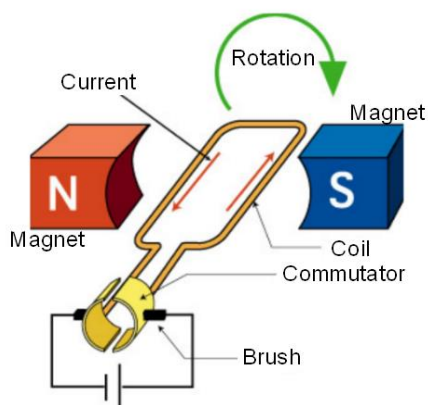
Mechanism of dynamo for bicycle

3) Generator and motor

As shown on the figure, as Electricity goes through the motor, electric current starts to flow through the coil, the coil and magnet start to interact with each other and from the magnet to the coil force of constant direction starts to operate. As a result, coil starts to rotate and shaft too, therefore it will become functional as a motor. The interaction between coil and magnet is called Fleming's left-hand rule.

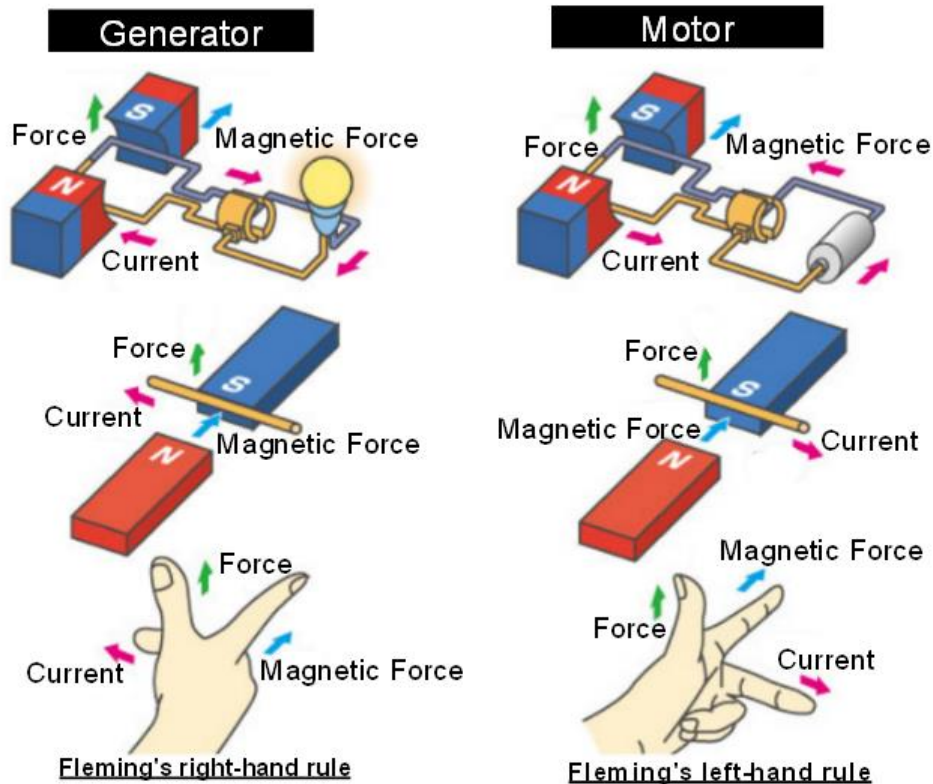


Internal structure of typical motor



Rotation principle of motor

By comparing motor and generator, you will notice that the structure is very similar. Each of them is using Fleming's right-hand rule and Fleming's left-hand rule principles, as shown in the following figure, therefore motor has function of generator and generator has function of motor too. Many power plants are using the same principle as well to generate electricity.



5. What is Genecon?

The name Genecon comes from hand generator, it is manual electricity power generator. It uses the same principle as dynamo on bicycle, by turning the handle electric energy is generated. By turning the handle direct current of around 3V (volts) can be generated. You can create electricity by yourself.



Genecon V3

6. [Experiment] Let's light a bulb by Genecon V3



1. Attach light bulb adapter to Genecon V3



2. Turn the handle of Genecon V3



3. The light bulb will light up

5. Summary (Questions)

1. By observing thoroughly Genecon V3, what features do you think it has?

Purpose of this question is encouraging the students to observe Genecon V3 carefully to realize the following features.

- 1) There is a built-in motor inside the Genecon V3.
- 2) There are three gears installed inside the Genecon V3 that rotate the motor shaft at

high speed.

3) Similar to a dynamo used for bicycle.

Also, teachers should show students the comparison between various power generation mechanisms/power generators and motor principle.

2. How does the lightness of a bulb change when you turn the handle of Genecon V3 quickly?

This is a reasonable question for students as long as they made experiment carefully.

→“The more quickly the Genecon handle is rotated, the brighter the bulbs will be lit.”

3. How does change the lightness of a bulb when you turn the handle of Genecon V3 slowly?

This is a reasonable question for students as long as they made experiment carefully.

→“The more slowly the Genecon handle is rotated, the darker the bulbs will be lit.”

4. Is there a difference in difficulty of turning the handle of Genecon V3?

Students would feel more loaded when they turn the Genecon V3 handle quickly than they turn it slowly. And, they should feel the difference quite carefully.

They will clearly realize the difference of the workload if they compare the loaded status and non-loaded status tuning the handle without bulb- adapter being connected to the Genecon. The difference of the workload will vary in the correlation of power consumption and power generation.