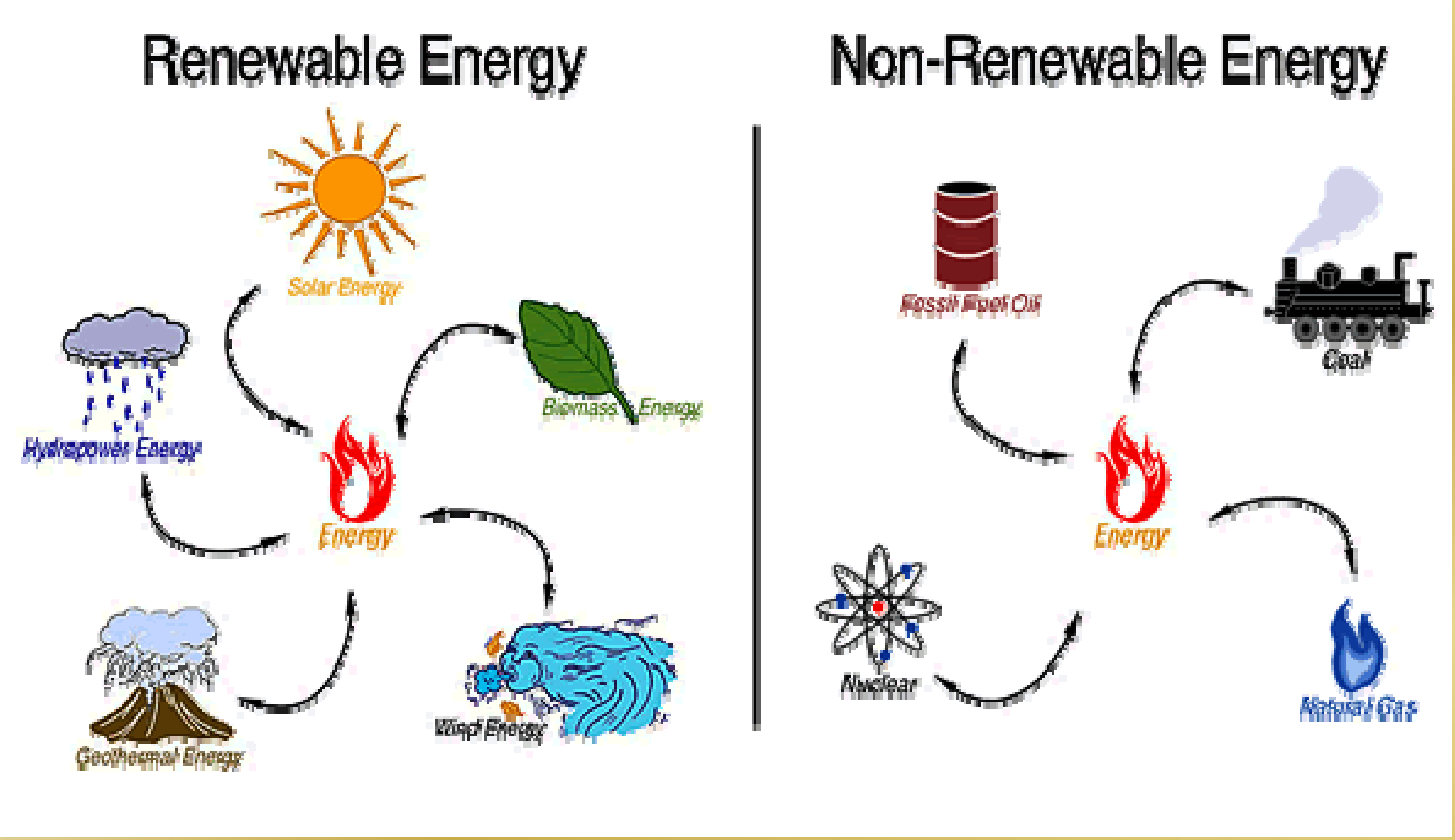
ENERGY

- It is defined as the capacity to produce an effect.
- It can exist in several forms like electrical , thermal etc.
- Energy can be transformed into a number of forms.

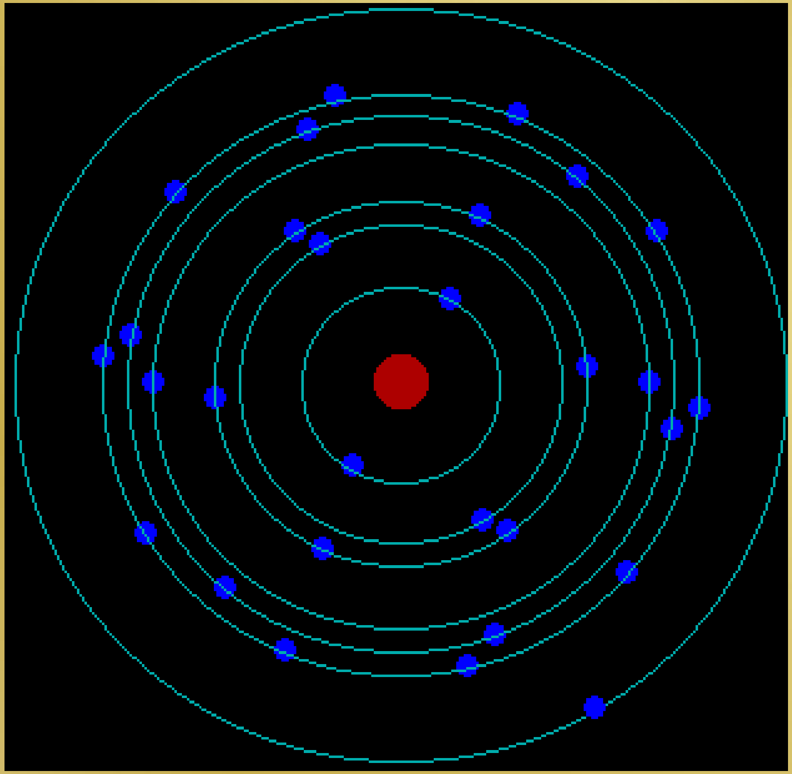
Types Of Energy

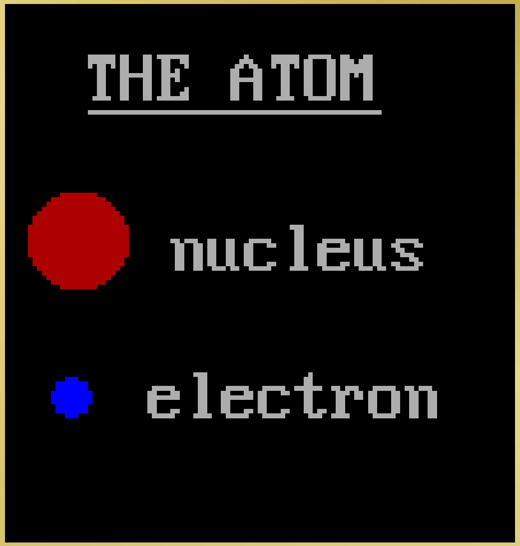


COMPARISON

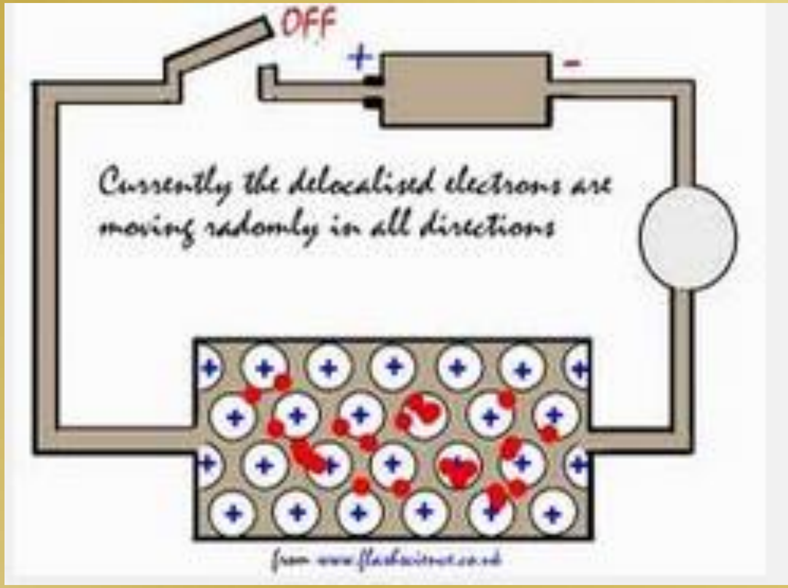
RENEWABLE ENERGY	NON-RENEWABLE ENERGY
1) Renewable and easily regenerated.	Once depleted, cannot be reused.
2) Non-Polluting.	Hazardous to environment.
3) No chances of the source being depleted in the long run.	Extensive use leads to rapid depletion in near future.
4) Ex: Solar Energy…	Petrol…

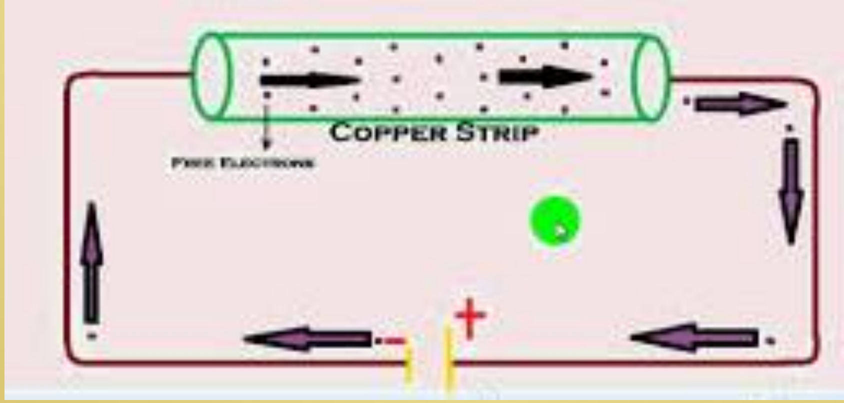
ATOM





What Is Electricity???





Electricity is generated from the motion of tiny charged atomic particles called electrons and protons

What Is Electricity???

- Electricity is generated from the motion of tiny charged atomic particles called electrons and protons.

- Atoms have protons, neutrons, and electrons.

- With same number of protons and electrons, it is balanced and neutral.

- Free electrons continuously move to spaces where electrons are missing.

- This electron movement creates a current of electricity.

Charge

Characteristic property of subatomic particles responsible for electric phenomena

Electron

Proton

−1.602×10−19 C

1.602×10−19 C

The unit of quantity of electric charge is
coulomb (C)

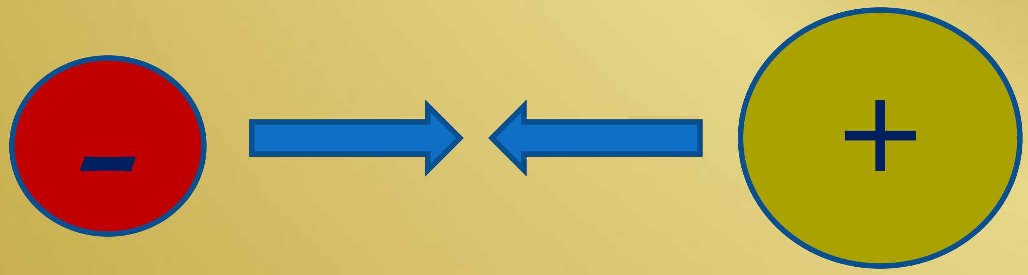
1 coulomb = 6.25 × 1018 *e*

e = elementary charge = charge of proton

Contd…

“Charged” particles exhibit forces

Like charges repel each other



Opposite charges attract one another

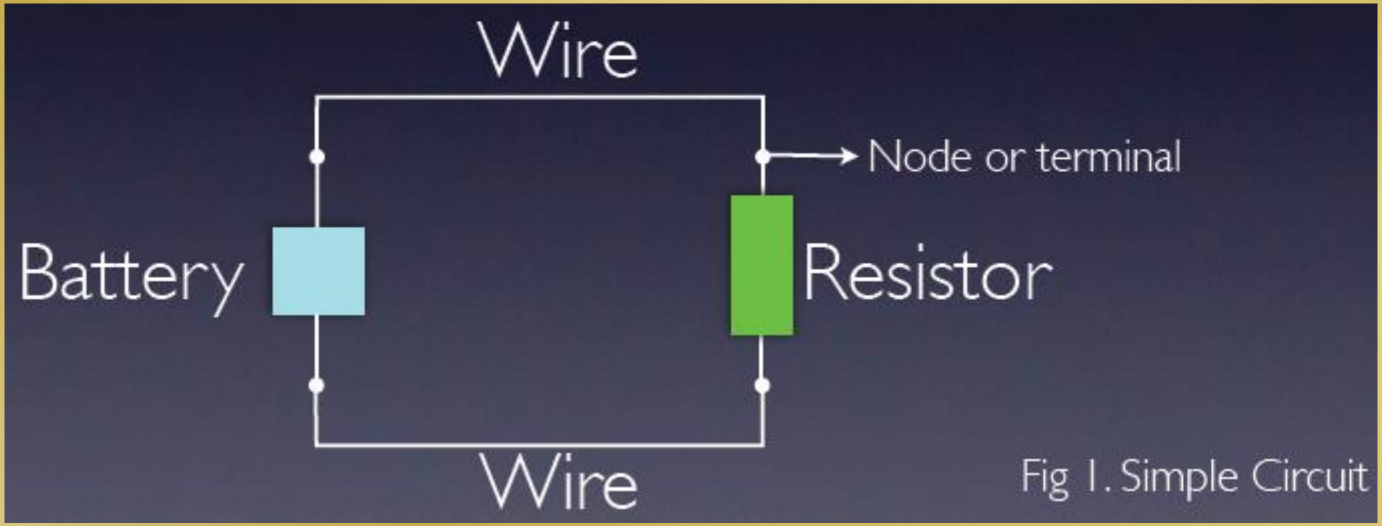
Charge is the source of one of the fundamental forces in nature (others?)

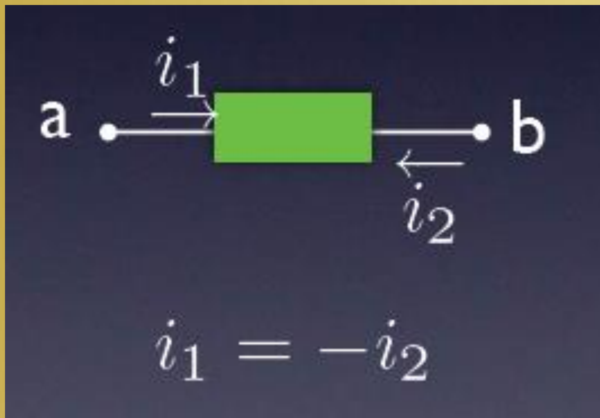
Electrical Circuits

Electric circuit

An electric circuit is an interconnection of ***electrical elements*** *linked together in a* ***closed path*** *so that electric current may flow continuously*

Circuit diagrams are the standard for electrical engineers



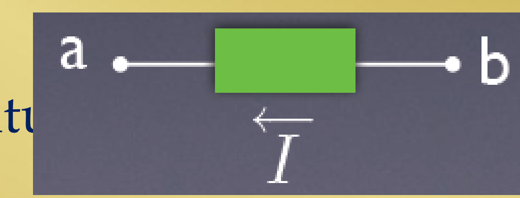


$\overrightarrow{i_1}$ Rate of flow of charge form **node a to node b**

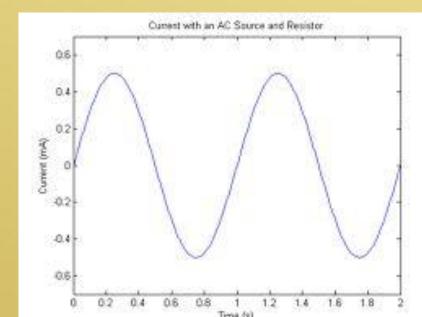
$\overleftarrow{i_2}$ Rate of flow of charge form **node b to node a**

(i = current)

A **direct current (dc)** is a current of constant magnitu

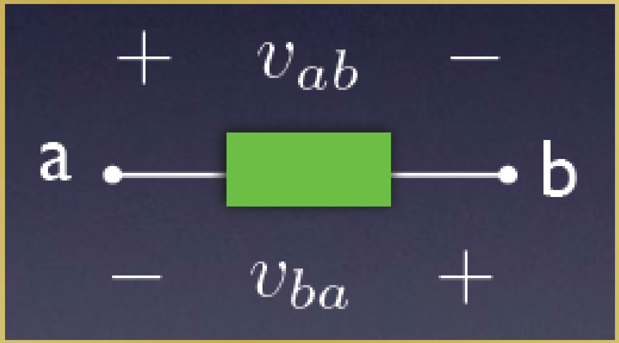


An **alternating current (ac)** is a current of varying magnitude and direction



Voltage

Driving "force" of electrical current between two points



V_{ab} Voltage at terminal a with respect to terminal b

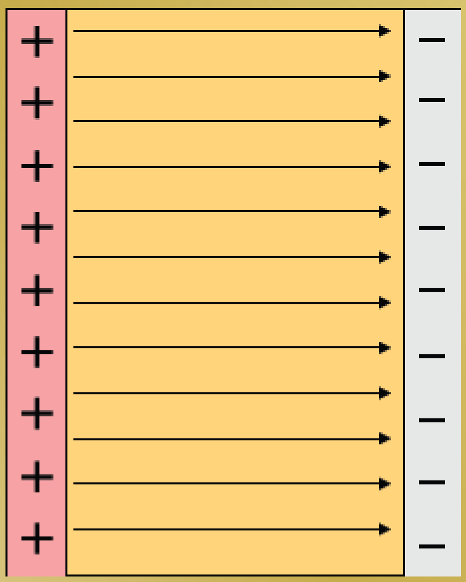
V_{ba} Voltage at terminal b with respect to terminal a

$$V_{ab} = -V_{ba}$$

Note: In a circuit, voltage is often defined relative to **"ground"**

Contd…

The voltage across an element is the work (energy) required to move a unit of positive charge from the “**−**” terminal to the “**+**” terminal



$$V = \frac{W}{Q} = \frac{\text{joules}}{\text{coulombs}} = \text{volts}$$

A **volt** is the potential difference (voltage) between two points when **1 joule of energy** is used to move **1 coulomb of charge** from one point to the other

Power

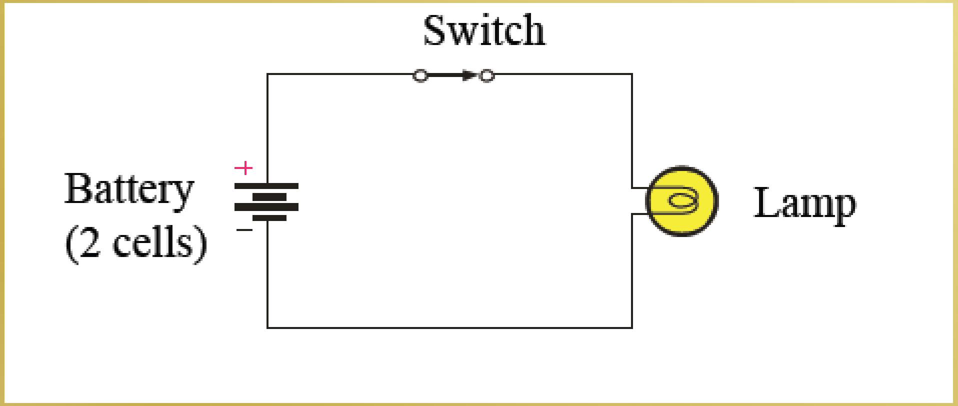
The rate at which energy is converted or work is performed

$$P = \frac{W}{t} = \frac{\text{joules}}{\text{second}} = \text{watt}$$

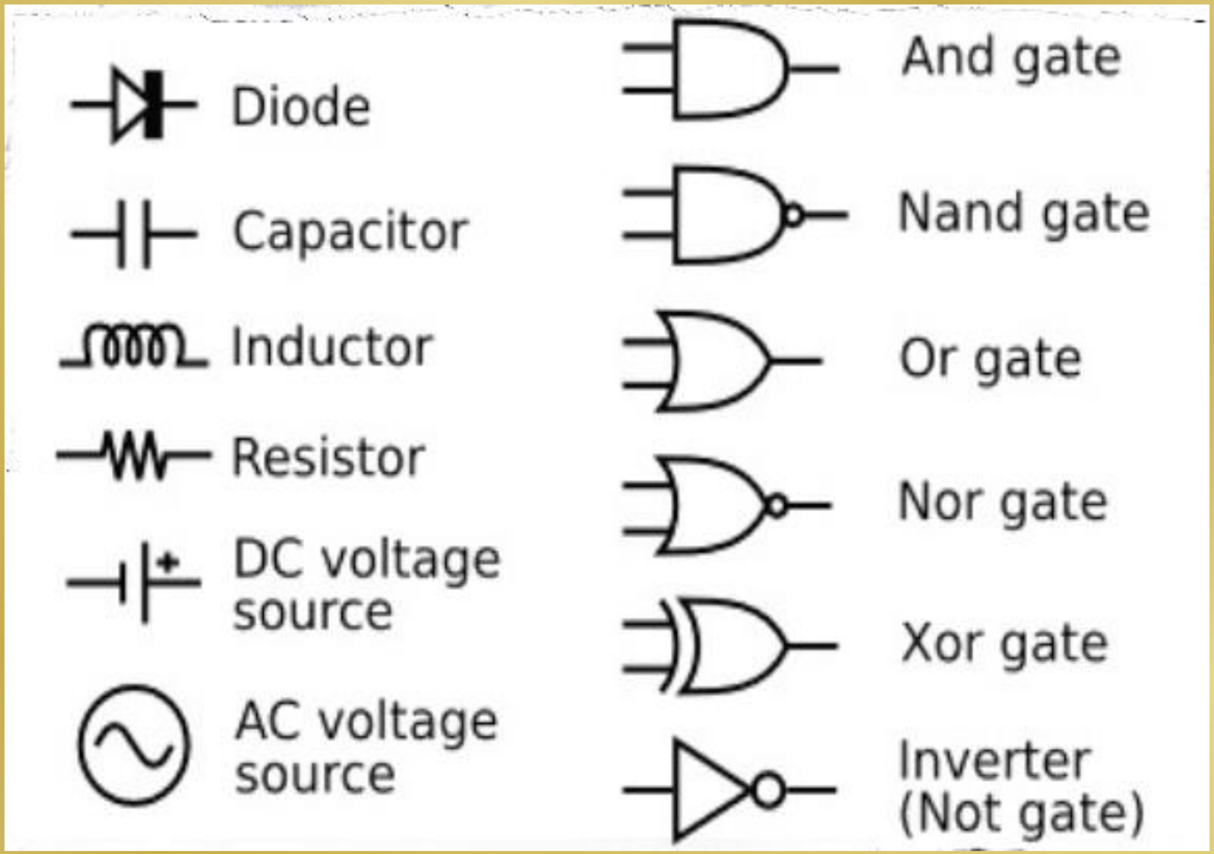
$$P = IV$$

A **watt** results when **1 joule of energy** is converted or used in **1 second**

Circuit schematic example



Circuit elements



Resistors

Resistor

Three resistors

Type	Passive

Electronic symbol

(Europe)

(US)

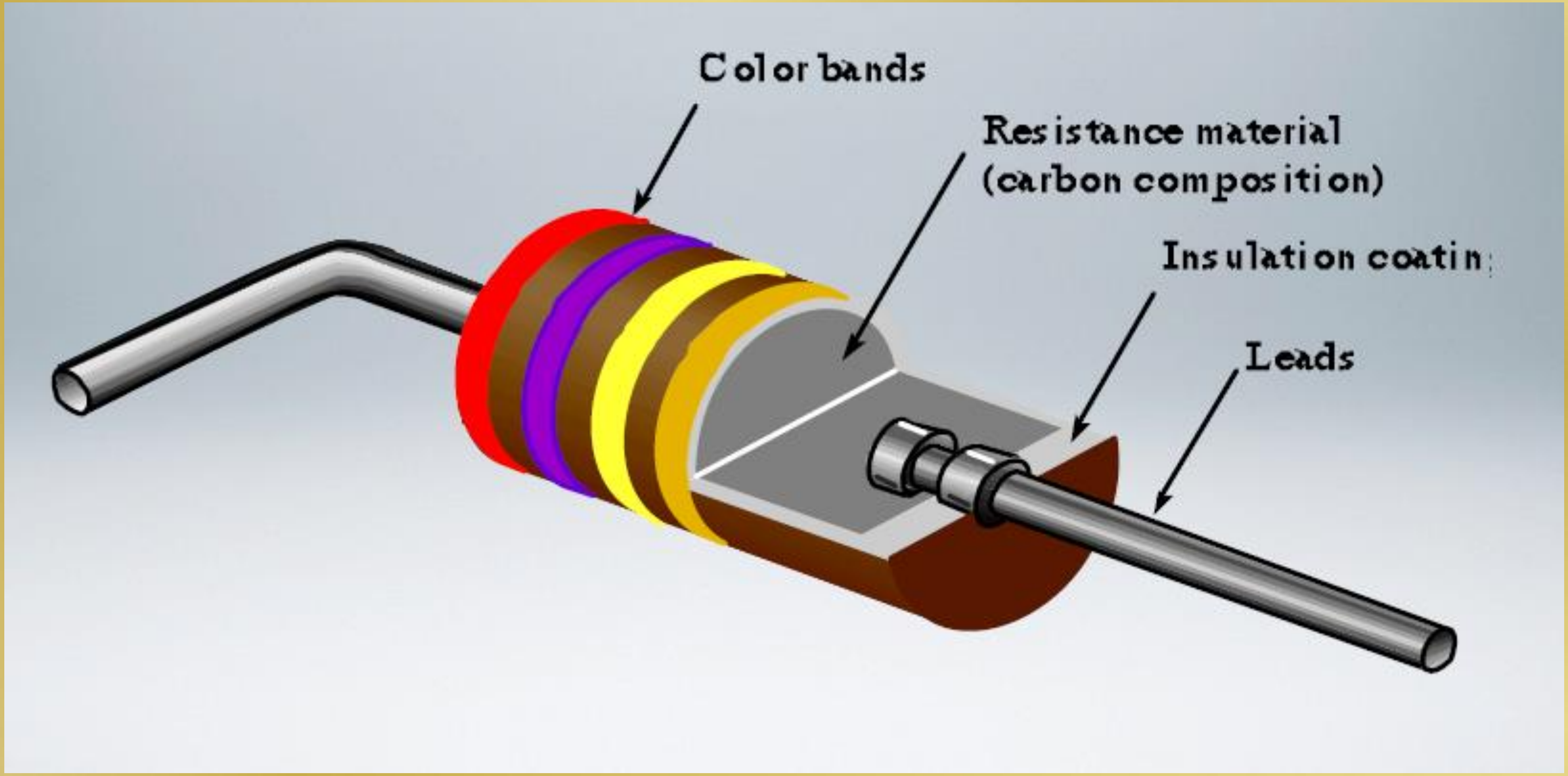
Resistance (R) is the physical property of an element that impedes the flow of current . The units of resistance are **Ohms (Ω)**

Resistivity (ρ) is the ability of a material to resist current flow. The units of resistivity are **Ohm-meters (Ω-m)**

Example:

Resistivity of copper	1.68×10^{-8} Ω·m
Resistivity of glass	10^{10} to 10^{14} Ω·m

Contd…


Color bands
Resistance material
(carbon composition)
Insulation coatin
Leads

Ohm's Law

$$I = \frac{AV}{\rho L}$$

A = Cross-sectional area of wire

L = length of wire

$$R = \frac{\rho L}{A}$$

Ohm's Law

$$\boxed{V = RI}$$

(remember, R is in Ω and ρ is in Ω-m)

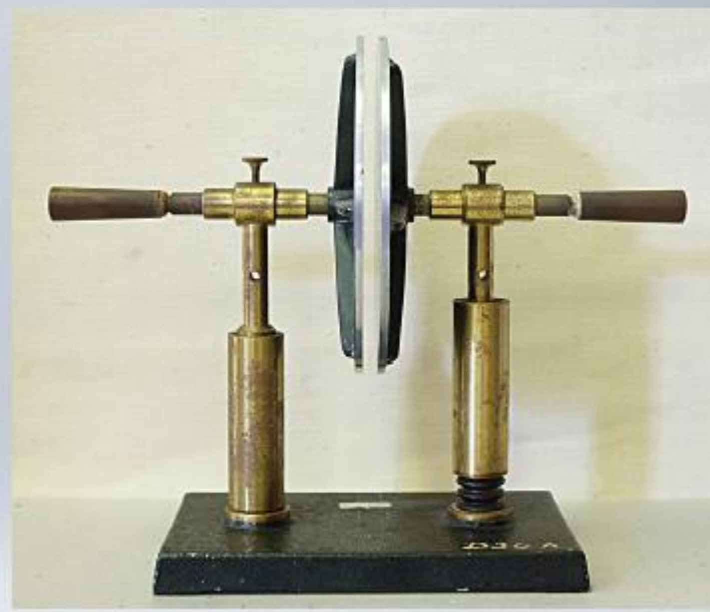
Capacitors

Capacitor

Modern capacitors, by a cm rule

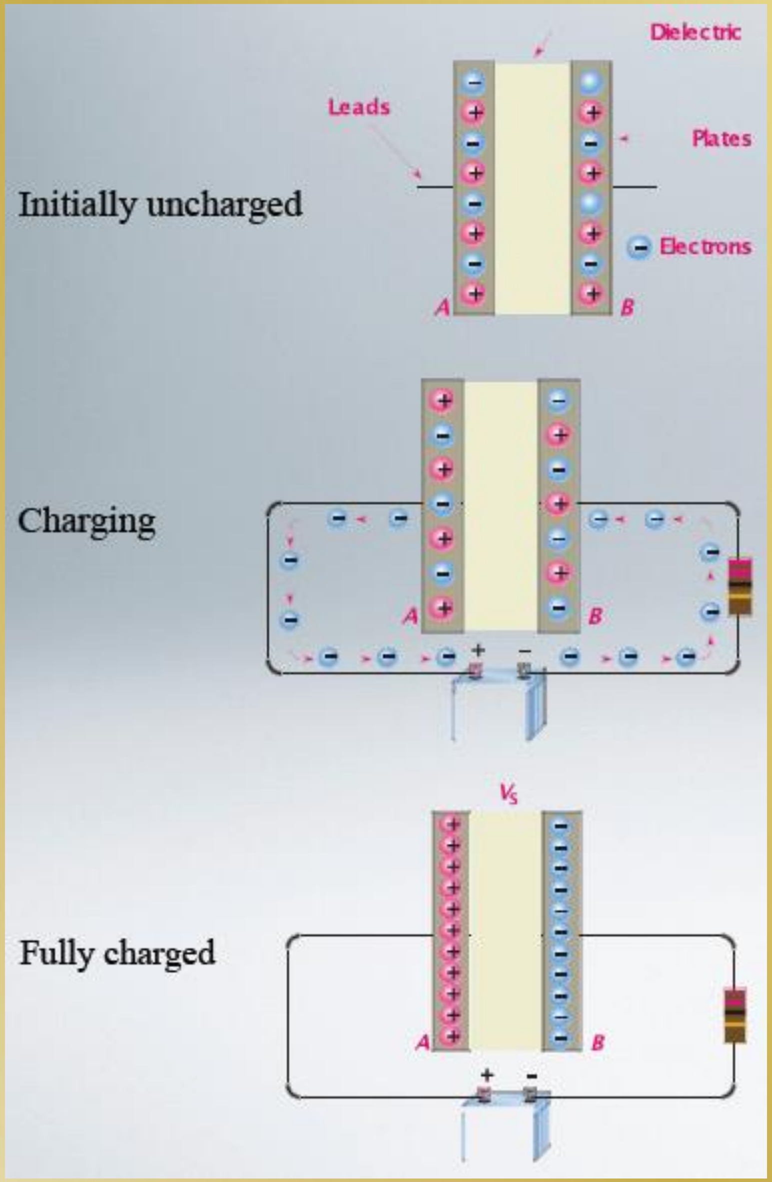
Type	Passive
Invented	Ewald Georg von Kleist (October 1745)

Electronic symbol



A simple demonstration of a parallel-plate capacitor

Contd…



*A **capacitor** consists of a pair of conductors separated by a dielectric (insulator).*

$$C = \frac{\epsilon A}{d} \qquad \begin{aligned} \epsilon &= permitivity \\ A &= area \\ d &= distance \end{aligned}$$

(ε indicates how penetrable a subtance is to an electric field)

Electric charge is stored in the plates – a capacitor can become "charged"

When a voltage exists across the conductors, it provides the energy to move the charge from the positive plate to the other plate.

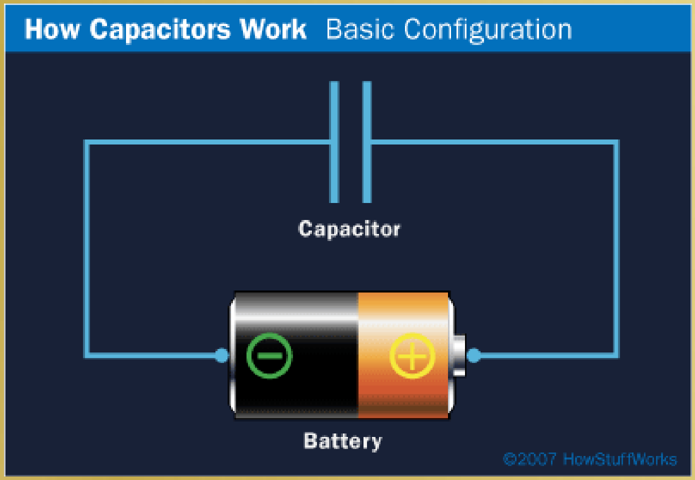
Contd…

***Capacitance (C)** is the ability of a material to store charge in the form of **separated charge or an electric field**. It is the ratio of charge stored to voltage difference between two plates.*

Capacitance is measured in **Farads (F)**

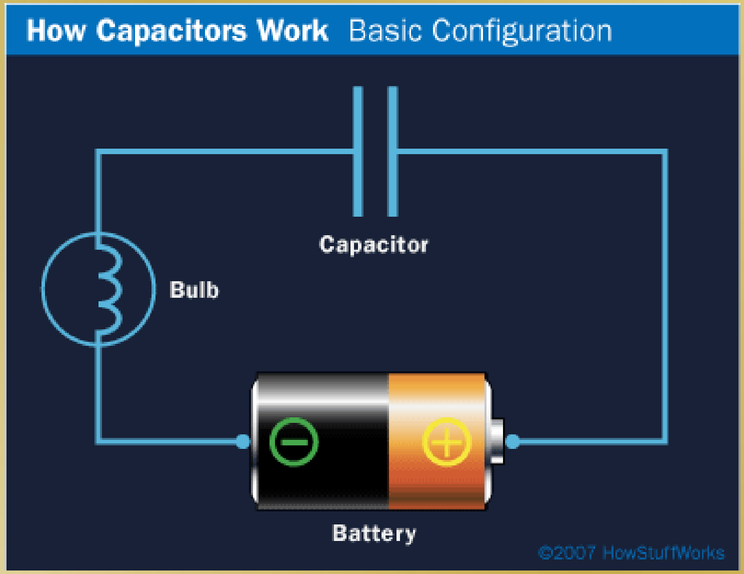
$$C = \frac{Q}{V} = \frac{Coloumb}{Volt} = Farad$$

Contd…



The capacitor plate attached to the **negative terminal** accepts **electrons** from the battery.

The capacitor plate attached to the **positive terminal** accepts **protons** from the battery.



What happens when the light bulb is initially connected in the circuit?

What happens if you replace the battery with a piece of wire?

Inductors

Inductor

A selection of low-value inductors

Type	Passive
Working principle	Electromagnetic induction
First production	Michael Faraday (1831)

Electronic symbol

An inductor is a two terminal element consisting of a winding of N turns capable of storing energy in the form of a magnetic field

Inductance (L) is a measure of the ability of a device to store energy in the form of a magnetic field. It is measured in Henries (H)

Contd…

Inductance in a cylindrical coil

$$L = \frac{\mu_0 K N^2 A}{l}$$

μ_0 = permeability of free space = $4\pi \times 10^{-7}$ H/m

K = Nagaoka coefficient

N = number of turns

A = area of cross-section of the coil in m^2

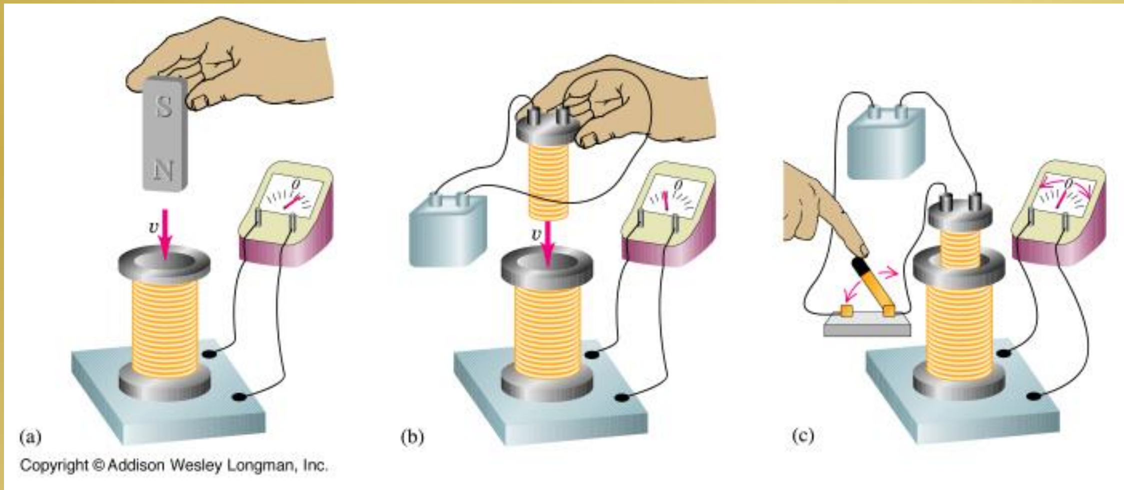
l = length of coil in m

Contd…

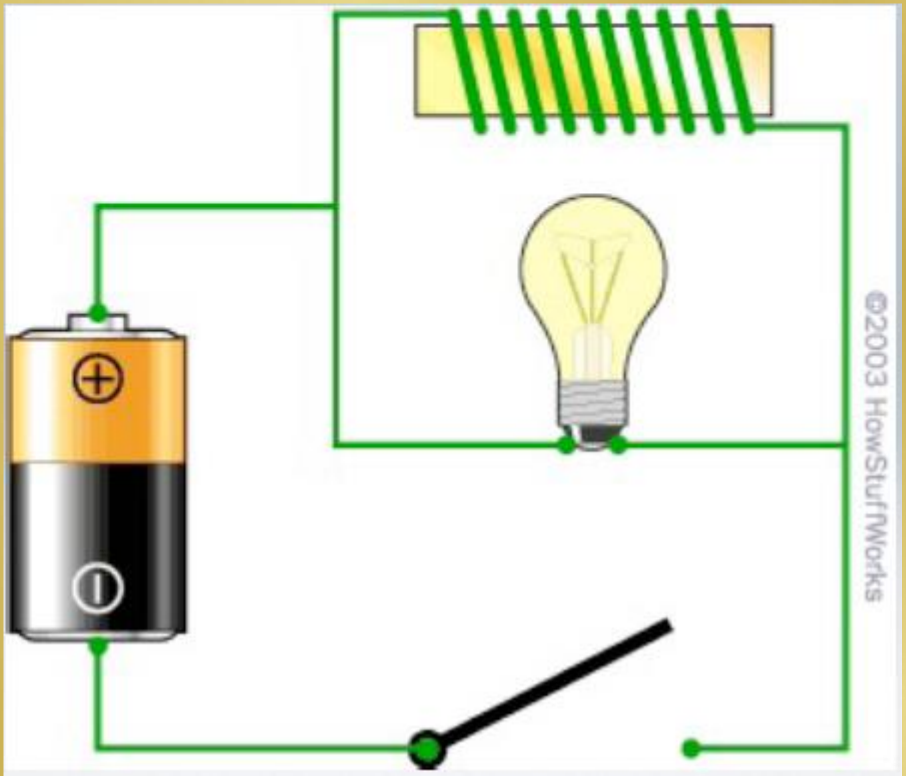
The magnetic field from an inductor can generate an induced voltage, which can be used to drive current

$$v = L\frac{di}{dt}$$

While building the magnetic field, the inductor **resists current flow**



Contd…



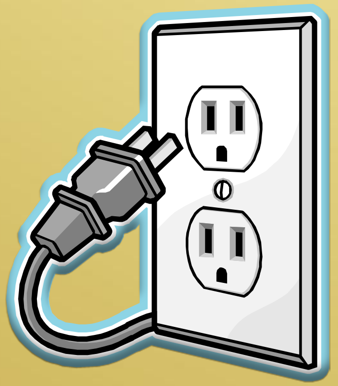
What happens to the light bulb when the switch is closed?

What happens to the light bulb when the switch is then opened?

Mains Electricity

- Most of the large appliances in our home are powered by Mains Electricity.
- Mains Electricity is a supply of electrical energy
- Mains appliances change or **convert** this electrical energy into other forms of energy

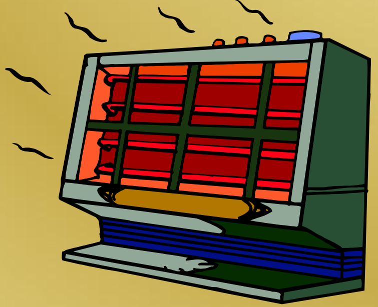
- Can you name them?

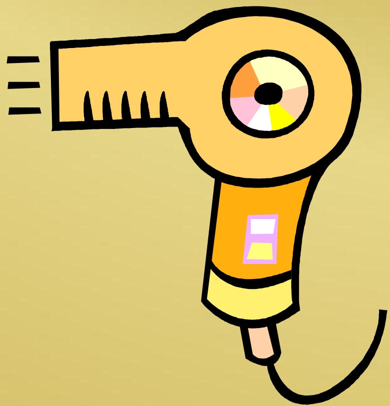


Types of Energy

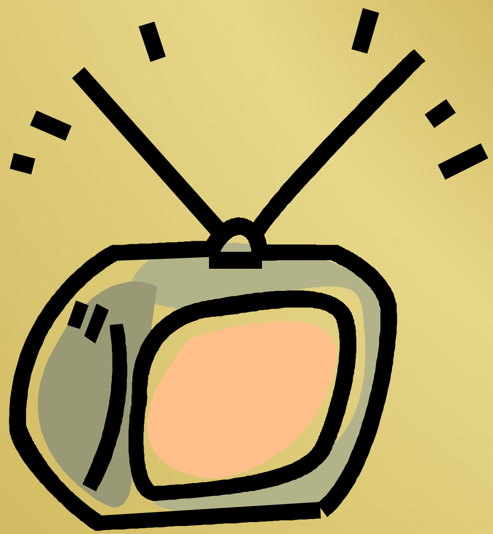
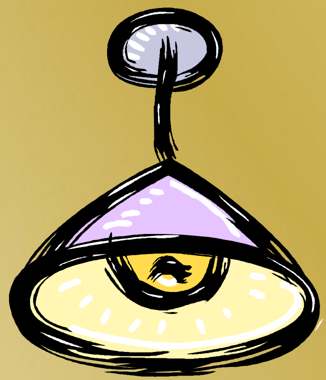
- Heat energy
- Light energy
- Sound energy
- Movement energy
- Mechanical energy
- Electromagnetic energy
- Electrical energy
- Chemical energy
- Thermal energy

Heat Energy

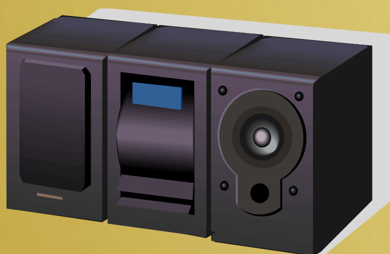


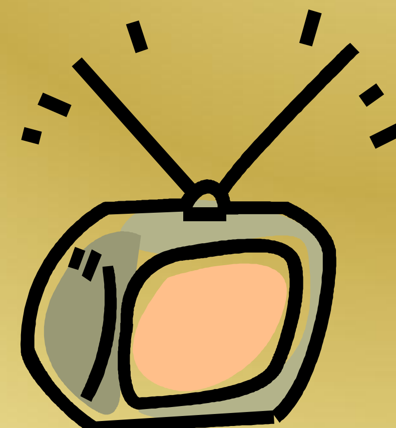


Light Energy

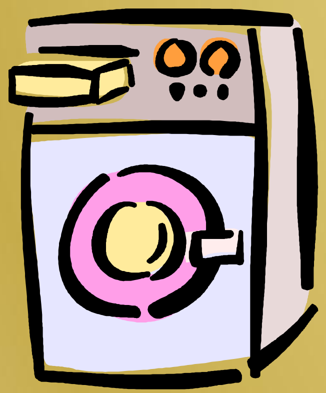




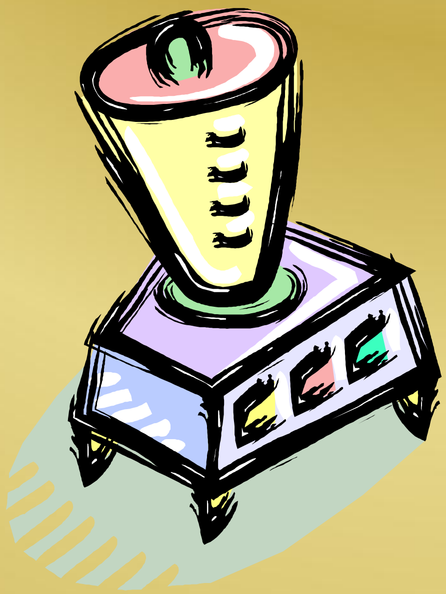

Sound Energy

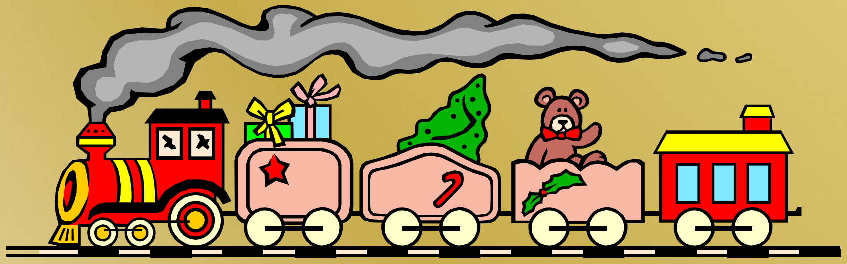




Movement Energy







What is Mechanical Energy?

- Energy due to a object's motion (kinetic) or position (potential).

The bowling ball has mechanical energy.

When the ball strikes the pins, mechanical energy is transferred to the pins!

Examples of Mechanical Energy

What is Electromagnetic Energy?

- Light energy
- Includes energy from gamma rays, xrays, ultraviolet rays, visible light, infrared rays, microwave and radio bands

What is Electrical Energy?

- Energy caused by the movement of electrons
- Easily transported through power lines and converted into other forms of energy

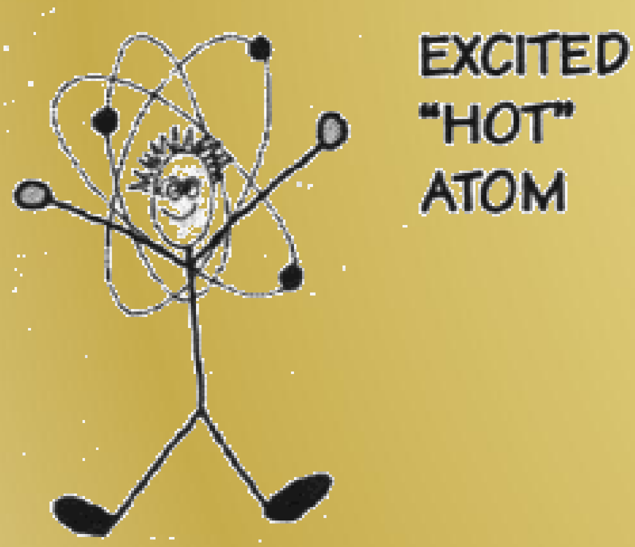
What is Chemical Energy?

- Energy that is available for release from chemical reactions.

The chemical bonds in a matchstick store energy that is transformed into thermal energy when the match is struck.

Examples of Chemical Energy

What is Thermal Energy?



- Heat energy
- The heat energy of an object determines how active its atoms are.

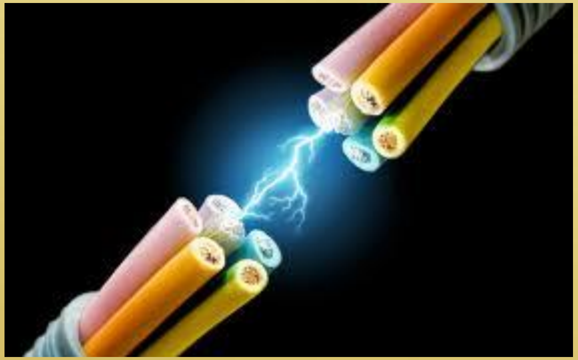
A hot object is one whose atoms and molecules are excited and show rapid movement.

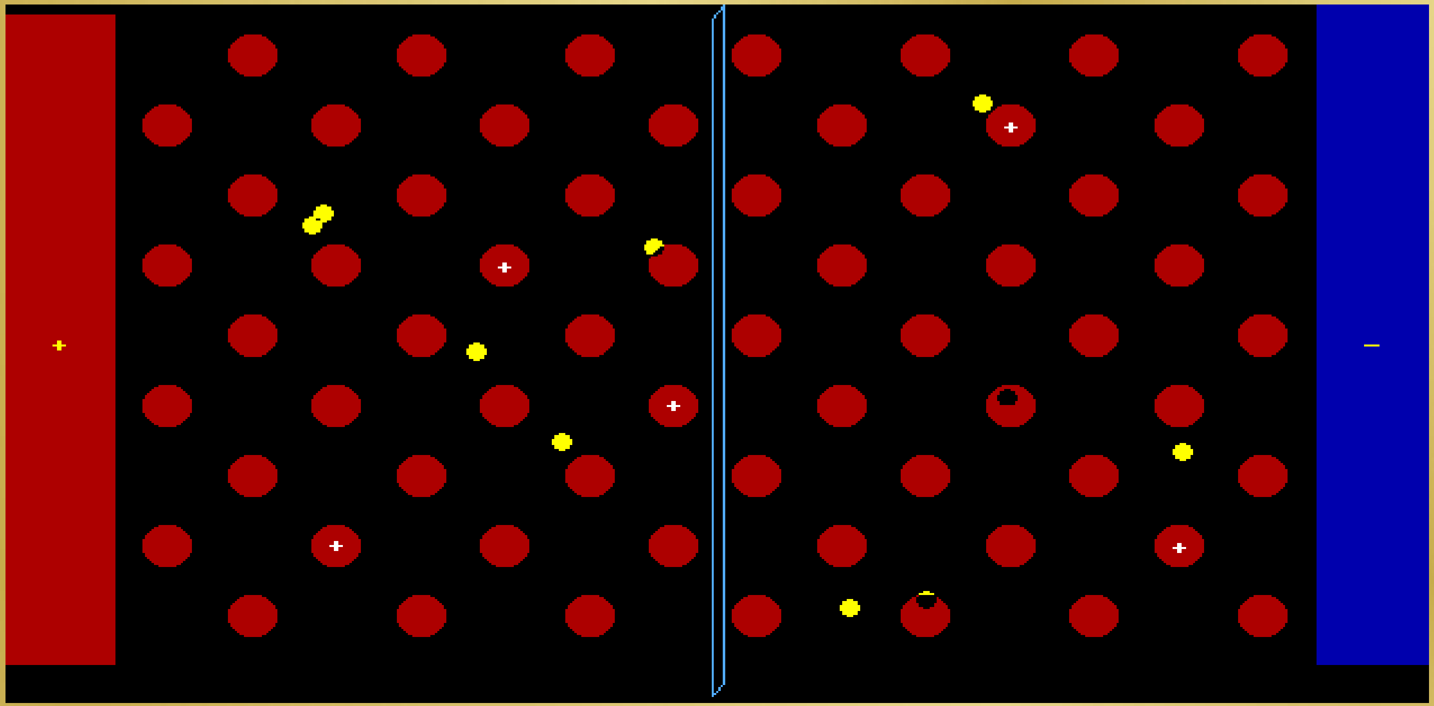
A cooler object's molecules and atoms will show less movement.

CONDUCTORS

A conductor is a material that current can pass through easily.

Eg: Metal, Paper clips, Silver,Wires,Water…





The above animation shows the electrons (yellow) flowing through a conductor. The conventional flow of electrons is from a positive charge towards a negative. This direction of flow was assumed, long before there was any method to check the actual direction the electrons moved in. We now know the electrons do actually flow from the negative to the positive.

This flow of electrons create **CURRENT**.

NON-CONDUCTORS

- Do not allow electricity to pass through easily.

1) Insulators
2) Rubber
3) Plastic
4) Glass

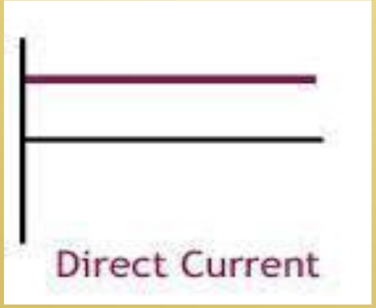
Types Of Current

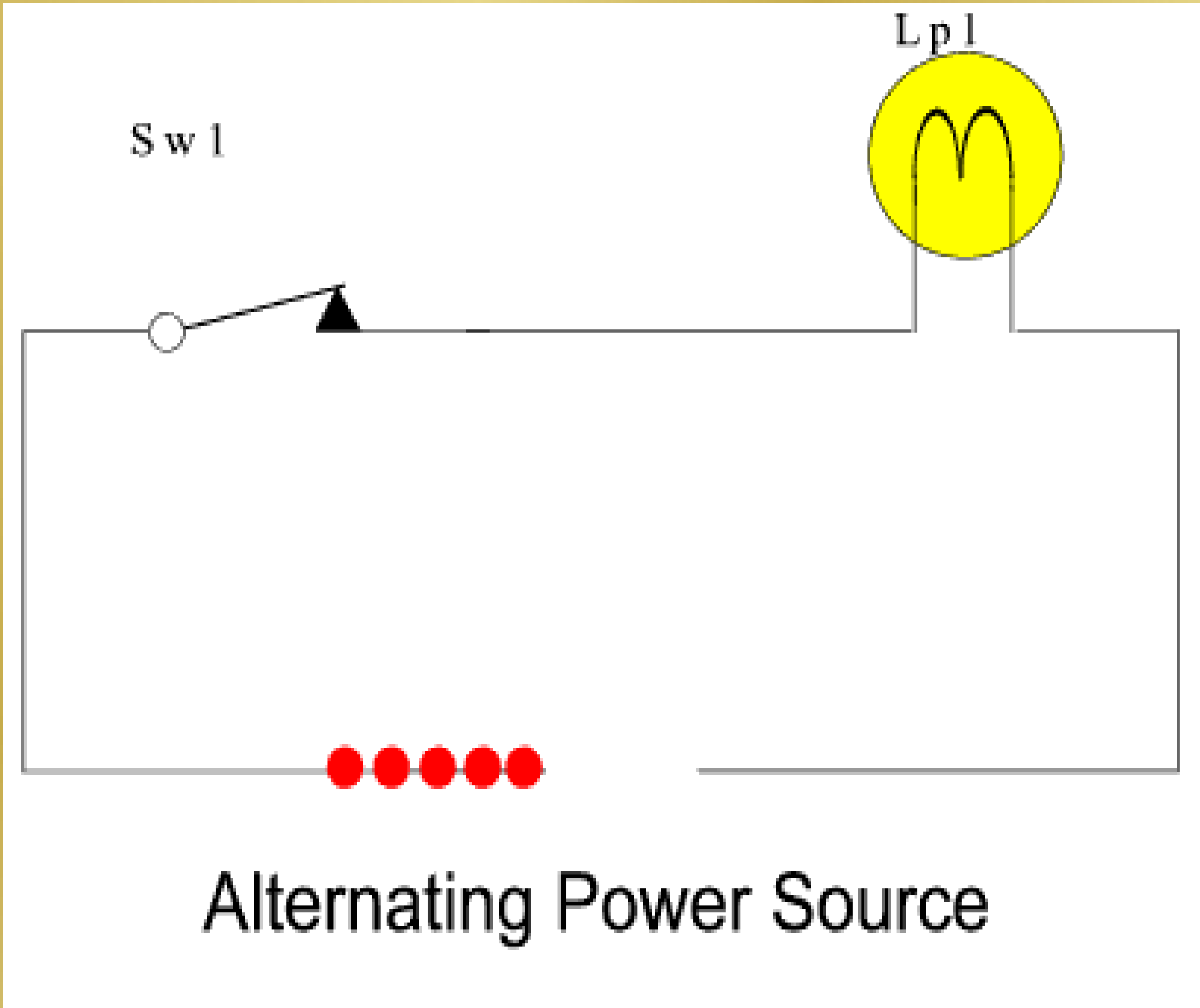
ALTERNATING CURRENT (AC)

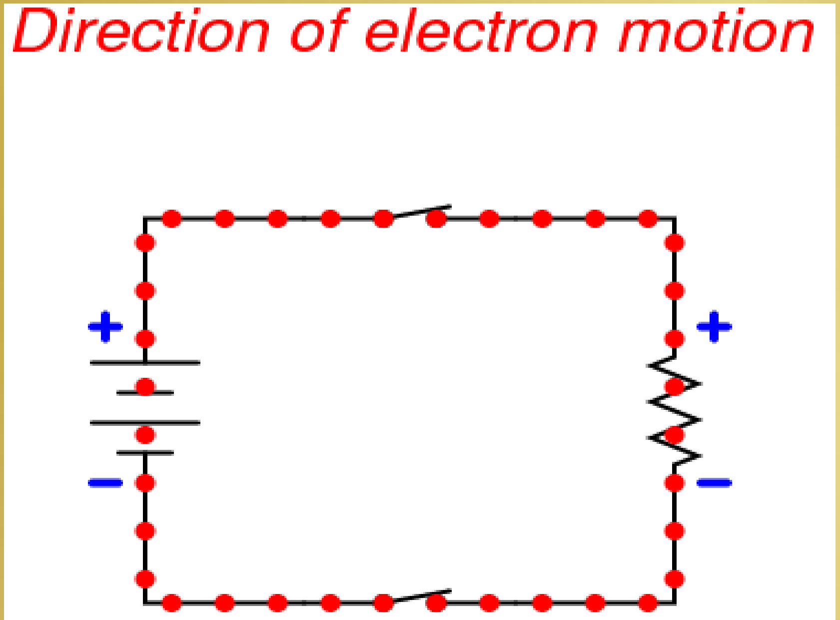
- It is the current of magnitude varying with time.
- It reverses its direction.
- Obtained from A.C Generator and mains.

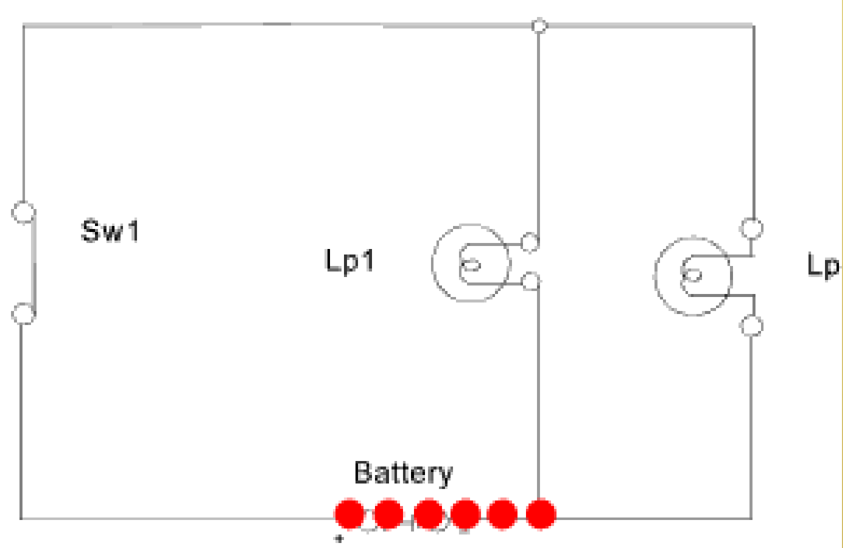
DIRECT CURRENT (DC)

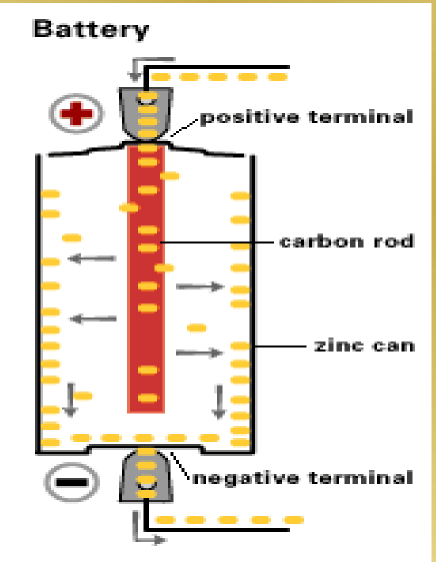
- It is the current of constant magnitude.
- It flows in one direction in the circuit.
- Obtained from cell or battery.




Sw1
Lp1
Alternating Power Source


Direction of electron motion
+
−
+
−


Sw1
Lp1
Lp
Battery


Battery
positive terminal
carbon rod
zinc can
negative terminal

DC

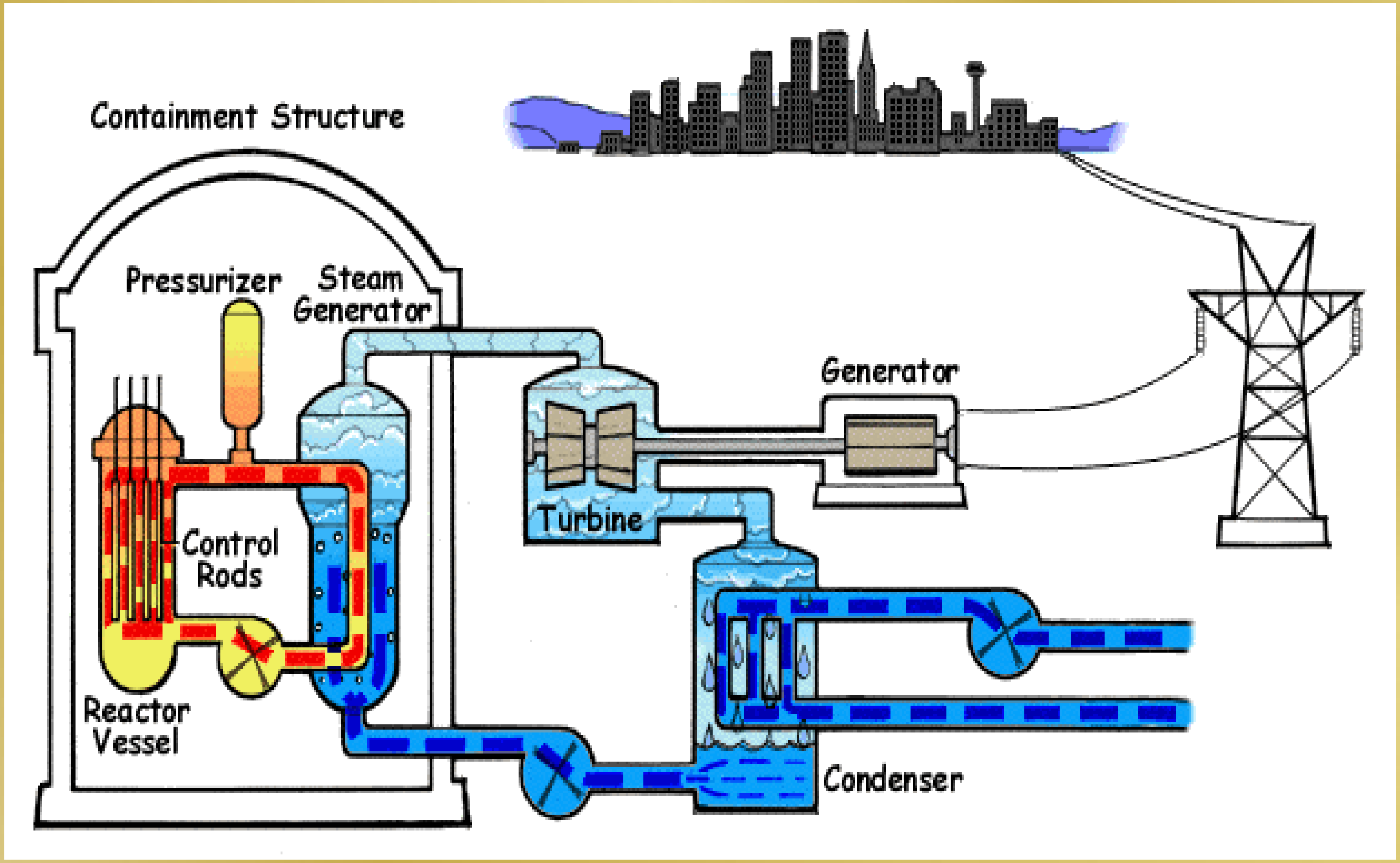
Battery Power

- Many small electrical appliances use batteries.
- Batteries are also a source of electrical energy
- Battery powered appliances also **convert** electrical energy into heat, light, sound and movement energy
- Can you think of some battery powered appliances for each source of energy?

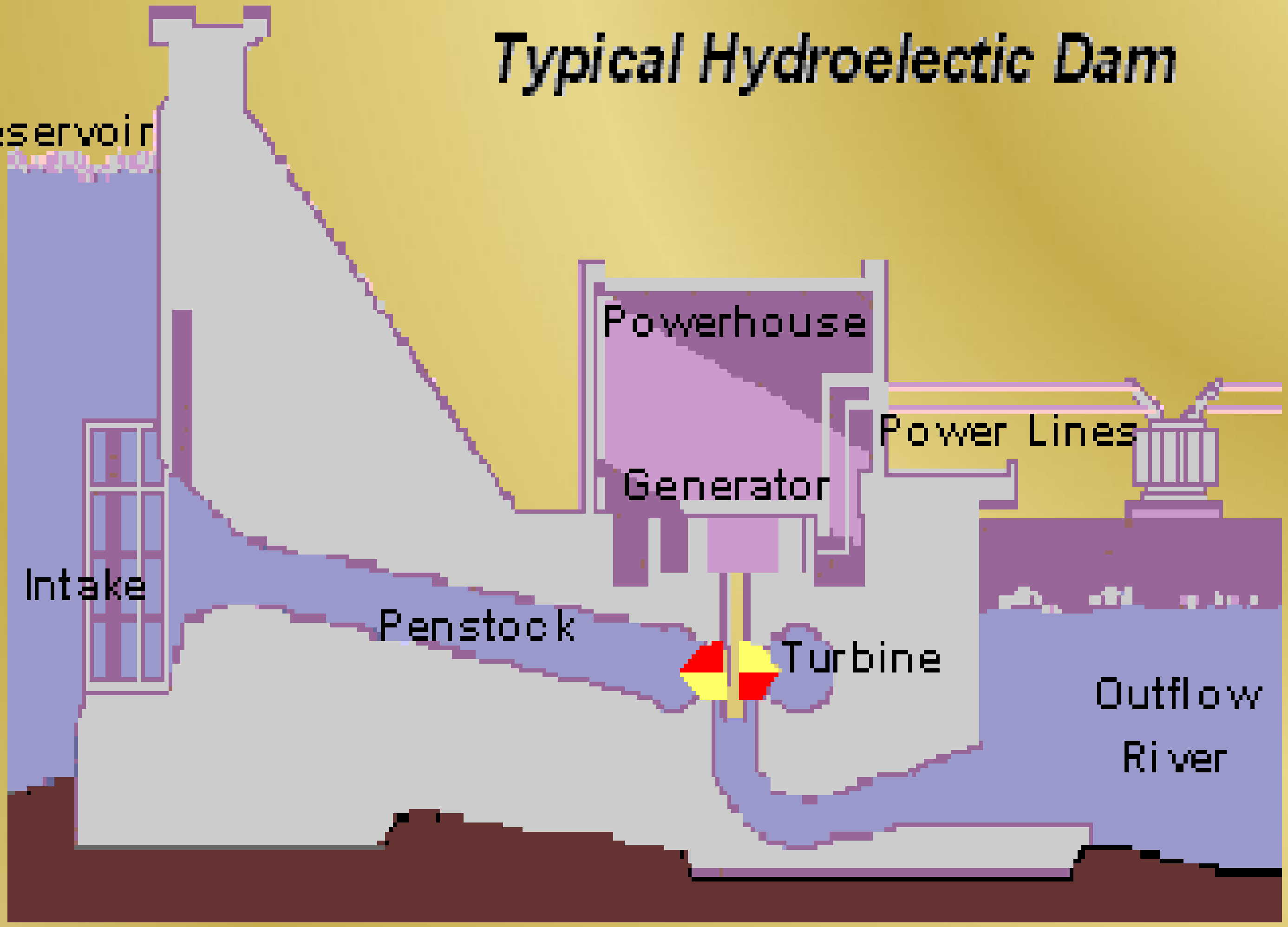
HOW IS ELECTRICITY GENERATED ????

Through Solar

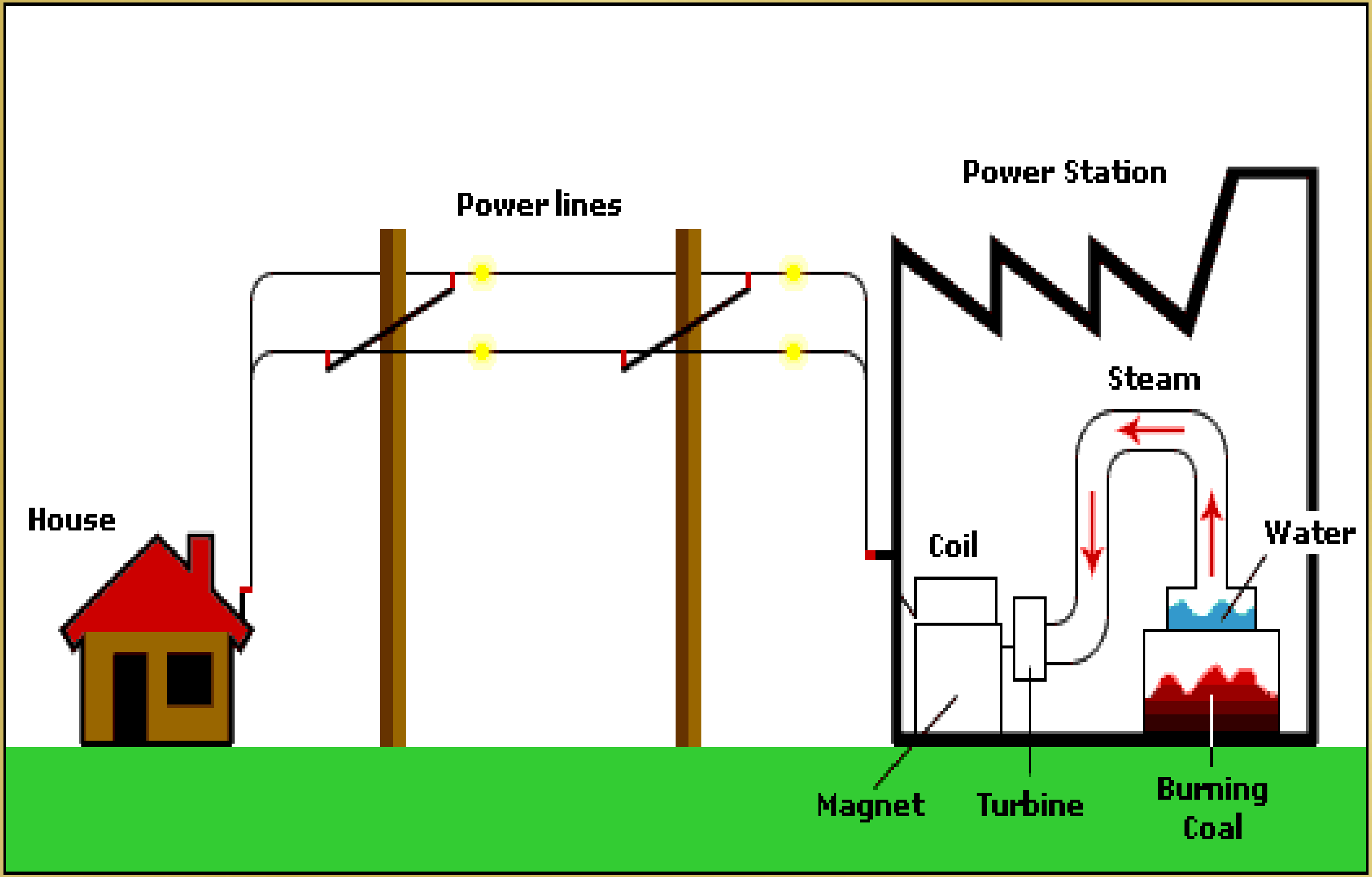
Nuclear Reactors



Typical Hydroelectic Dam



From Coal



Power Station
Power lines
Steam
House
Coil
Water
Magnet
Turbine
Burning
Coal

CURRENT SCENARIO !!!

- *"At the moment about 30 billion barrels of oil are consumed annually, and that is probably close to the maximum that will ever be possible. By the year 2030, some analysts say, oil production will be down to about half of that amount."*
- *"The use of nuclear fuels is a very controversial and debatable issue, as these highly hazardous elements cause a lot of pollution."*
- *These above statements surely questions the reliability factor of depending on the Non-renewable sources…*

IS THERE A SOLUTION ???

SOLUTION IS AS BRIGHT AS THE SUN

SOLAR ENERGY

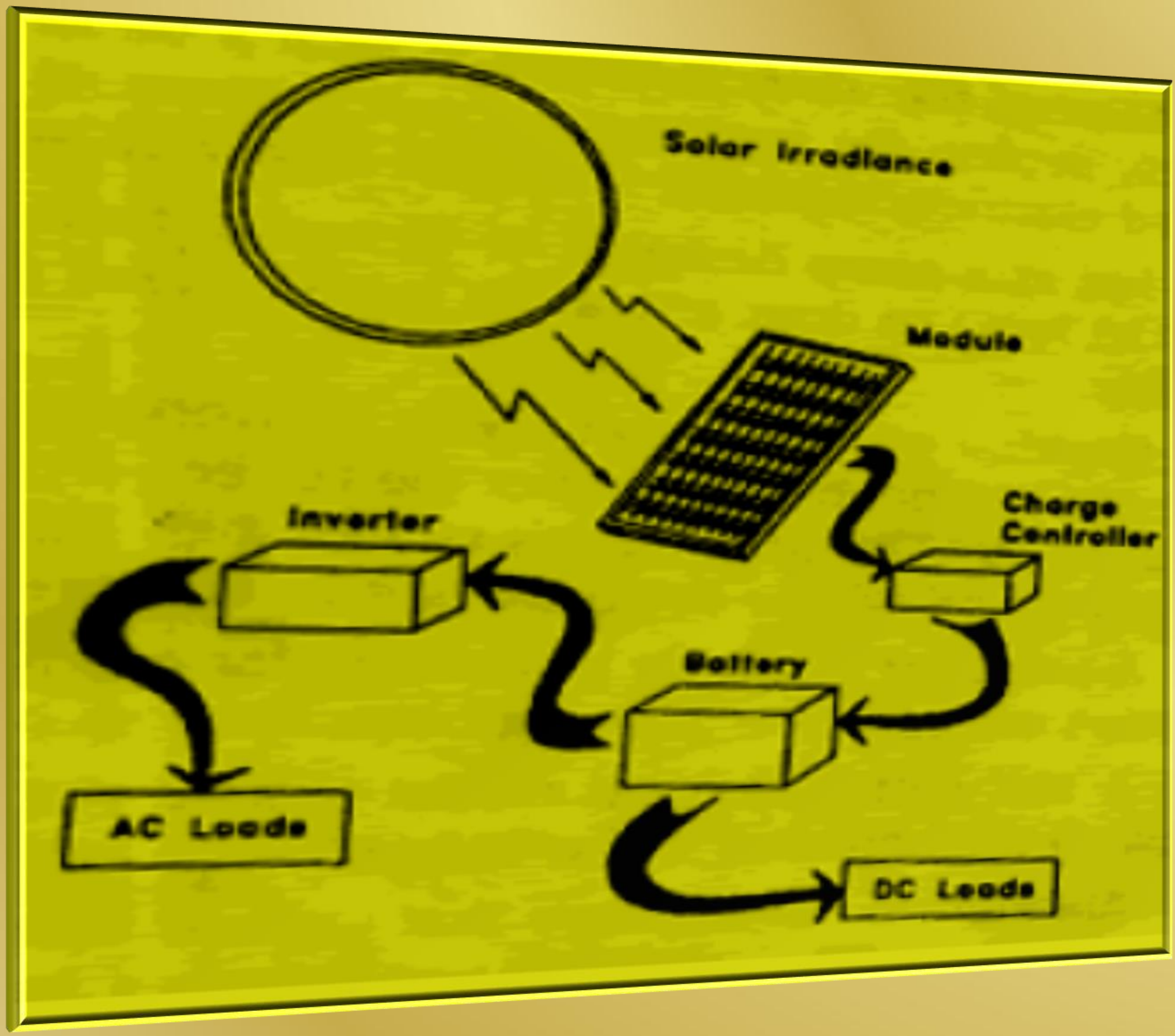
- Solar is something that is related with the Sun- the supreme source of energy.
- Solar energy is that which we receive directly from the sun.
- Solar power is the conversion of the sunlight into electricity either directly with photodiodes (Solar panels) or indirectly using concentrated solar power.

HOW TO TRAP SOLAR ENERGY ?

- SOLAR PANELS
- They use light energy from the sun to generate electricity through photovoltaic effect.

- CSP
- Concentrated Solar Power use mirrors or lenses to concentrate a large area of sunlight onto a small area.

SOLAR PANELS : : WORKING



- Photovoltaic modules (solar panels) convert sunlight into electricity.

- Wire conducts the electricity to batteries where it is stored until needed.

- On the way to the batteries, the electrical current passes through a controller (regulator) which will shut off the flow when the batteries become full.

Contd...

- For some appliances, electricity can be used directly from the batteries. This is "direct current" and it powers "DC" appliances such as car headlights, flashlights, portable radios, etc.

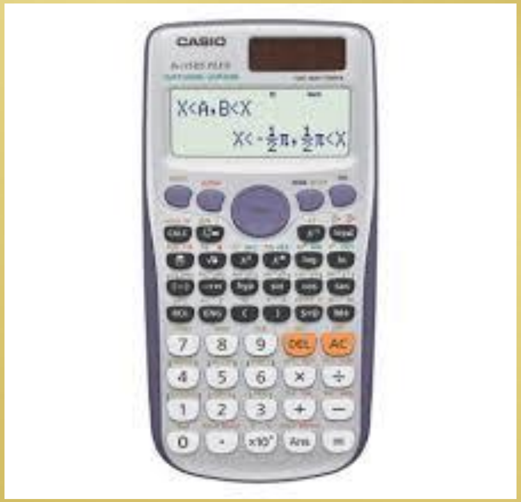
- To run most appliances found in the home, however, we need to "AC".

- This we can produce utilizing an inverter which transforms DC electricity from the batteries into AC.

APPLICATIONS

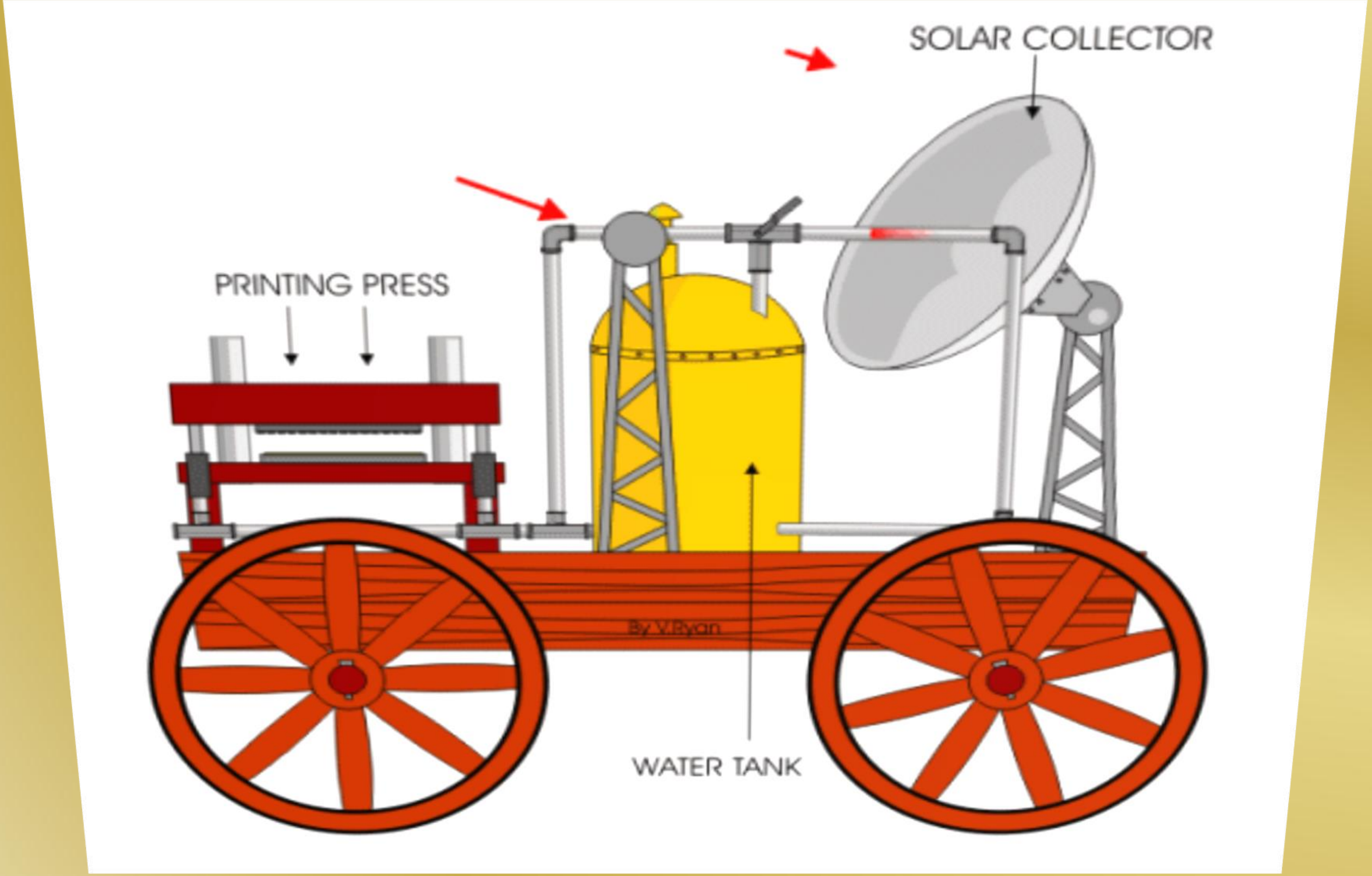
1) Household Applications
2) Industrial Applications
3) Entertainment
4) Robotics

HOUSEHOLD APPLICATION


CASIO

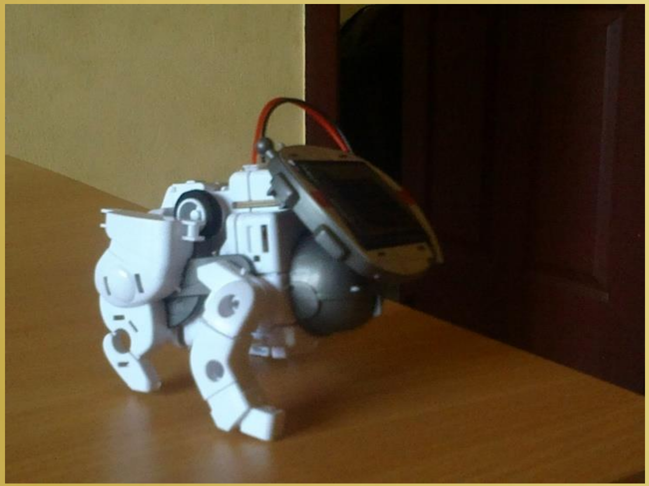
INDUSTRIAL APPLICATION

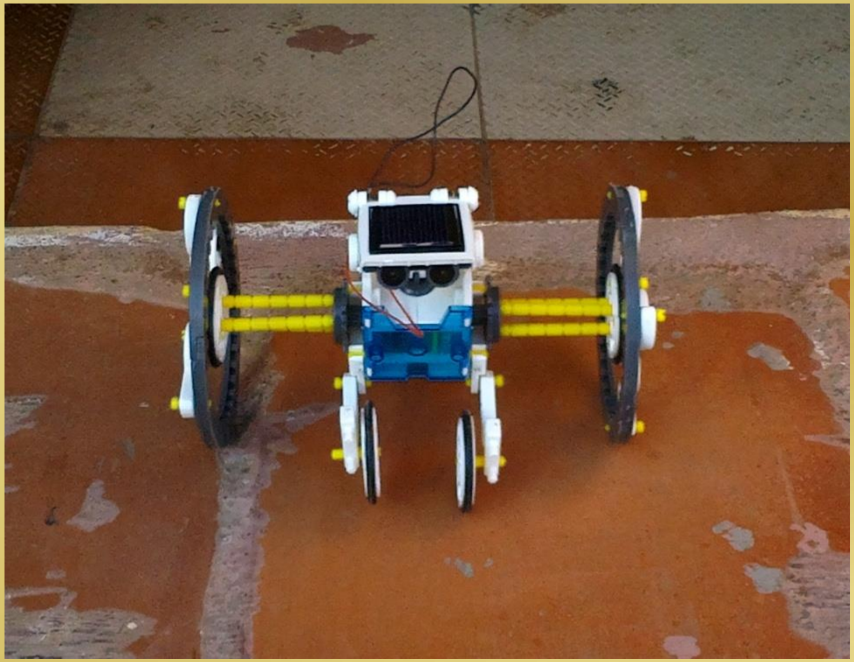
VINTAGE...

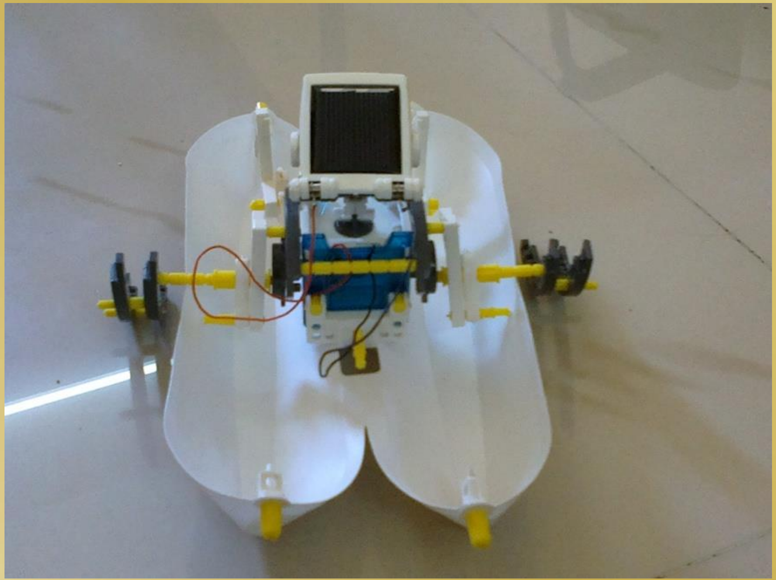


ENTERTAINMENT

ROBOTICS







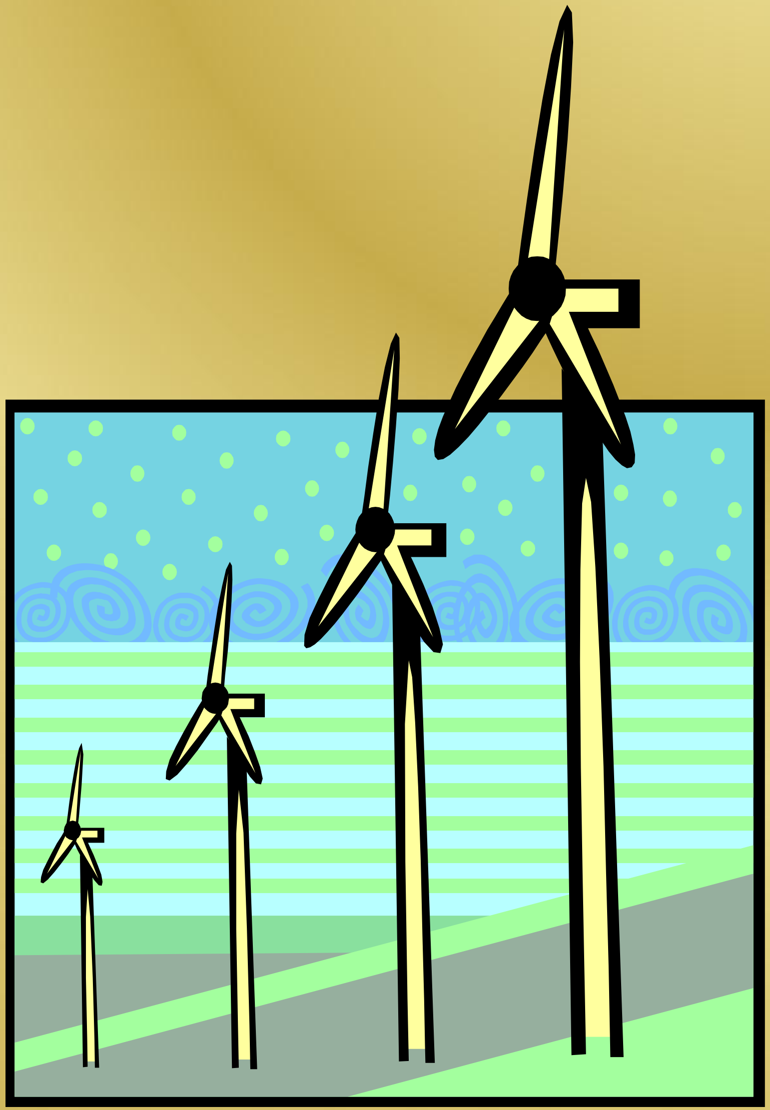





WIND ENERGY

WIND POWER

- What is it?
- How does it work?
- Efficiency



WIND POWER - What is it?

- Winds are influenced by the ground surface at altitudes up to 100 meters.
- Wind is slowed by the surface roughness and obstacles.
- When dealing with wind energy, we are concerned with surface winds.
- A wind turbine obtains its power input by converting the force of the wind into a torque (turning force) acting on the rotor blades.
- The amount of energy which the wind transfers to the rotor depends on the density of the air, the rotor area, and the wind speed.

WINDMILL DESIGN

- A Windmill captures wind energy and then uses a generator to convert it to electrical energy.
- The design of a windmill is an integral part of how efficient it will be.
- When designing a windmill, one must decide on the size of the turbine, and the size of the generator.

Wind Turbines

LARGE TURBINES:

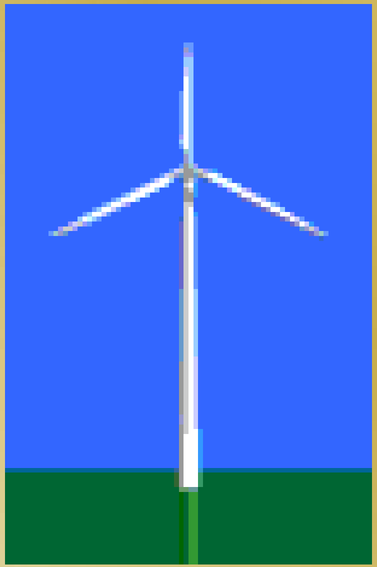
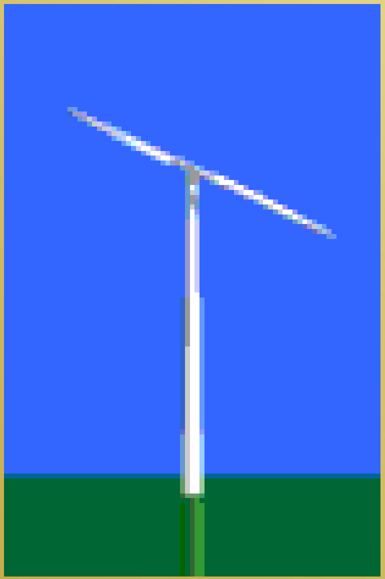
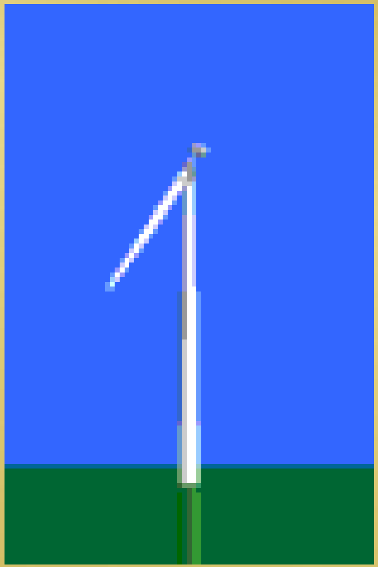
- Able to deliver electricity at lower cost than smaller turbines, because foundation costs, planning costs, etc. are independent of size.
- Well-suited for offshore wind plants.
- In areas where it is difficult to find sites, one large turbine on a tall tower uses the wind extremely efficiently.

SMALL TURBINES:

- Local electrical grids may not be able to handle the large electrical output from a large turbine, so smaller turbines may be more suitable.
- High costs for foundations for large turbines may not be economical in some areas.
- Landscape considerations

Wind Turbines: Number of Blades

- Most common design is the three-bladed turbine. The most important reason is the stability of the turbine. A rotor with an odd number of rotor blades (and at least three blades) can be considered to be similar to a disc when calculating the dynamic properties of the machine.
- A rotor with an even number of blades will give stability problems for a machine with a stiff structure. The reason is that at the very moment when the uppermost blade bends backwards, because it gets the maximum power from the wind, the lowermost blade passes into the wind shade in front of the tower.

ADVANTAGES

- The wind blows day and night, which allows windmills to produce electricity throughout the day. (Faster during the day)
- Wind energy is a domestic, renewable source of energy that generates no pollution and has little environmental impact. Up to 95 percent of land used for wind farms can also be used for other profitable activities including ranching, farming and forestry.
- The decreasing cost of wind power and the growing interest in renewable energy sources should ensure that wind power will become a viable energy source.