Energy

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Energy is the ability to do work or effect change.

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Energy exists in many different forms.

Electrical energy: Energy carried by electrons in motion.

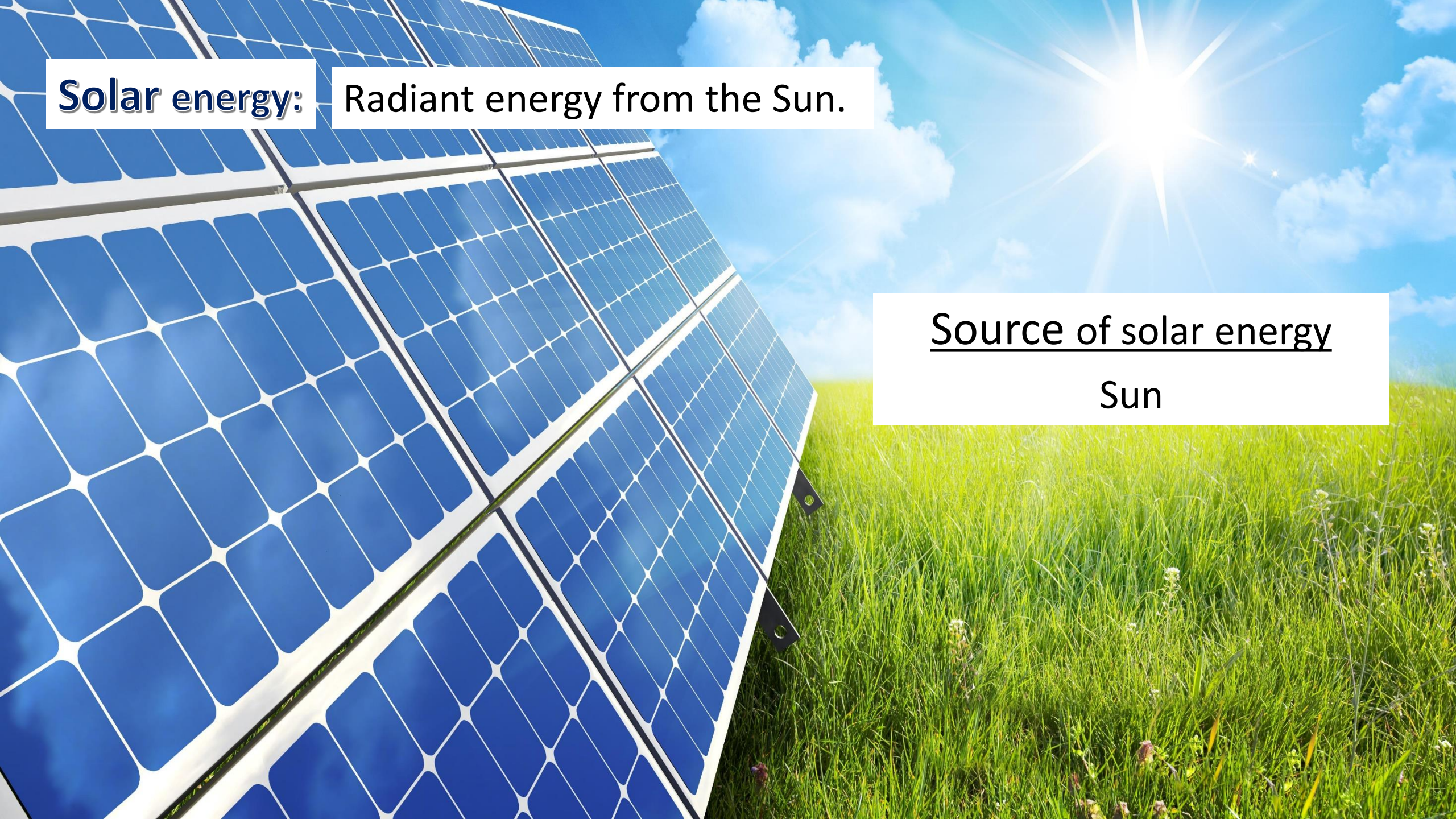
Electrical energy:

Sources of electrical energy

Power plants

Batteries

Generators



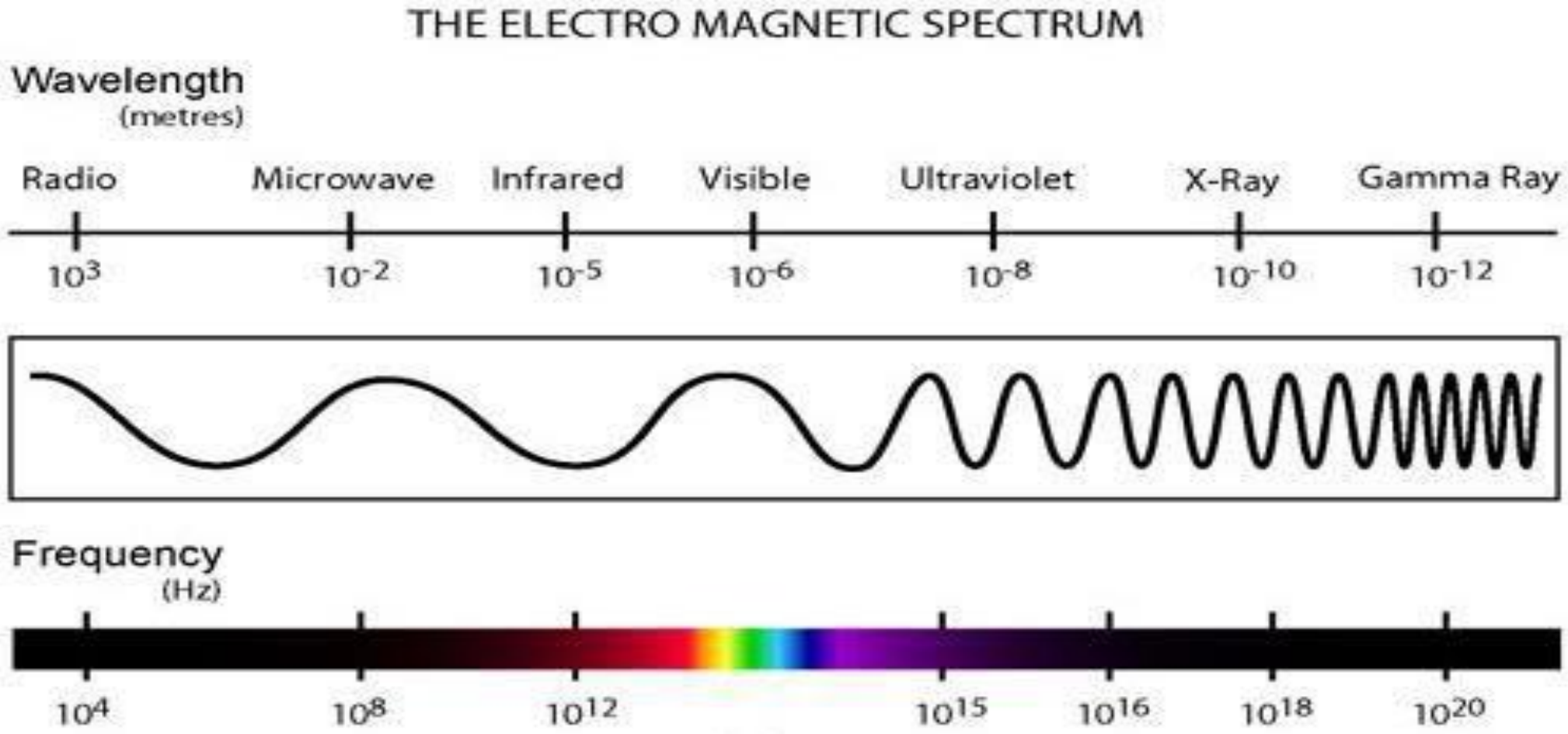
Solar energy: Radiant energy from the Sun.

Source of solar energy

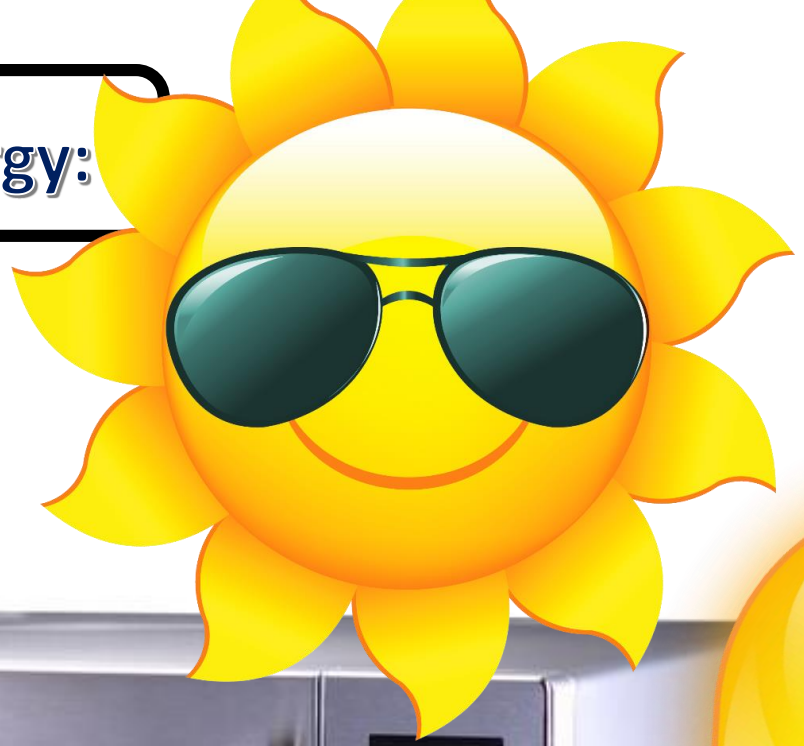
Sun

Radiant energy:

Energy carried by electromagnetic radiation.
(Includes visible light, as well as solar energy)



Radiant energy:



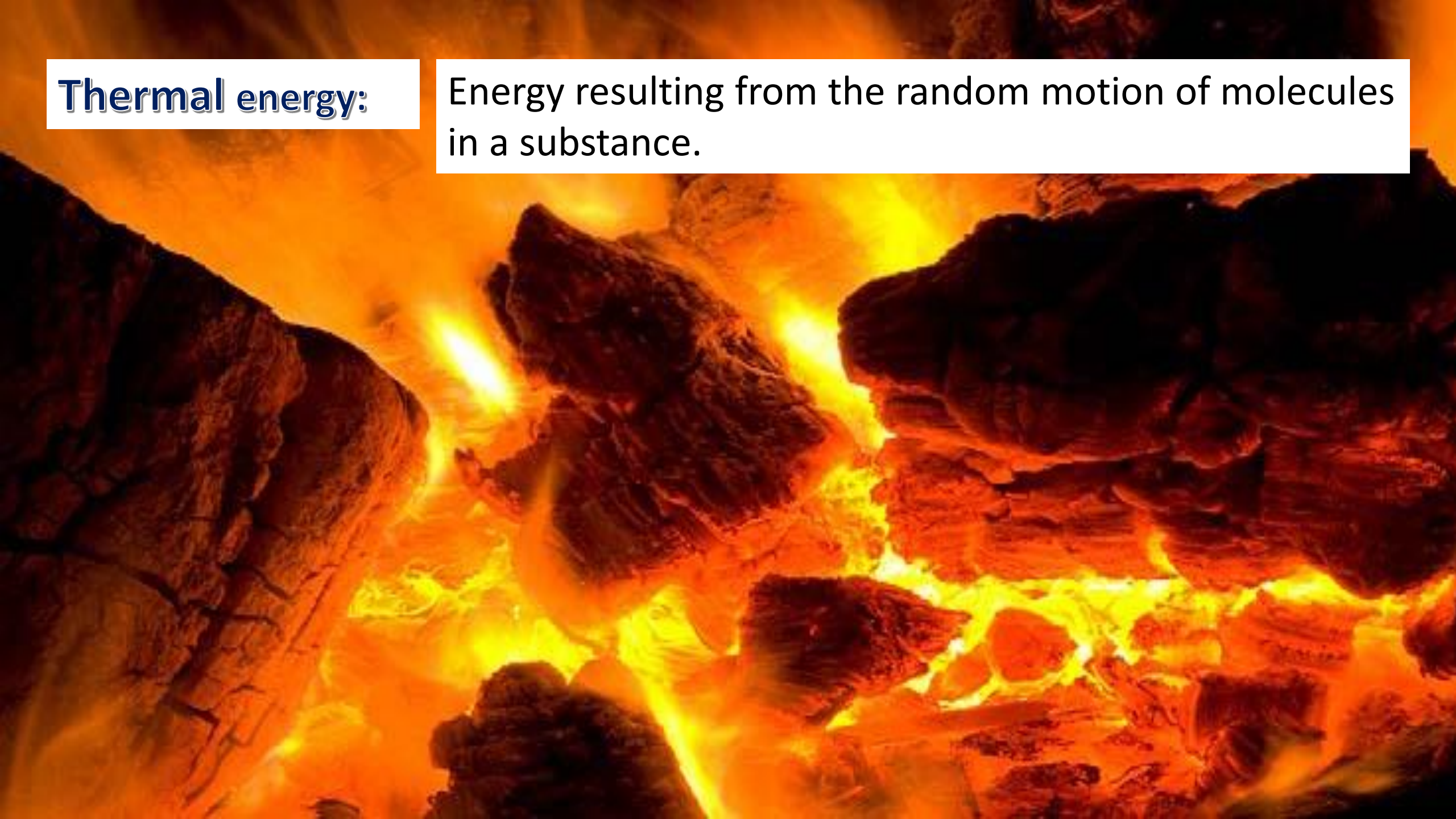
Sources of radiant energy

Light bulbs

The Sun

Cellphones

Microwave ovens



Thermal energy:

Energy resulting from the random motion of molecules in a substance.

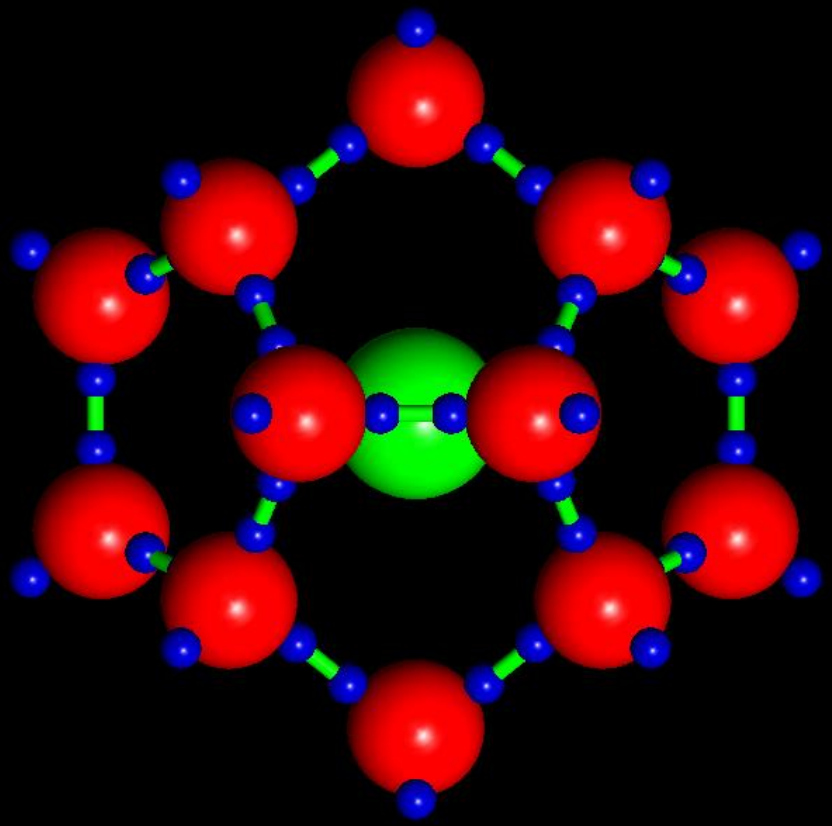
Thermal energy:

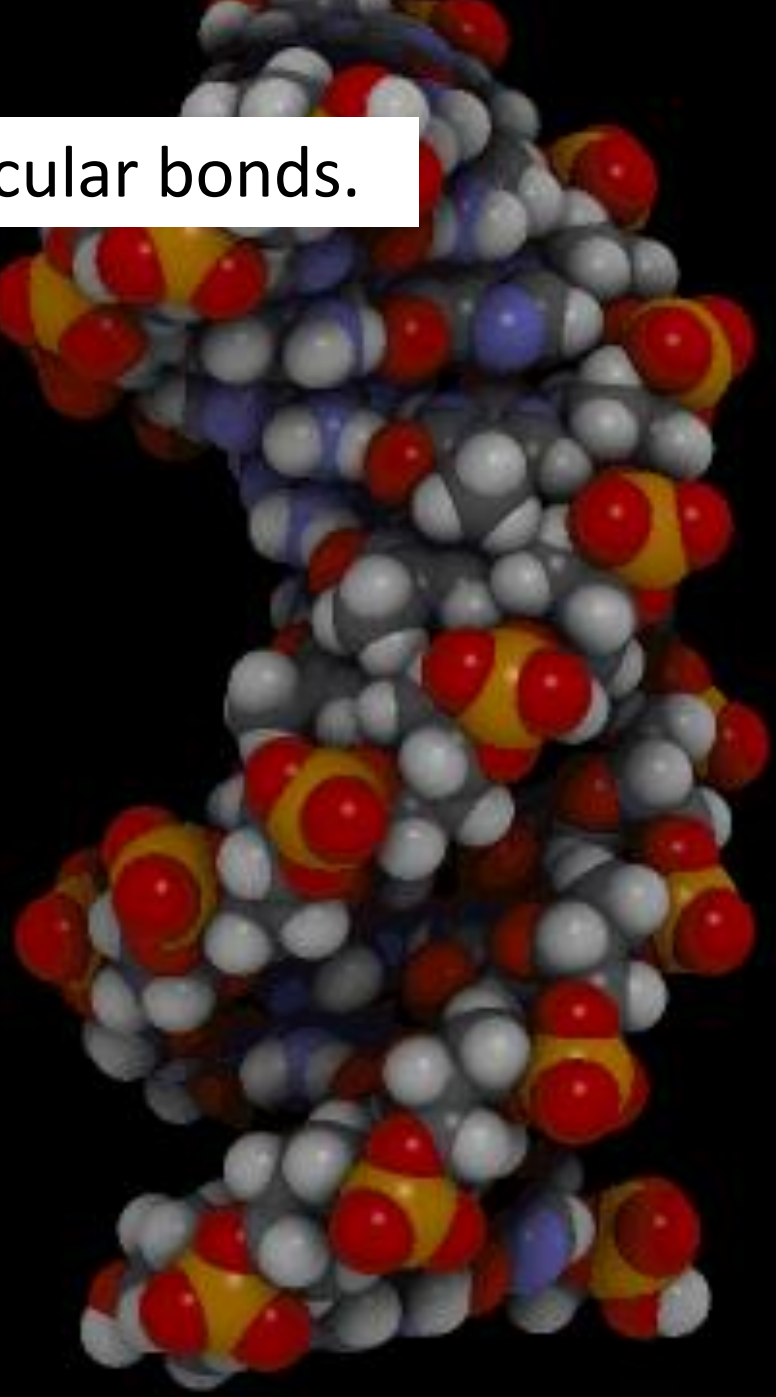
Sources of thermal energy

Fire

Heating elements

Chemical energy: Energy stored in molecular bonds.





Chemical energy:

Sources of chemical energy

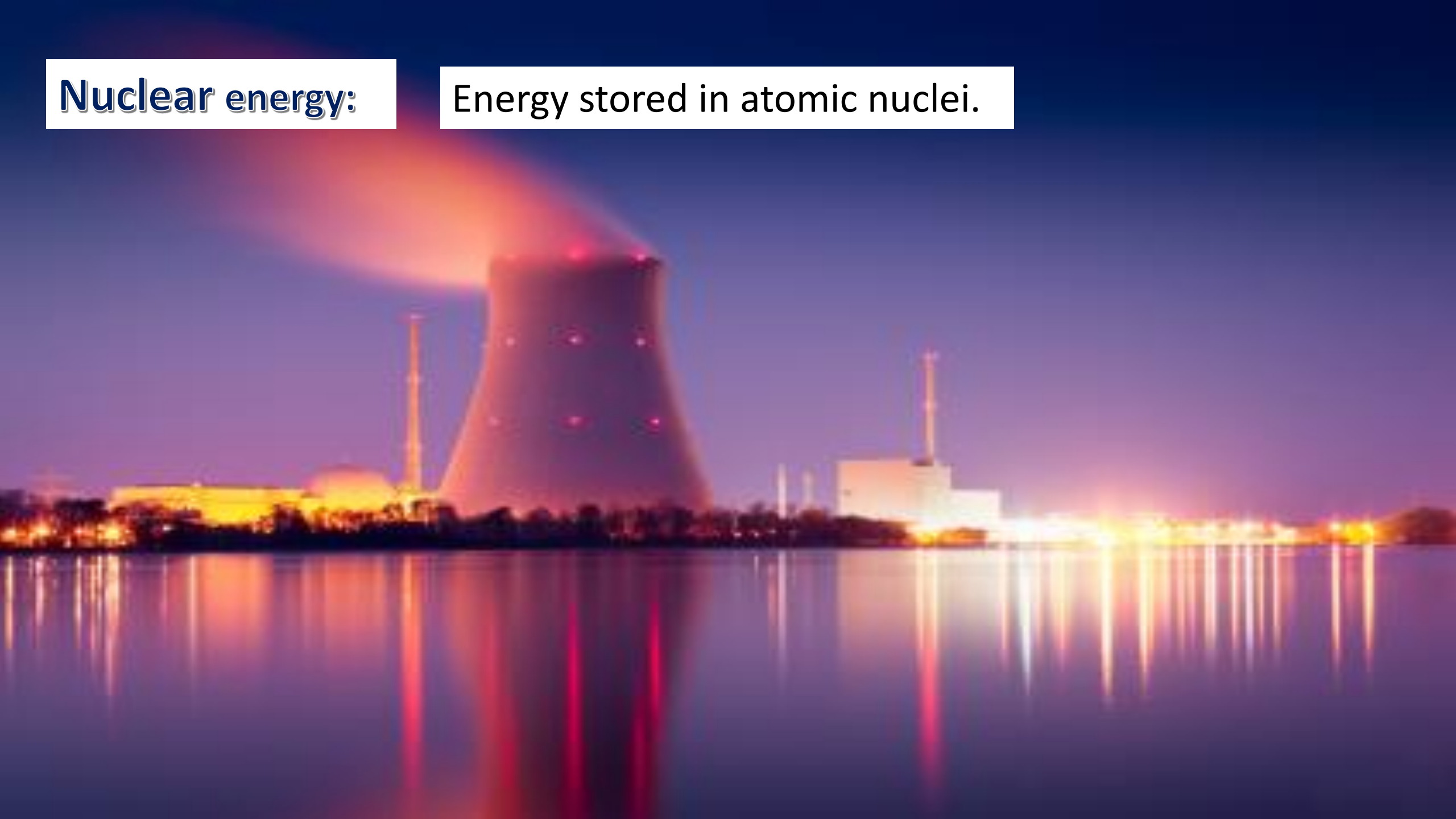
Fossil fuels

Food

Nuclear energy:

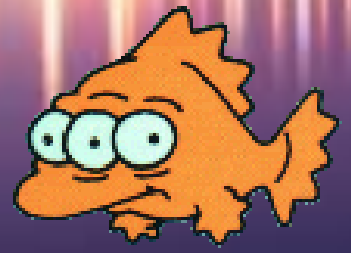
Nuclear energy:

Energy stored in atomic nuclei.

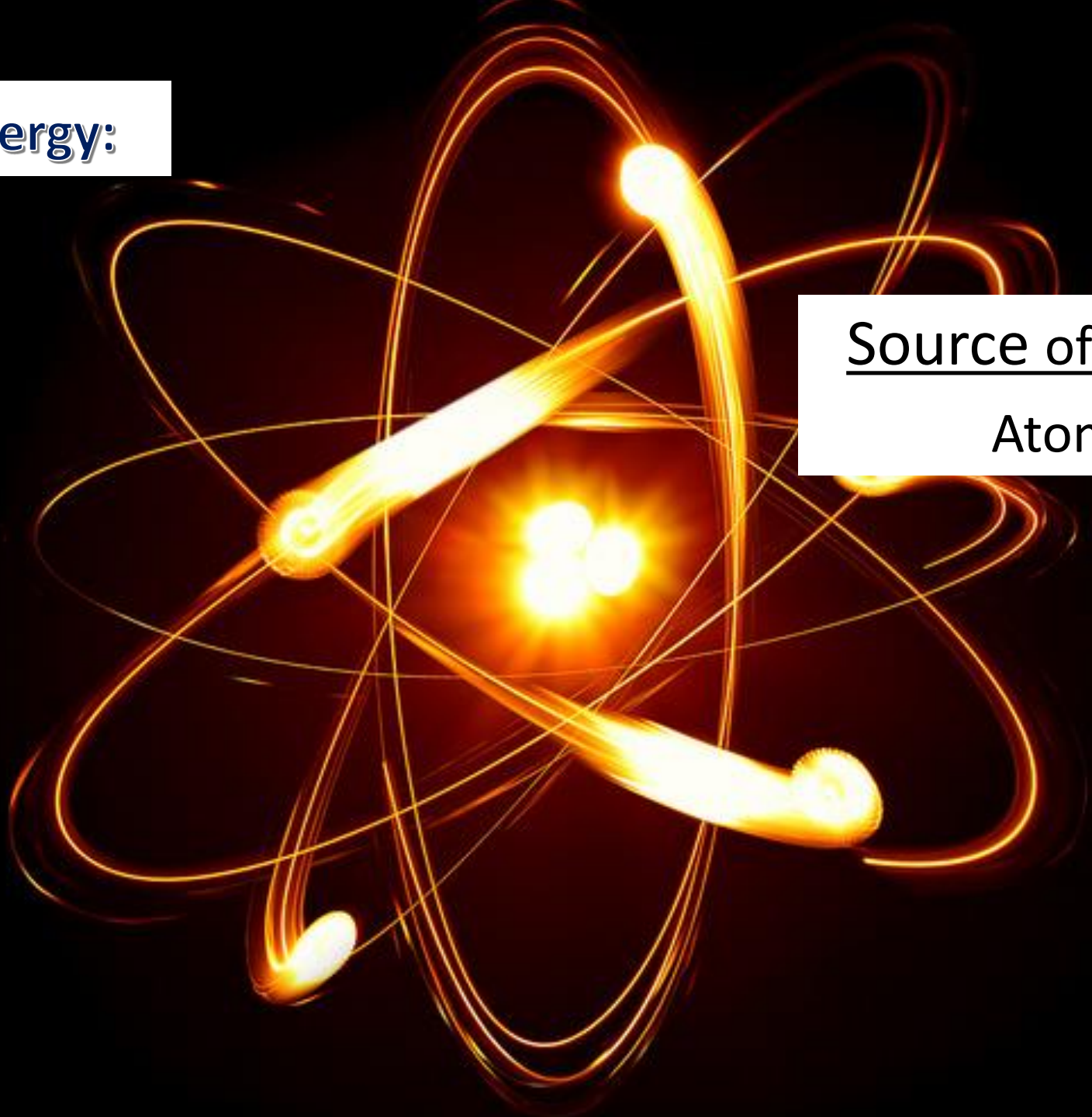


Nuclear energy:

Energy stored in atomic nuclei.



Nuclear energy:



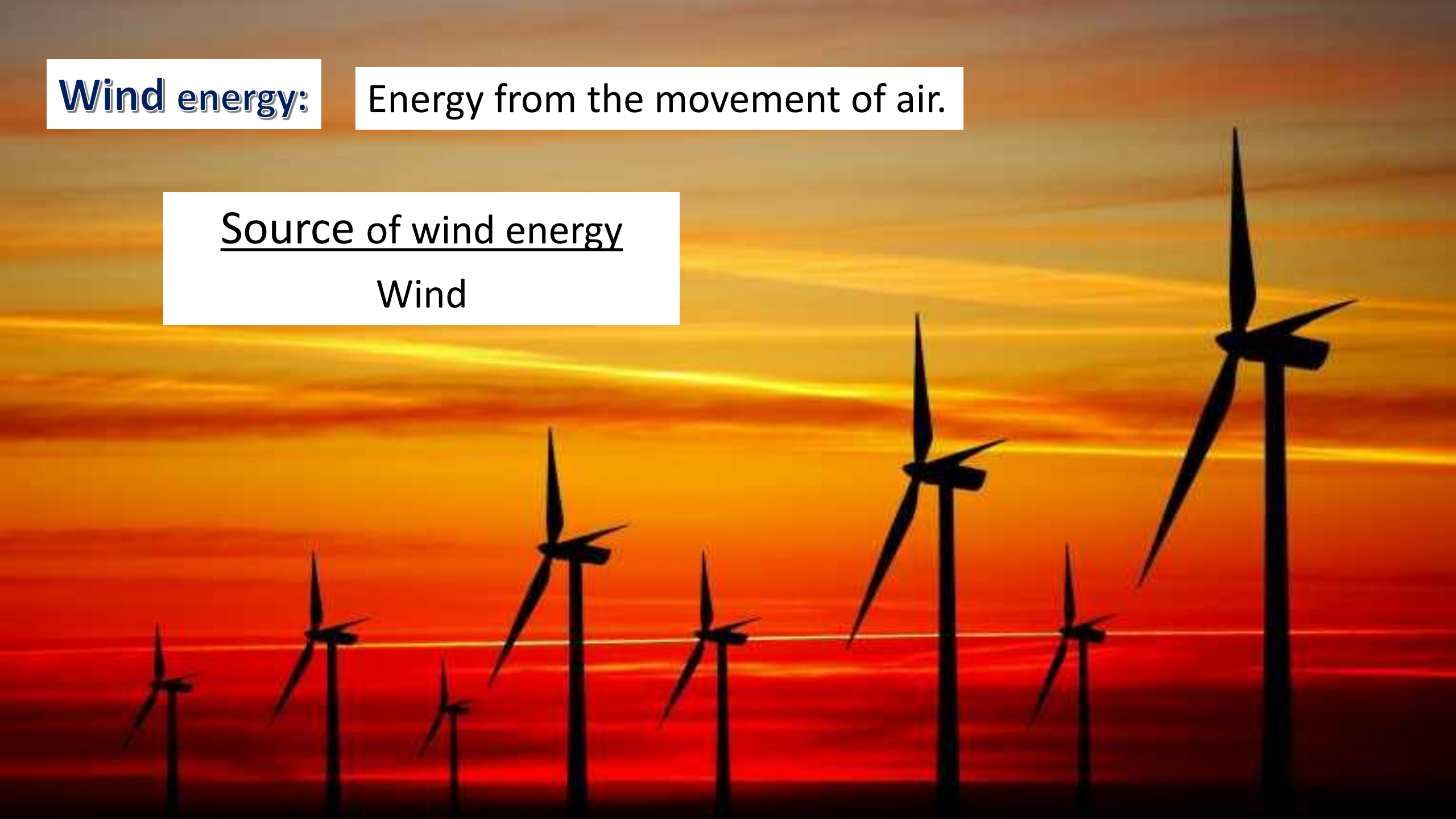
Source of nuclear energy

Atomic nuclei

Nuclear energy:

Source of nuclear energy

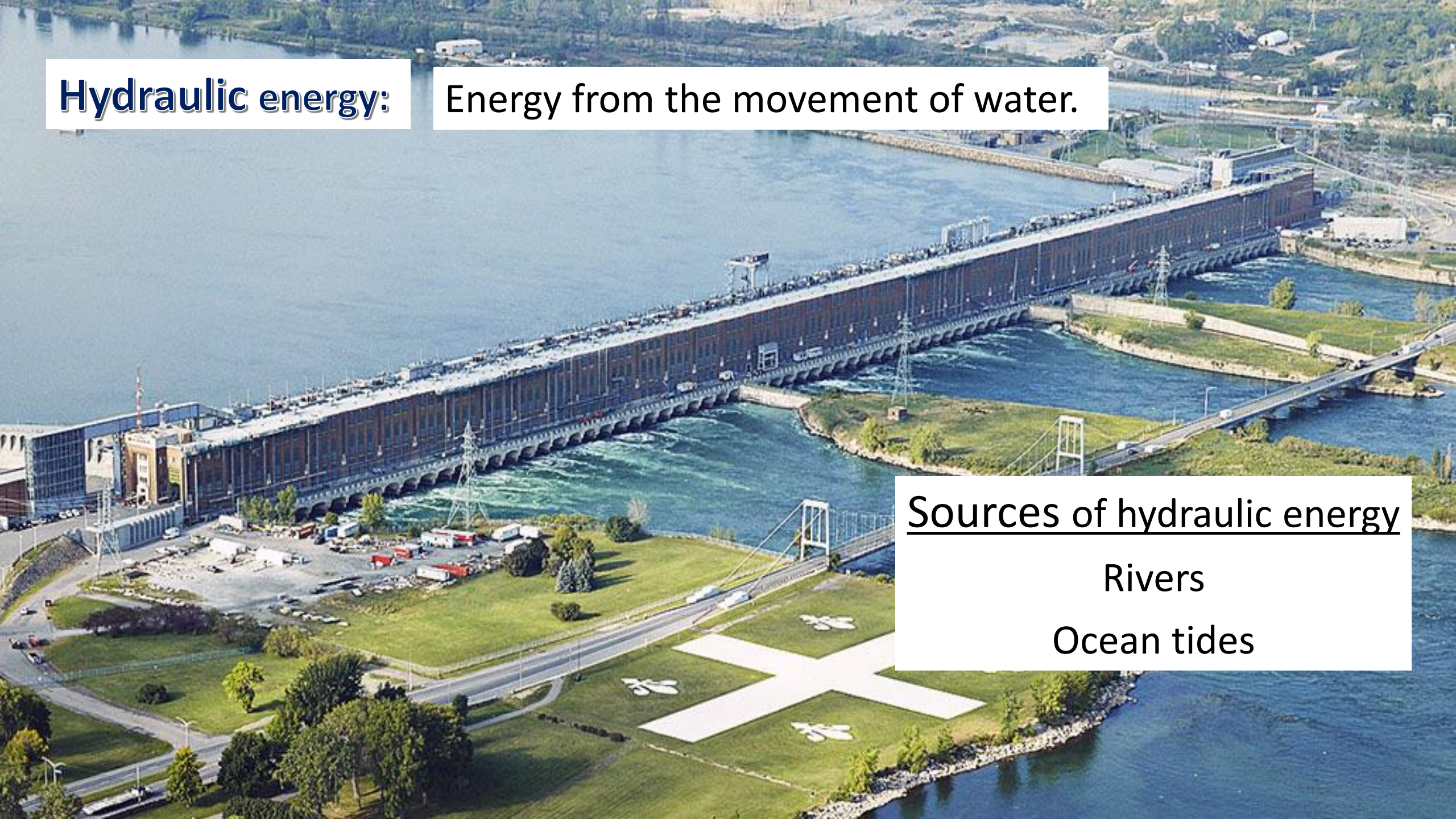
Atomic nuclei



Wind energy: Energy from the movement of air.

Source of wind energy

Wind

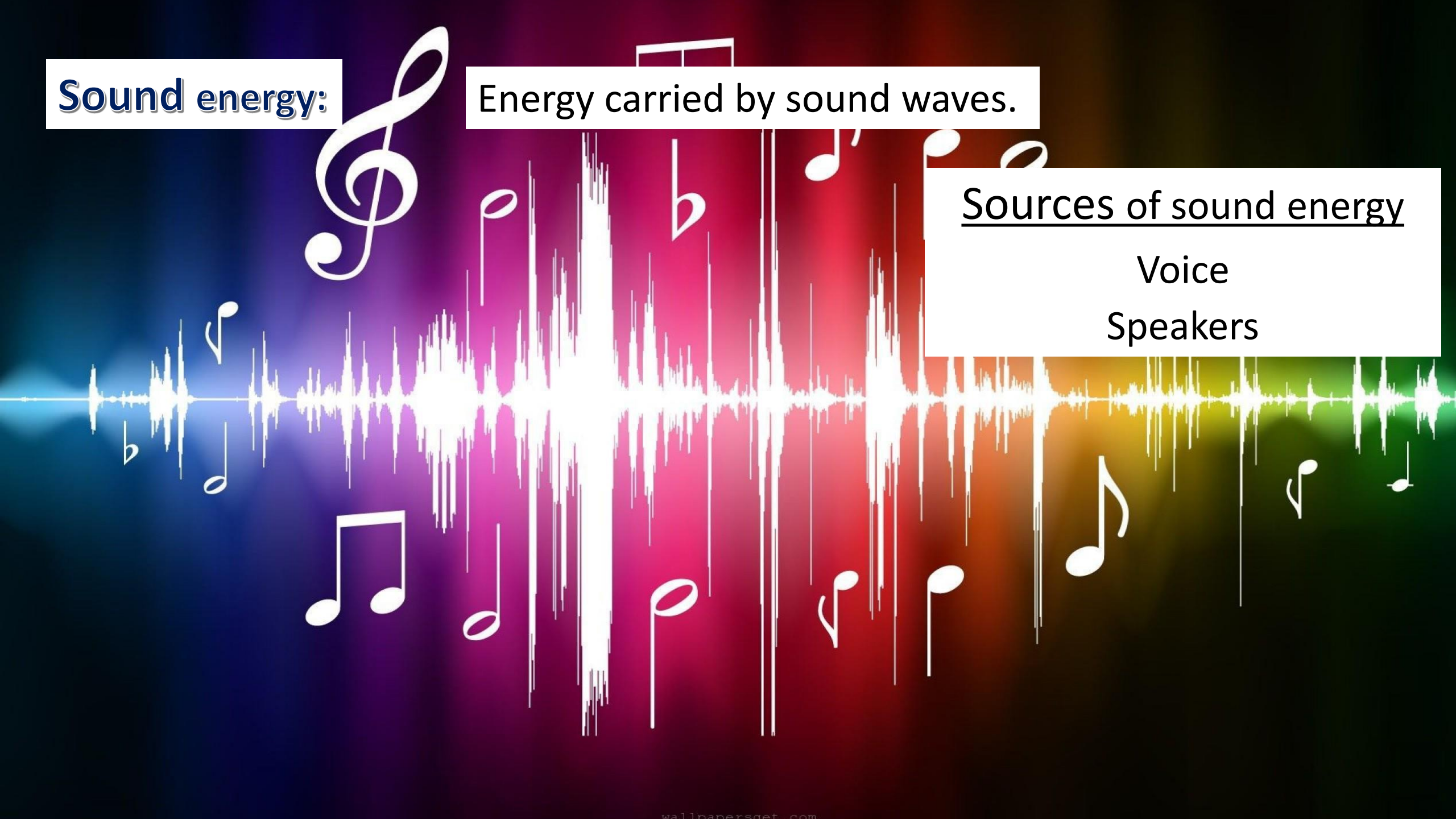


Hydraulic energy: Energy from the movement of water.

Sources of hydraulic energy

Rivers

Ocean tides



Sound energy:

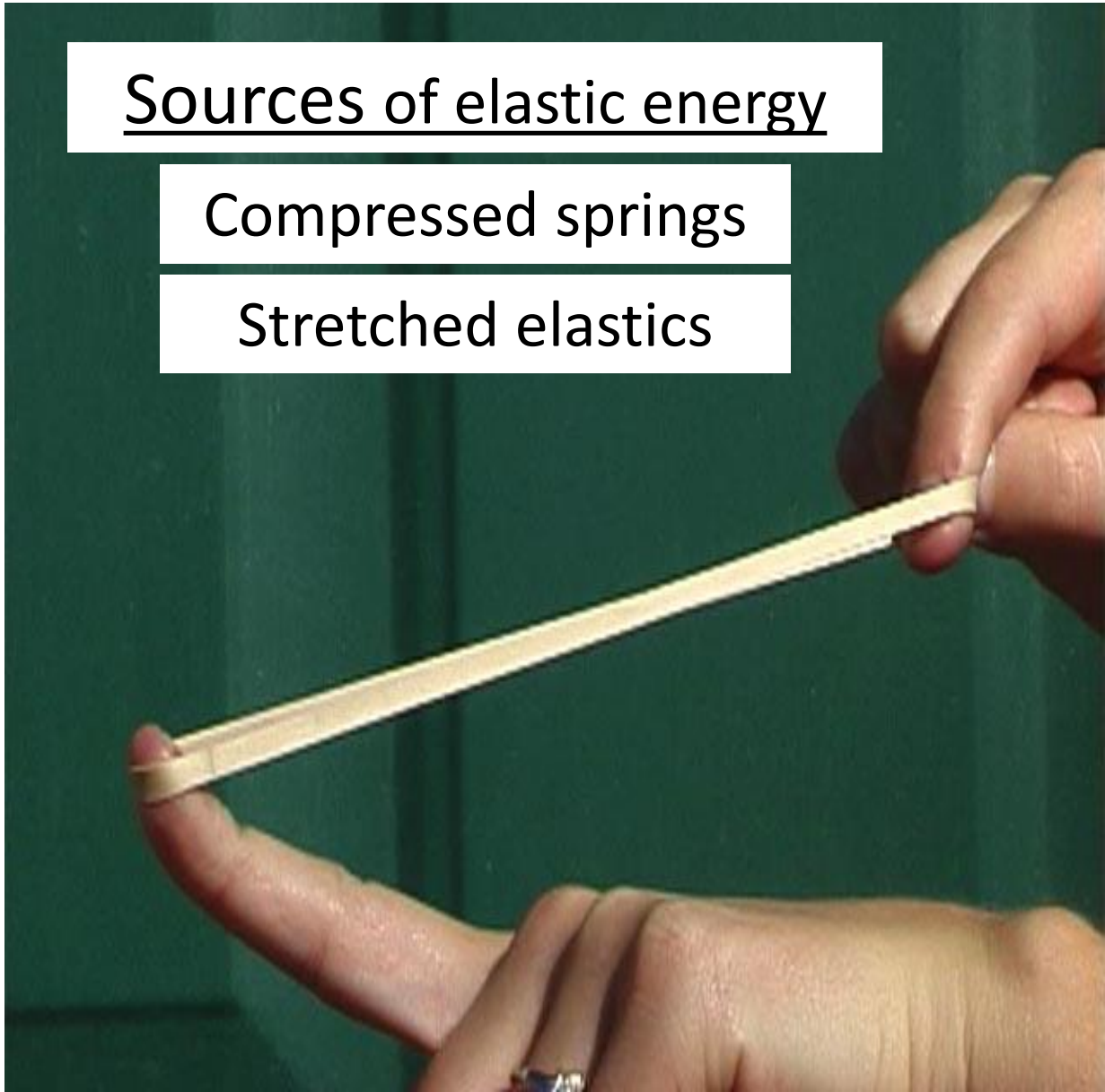
Energy carried by sound waves.

Sources of sound energy

Voice

Speakers

Elastic energy: Energy stored in an object due to its compression or extension.

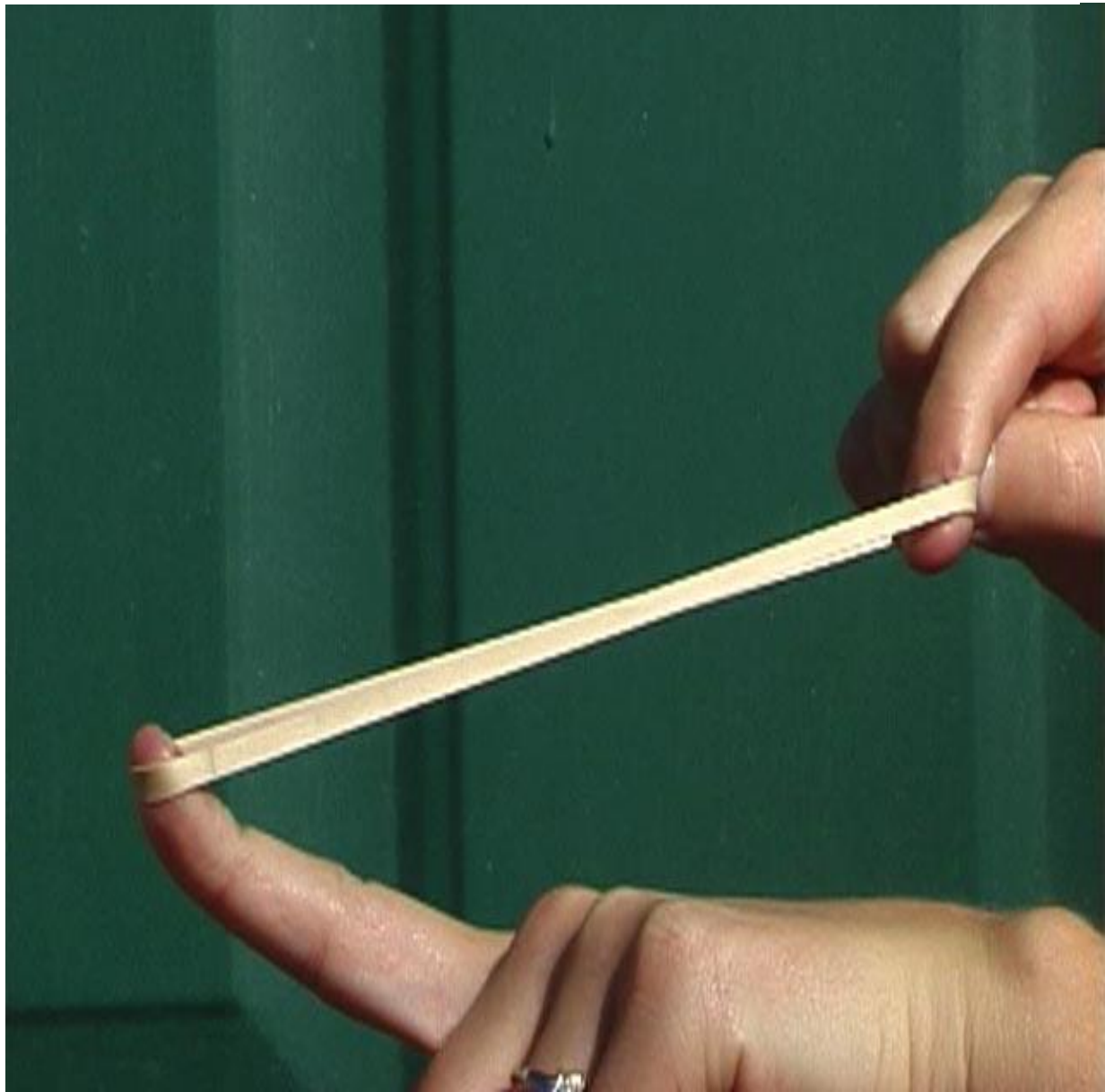


Sources of elastic energy

Compressed springs

Stretched elastics

Elastic energy: Energy stored in an object due to its compression or extension.



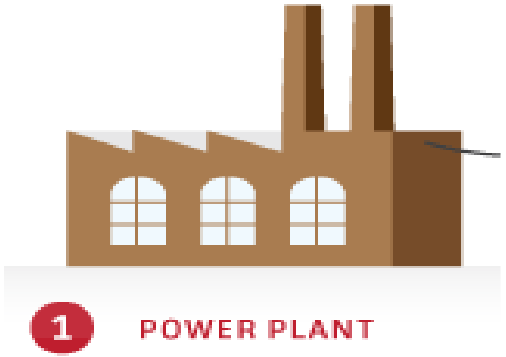
Law of Conservation of Energy:

Energy can be neither created nor destroyed.

- Energy can be transmitted (from one place to another).
- Energy can be transformed (from one form into another).
- The total energy does not change.

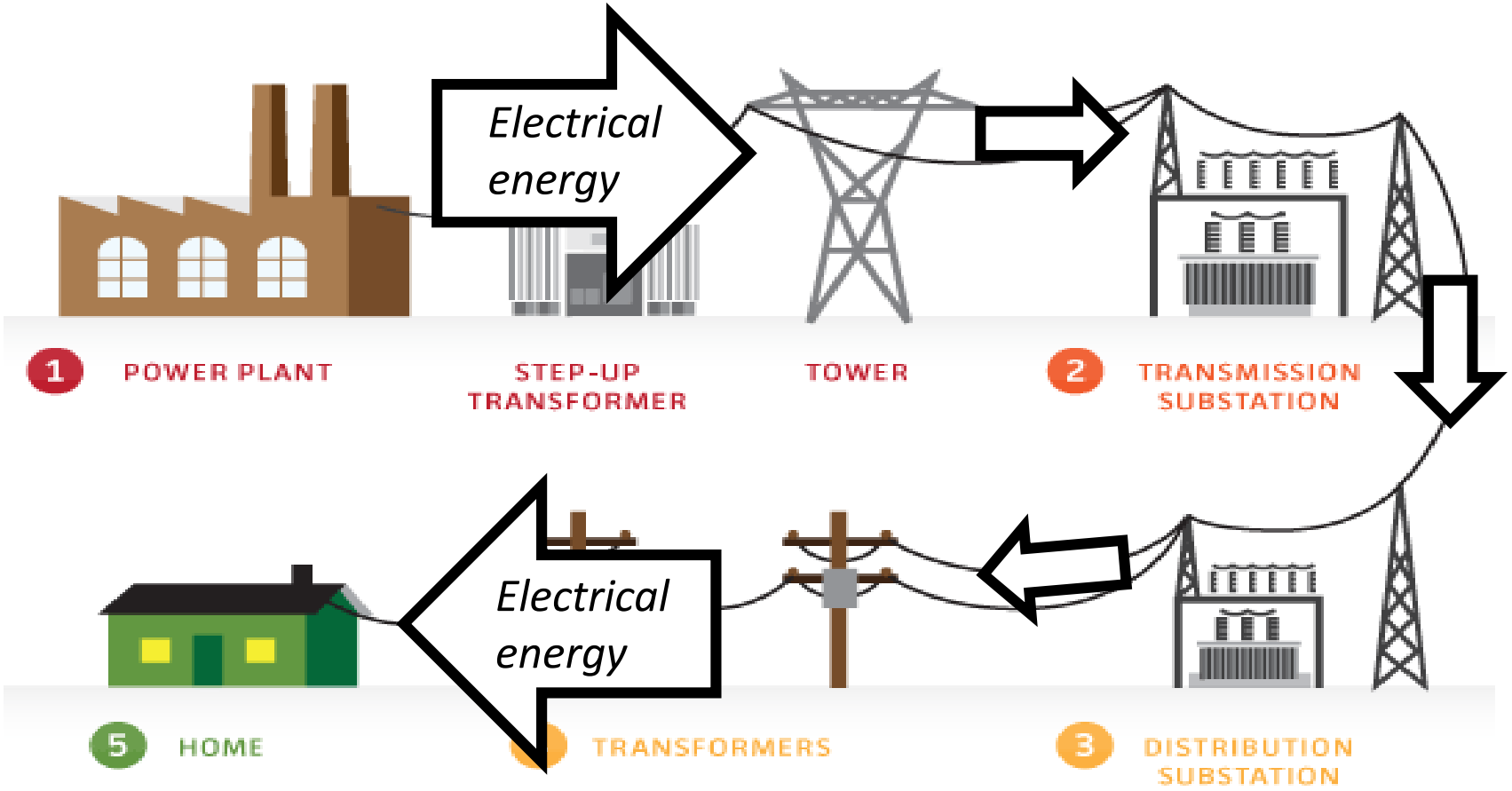
Transmission of Energy: *(Energy can be transmitted from one place to another)*

Ex 1



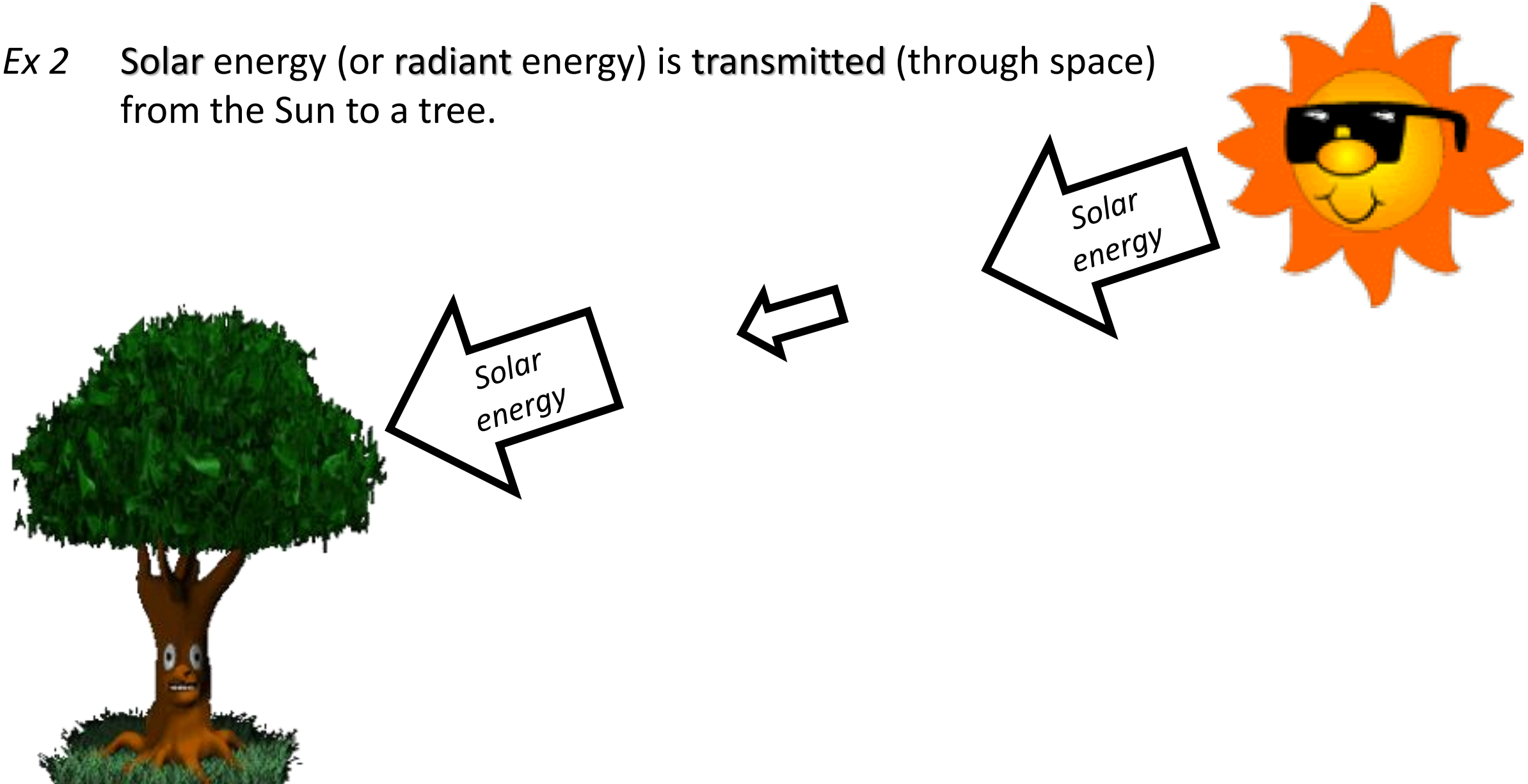
Transmission of Energy: *(Energy can be transmitted from one place to another)*

Ex 1 Electrical energy is transmitted (through wires) from a power station to a house.



Transmission of Energy: *(Energy can be transmitted from one place to another)*

Ex 2 Solar energy (or radiant energy) is transmitted (through space) from the Sun to a tree.

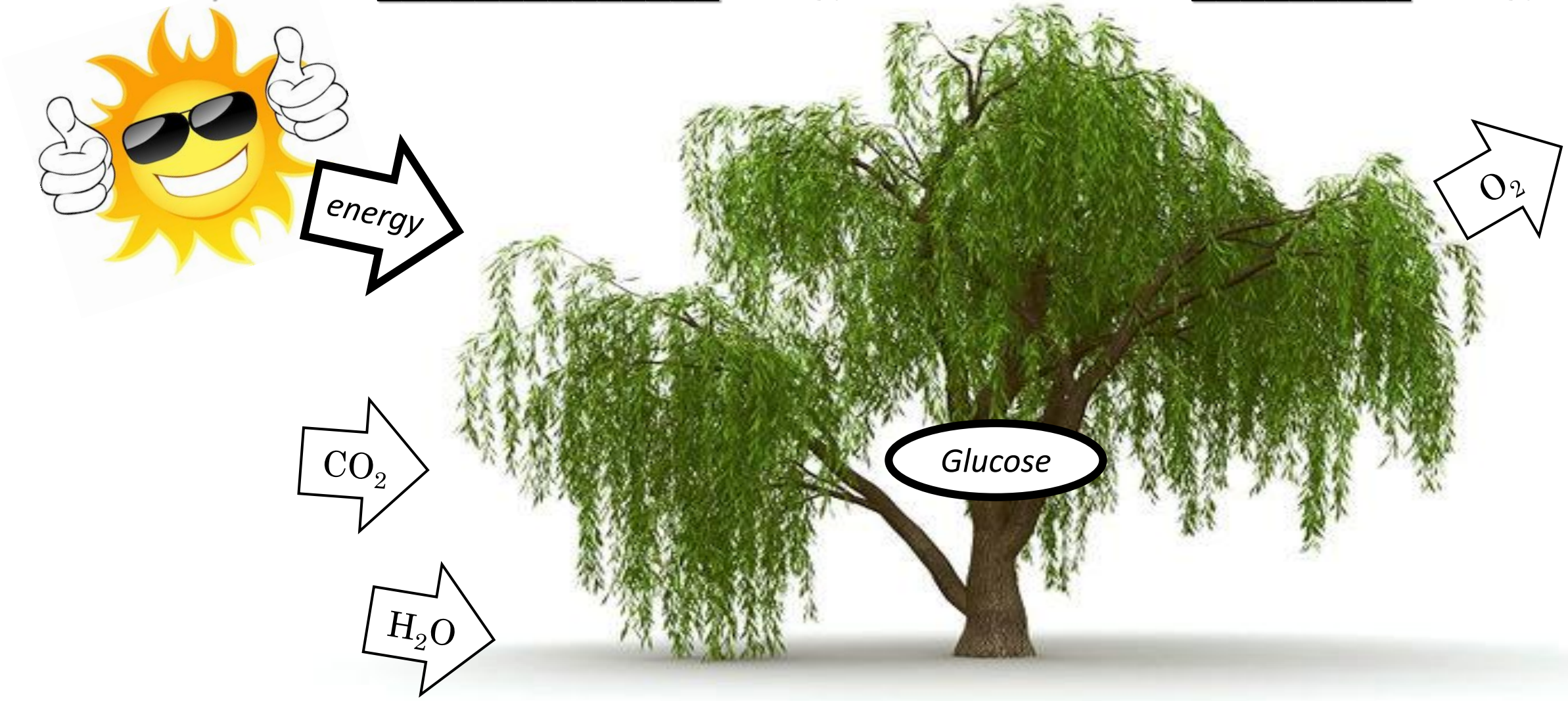


Transformation of Energy: *(Energy can be transformed from one form into another)*

Ex 1 A toaster: Electrical energy is transformed into thermal energy.

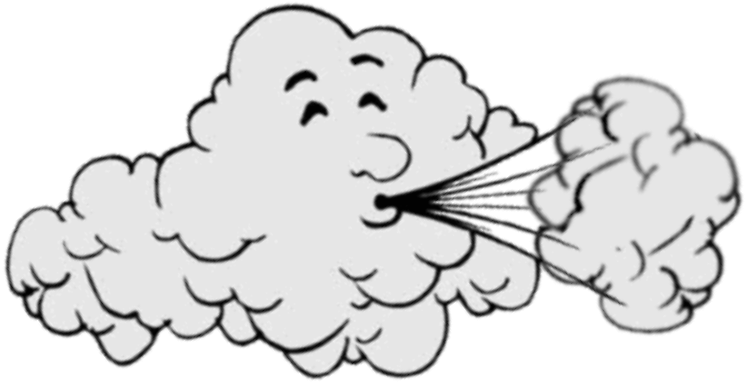
Transformation of Energy: *(Energy can be transformed from one form into another)*

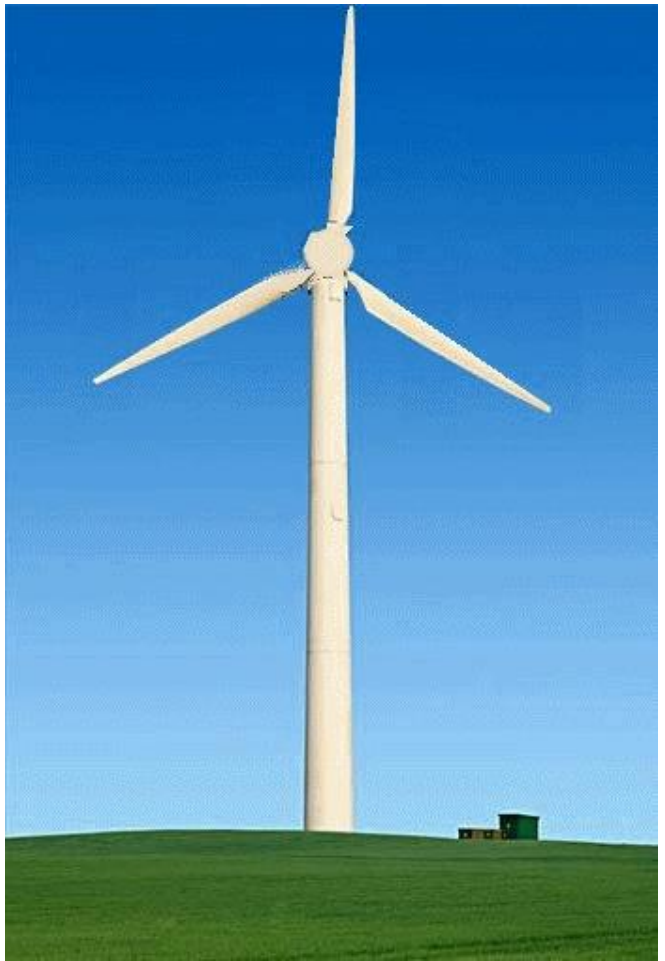
Ex 2 Photosynthesis: Solar (or radiant) energy is transformed into chemical energy.



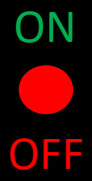
Transformation of Energy: *(Energy can be transformed from one form into another)*

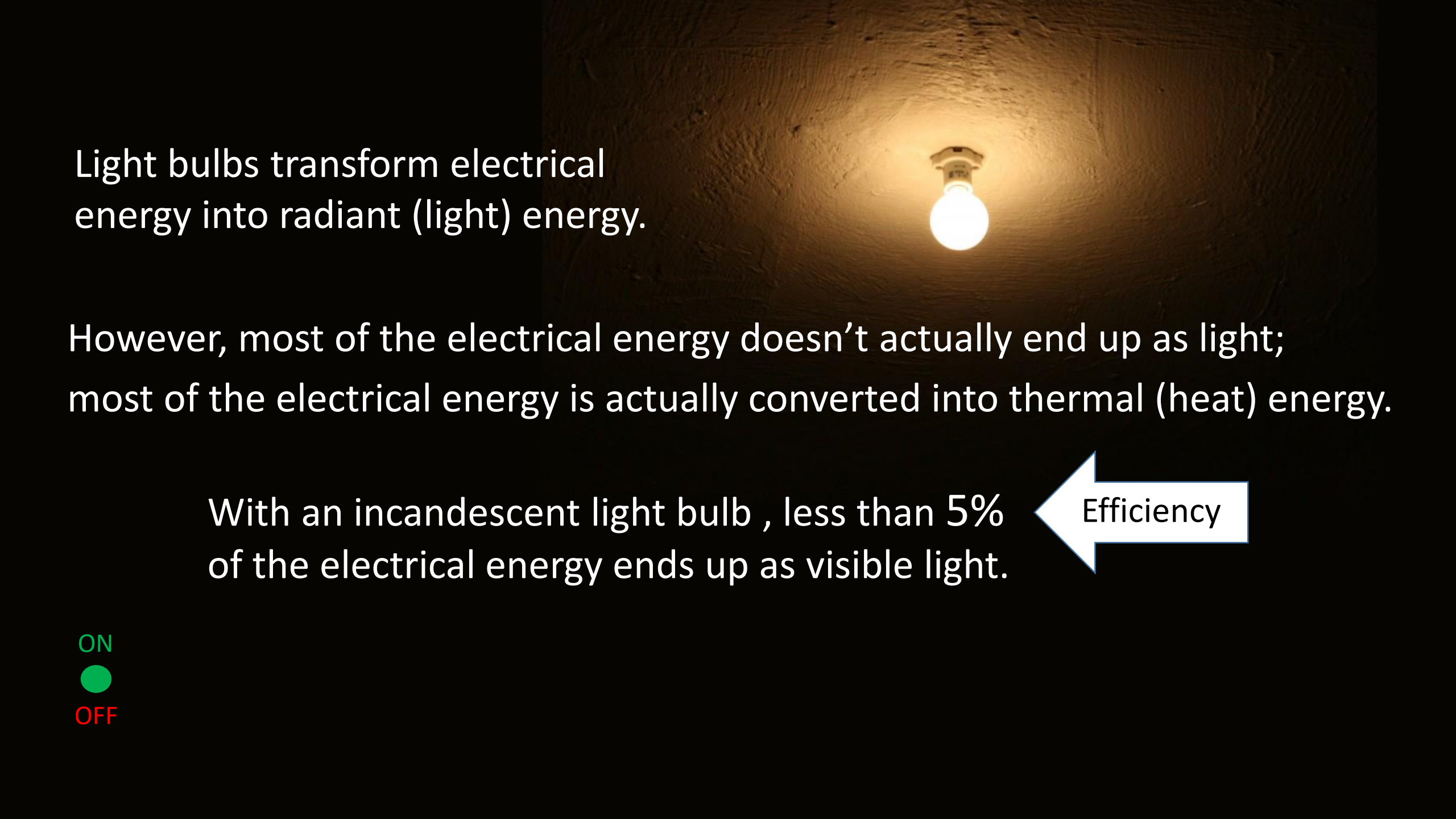
Ex 3 A wind turbine: Wind energy is transformed into electrical energy.





Energy Efficiency


ON
OFF



Light bulbs transform electrical energy into radiant (light) energy.

However, most of the electrical energy doesn't actually end up as light; most of the electrical energy is actually converted into thermal (heat) energy.

With an incandescent light bulb , less than 5% of the electrical energy ends up as visible light.

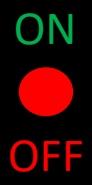
Efficiency

ON

OFF

Energy efficiency gives the percentage of energy consumed by a device that is actually transformed into what is called useful energy.

$$(\text{Energy})\text{Efficiency} = \frac{\text{Useful energy}}{\text{Total energy consumed}} \times 100\%$$



Example 1: A compact fluorescent light bulb (CFL bulb) is more efficient than an incandescent or a halogen light bulb. Still, not great.

A 13 watt CFL bulb operating for 10 hours consumes 468 000 joules of electrical energy. In this time the bulb gives off 39 780 joules of radiant (light) energy. Determine the efficiency of this CFL light bulb.

$$\text{Efficiency} = \frac{\text{Useful energy}}{\text{Total energy consumed}} \times 100\%$$

$$\text{Efficiency} = \frac{39\,780\ \text{J}}{468\,000\ \text{J}} \times 100\%$$

$$\text{Efficiency} = 8.5\ \%$$

Example 2: Car motors are not very efficient. Only about 12% of the chemical energy in gasoline (consumed energy) actually turns the wheels to make the car move (useful energy).

How much chemical energy is consumed by a car in order to provide 600 000 J of energy to turn the wheels and make the car move?

$$\text{Efficiency} = \frac{\text{Useful energy}}{\text{Total energy consumed}} \times 100\%$$

$$12\% = \frac{600\,000\ \text{J}}{\text{E}_{\text{consumed}}} \times 100\%$$

$$0.12 = \frac{600\,000\ \text{J}}{\text{E}_{\text{consumed}}}$$

$$(0.12)(\text{E}_{\text{consumed}}) = 600\,000\ \text{J}$$

$$\text{E}_{\text{consumed}} = \frac{600\,000\ \text{J}}{0.12}$$

$$\text{Efficiency} = 5\,000\,000\ \text{J}$$

Example 3: An electric kettle uses 1600 watts of power for 5 min. in order to boil 1 L of water; 300 000 J of thermal energy was absorbed by the water in this time.

Calculate the energy efficiency of this kettle.

$$\text{Efficiency} = \frac{\text{Useful energy}}{\text{Total energy consumed}} \times 100\%$$

Useful Energy $= 300\ 000\ \text{J}$

(thermal energy to boil the water)

Electrical energy consumed by the kettle $= ?$

(We need to know how much energy the kettle used)

$$E = P\,\Delta t$$

Example 3: An electric kettle uses 1600 watts of power for 5 min. in order to boil 1 L of water; 300 000 J of thermal energy was absorbed by the water in this time.

Calculate the energy efficiency of this kettle.

$$E = P\,\Delta t$$

$$E = (1600\ \text{W})(300\ \text{s})$$

$$E = 480\,000\ \text{J} \quad \text{(consumed)}$$

$$\text{Efficiency} = \frac{\text{Useful energy}}{\text{Total energy consumed}} \times 100\ \%$$

$$\text{Efficiency} = \frac{300\,000\ \text{J}}{480\,000\ \text{J}} \times 100\ \%$$

$$\text{Efficiency} = 62.5\ \%$$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