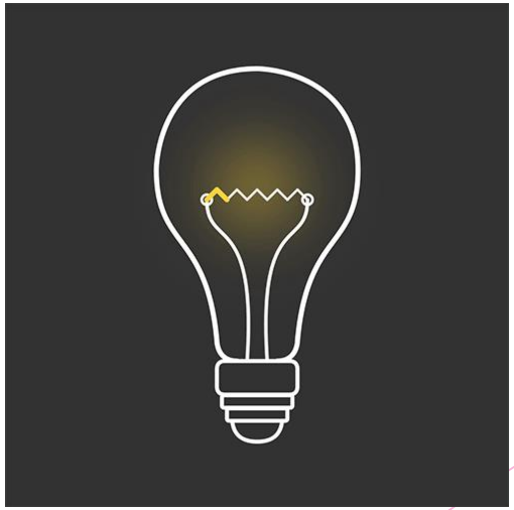
Energy Efficiency

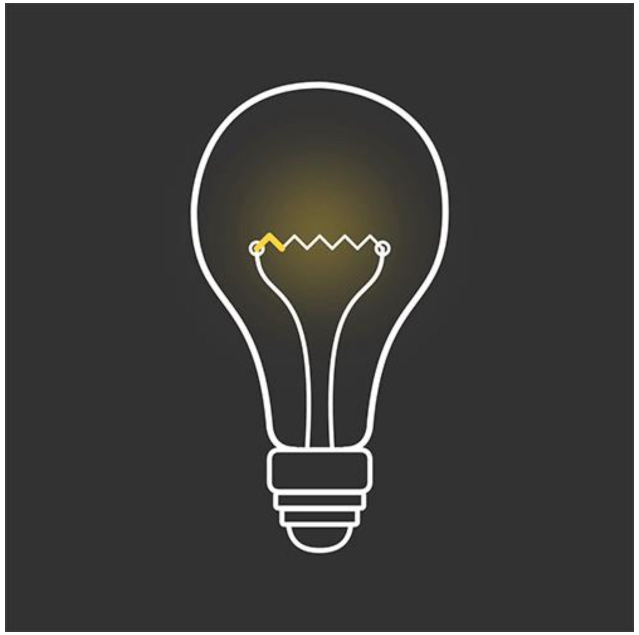
Recall

- One of the electrical functions in a circuit is:
  - **Energy transformation**
    - E.g.: light bulbs, speakers, heating elements, etc.



Energy Efficiency

- Problem is **not all** of the energy is usually **transformed** into the form we want



Energy Efficiency

- Ex: when you turn on a light bulb **only some** of the **electrical energy** is transformed into **radiant (light) energy**
- A lot of it is actually converted into **thermal energy (heat)**
  - In fact, with an incandescent light bulb, only about **5%** of the electrical energy ends up as light energy

Energy Efficiency

- We can represent **how much (in percent)** of the energy consumed by a device is **actually transformed** into the type of energy we want (known as **useful energy**)

Energy Efficiency

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

Energy Efficiency

- This is the equation we use:

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

Keep in mind: the total energy always has to be **BIGGER** than the useful!

Total > useful

Vocabulary

- **Consumed energy**
  - The **total energy** that we started off with
  - The amount of energy **before any loss or transformation**
- **Useful energy**
  - The energy **used for the system to function**
    - The portion of the energy that **actually does what we want/need**
- **Lost energy**
  - The energy that is **NOT turned into useful energy**
    - It's lost to other systems
    - Most often energy is lost through **heat**

Vocabulary

- **Consumed energy**
  - *Consumed energy (total)= useful energy + lost energy*
- ***Useful energy***
  - *Useful energy = Consumed energy – lost energy*
- ***Lost energy***
  - *Lost energy = Consumed energy – useful energy*

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?

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

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

$$0.12 = \frac{600\,000\ \text{J}}{E_{\text{cons}}}$$

$$(0.12)(E_{\text{cons}}) = 600\,000\ \text{J}$$

$$E_{\text{cons}} = \frac{600\,000\ \text{J}}{0.12}$$

$$E_{\text{cons}} = 5\,000\,000\ \text{J}$$

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.

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

(thermal energy to boil the water)

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

$$\text{Electrical energy consumed by the kettle} = ?$$

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

$$\text{E} = \text{P}\ \Delta\text{t}$$

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.

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

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

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

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

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

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