PHYSICS VI

POWER

SUSTAINABILITY

GENERATING ELECTRICAL ENERGY

POWER

There are two main ways that we are able to measure electrical energy:

- Watts and Kilowatts
- Kilowatt-hours

POWER

These two ways of measuring out electrical energy is related to the power output by the load. Electrical power is the rate that electrical energy is used by a load.

- Electrical power is measured in watts (W) or kilowatts (kW)
  - 1 kW = 1000 watts

POWER

Appliances all have a power rating (the rate that they use energy).

Table 3.2 Typical Power Ratings of Appliances

Appliance	Typical Power Rating (kW)
Clock	0.0050
Clothes dryer	5.0
Washing machine	0.50
Coffee maker	1.0
Computer	0.20
Dishwasher	1.8
Freezer	0.34
Microwave oven	1.5
Toaster	1.1
Vacuum (portable)	1.6

Example:
Lightbulb: 100 W
Iron: 1000 W
If we compare the power rating of a light bulb and an iron that is on for the same length of time, the iron will use 10 times more energy.

KILOWATT-HOURS

Electrical energy used by an appliance over a period of time is measured in kilowatt-hours (kWh). We can find this quantity by first looking at the power rating of the appliance and by measuring the amount of time the load has been used.

VIDEO

https://www.youtube.com/watch?v=zRYESRObKqA&ab_channel=EnphaseEnergy

EXAMPLE:

If you used a 1.8 kW dishwasher for 2.0 hours, how many kilowatt-hours of electrical energy would you have used?

$$Power = kilowatt \times hours$$

$$Power = 1.8\ kW \times 2.0\ hours$$

$$Power = 3.6\ kWh$$

EXAMPLE:

If a 1600 W vacuum has been turned on for 30 minutes, how many kilowatt-hours of electrical energy would have been used?

$$1600\ W \times \frac{1\ kW}{1000\ W} = 1.6\ kW$$

$$30\ minutes = 0.5\ hours$$

$$Power = kilowatt \times hours$$

$$Power = 1.6\ kW \times 0.5\ hours$$

$$Power = 0.8\ kWh$$

SMART METERS

In our homes and in buildings, we are able to measure the amount of electrical energy used by using a smart meter. A smart meter is able to measure how energy use changes in a building over the course of a day.

SUSTAINABILITY

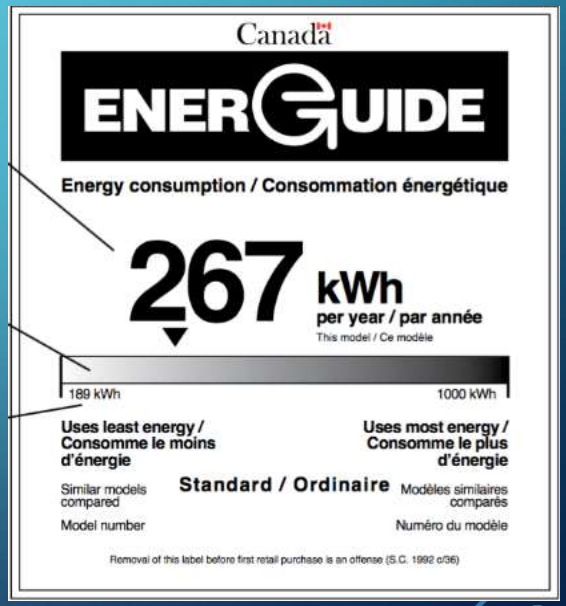
Many appliances that we buy are able to tell us how much energy it uses through two labels:

- EnerGuide labels
- ENERGY STAR ® label

ENERGUIDE LABEL

This is a label that gives details about the amount of energy that an appliance uses during one year of normal use

- Large number: Shows how much energy is used in one year of normal use
- Shaded bar: Shows how the appliance compares with similar ones on the market
- Numbers on the shaded bar: Gives a range of efficiency for yearly energy use



ENERGY STAR ® LABEL

This is a label that is located on appliances. It tells us if a product is an energy efficient appliance. Appliances with this label use 10-50% less energy compared with a standard product in the same category.

PHANTOM LOADS

In our homes, we may have appliances that continue to use energy even if it is not on. This is called a phantom load.

- A phantom load occurs when electrical energy is being used on a device when it is turned off
- Appliances in stand-by mode (TVs, computers) are actually "on" and have phantom loads
- Phantom loads account for about 900 kWh of energy use each year in the average home.

PHANTOM LOADS

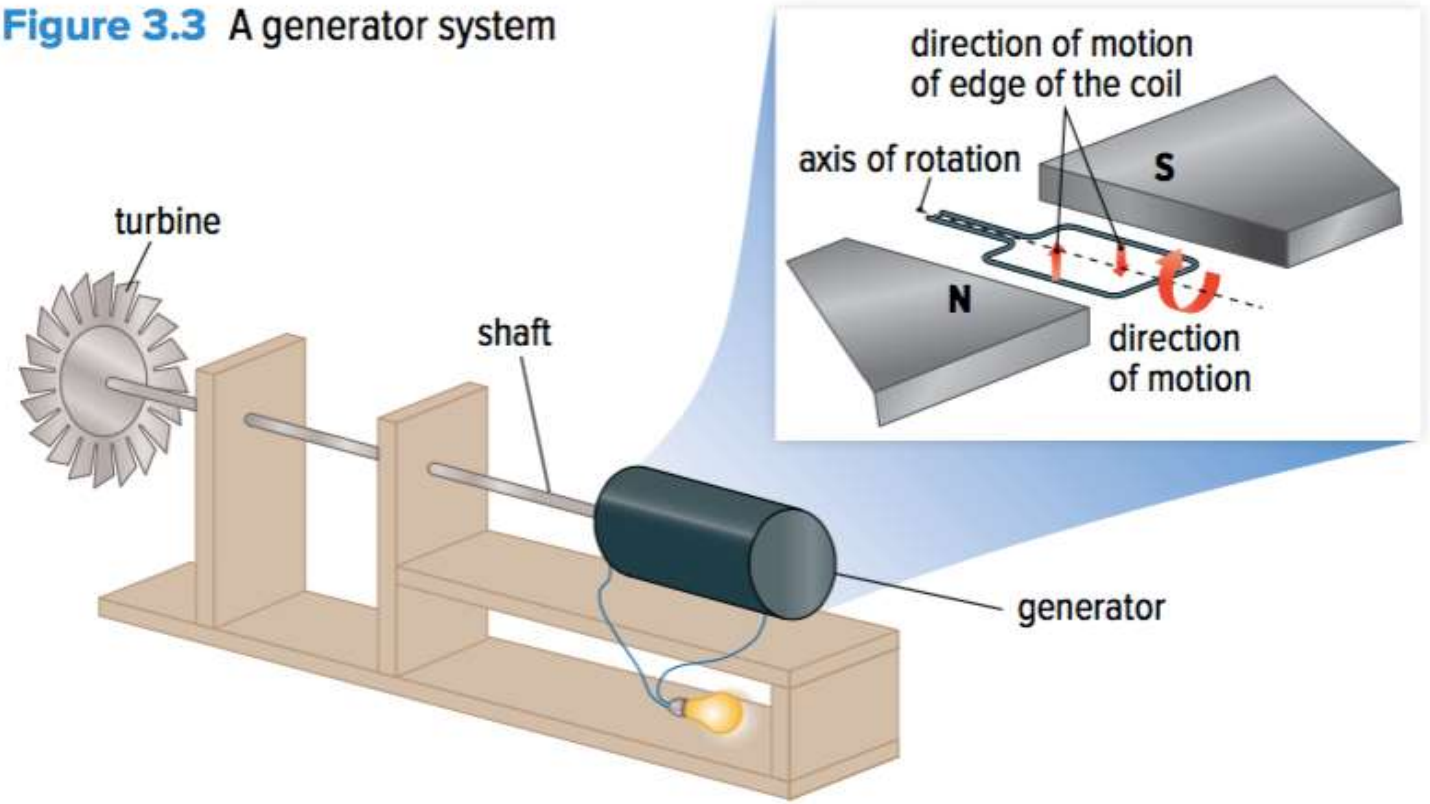
In order to save energy, unplug your devices when not in use!!

GENERATING ELECTRICAL ENERGY

In order to generate electrical energy, most stations will use a generator system. A generator system is composed of three main parts:

- Turbine: steam, water, or wind will cause the turbine to spin
- Shaft: The shaft connects the turbine to the generator; if the turbine spins, the shaft spins
- Generator: Kinetic energy from the shaft is transformed into electrical energy in the generator

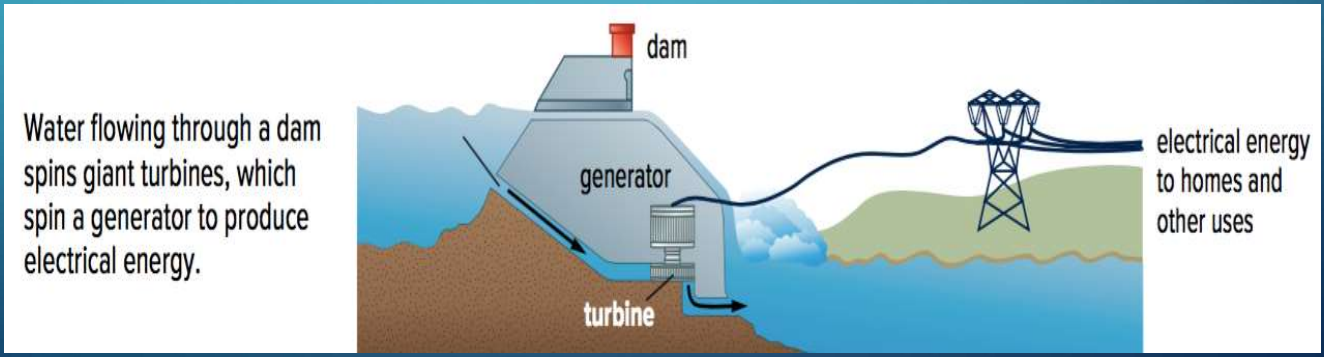
Figure 3.3 A generator system



GENERATING ELECTRICAL ENERGY

In BC, much of our energy is supplied through hydroelectric energy.

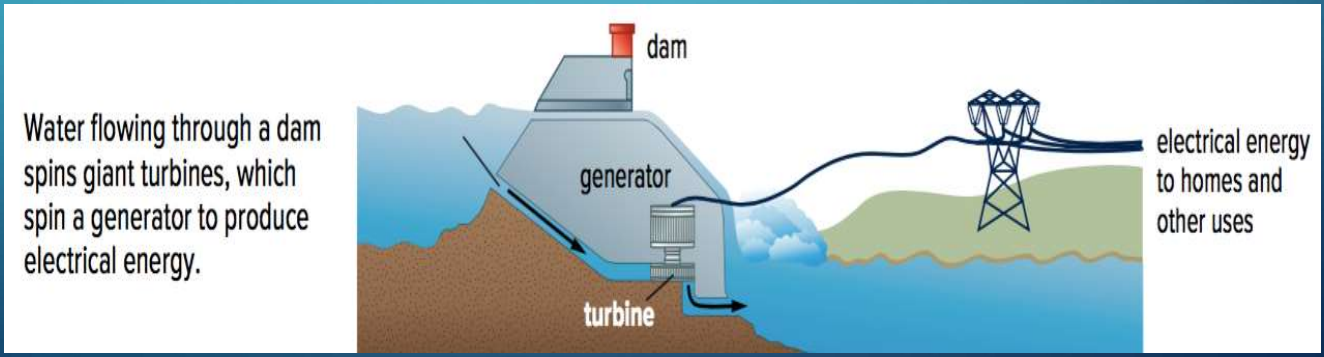
- Dam station: will use the kinetic energy from the water as it flows downhill to turn a turbine in order to generate electrical energy



GENERATING ELECTRICAL ENERGY

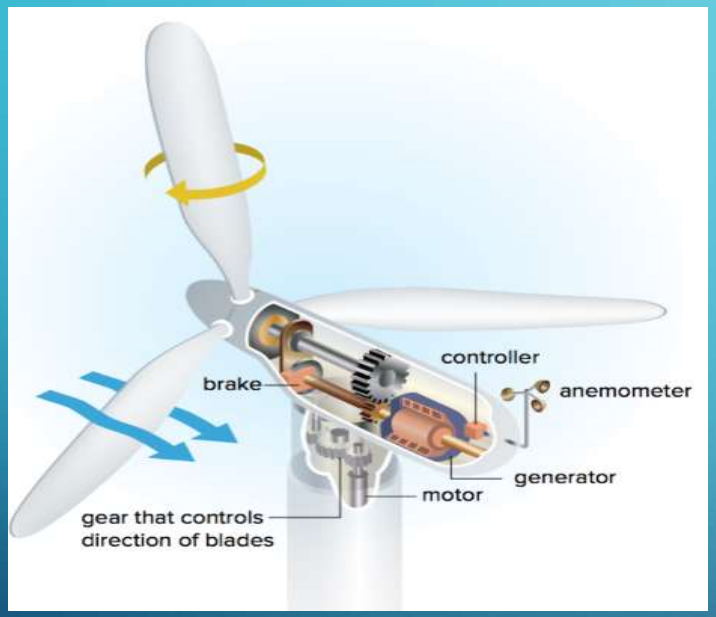
In BC, much of our energy is supplied through hydroelectric energy.

- Run-of-river station: water flowing freely in a river turns a turbine



OTHER WAYS OF GENERATING ELECTRICAL ENERGY:

- Wind turbines: kinetic energy of the wind is transformed into electrical energy as the wind moves the turbine of the generator system
- Solar panels: Photovoltaic cells within the solar panel transform solar energy into electrical energy. The solar energy is absorbed by the electrons in the photovoltaic cells which allows them to flow.
- Geothermal sources: Steam from the Earth's crust can be used to turn turbines in the generator system.


brake
controller
anemometer
generator
motor
gear that controls
direction of blades

VIDEO

https://www.youtube.com/watch?v=RnvCbquYeIM&ab_channel=TED-Ed