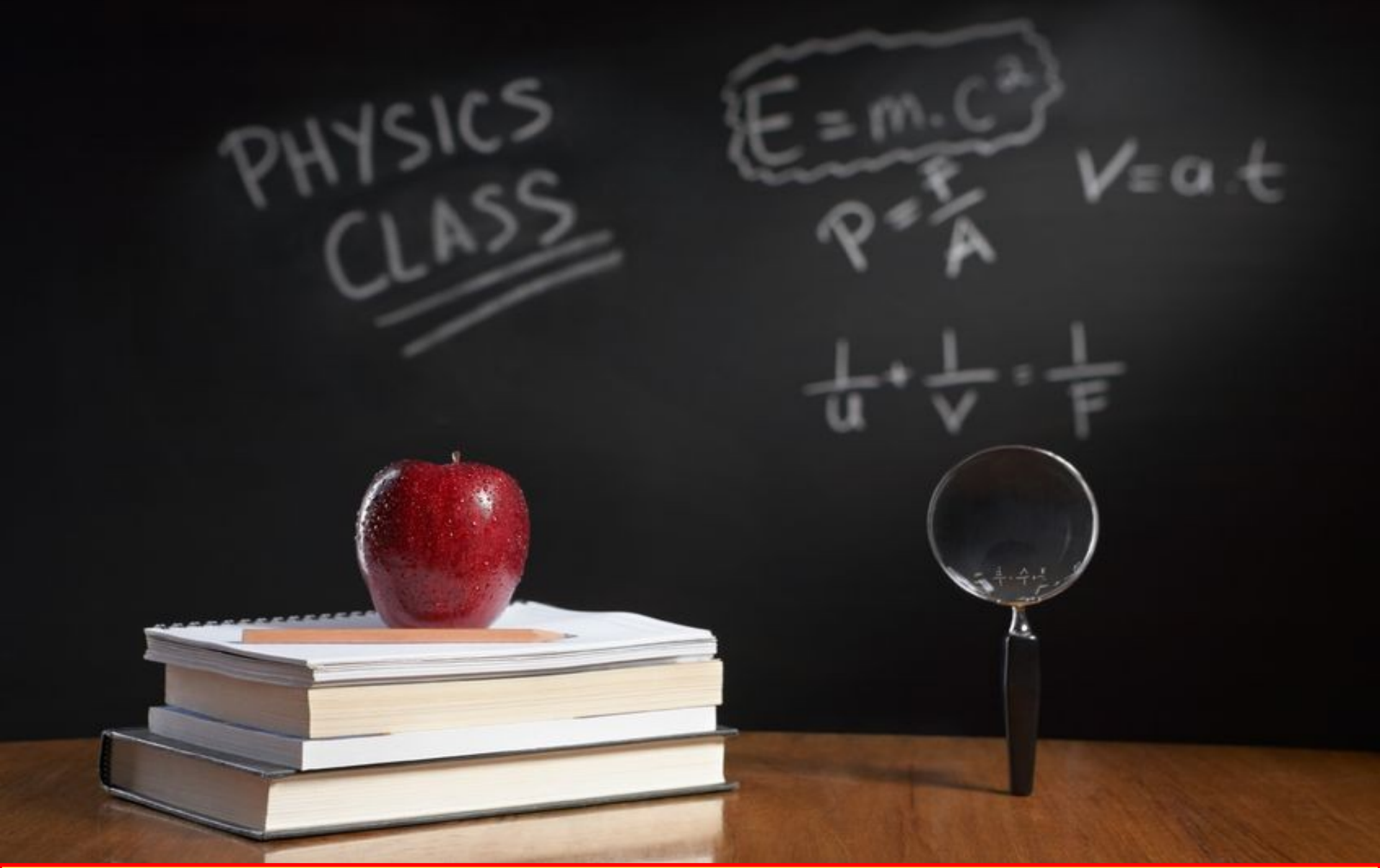


PHYSICS – Energy Resources

LEARNING OBJECTIVES

1.7.2 Energy resources

Core

• Describe how electricity or other useful forms of energy may be obtained from:
– chemical energy stored in fuel
– water, including the energy stored in waves, in tides, and in water behind hydroelectric dams
– geothermal resources
– nuclear fission
– heat and light from the Sun (solar cells and panels)
– wind
• Give advantages and disadvantages of each method in terms of renewability, cost, reliability, scale and environmental impact
• Show a qualitative understanding of efficiency

Supplement

• Understand that the Sun is the source of energy for all our energy resources except geothermal, nuclear and tidal
• Show an understanding that energy is released by nuclear fusion in the Sun

• Recall and use the equation:

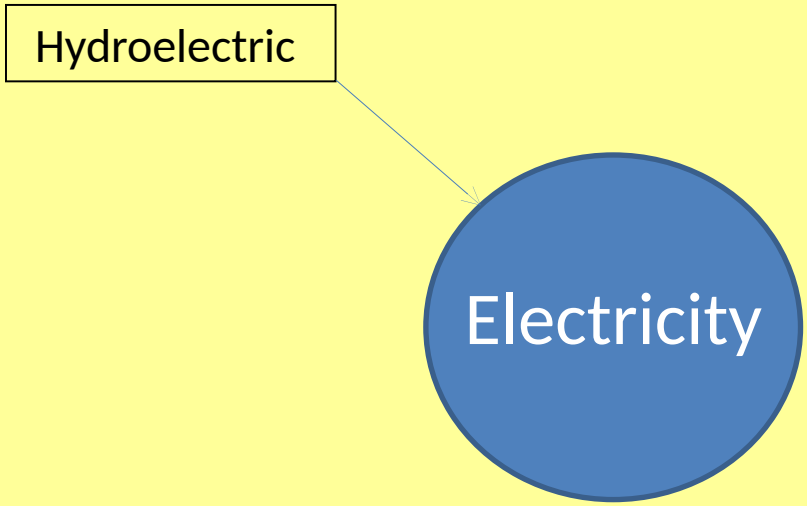
$$\text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100\%$$

• $$\text{efficiency} = \frac{\text{useful power output}}{\text{Power input}} \times 100\%$$

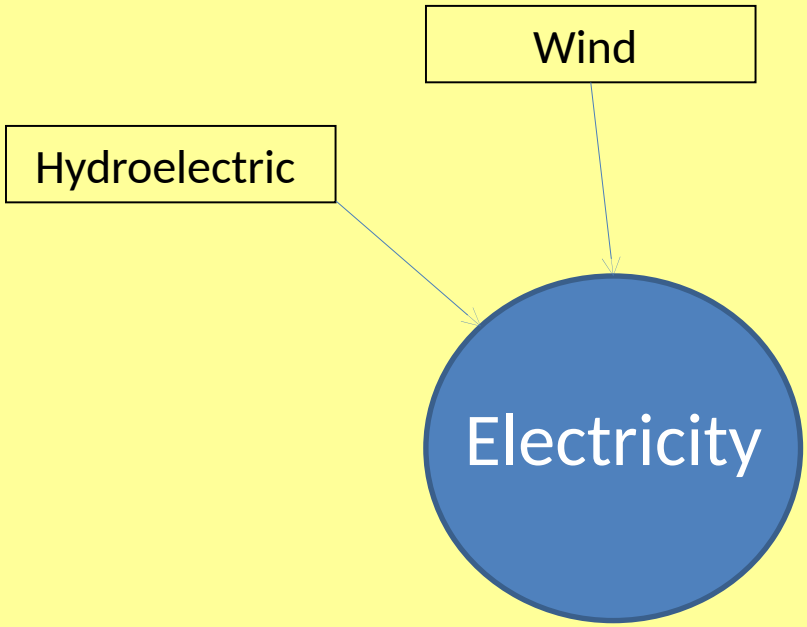
Electricity

Electricity is known as a secondary energy source because it is produced using primary energy sources (eg. Coal, nuclear fuel, wind power).

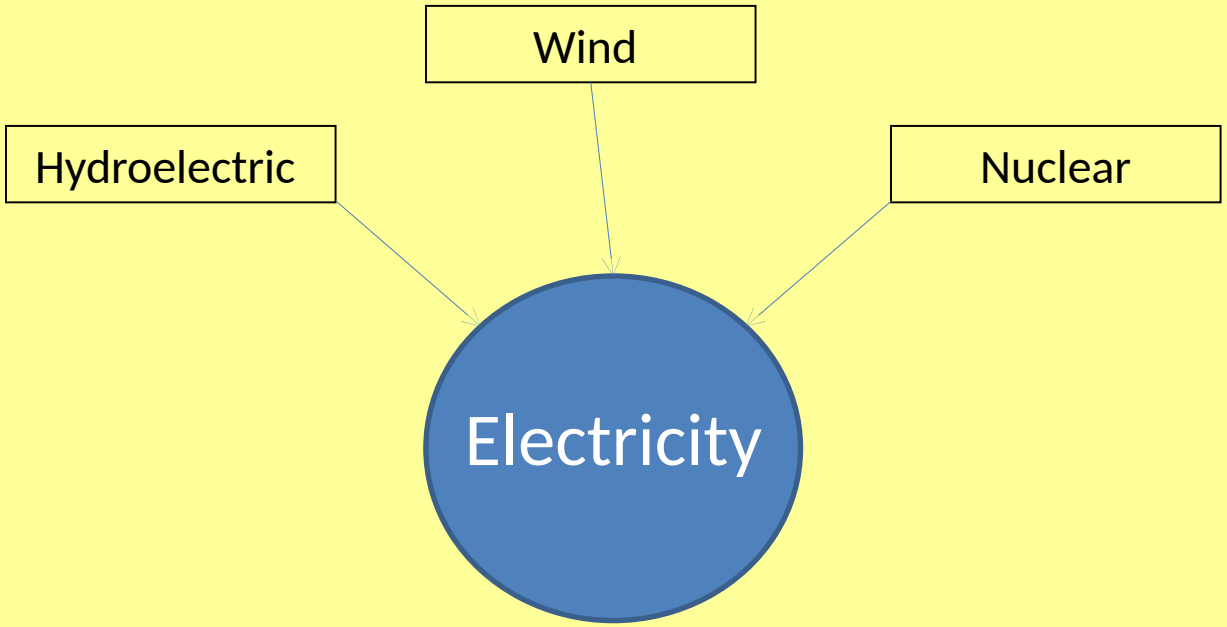
How is electricity generated?



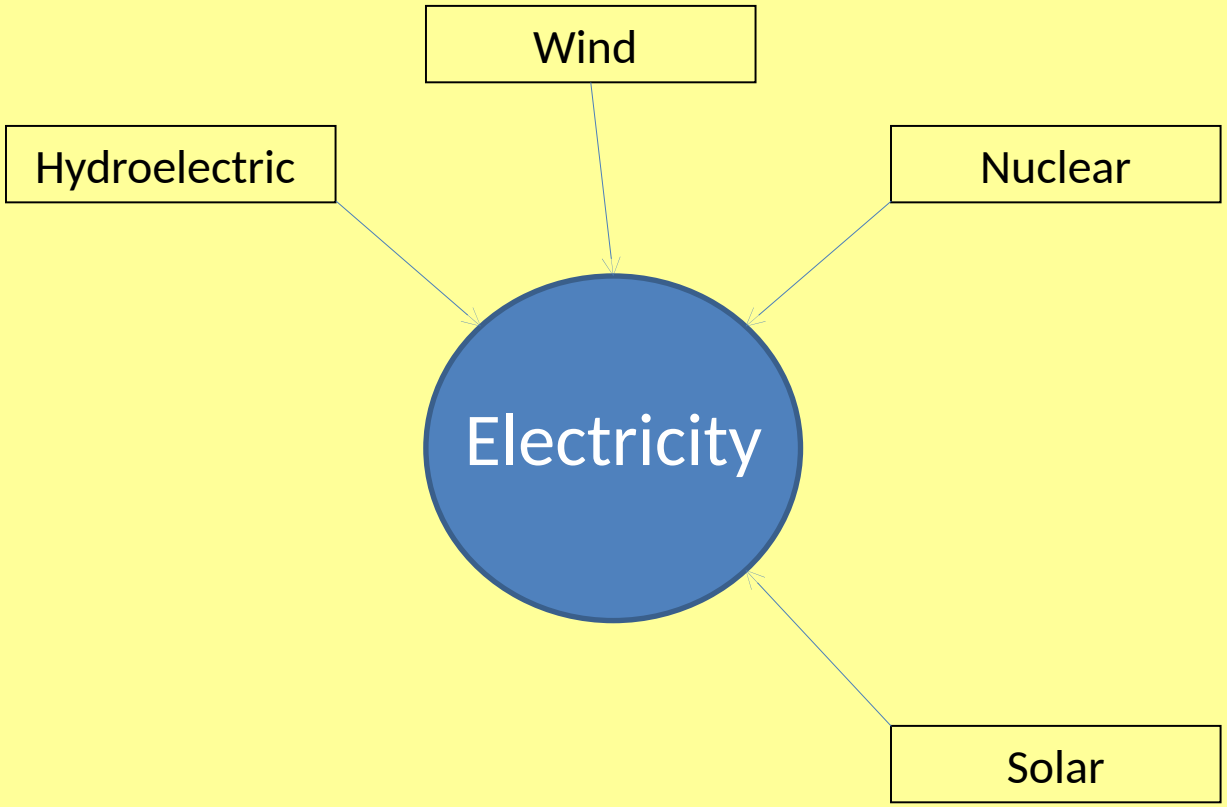
How is electricity generated?



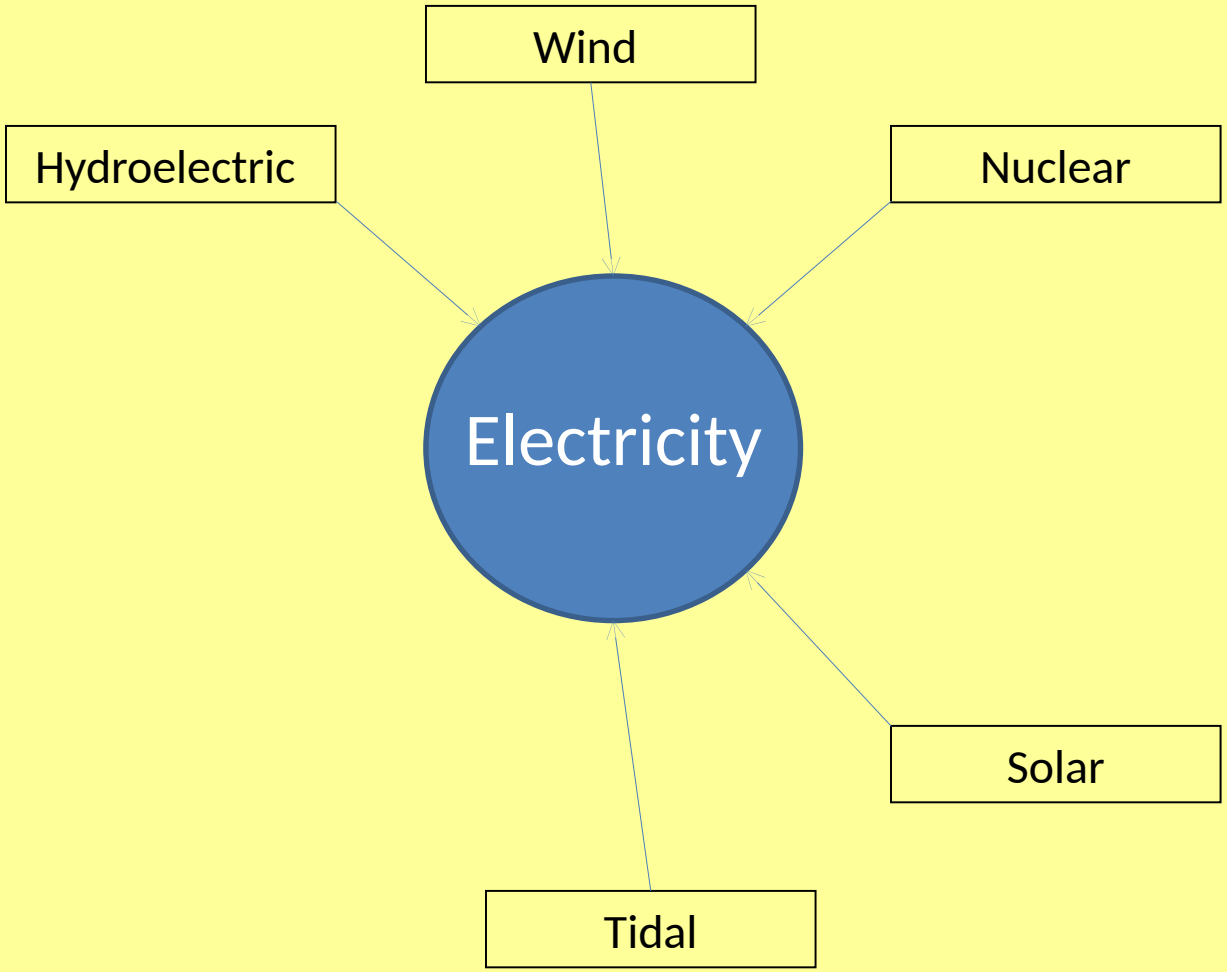
How is electricity generated?



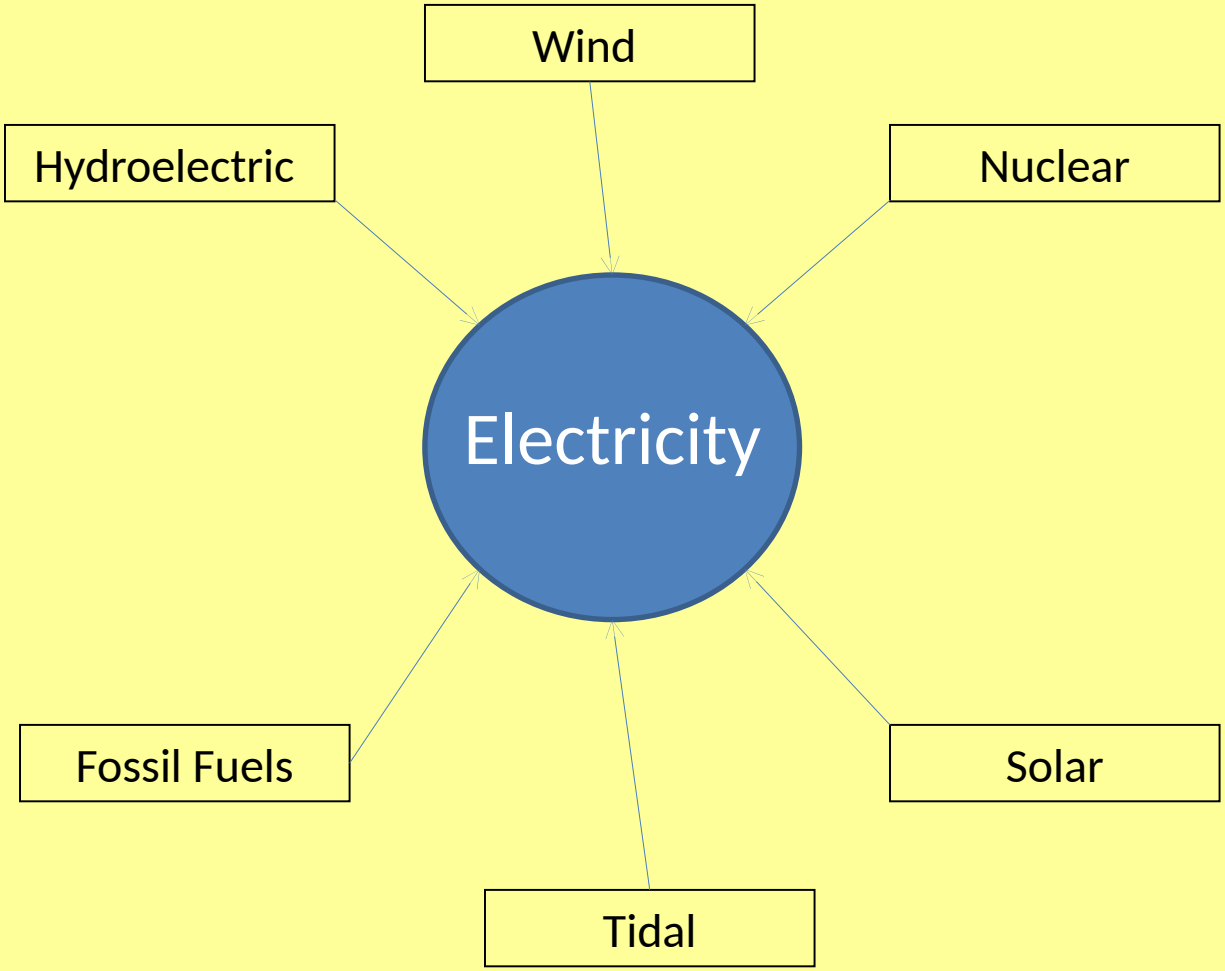
How is electricity generated?



How is electricity generated?



How is electricity generated?



Electricity

Electricity is known as a secondary energy source because it is produced using primary energy sources (eg. Coal, nuclear fuel, wind power).

NON-RENEWABLE SOURCES

1. Fossil fuels – coal, oil and natural gas
2. Nuclear fuels (uranium and plutonium)

- They will all 'run out' one day.
- They all damage the environment
- They currently provide most of our energy.

Electricity

Electricity is known as a secondary energy source because it is produced using primary energy sources (eg. Coal, nuclear fuel, wind power).

NON-RENEWABLE SOURCES

1. Fossil fuels – coal, oil and natural gas
2. Nuclear fuels (uranium and plutonium)

- They will all 'run out' one day.
- They all damage the environment
- They currently provide most of our energy.

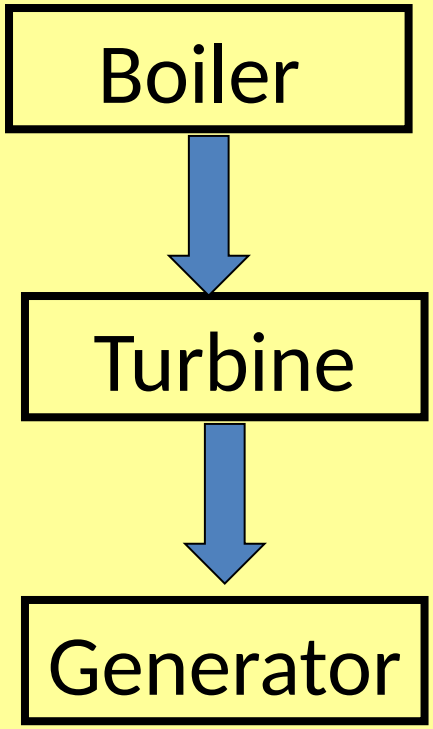
RENEWABLE SOURCES

1. Wind
2. Waves
3. Tides
4. Hydroelectric
5. Biofuels
6. Geothermal
7. Solar (from Sun)

- They will never run out.
- They do much less damage to the environment.
- They don't provide much energy and can be unreliable if they depend on the weather.

Generating electricity

3 stages:



Generating electricity

- In the boiler fuel burns to heat water. The water turns into steam.
- Fuels used may be coal, oil or gas.

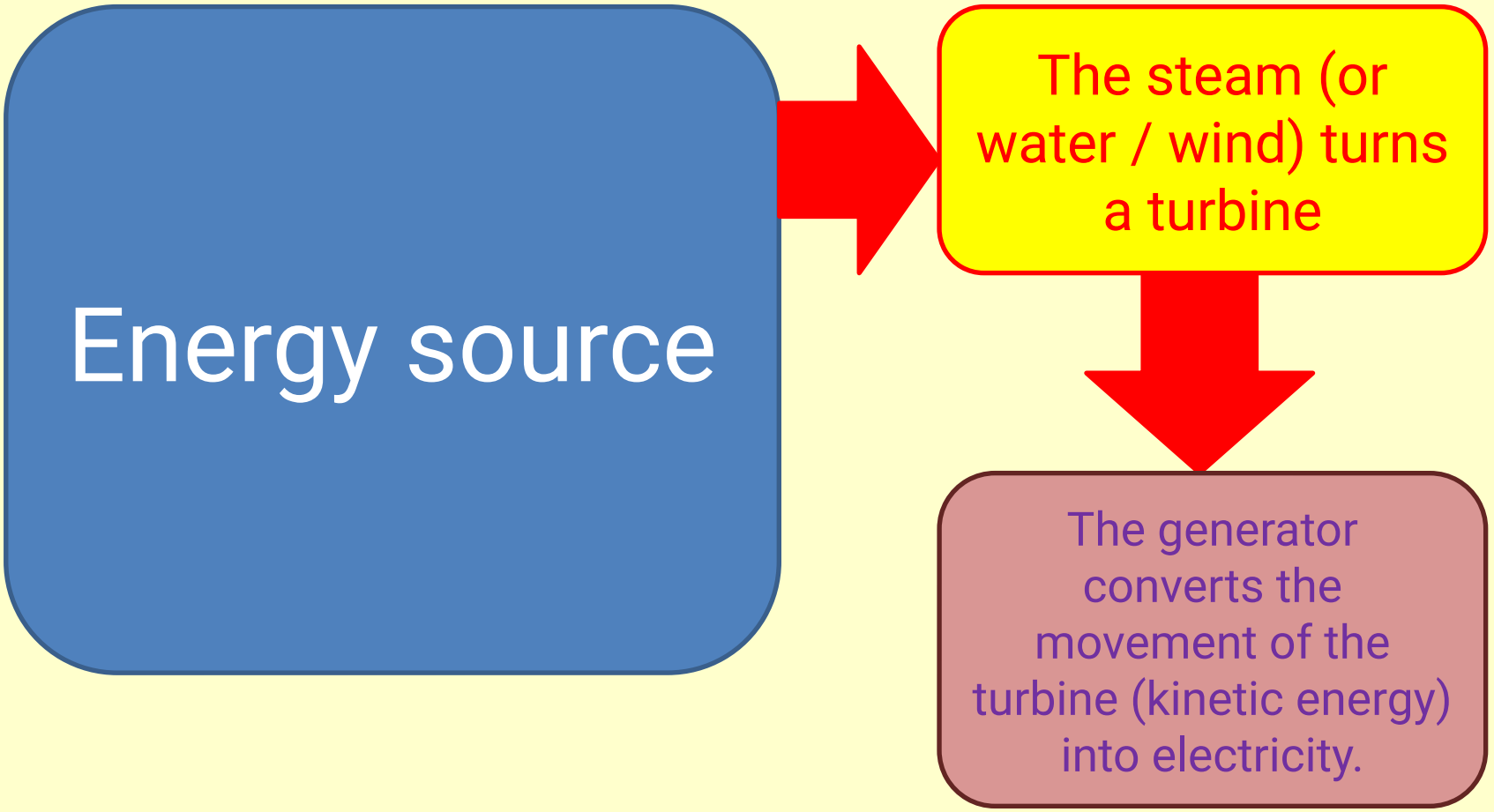
Generating electricity

- Steam travels along pipes and makes the turbine spin.

Generating electricity

- The turbine turns a generator.
- Inside the generator there is a magnet inside a coil of wire.
- As the magnet spins, electricity is generated.

Let's just repeat the basics:-



Fossil fuels

http://en.wikipedia.org/wiki/Ferrybridge_power_stations

Advantages: fuels are readily available, they are relatively cheap, and are not reliant upon the weather.

Disadvantages: highly polluting, contributing to global warming and climate change. Burning fossil fuels can produce acid rain. Oil spillages cause serious damage to the environment.

In a fossil fuel power station coal, oil or natural gas burn, releasing heat energy which is used to turn water into steam.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Biofuels

http://www.climatetechwiki.org/technology/agriculture-biofuel-production

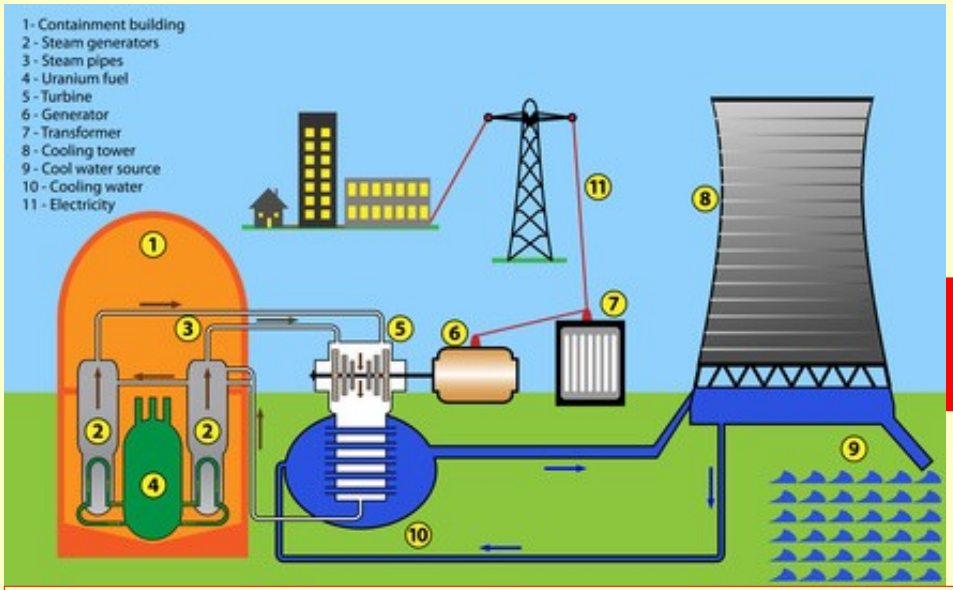
Biofuels are renewable energy sources. They can be solids (eg. Straw, woodchip), liquids (eg. Ethanol) or gases (eg. Methane biogas from sludge digesters).
They are burnt to turn water into steam, which drives the turbine and producing electricity in the generator.

Advantages: relatively quick and natural sources of energy and are considered to be carbon neutral (do not release additional carbon dioxide into the atmosphere).
Disadvantages: natural habitats may be cleared to make way for biofuel crops, and some food crops may be lost.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Nuclear energy

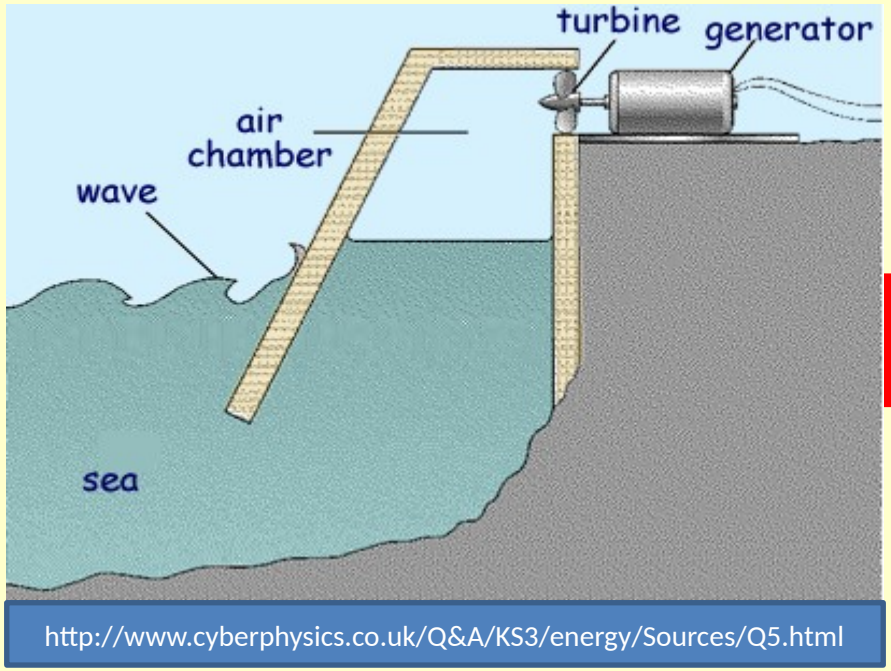


The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Nuclear fission, involving the splitting of atoms of a nuclear fuel (eg. Uranium) releases a lot of heat energy.
Water is used as a coolant to take away this heat energy, which is used to produce steam to drive a turbine which then turns the generator.
The main disadvantage of a nuclear power station is that radioactive waste is produced. This can be very dangerous and difficult to dispose of.

Wave Power



http://www.cyberphysics.co.uk/Q&A/KS3/energy/Sources/Q5.html

As waves come in to the shore they provide up and down motion which can be used to directly drive a turbine which is linked to a generator. The waves force the air through the turbine, causing it to spin.

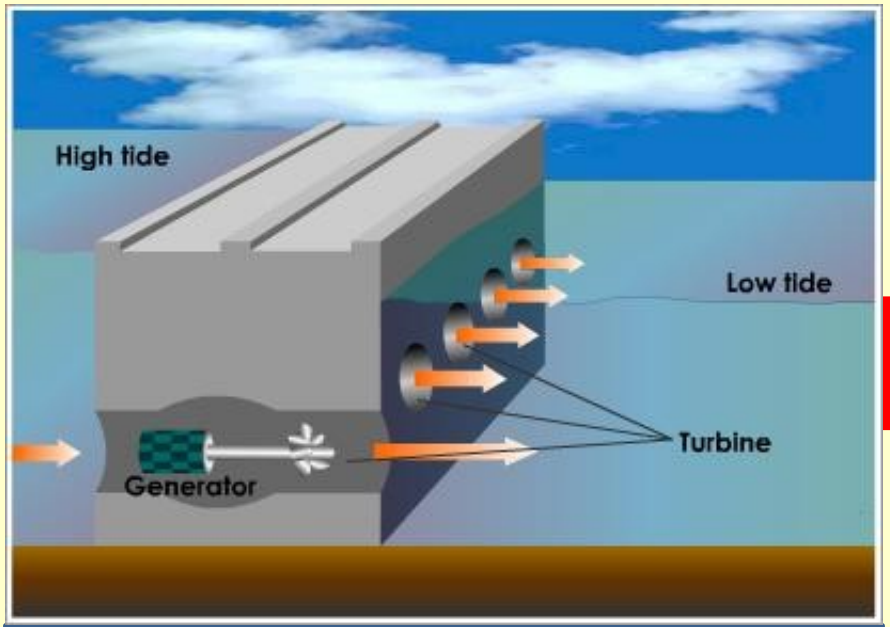
Advantages: no pollution, no fuel costs, minimal running costs. Can be very useful on small islands.

Disadvantages: hazard to boats, can be an eyesore, fairly unreliable as waves disappear when the wind drops, initial costs can be very high, environmental impact.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Tidal Power



http://www.tutorvista.com/content/physics/physics-ii/fission-and-fusion/tidal-power.php

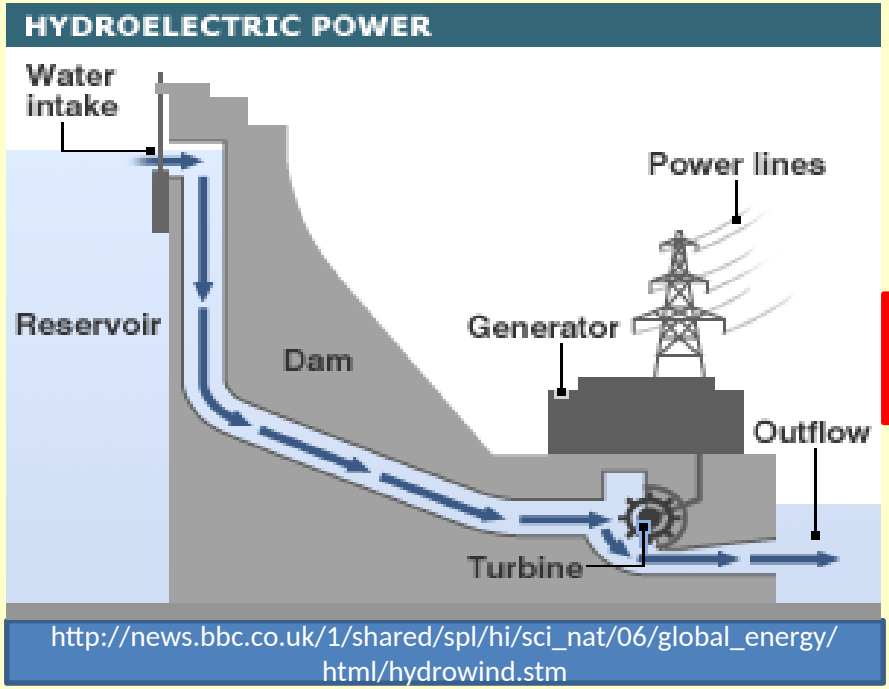
Advantages: no pollution, no fuel costs, minimal running costs. Tides are reliable, and barrages are excellent for storing energy.
Disadvantages: hazard to boats, can be an eyesore, initial costs can be very high, environmental impact. Height of the tide is variable, so energy output varies.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Tidal barrages are big dams built across river estuaries. As the tide comes in it fills the estuary – the water is released so that the turbines are turned at a controlled speed. The source of the energy is the gravity of the Sun and the Moon.

Hydroelectric Power



http://news.bbc.co.uk/1/shared/spl/hi/sci_nat/06/global_energy/html/hydrowind.stm

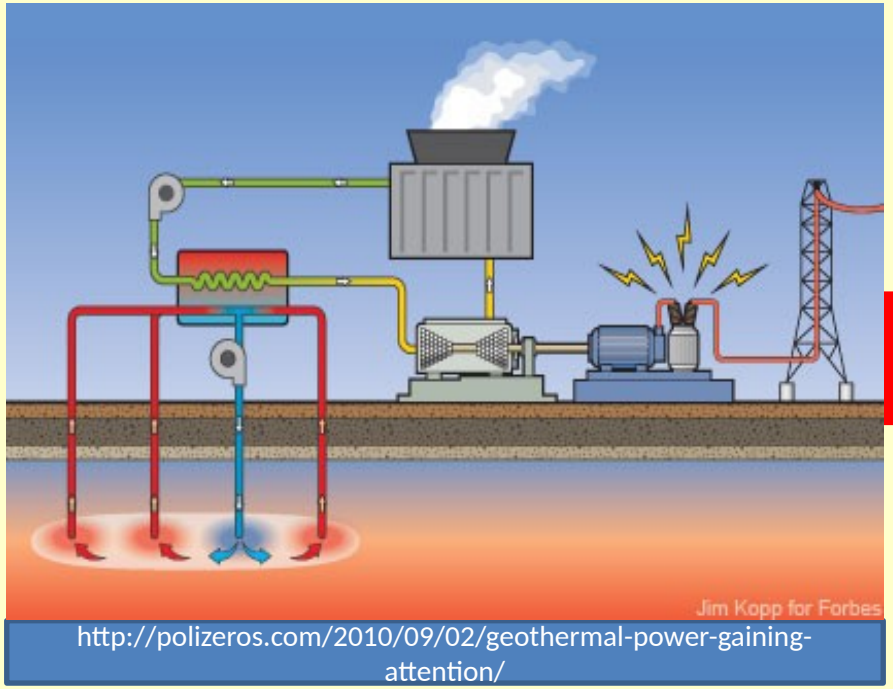
Advantages: no pollution, no fuel costs, minimal running costs. Immediate response to increased demand, and fairly reliable.
Disadvantages: flooding a valley has a big impact on the environment, with much loss of habitats. Initial costs are high. Adversely affected during times of drought.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Hydroelectric power usually involves flooding a valley to form a reservoir behind a big dam. As water is released from the reservoir it falls through the dam and turns the turbines, which then spin the generators which in turn produce electricity.

Geothermal Energy



http://polizeros.com/2010/09/02/geothermal-power-gaining-attention/

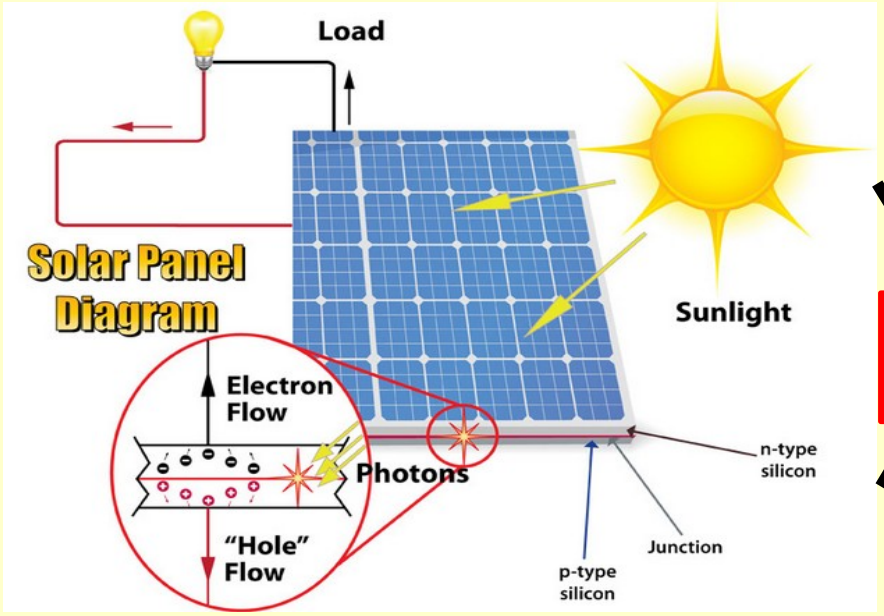
Advantages: free, renewable energy source. No real environmental problems.
Disadvantages: cost of drilling down several km to the hot rocks.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Used where hot rocks lie quite near to the surface. Cold water is pumped in pipes down to the hot rocks, and returns as steam to drive the turbines. Unfortunately there are very few places where this is an economic option.

Solar cells



http://etap.com/renewable-energy/photovoltaic-101.htm

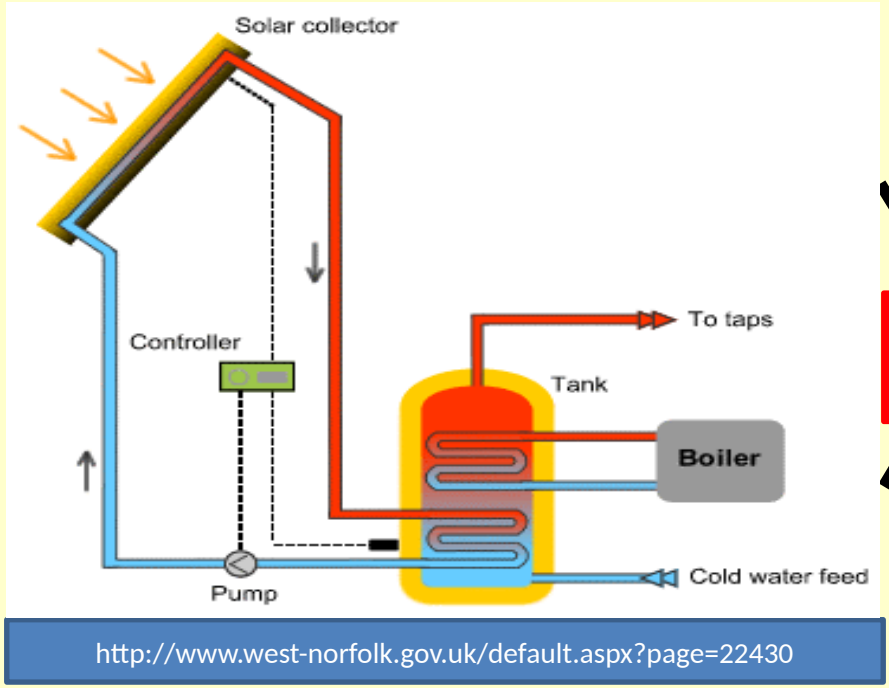
Advantages: no pollution, a very reliable source in sunny countries. Energy is free, and running costs are almost nil.
Disadvantages: initially very expensive, and a developing technology. Only produce electricity in daytime.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Solar cells generate electricity directly from sunlight. Solar cells are usually used to provide electricity on a relatively small scale, such as for individual houses. Solar cell 'farms' are being developed, but connecting to the National Grid can be expensive.

Solar panels



http://www.west-norfolk.gov.uk/default.aspx?page=22430

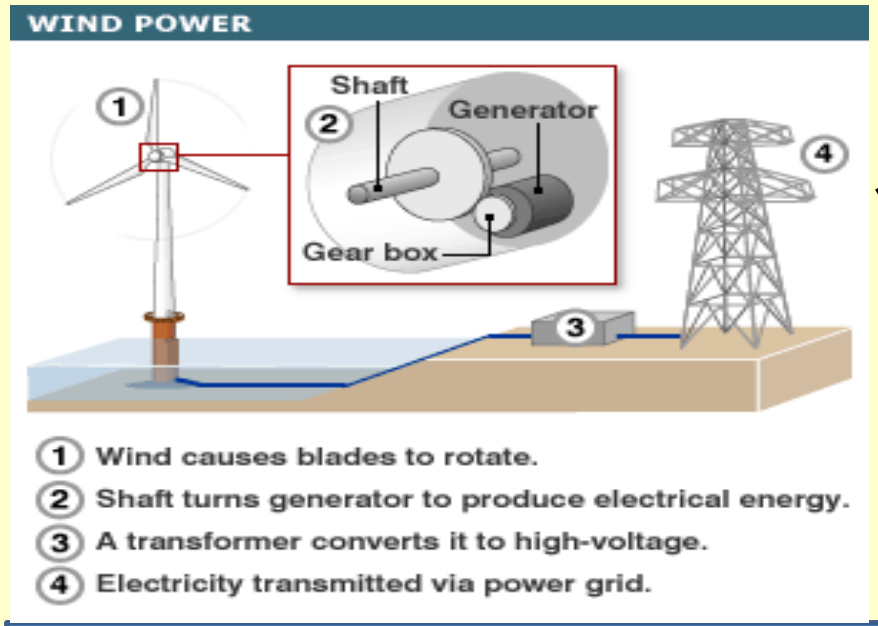
Advantages: no pollution, a very reliable source in sunny countries. Energy is free, and running costs are almost nil.
Disadvantages: Only heats water in daytime. Not used to produce electricity.

The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Solar panels use the Sun's thermal radiation to warm up water for the house. A blackened layer behind the pipes helps the absorption of the radiant energy and the warming of the water flowing through the pipes.

Wind Power



http://www.newhomewindpower.com/wind-power-generators.html

Advantages: no pollution. Energy is free, and running costs are almost nil.
Disadvantages: can be considered an eyesore, and there is some noise pollution. No power is produced when the wind drops.

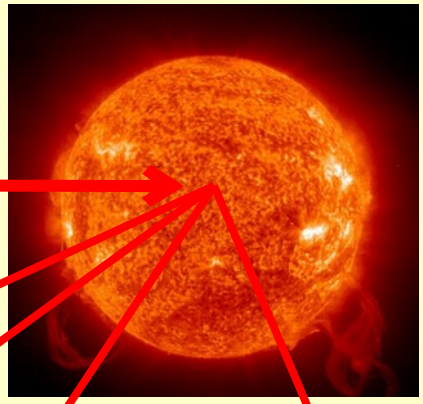
The steam (or water / wind) turns a turbine

The generator converts the movement of the turbine (kinetic energy) into electricity.

Wind turbines are put up in exposed places, such as hilltops and around the coast. Each wind turbine has its own generator, so electricity is generated directly.

The Sun as the ultimate source of energy

The Sun radiates energy because of nuclear fusion reactions deep inside.



Tidal

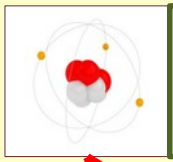
Tides are created by the gravitational pull of the Moon on the Earth's oceans.

Solar cells

Solar panels

Energy in plants

Weather systems



Radioactive atoms release energy

Nuclear

Geothermal

Solar panels

Wind

Solar panels

Waves

Hydroelectric

Efficiency

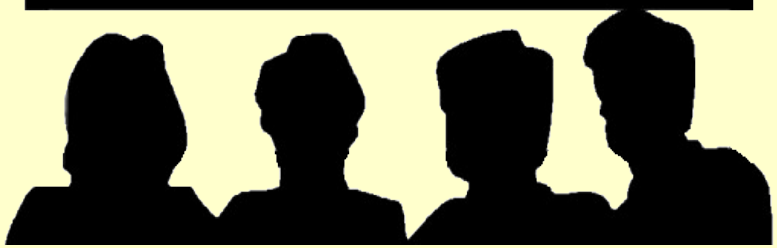
http://en.wikipedia.org/wiki/Ferrybridge_power_stations

A fossil fuel power station has an efficiency of about 33%.

Efficiency

http://en.wikipedia.org/wiki/Ferrybridge_power_stations

This means that 1/3 of the heat energy released from the fuel gets turned into electricity.

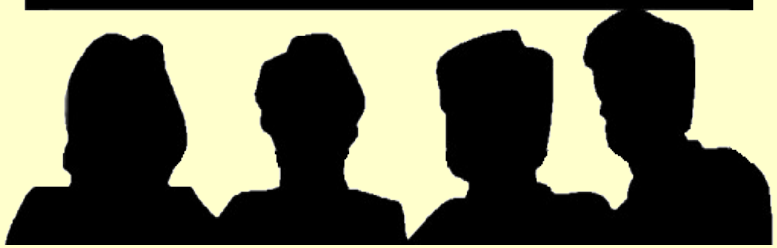


A fossil fuel power station has an efficiency of about 33%.

Efficiency

http://en.wikipedia.org/wiki/Ferrybridge_power_stations

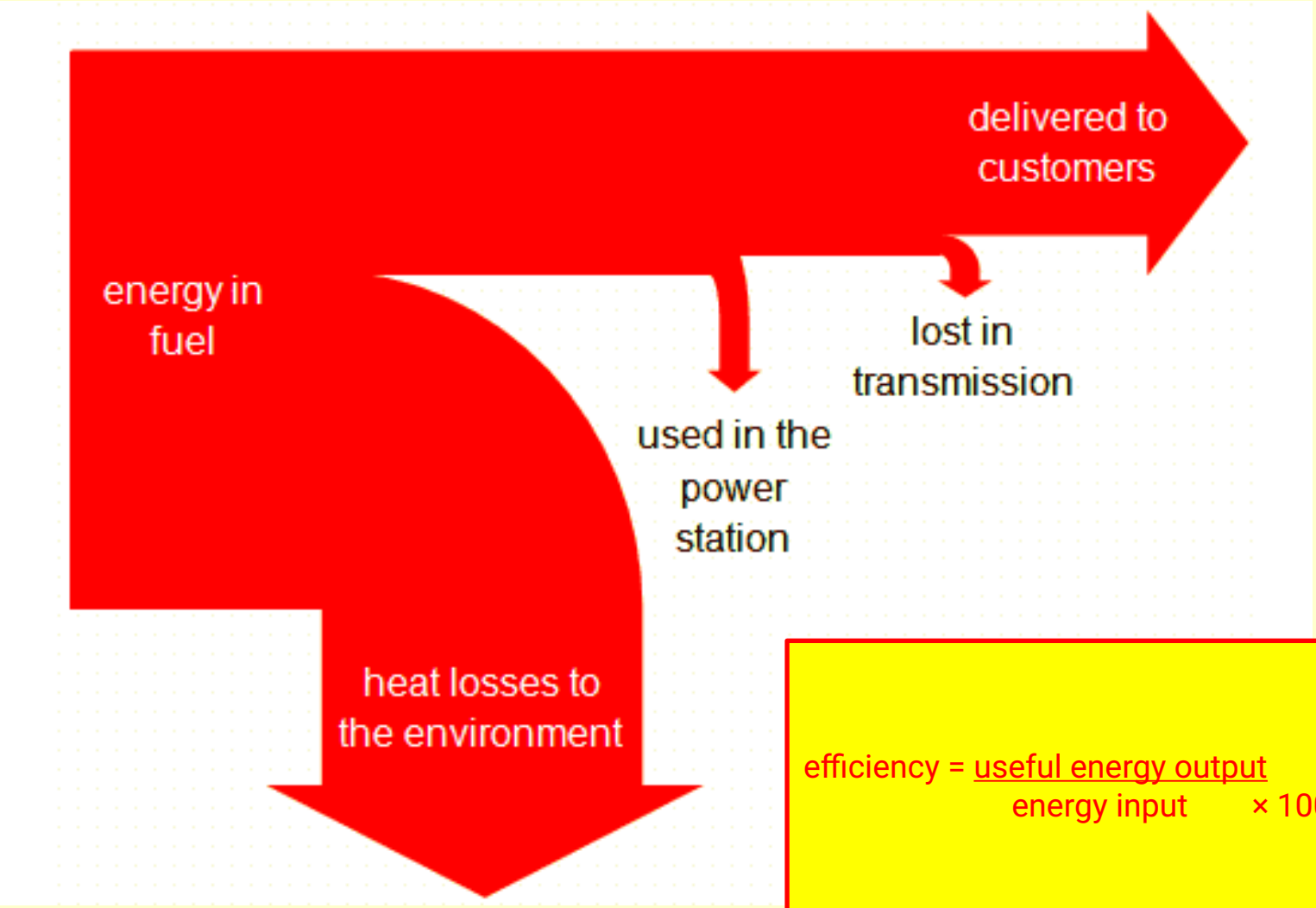
This means that 1/3 of the heat energy released from the fuel gets turned into electricity.



A fossil fuel power station has an efficiency of about 33%.

The other 2/3 of the energy ends up as waste heat – it just warms up the power station and its surrounding environment.

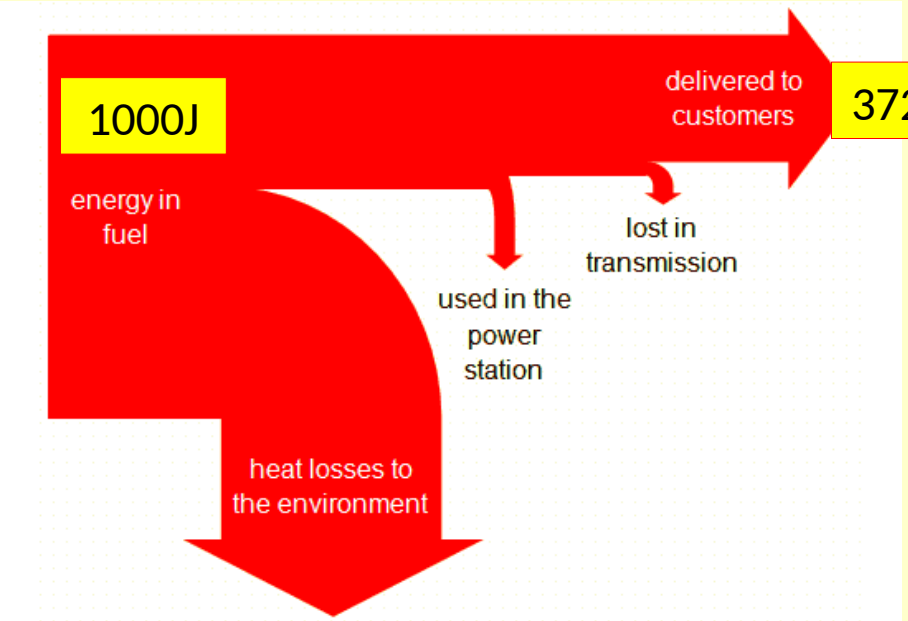
Efficiency



efficiency = $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$

Efficiency

http://en.wikipedia.org/wiki/Ferrybridge_power_stations

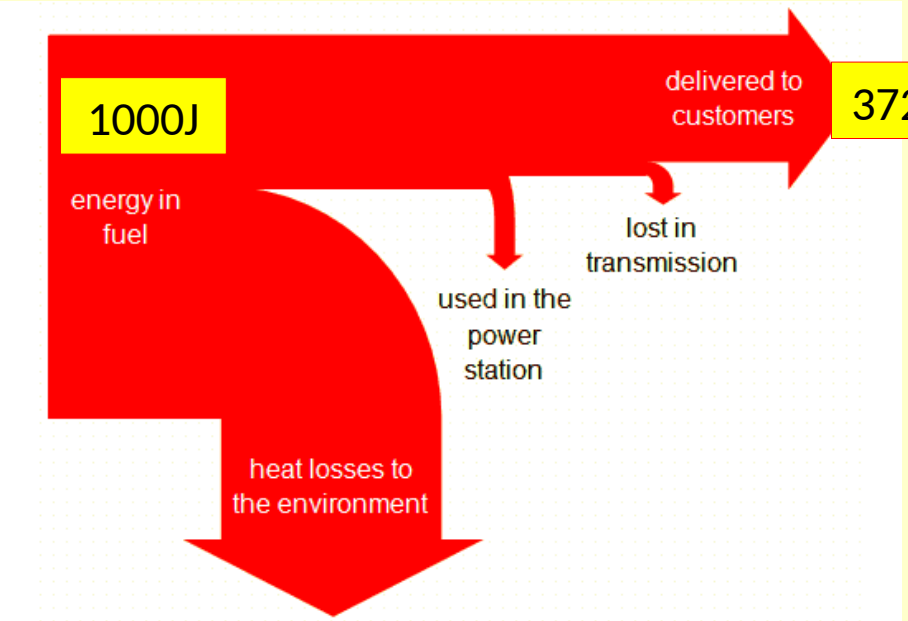


efficiency = $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$

Overall efficiency = $\frac{372}{1000} \times 100 = 37.2\%$

Efficiency

http://en.wikipedia.org/wiki/Ferrybridge_power_stations



efficiency = $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$

efficiency = $\frac{\text{useful power output}}{\text{Power input}} \times 100\%$

You need to be aware of both equations!

Overall efficiency = $\frac{372}{1000}$ x 100 = 37.2%

LEARNING OBJECTIVES

1.7.2 Energy resources

Core

• Describe how electricity or other useful forms of energy may be obtained from:
– chemical energy stored in fuel
– water, including the energy stored in waves, in tides, and in water behind hydroelectric dams
– geothermal resources
– nuclear fission
– heat and light from the Sun (solar cells and panels)
– wind
• Give advantages and disadvantages of each method in terms of renewability, cost, reliability, scale and environmental impact
• Show a qualitative understanding of efficiency

Supplement

• Understand that the Sun is the source of energy for all our energy resources except geothermal, nuclear and tidal
• Show an understanding that energy is released by nuclear fusion in the Sun

• Recall and use the equation:

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100\%$$

• $$\text{efficiency} = \frac{\text{useful power output}}{\text{Power input}} \times 100\%$$

Video resources

Burning waste to produce electricity

https://www.youtube.com/watch?v=94Qqzbz7hZE

How does a wind turbine work?

https://www.youtube.com/watch?v=gE6A5V9qkdQ

How does a thermal power plant work?

https://www.youtube.com/watch?v=IdPTuwKEfmA

Wind power plant installation documentary

https://www.youtube.com/watch?v=wQKmMosjknc

Germany’s hidden leaking nuclear waste dump

https://www.youtube.com/watch?v=hOWQgLeRM-M

Practice resources

1. What is the efficiency of burning waste to produce electricity?

2. What is the efficiency of a wind turbine?

3. What is the efficiency of a fossil fuel thermal power plant?

4. What is the efficiency of a modern solar cell or photovoltaic?

5. How long does it take for nuclear waste to become safe?

6. Which method(s) of producing electricity is most suitable for an island?

7. Which method(s) of producing electricity is most suitable for a river valley?

8. Which method of producing electricity is most suitable for a volcanic region?

9. Do solar panels only produce hot water?

10. Which methods of energy production emit less carbon dioxide?

Research on the internet to find the correct answers on your own, in case you have any difficulty answering the questions!