Single Award Science
Unit 3 – Physics

Topic 2
Energy & Electricity Generation

Name: ____________________

Class: ____________________

Teacher: ____________________

Cookstown High School, Northern Ireland

Single Award Science
3.3 & 3.4 Energy and Electricity Generation

Learning Intentions	Completed	What I know
1. To know that energy exists in different forms like chemical, heat, electrical, sound, light, magnetic, strain energy, kinetic and gravitational potential. 2. To know that energy is measured in joules (J). 3. To know the Principle of Conservation of Energy - that energy can be changed from one form to another but the total amount of energy does not change. 4. To be able to draw and interpret energy transfer diagrams. 5. To know that not all of the energy used by a device is useful. 6. To know that efficiency is a measure of how much of the input energy is used usefully. 7. To use the equation: $Efficiency = \frac{Useful\ Output\ Energy}{Total\ Input\ Energy}$ 8. To know what renewable energy is. 9. To know what a non-renewable energy source is. 10. To know examples of renewable energy such as sunlight, wind, rain, tidal, waves, wood and geothermal heat. 11. To know what biomass means. 12. To understand that biomass is non-renewable if it uses plants that are not regrown. 13. To know examples of non-renewable energy like fossil fuels such as oil, natural gas and coal as well as nuclear energy based on fission. 14. To be able to explain why we need alternative renewable fuels		

15. To understand how electricity is generated. 16. To know the parts of power stations and their functions. 17. To know the energy transfers that take place in power stations.		
Physics drawings success criteria Use a sharp pencil Draw straight, **ruled** lines Keep drawing in proportion Be accurate Show all working out for calculations To give units with any numerical answers		

Keywords: 3.3 – 3.4 Energy and Electricity Generation

Keyword	Spelling	What do you know about this word
1. Energy		
2. Joule		
3. Renewable		
4. Non-renewable		
5. Fossil Fuel		
6. Nuclear		
7. Solar		
8. Hydroelectric		
9. Biomass		
10. Geothermal		
11. Solar		
12. Tidal		
13. Efficiency		
14. Boiler		
15. Turbine		
16. Generator		

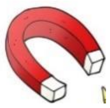
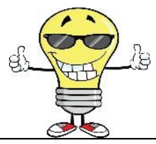
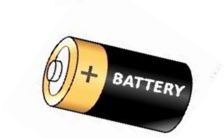
Energy

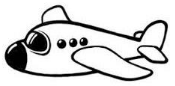
Energy is used to do work. There are **9** different ways which we see energy.

The amount of energy is measured in **Joules** (the symbol **J**)

Use the names in the box to **identify each form of energy** shown in the pictures. Then think of some more examples for each form of energy.

Kinetic (Movement) **Magnetic** **Elastic (Strain)**
Chemical **Sound** **Light** **Heat (Thermal)**
Gravitational Potential **Electrical**

Picture	Energy Form	Other examples
		
		
		
		
		
		
		
		

Energy transfers

When an object or device is working, it **changes energy from one form to another**. This is called an **energy transfer**. Some devices change energy into several different forms.

e.g. a TV transfers **electrical** energy into **light** (screen), **sound** (speakers) and **heat**.

Complete the table below by adding the input energy and output energy (or energies) for each device.

Input Energy	Device	Output energy
	light-bulb	
	A match	
	catapult	
	human body	
	electric fire	
	electromagnet	
	car engine	
	microphone	

In every energy transfer, some of the energy will be transferred usefully, and some of the energy will be wasted. Wasted energy is usually given out as **heat and sound**.

However, **the total amount of energy must stay the same.**

This is known as **the Law of conservation of energy**, which states:

Energy cannot be created or destroyed, it can only change form.

This means if we **supply 1000J** of electrical energy to a TV, we must get 1000J back out. This could be:

500J of Light
350J of Sound

+ 150J of Heat

but the total output is still =

Energy Transfer Diagrams

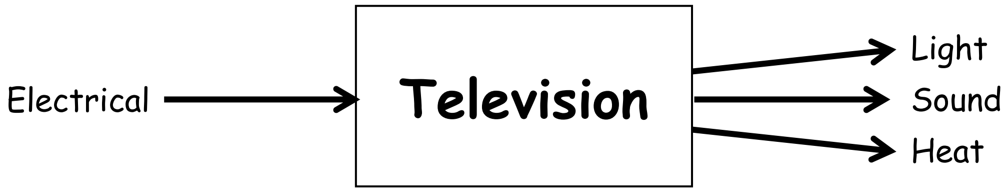
Energy transfers can be shown using simple diagrams.
These diagrams should be drawn using a **ruler and pencil**!

An energy transfer diagram shows the input and output energies for a device.
E.g. a TV:

The input goes on the left (arrow pointing in)

The device is in a box in the middle

The output energies on the right (arrow out)



Using the table on the previous page, draw energy transfer diagrams for:

1. A match

2. A Human

3. A car engine

4. A microphone

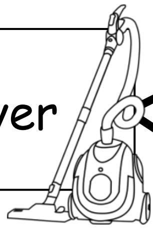
Sometimes we can include the amount of energy in energy transfer diagrams.

e.g. an energy saving light bulb

100J of Electrical Energy → Light bulb → 75J of Light energy / 25J of Heat energy

Fill in the blanks in the energy transfer diagrams below. Then highlight the useful energy form.

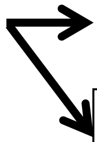
2000J of Electrical Energy → Hoover → 1500J of kinetic energy / ______J of Sound energy



45,000J of ________ Energy → Car → ______J of kinetic energy / 9000J of Heat energy / 7500J of Sound energy

6000J of Kinetic Energy → Generator → 1700J of Heat energy / ______J of ______________ energy / 900J of Sound energy

23,000J of Kinetic Energy → Wind turbine → ____J of Electrical energy / 5450J of Heat energy



6740J of Sound energy

Efficiency

When a device is **very good at transferring energy into useful forms**, we say it is very **efficient**.

If a device **transfers a lot of energy into wasted forms** (like heat and sound) we say it is **inefficient**.

We can calculate a value for efficiency using the equation:

$$\textbf{Efficiency} = \frac{\textbf{Useful Output Energy}}{\textbf{Total Input Energy}}$$

This will ALWAYS give an answer less than 1 as no device can give out more energy that is put into it.

e.g. if 200J of electrical energy is used by a lightbulb, and it produces 150J of light, how efficient is it?

$$\textbf{Efficiency} = \frac{\textbf{Useful Output Energy}}{\textbf{Total Input Energy}}$$

$$\textbf{Efficiency} = \frac{\textbf{150}}{\textbf{200}}$$

$$\textbf{Efficiency} = \textbf{0.75}$$

Calculate the efficiency for each of the following. Remember to **show all your working out!**

Input Energy	**Device**	**Useful output energy**	**Efficiency**	**%**
200J Kinetic	**Catapult**	180J Elastic		
500J Electrical	**Sewing Machine**	300J Kinetic		
2500J Electrical	**Kettle**	2400J Heat		
12,500J Light	**Solar Panel**	500J Electrical		

Sometimes we multiply the efficiency by 100 and write it as a percentage.
e.g. the lightbulb above had an efficiency of 0.75:

0.75 × 100 = 75

We say the bulb is 75% efficient

Complete the table above by calculating the percentage efficiency for each device.

Energy Resources

An energy resource is a means of getting useful energy to meet our everyday requirements. The most useful form of energy is electrical as it can be easily distributed and transferred into other forms.

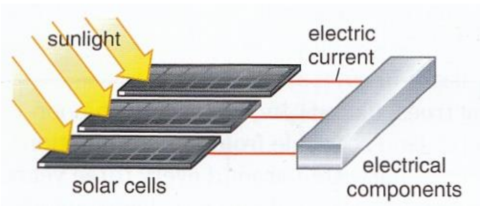
Energy resources can be classified into **renewable** and **non-renewable resources**.

Renewable resources:	**"Those that can be replaced by nature in less than a human lifetime."** They will not run out.
Non-renewable resources:	**"Those that are used faster than they can be replaced by nature."** They will run out.

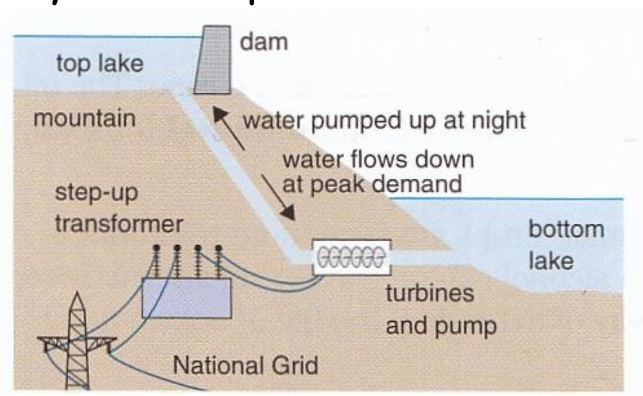
Renewable energy resources

Solar cells

These convert sunlight (solar energy) directly into electricity.



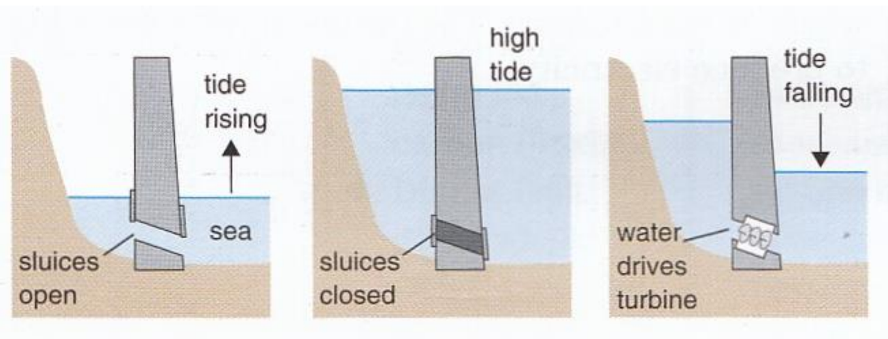
Hydroelectric power stations



The water cycle (rain) can be used to fill up reservoirs. The water is allowed to fall from the dam through a pipe. This fast-flowing water is used to turn a turbine, which spins and drives a generator. The generator generates electricity.

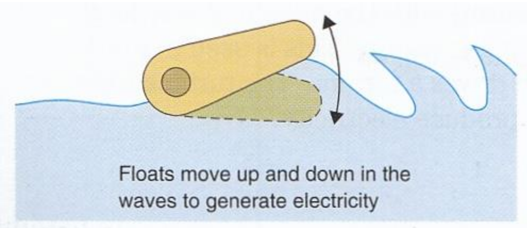
Tidal

A tidal barrage is created when a dam is built where the river flows into the sea. The tide rises and falls every 12 hours, and as long as the water levels on each side of the dam are not equal, water will flow through a gate in the



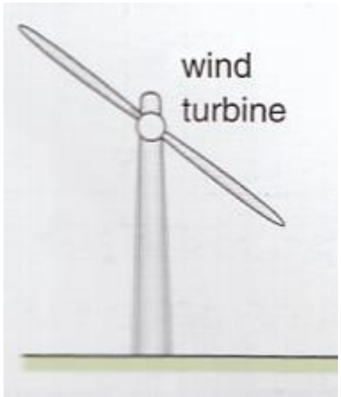
dam. This flowing water drives a turbine, which spins and drives a generator. The generator generates electricity.

Wave machines.



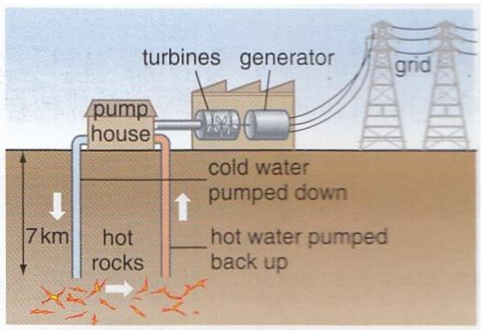
Waves are mostly produced by the wind moving over the surface of the water. A wave machine floats on the surface of the water and the up and down motion of the water drives a turbine to produce electricity.

Wind turbines



As the wind blows, the large blade turns and this drives a turbine. The turbine drives a generator, which in turn produces electricity. Large numbers of turbines are often grouped together to form a wind farm.

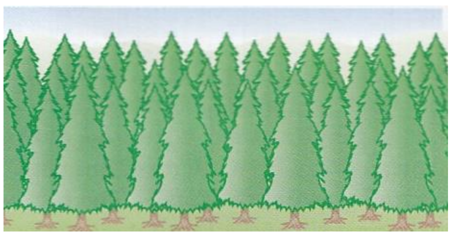
Geothermal energy.



Geothermal (Geo – Earth, Thermal – heat) power stations use heat from the hot rocks deep inside the Earth. Cold water is passed down a pipe to the rocks. The water is heated by these rocks and turns into steam. This steam is then used to turn a turbine.

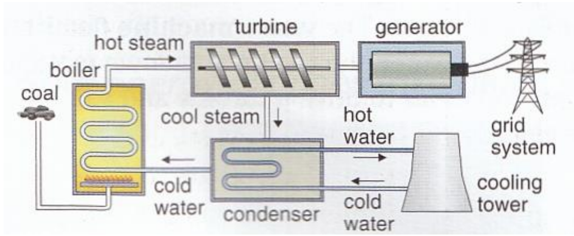
Biomass

When plants are grown to be burnt in order to produce energy, we call this Biomass.
Fast-growing trees, like willow, are grown on poor quality land. The timber is dried and turned into woodchips which are then burned in power stations to produce electricity.

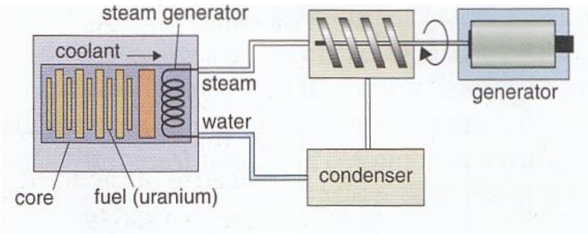


Biomass can also be produced from other plants such as the oil from rapeseed or using a digester for silage (grass).
However, **biomass is only renewable if the trees are replanted**.
If a forest is cutdown for fuel and not regrown, then this biomass is non-renewable.

Non-renewable energy resources.



Fossil fuels — coal, oil, natural gas
The fuel is mined or drilled from underground sources. It is then burned in a power station to produce steam which drives a turbine. The turbine turns a generator to produce electricity.



Nuclear power stations. Uranium fuel

Uranium nuclei in a reactor split into lighter nuclei (nuclear fission) with the release of very large amounts of energy. This heat energy is used to produce steam, which drives a turbine. The turbine turns a generator to produce electricity.

Renewable vs Non-renewable

Coal, oil and gas are fossil fuels – this means they are made from the remains of living things (plants and animals) that have died a very long time ago, and have fossilised into these fuels. Uranium fuel (for nuclear energy) is a type of metal that is mined and cannot be replaced.
It is important that we find better, renewable, ways to produce energy. There are two main reasons for this:

1. **Non-renewable resources are running out.**
   The amount of coal, oil and gas in the world is limited. This means we need to find another way of producing the energy we need before we run out of fuel.
2. **Non-renewable resources produce pollution.**
   Burning **coal, oil and gas releases carbon dioxide**. This gas builds up in our atmosphere, and traps heat from the sun. This causes climate change.

Although they are problems with renewable resources as well, they will never run out, and most of them do not produce carbon dioxide.

Energy resources summary table:

Renewable resource	Non-renewable resource

Generating Electricity

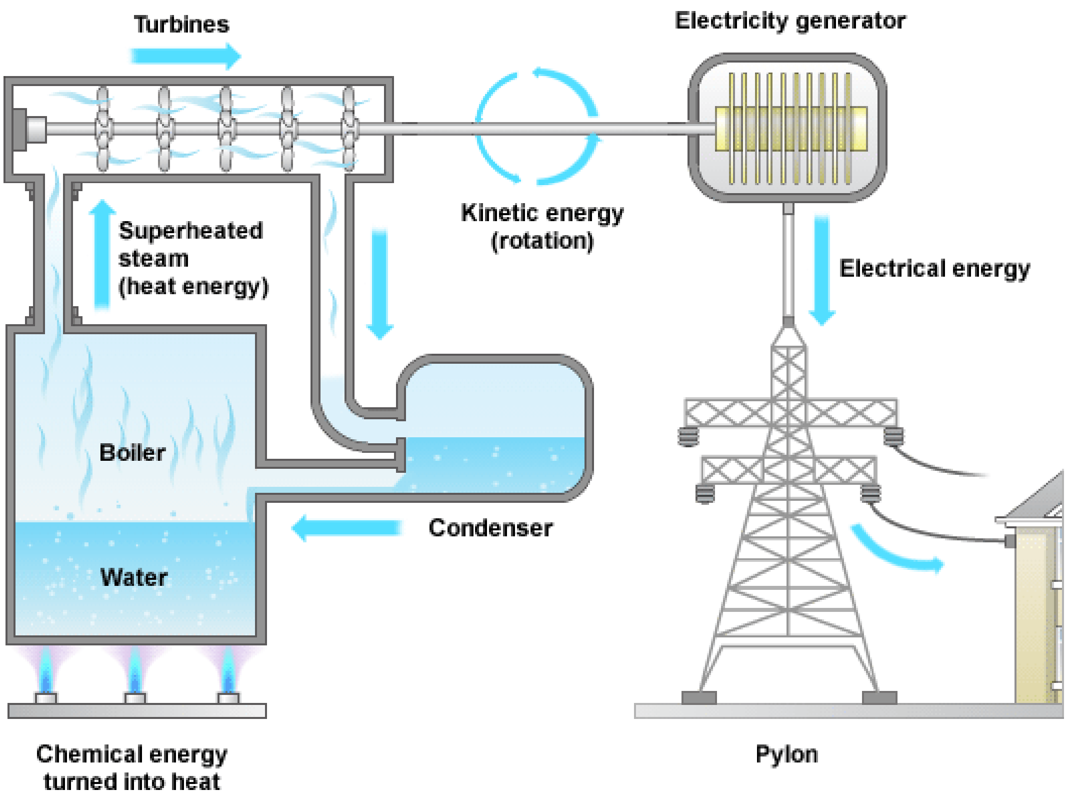
Electricity is the most useful form of energy as it can be easily sent over long distances (to our homes and businesses) and then it can be transferred into the other forms of energy we need.

Can you think of some devices that transfers energy into the following forms we need in our homes?

Input energy	Device(s)	Output energy
Electrical Energy		Heat Energy
Electrical Energy		Light Energy
Electrical Energy		Sound Energy
Electrical Energy		Kinetic Energy
Electrical Energy		Chemical Energy

Most of our electricity is produced in large fossil fuel power stations. They turn the chemical energy found in gas, oil and coal into electrical energy, before transporting it, through cables, to our homes.

The diagram below shows a fossil fuel power station



Put the sentences below in order to show how we produce electricity from fossil fuels.

- The turbine turns a generator
- The heat is used to boil water and make steam
- The steam builds up pressure and is forced through a turbine
- The generator produces electricity
- The fossil fuel is burnt to produce heat

The process of a fossil fuel power station:

1.

2.

3.

4.

5.

We have lots of fossil fuel power stations in the UK already built and working, so why are we trying to find other energy resources?

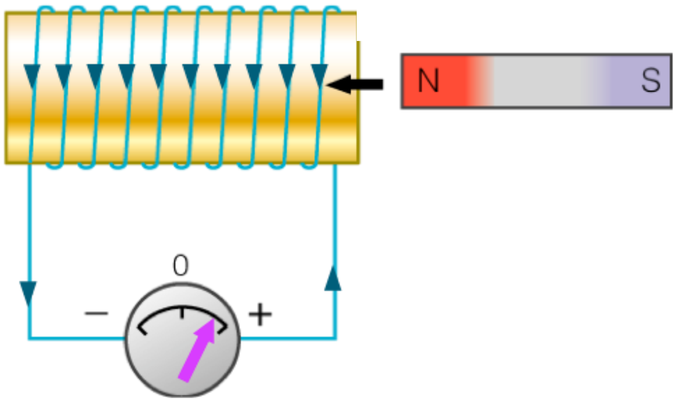
There are two main problems with using fossil fuels:

1. They are non-renewable this means they cannot be replaced in a ____________
2. Burning fossil fuels produces a harmful gas called ___________ ____________

The generator

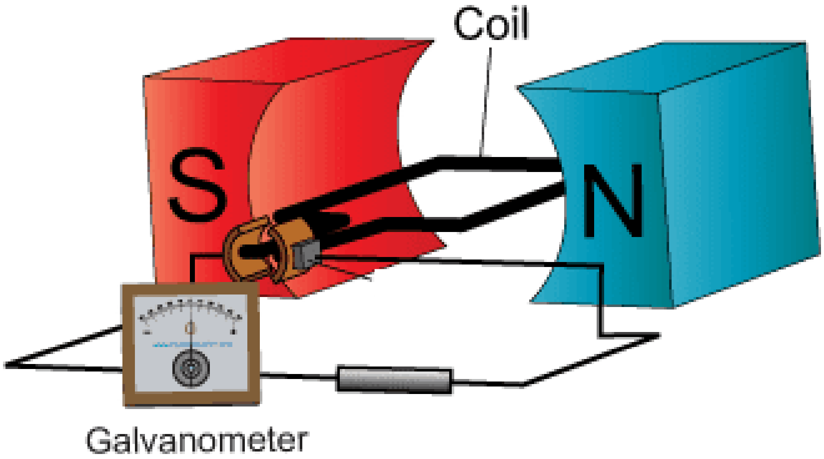
Have you ever wondered how a generator turns movement (kinetic energy) into electricity (electrical energy)?

If a very strong magnet is pushed into a coil of wire, like in the diagram below, a small current flows for a very brief time.



If the magnet is left sitting in the coil, nothing happens.
When the magnet is pulled out again, the current flows again, but in the opposite direction.
The magnet field of the magnetic pushes the electrons around the circuit, but this can only happen when the magnet is moving!
This is a very basic generator.

Another way of doing this, is to make the coil of wire rotate inside the magnet field as shown below.



You can try this in your classroom, but it takes a lot of spinning! This is why we need to put such a large turbine, spinning at a very fast rate in order to make enough electricity for our homes.