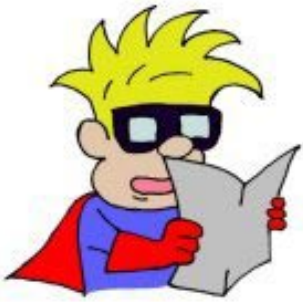


Mission 6:

Renewable Energy



What is Renewable Energy?



There are some ways to make electricity without burning fossil fuels. We are surrounded by **natural** sources of energy, such as the **sun** and the earth's **winds** and **waters**. For hundreds of years man has been using these sources of energy to power different types of machinery....

By using the **wind** to turn a windmill...



... or using **water** to turn a water wheel.

Today we can harness energy from the **sun**, **wind**, **water** and the **natural heat of the earth** to produce electricity with very little harm to our environment. These forms of energy are **renewable**, which means that they will never run out. Fossil fuels such as coal, oil and gas will eventually run out, they are called **non-renewable**.

Non-renewable energy
Coal Oil Gas Peat

Renewable energy
Wind power Water power Solar power Geothermal power

Quiz - What is Renewable Energy?

Name the energy resource for the pictures below. You will find the word you need in the box. Say whether you think each energy resource is **RENEWABLE** or **NON-RENEWABLE**.

coal

sun

water

petrol

wind

fossil fuel



energy resource

renewable / non-renewable







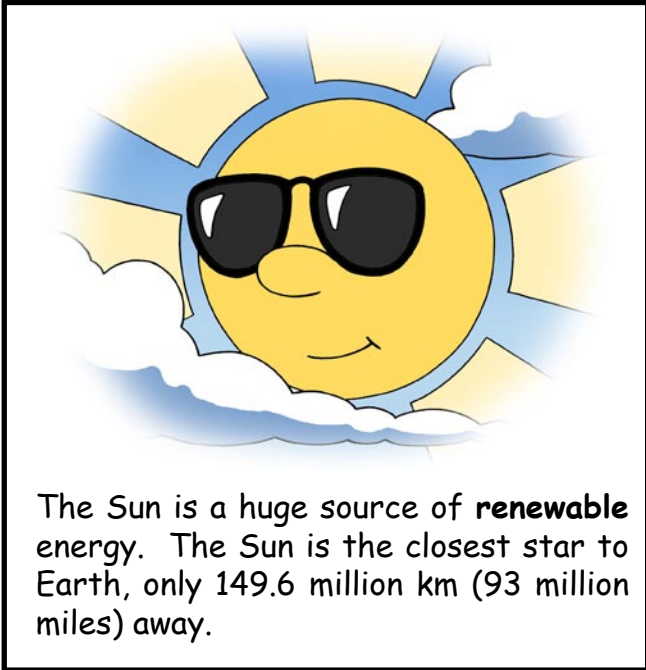




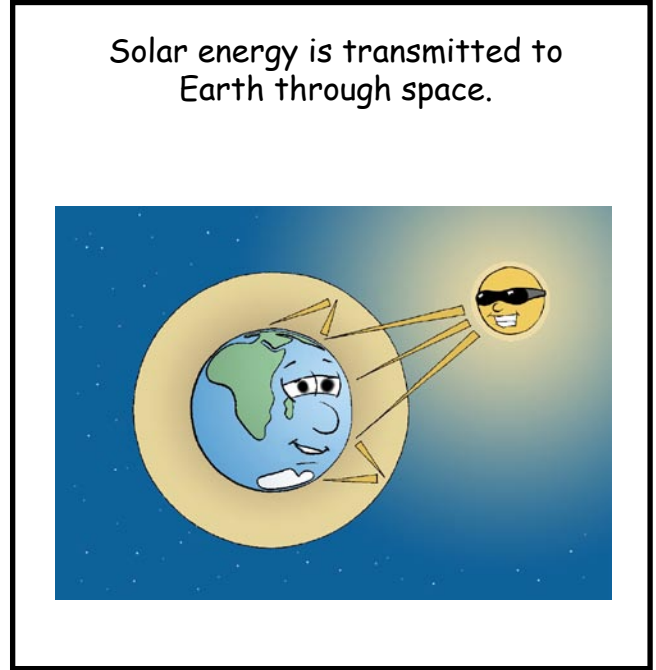
Solar Energy



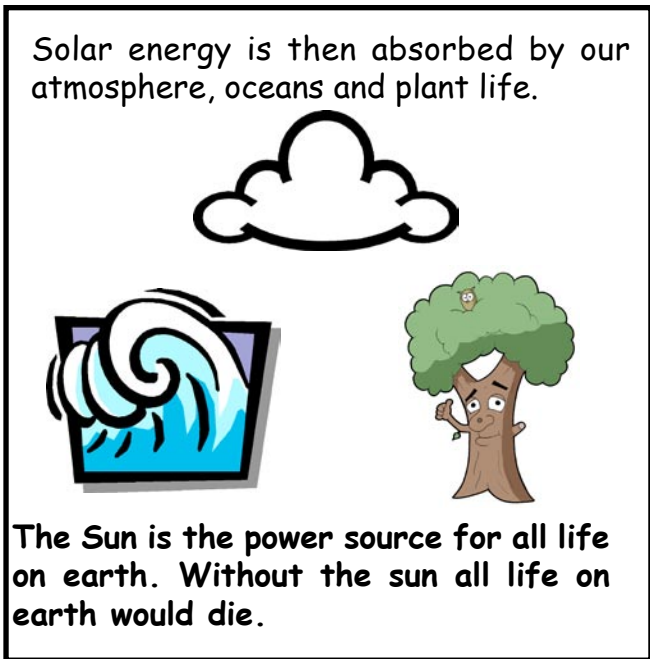
Energy from the sun is called **SOLAR** energy. Let's find out a bit more about it...



The Sun is a huge source of **renewable** energy. The Sun is the closest star to Earth, only 149.6 million km (93 million miles) away.

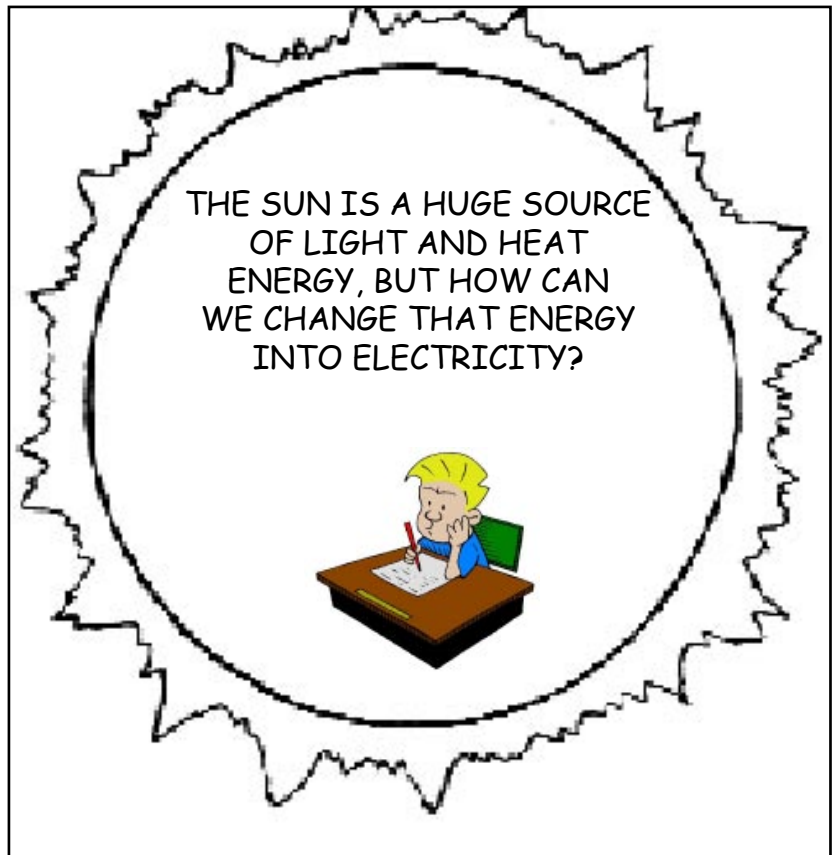


Solar energy is transmitted to Earth through space.



Solar energy is then absorbed by our atmosphere, oceans and plant life.

The Sun is the power source for all life on earth. Without the sun all life on earth would die.



THE SUN IS A HUGE SOURCE OF LIGHT AND HEAT ENERGY, BUT HOW CAN WE CHANGE THAT ENERGY INTO ELECTRICITY?

Solar Energy



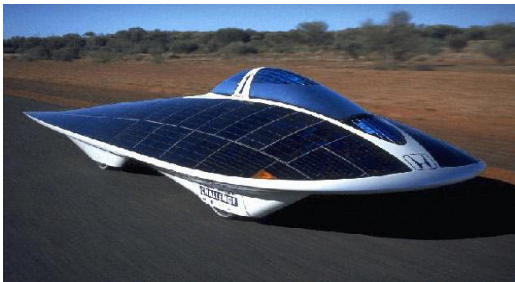
Sunlight contains electromagnetic energy. This energy can be changed into electrical energy by **photovoltaic cells**.



← **photovoltaic cell**

These cells are made of a material called silicon. When this material is exposed to sunlight an electric current can be produced. This is how a calculator works.

The sun's energy can be used to heat homes, to power cars, weather stations, and even satellites.



Use the internet or look in the library to find out about solar cars. See if you can answer the questions below.

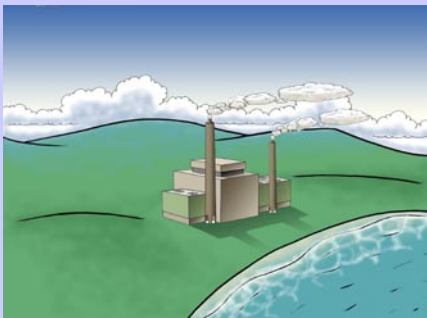
1. How does a solar powered car move at night time?

2. How does a solar powered car stop?

3. In which country does a solar powered car race take place every year?

Solar Power Stations

There is a solar power station in France. It is called a **Concentrated Collector** and uses mirrors. The sun's energy can be deflected and concentrated from a wide area. 63 large mirrors follow the sun, reflecting the energy on to 9,500 smaller mirrors. These are focused on a single target. The energy concentrated at the target is 3000 times that received by any single mirror, producing temperatures of up to 3,800 C.



In an ordinary power station, coal or oil is burnt to boil water and produce steam. The steam is used to spin a turbine which is connected to a generator. When the generator is spun very fast it produces electricity.

Use the information in the boxes above to describe how a solar power station turns solar energy into electricity.

Solar Heating Experiment



Solar energy can be used to heat buildings. Flat-plate collectors are made of dark metal plates, covered with glass which absorbs heat. The heat is transferred to air or water which circulates round a building.

Let's have a go at making a solar collector!



You will need:

different sizes of Aluminium containers (deep, shallow, wide) black paint, measuring jug, water, cling film, newspapers and a thermometer.

1. Paint the inside of each container black.
2. Add 200ml of water to each container.
3. Carefully cover the containers with cling film, tape in place if necessary.
4. Place the containers on a stack of newspapers in the sun for 10 minutes.
5. After 10 minutes pour the water into a container and measure and record the temperature. Repeat for each container.

Which shape works best as a solar collector?

Container	1	2	3	4	5

- 1 Draw a sketch of the best solar collector and explain why you think it worked better than the other containers.

2. Why was the inside of the containers painted black?

3. Why was newspaper used to put the containers onto?

Quiz - Solar Power

Solar panels are put onto roofs facing South, as this is where they will get the most sunlight.



This house faces south



Which of these houses should have solar panels on the roof? Colour it in.



This house faces east

Draw a line from the sun to the things that get their energy from solar power.



Wind Power



In the past, wind energy has been turned into mechanical energy by windmills to run machinery. For thousands of years, Man has tried many different designs to get as much power as possible from the wind.

DESIGN NUMBER 1 - GREEK WINDMILLS



To make the blades as light and as fast as possible, cloth sails were used. To get the most energy out of the wind, the sails were angled so that the wind hit them from the side.

DESIGN NUMBER 2 - DUTCH WINDMILLS

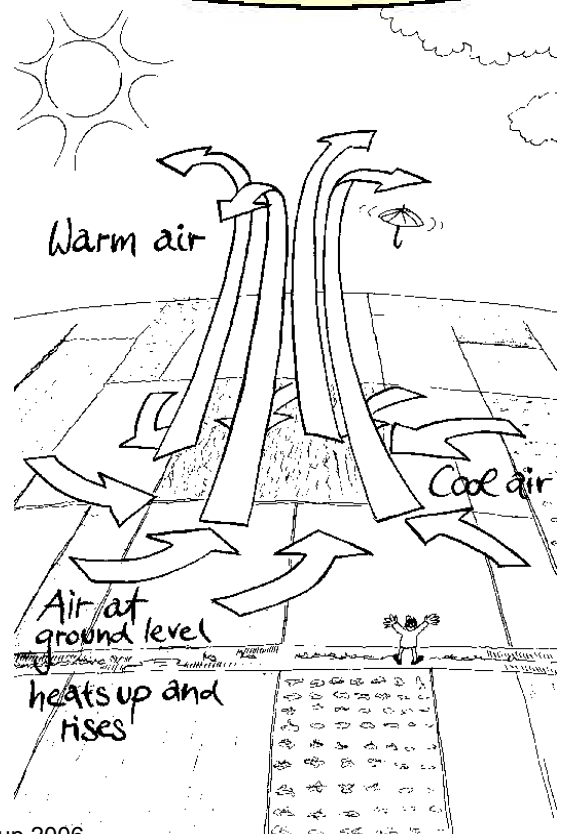


In the North, winds are much stronger, and windmills needed to be much more solidly built, with wooden sails. Windmills are still used in Holland to pump water and were used all over Northern Ireland to grind corn.



But where does the wind get its energy from?

The sun heats some parts of the earth more than other places. The warmer air rises into the atmosphere and is replaced by cooler air, hey presto, winds. Wind energy is second hand solar energy.



Wind Turbines

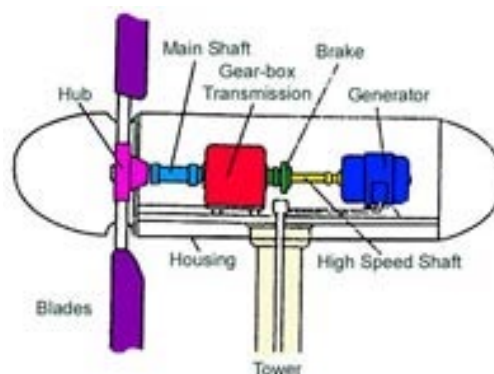
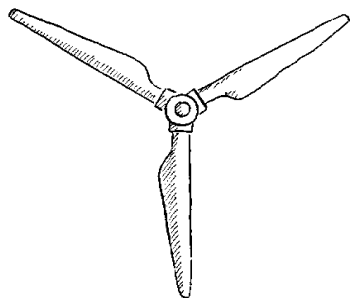
Today, instead of changing wind energy into mechanical energy, it is changed into electrical energy. If you make a generator spin very fast, it will produce electricity. What better way to make it spin than by using the wind?



A windmill that produces electricity is called a **wind turbine**, or a wind energy converter (WEC). Wind turbines are much larger than windmills, over 39 metres high.

The amount of electricity a turbine can produce depends on the strength of the wind, and also the size of the blades. If the wind is too strong the turbine has to shut down.

Unlike old-fashioned windmills, which usually have sails, wind turbines have **blades**. These blades have a curved surface, like the wings of an aircraft: this makes them very efficient. The blades need to be light enough to turn easily, but strong enough to stand up to storms.



The wind changes direction all the time, so the top of the turbine rotates round so that the wind can always spin the blades. The box behind the blades contains the turbine. As the blades turn the turbine spins a shaft which spins the generator which produces electricity.

Wind Farms

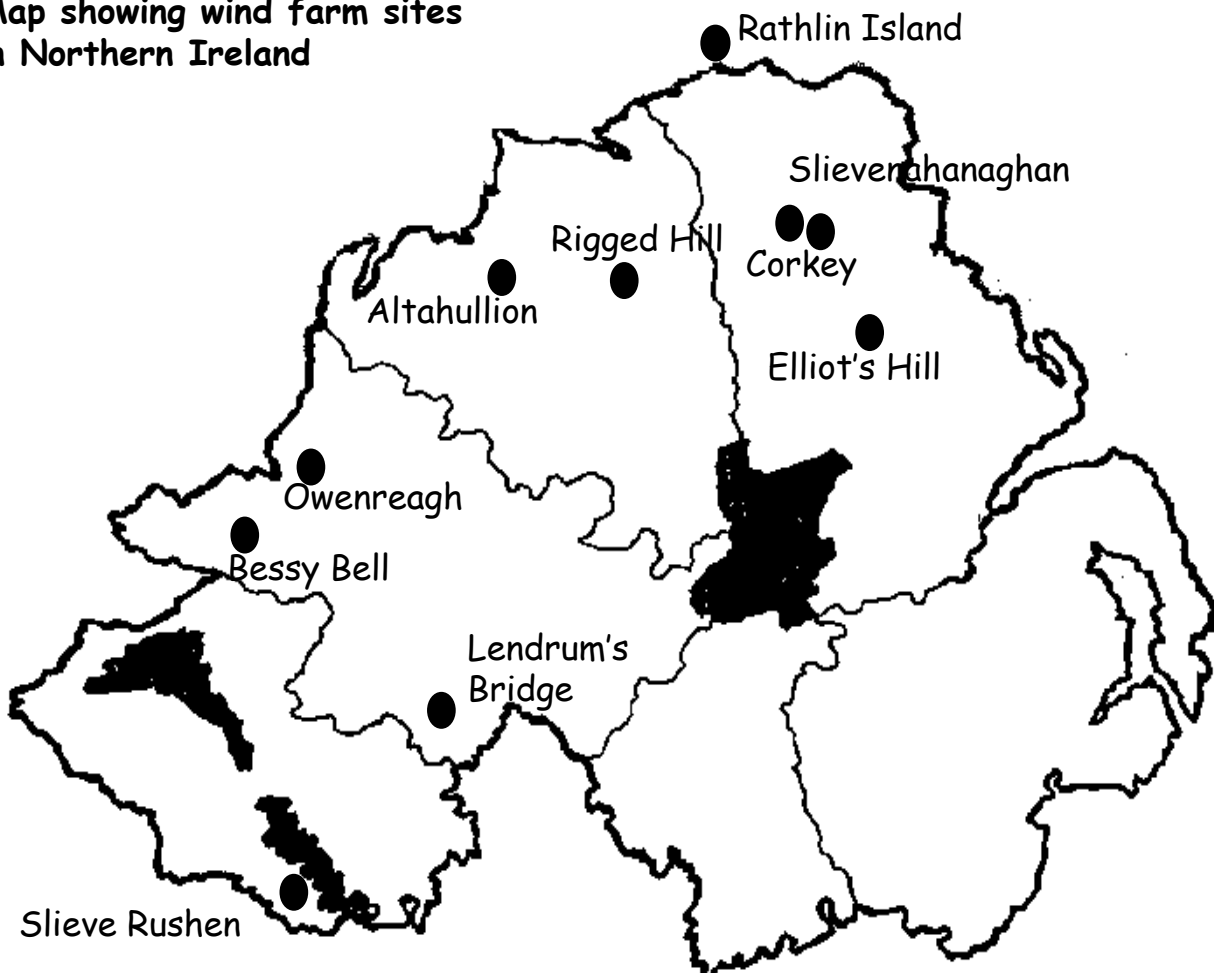
Circle the correct answer.

1. Wind turbines are built in **exposed** / **sheltered** locations.
2. The best location is **on top of a mountain** / **in a valley**.
3. Wind turbines are enormous and need **a lot of space** / **very little space**.
4. Wind energy is a **non-renewable** / **renewable** source of energy.



A group of wind turbines is called a **wind farm**. They are usually found on top of hills, where the wind can flow freely and is not blocked by trees or buildings. There must be plenty of space between each turbine to give the blades room to spin. In some countries, wind farms can have hundreds of turbines. In Northern Ireland however they are much smaller - usually about 10 turbines. On Rathlin Island there are 3 wind turbines - they supply the population with electricity, as the island is not connected to the mainland electricity system.

Map showing wind farm sites in Northern Ireland

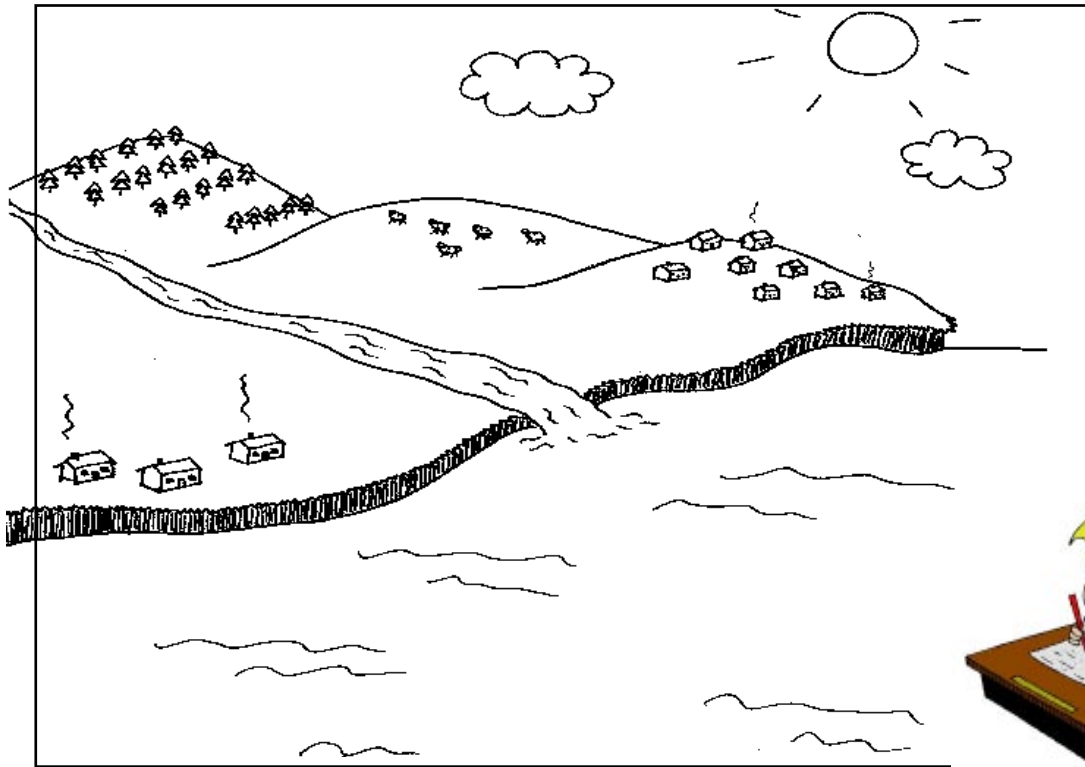


Wind Farms

Offshore wind farms are found in the sea, a few miles out from the coast. As the sea is flat, the wind here is very strong because there is nothing to obstruct its flow.



Draw a new 4 turbine wind farm in a suitable location on the picture below.



1. Explain why you have chosen this site for your wind farm.

2. What would be a suitable name for your wind farm?

3. Who do you think might object to your wind farm being built? Why?

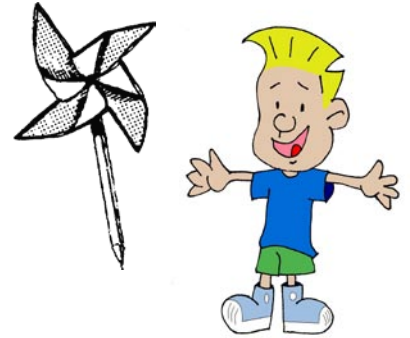
4. What are the benefits of using wind turbines to make electricity?

5. What other sources of renewable energy can you see in the picture?

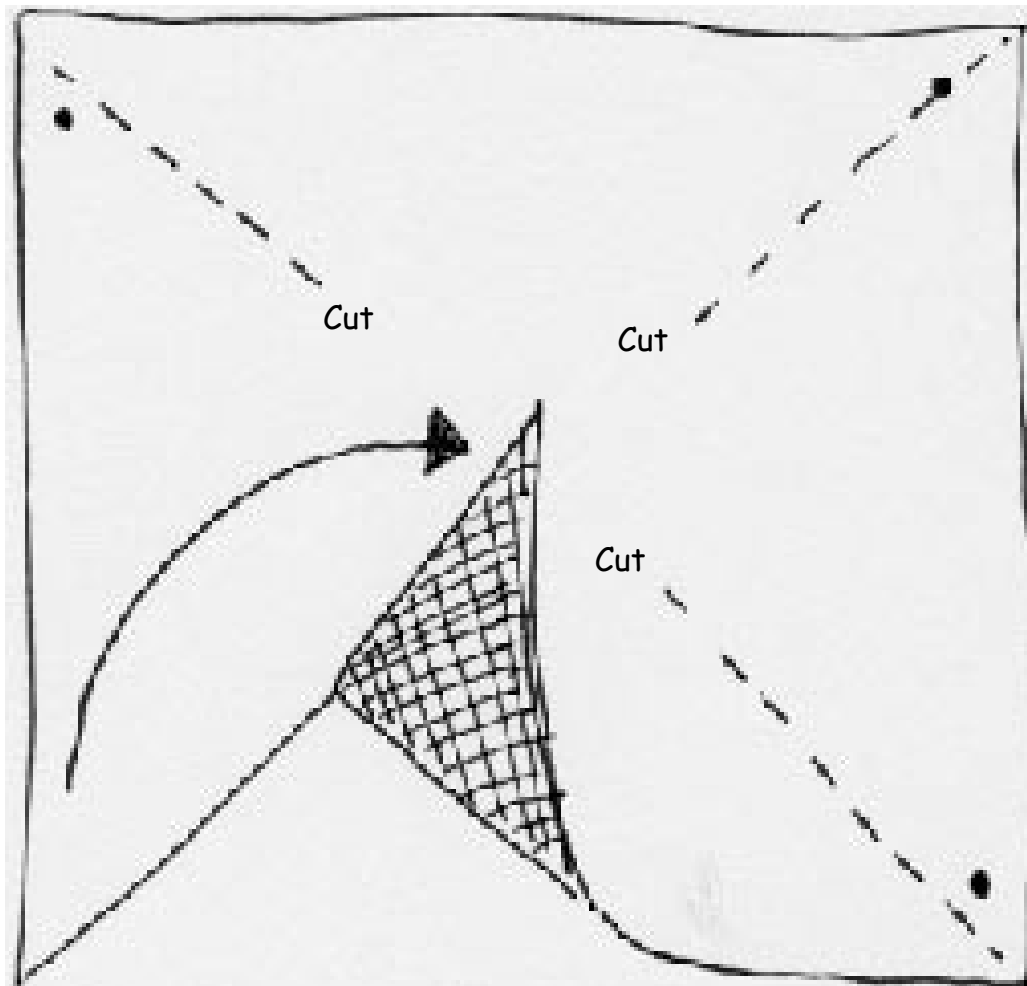
Make Your Own Windmill!

What you will need...

Card
A pipe cleaner
A straw
A pair of scissors.



1. Cut out a square of card about 15 cm by 15 cm..
2. From each corner, cut in a diagonal line ending about 2cm from the centre.
3. Fold every other corner into the centre.
4. Draw a dot on each corner to mark where a hole will be made.
5. Carefully put a hole in each corner and in the centre of the square.



6. Make a small loop at one end of the pipe cleaner and push the other end through the holes.
7. Thread the pipe cleaner through the straw and bend at the bottom to secure it.

Quiz - Wind Energy



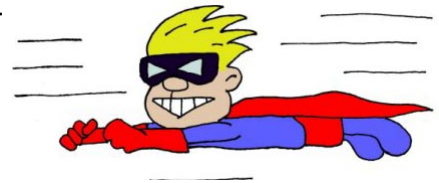
1. The wind changes speed and direction from place to place, at different times of the year, and even during the same day. Do you think we can depend on wind energy as our only source of power in any one place? Why?

2. Mark the things that you think are good about wind energy with a tick.
Mark the things that you think are bad about wind energy with a cross.

- a. Wind power is a very clean kind of energy.
- b. Wind turbines are very big and can be seen for miles.
- c. Wind does not have to be paid for.
- d. Wind turbines can be noisy.
- e. Wind does not blow all the time.
- f. Wind will never run out.

Are there more ticks or crosses? What are the advantages and disadvantages of wind energy?

3. Cross out the wrong answers in these sentences.

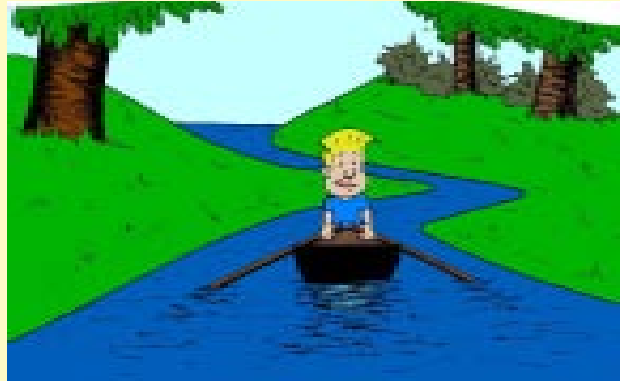


- a. The wind was used to produce electricity **10 / 200** years ago.
- b. Electricity is made by spinning a generator, so windmills are a **useless / perfect** way of doing it.
- c. A windmill that produces electricity is called a **WIT / WEC**.
- d. A wind turbine's blades need to be strong and also as light/heavy as possible.
- e. The amount of electricity a wind turbine produces depends on the strength of the wind, but also on the size of the **gearbox / blades**.

Water Energy



70% of the world is covered with water in the form of our oceans, lakes and rivers. That's a lot of water which equals a huge source of renewable energy. The power of water flowing in rivers was one of the earliest forms of energy harnessed by man to do mechanical work. Water or hydro-power is a **renewable** source of energy.

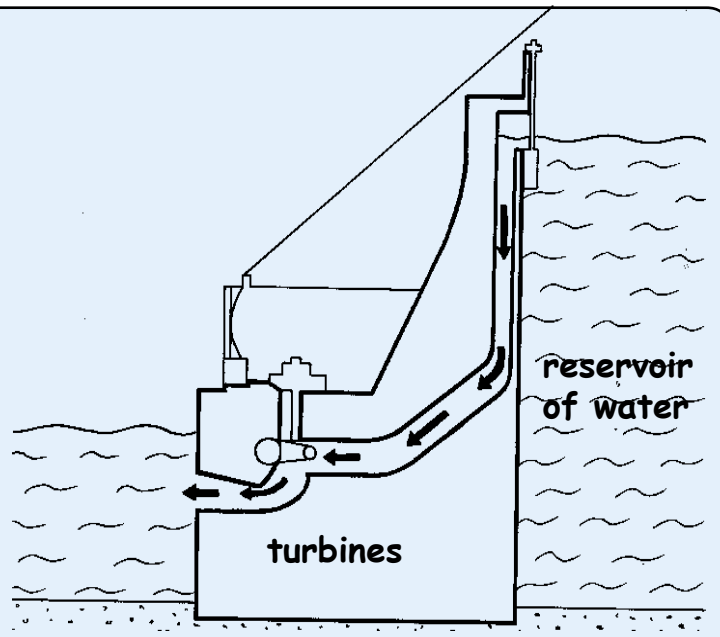


We have been using water power for hundreds of years in Northern Ireland e.g. using our rivers to power lots of different kinds of machinery. Take a look below.....

1. **Castle Ward** on the shores of Strangford Lough: they used the incoming and outgoing tides to power a mill which ground corn in the 1700's.
2. **Wellbrook Beetling Mill**, Cookstown: in the 1800's the running water from a river was used to power large hammers to beat out flax for linen manufacturing.
3. **Barbour Threads**, Lisburn: used the running waters of the River Lagan to power the looms which turned flax into linen.
4. **Patterson's Spade Mill**, Templepatrick: in 1919 water energy was used to power the machinery to make spades and are still using it today.

The larger the river the more energy can be harnessed, so in some parts of the world large rivers are used by **Hydro Power Stations** to make **electricity**.

In **hydroelectric stations**, water is stored in reservoirs or behind dams. Water flows downhill through large pipes and through the **turbines**. The falling water turns the turbines, spins the shaft, and turns the **generator** to make **electricity**, simple!



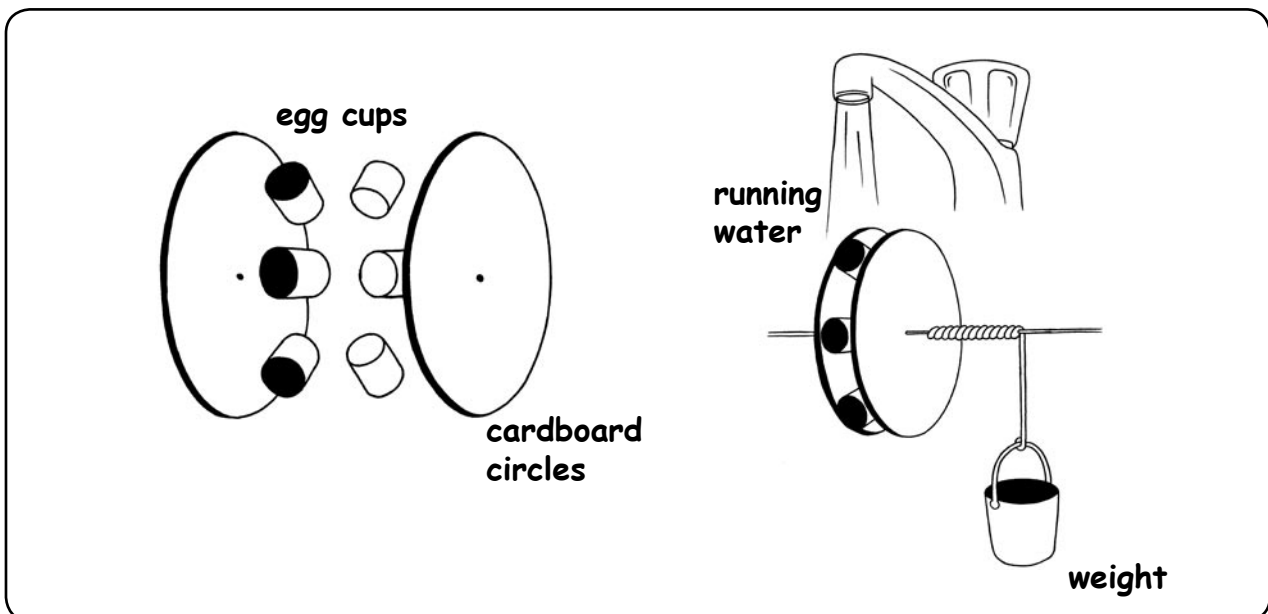
Hydro Power Activity

Make a model overshoot waterwheel. This model is like the old waterwheels used for grinding corn or powering linen mills. It is the weight of the water in the buckets that causes the wheel to overbalance and turn.

Instructions

1. **Carefully** cut out two cardboard circles, about 15cm in diameter. Brightly colour one side of each circle.
2. **Carefully** cut out the egg cups from an egg carton. You need to decide how many egg cups your wheel will need.
3. Evenly staple the cups around the outside edge of one of the circles, then staple the second disc onto the other side of the egg cups.
4. Push a pencil through the holes in the centre of the circles and your waterwheel is ready to go.

Once you have tested the wheel you can attach some string and a basket (empty film container or egg cup) to the pencil and test how much weight the wheel will lift.



Explain how the overshoot wheel works, and if you could make the design better.



Tidal And Wave Energy

Rivers are not the only source of water energy. Oceans and seas are a huge source of mechanical energy. Energy from **waves** and **tides** can be used to make electricity.

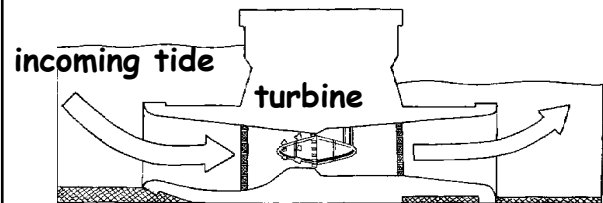


High tide

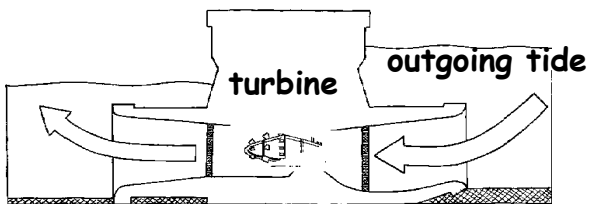


Low tide

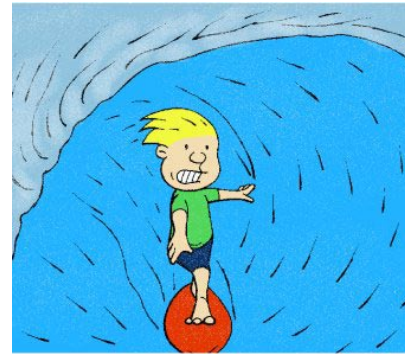
Tides come in and out twice every day. Tides occur due to the pull of the moon on our oceans. This movement of water can be used to make electricity.



Tidal power stations are built across a bay or an estuary. Along the length of the station, turbines spin as the tides come in and out.



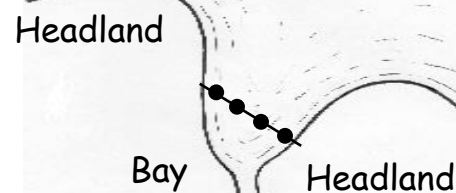
Every time the tide comes in and goes out electricity can be generated. Tidal power is a **renewable** source of energy.



Think about the sea on a stormy day, huge waves crashing into the shore. We can use this wave energy to make electricity.



Waves are formed by wind blowing across the surface of the water. Waves can travel 1000's of miles before they reach the shore, full of energy.







A line of 'boxes' with a turbine in each of them are anchored off shore. The movement of the waves force air up through the turbine. The turbine is forced to spin, this is transferred to a generator which produces electricity.

Geothermal Energy

Geothermal energy is the natural heat of the earth. If you sliced the earth in half, you would find that it is made up of layers.

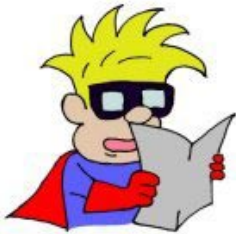


-  core
-  outer core
-  mantle
-  crust

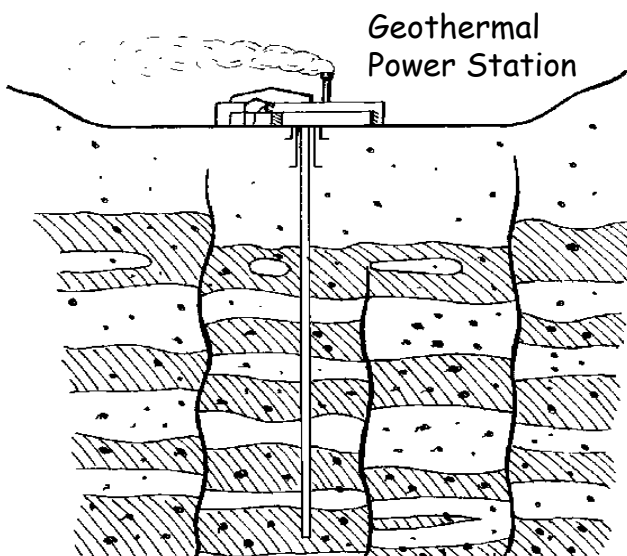
The outer core of the earth and the mantle are 'liquid' rock, or **molten**. The core in the centre of the earth is hotter than the surface of the sun. This heat energy is a source of **renewable energy**.



Rainwater naturally seeps into the rock below the surface of the earth. The hot rocks heat the water up, and when it resurfaces through a crack in the earth, it is called a **hot spring**. If it explodes into the air, it is called a **geyser**.



Let's find out how geothermal energy can be used to make electricity...



Step 1 - A deep hole or well is drilled down into the reservoir of steam or hot fluids.

Step 2 - Cool water is pumped down through a pipe, where it is heated by the hot fluids.

Step 3 - The steam produced is released at the surface and used to drive a turbine generator to make electricity.

Step 4 - The geothermal water (the water from inside the earth) is then pumped back down the bore hole to be reheated by the earth.

Quiz - Geothermal Energy

1 True or False, circle the correct answer.

- a. Geothermal energy is **renewable/non-renewable**.
- b. Geothermal energy comes from deep inside the **earth/sun**.
- c. Geysers are powerful **hot/cold** springs.
- d. Geothermal energy **can/cannot** be used to produce electricity.



2 Some of the world's hotspots.

Name the geothermal areas marked on the map (North America, Iceland, Italy and New Zealand).

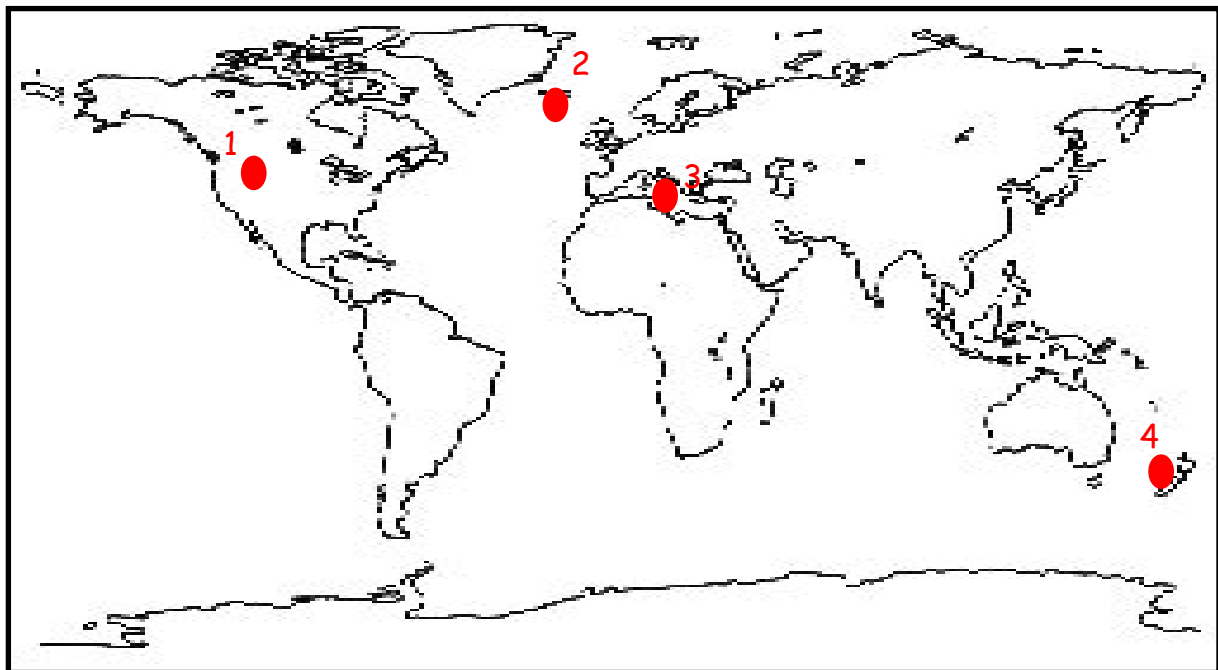
Below is a map showing different geothermal areas in the world. Can you name the places? Choose from the countries given below.

Italy

New Zealand

North America

Iceland



1. _____

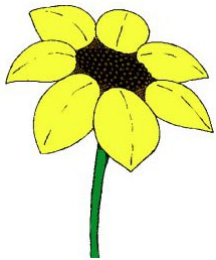
3. _____

2. _____

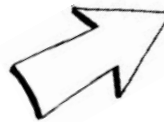
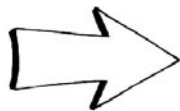
4. _____

Biomass Energy

Biomass is the name given to all living material - trees, crops, wood, branches, leaves and animal waste. These all contain stored sunlight in the form of **chemical energy**.



When burned, the chemical energy is released as **heat**. The wood you burn in a fireplace is a biomass fuel. People have been burning wood to heat their homes for thousands of years.



Biomass is a **renewable** source of energy as it can be regrown. Willow trees grow very quickly. Their branches can be cut off every 3-5 years, chopped up and used as fuel to heat homes or to make electricity in power stations.

Biomass Energy

Biomass can also be used to produce fuel for cars and other vehicles. Plant material is put into large heated tanks called **digesters**. Inside the tanks, chemicals are added which change the plant material into a type of alcohol called **ethanol**. The ethanol can then be used as a fuel in vehicles, producing less pollution than ordinary petrol.



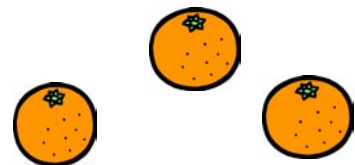
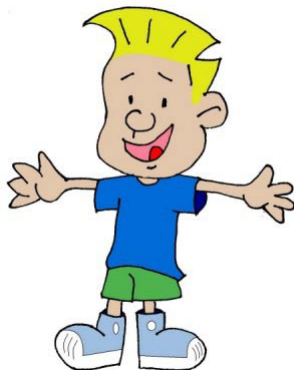
In Brazil many cars run on ethanol made from sugar cane plants. These are the same plants that give us the sugar lumps to put into our tea and coffee!



In the U.S.A. ethanol produced from corn is added to petrol to reduce pollution.



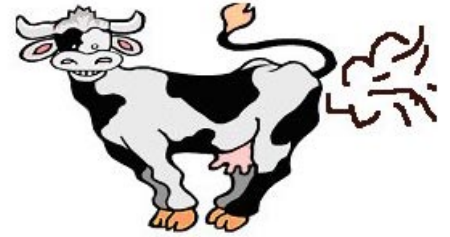
In the future, it may even be possible to have cars which run on fuel made from oranges!



Biomass Energy



When humans or other animals digest their food, they sometimes produce a gas....you know the one that can make an embarrassing noise or smell when it escapes?! This is called **BIOGAS**.



Biogas is also produced in bogs and in landfill sites as rotting vegetation is broken down. The gas from landfill can be burned and used to heat buildings nearby.



Biogas is a mixture of methane and carbon dioxide. It can be produced in large generators from shredded plants and animal waste. When these materials start to break down, biogas collects at the top of the tank. It can then be stored and used instead of natural gas in cooking and heating. The biggest advantage of biogas is that unlike natural gas, it will never run out!

Quiz - Biomass Energy



Circle the correct answer for each of the questions.



1. What does the term **BIOMASS** mean?

All living material

Under the sea

Oil and gas

Fossils

2. Name three different uses for biomass energy.

Heating homes

Fuel for vehicles

To help you run

Gas for cooking

3. Why is willow an ideal biomass crop?

You can eat it

It is free

It grows quickly

It looks nice

4. Name one advantage of using ethanol as a fuel instead of petrol.

It causes more pollution

It gives less power

It causes less pollution

5. Name two different plants that are used to produce ethanol.

Cactus

Sugar cane

Rubber plant

Corn

Daffodil

6. Name two ways in which biogas is naturally produced.

In landfill sites

From burning oil

From cows

7. What gas is biogas made of?

Helium

Hydrogen

Oxygen

Methane

