



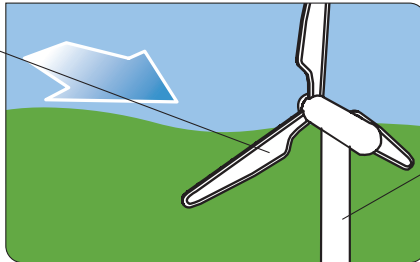
## Energy source: wind

### What is wind energy?

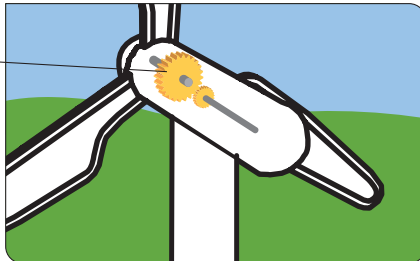
Wind has been used for a long time to make sailing boats move and windmills work. Now, giant wind turbines use the force of the wind to turn electricity generators. Where lots of these turbines are built in one place, it is known as a wind farm. Wind energy is the fastest-growing form of renewable energy in the UK.

### How a wind turbine works

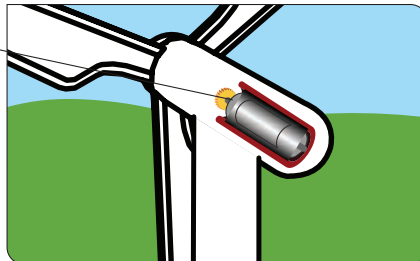
1. The wind blows against turbine blades, making them turn.



2. The blades are connected to a shaft and gears, which spin quickly.



3. The gears turn a machine called a generator, which makes electricity.



4. The electricity flows along wires in the tower, down to a thick cable buried in the ground.

5. The turbine has equipment to make sure that it always faces the wind, and a brake to shut it down in strong gales.

#### Facts

- There are 20 wind farms over 25MW capacity in the UK.
- Most of these are located in Scotland and the west coast of England and Wales.
- Wind energy supplies 0.5% of the UK's electricity.
- A 25MW wind farm can supply enough electricity for 16,000 homes.

#### Using wind energy to generate electricity

##### Advantages

- Wind is a renewable source so it will not run out.
- It does not produce any carbon dioxide which can lead to problems like making countries hotter and drier.
- Wind farms are safe and easy to build.

##### Disadvantages

- We cannot control when the wind blows. Wind turbines shut down in very strong or very weak winds.
- They can only be built in certain areas. These areas need to be windy places, usually hilly areas or coasts.
- Not everyone likes the appearance of wind farms.

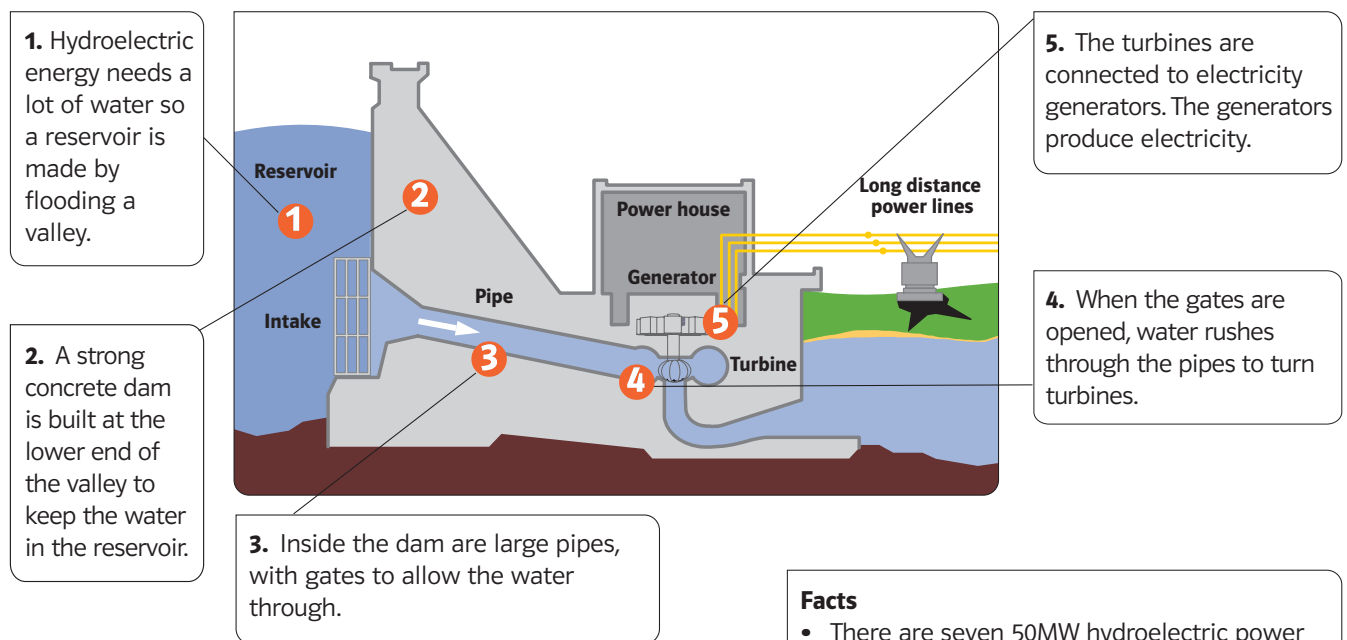


## Energy source: hydroelectric

### What is hydroelectric energy?

Moving water contains a lot of energy. Hydroelectric energy involves generating electricity using the power of moving water ('hydro' is a Greek word meaning water). Modern hydroelectric energy is used in two ways: firstly by building large reservoirs and dams (barriers built across a waterway) to trap water and control its flow; secondly by allowing water to turn machinery as it flows from a high reservoir to a low one.

### How a hydroelectric dam works



### Using hydroelectric energy to generate electricity

#### Advantages

- It does not produce any carbon dioxide which can lead to problems like making countries hotter and drier.
- It is renewable - the rain which fills the reservoir never runs out.
- Some dams can store water so we can control when electricity is made.

#### Disadvantages

- Valuable land is flooded when a reservoir is made: homes and wildlife habitats can be lost.
- A good site for a hydroelectric power plant, such as a mountainous region, is not always near towns where energy is needed.
- There are not many suitable sites in the UK for new hydroelectric schemes.

### Facts

- There are seven 50MW hydroelectric power schemes in the UK.
- Hydroelectric power plants need to be built near large lakes, reservoirs high above sea level or where a lot of water can be dammed.
- Hydroelectric energy supplies 1.2% of the UK's electricity.
- An 110MW hydroelectric energy plant can generate enough electricity for about 75,000 homes.



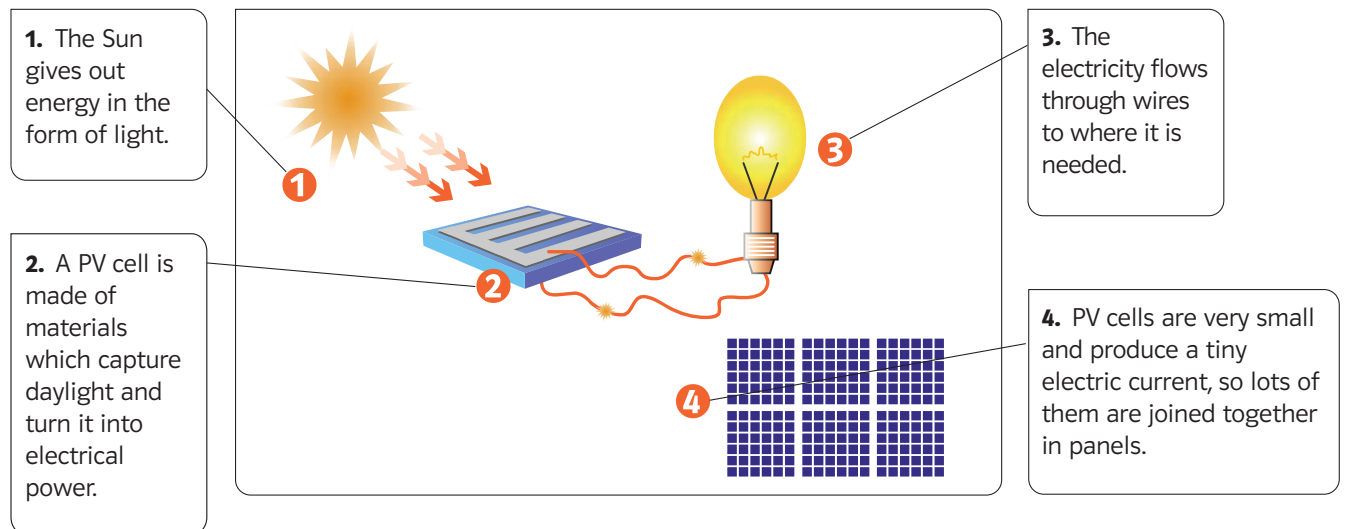
## Energy source: solar

### What is solar energy?

Solar energy is energy from the Sun. The Sun gives off plenty of energy, which can be used to provide heat and to generate electricity. There are two kinds of solar panels: solar thermal panels, which heat water, and solar PV (photovoltaic) panels, which change light energy into electricity.

There are no big solar power stations in the UK at the moment, but in countries where there is a lot of sunshine such as Australia, there are large 'farms' of solar panels. Solar power usually works on a small scale, for example, some homes use solar thermal panels to boost their heating.

### How solar PV cells work



#### Using solar energy to generate electricity

##### Advantages

- PV cells can be used almost anywhere and do not make any noise.
- Solar energy does not produce carbon dioxide which can lead to problems like making countries hotter and drier.
- Solar energy is renewable and the Sun's heat and light is free.

##### Disadvantages

- PV cells do not work so well when it is cloudy and do not work at night.
- The UK is not a very sunny country! Solar power works better in hot places.

#### Facts

- There are over 100,000 small solar heating systems in the UK but very few houses have solar PV panels.
- Solar energy supplies less than 0.1% of the UK's electricity.
- PV cells are used to power satellites and space stations.
- Solar panels work best on south-facing roofs.

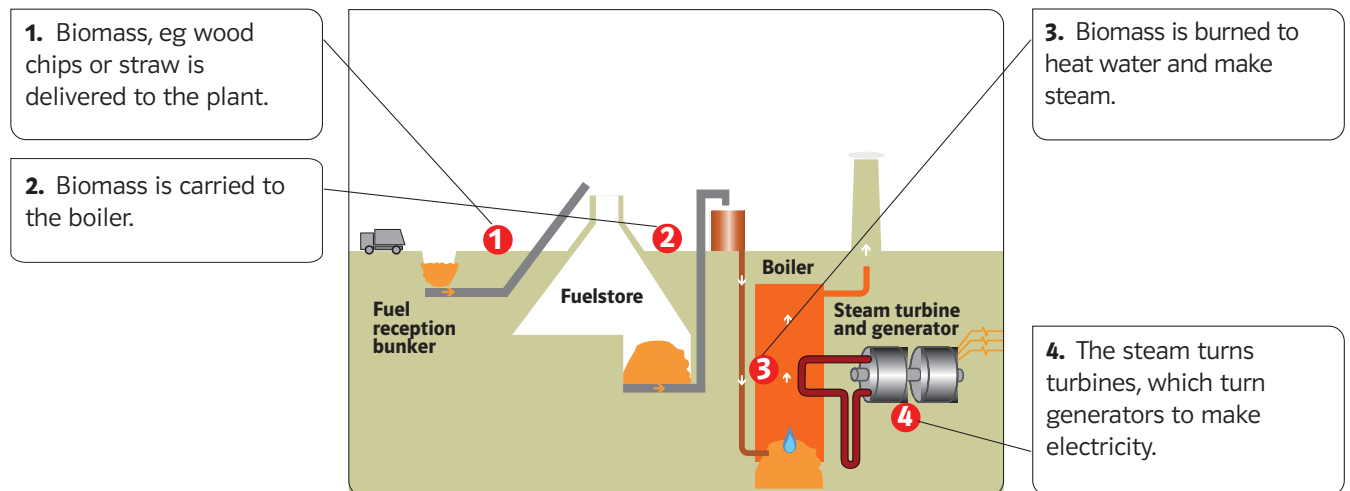


## Energy source: biomass

### What is biomass?

Biomass means plant and animal material and waste food that can be burnt as fuel to provide heat energy. Humans have used wood to make fires throughout history, and today wood chips and other plant material can be used to generate electric power.

### How a biomass power plant works



### Using biomass to generate electricity

#### Advantages

- It is renewable - new plants and trees can be grown to replace those used for fuel.
- It supports farmers and foresters by providing markets for their crops.
- It is a carbon neutral source of energy. This means that the amount of carbon dioxide released when the fuel is burnt is the same as the amount of carbon dioxide absorbed by the plants when they were growing.

#### Disadvantages

- It is an expensive method of generating electricity.
- Biomass power plants need to be built near a plentiful supply of biomass fuel.

### Facts

- Biomass power stations in the UK currently range up to 50MW in size, but future stations may go up to 350MW.
- Biomass energy supplies 2% of the UK's electricity.
- Sewage treatment works produce a lot of biomass; animal waste can be used too.
- Some UK schools are heated by wood chip boilers.

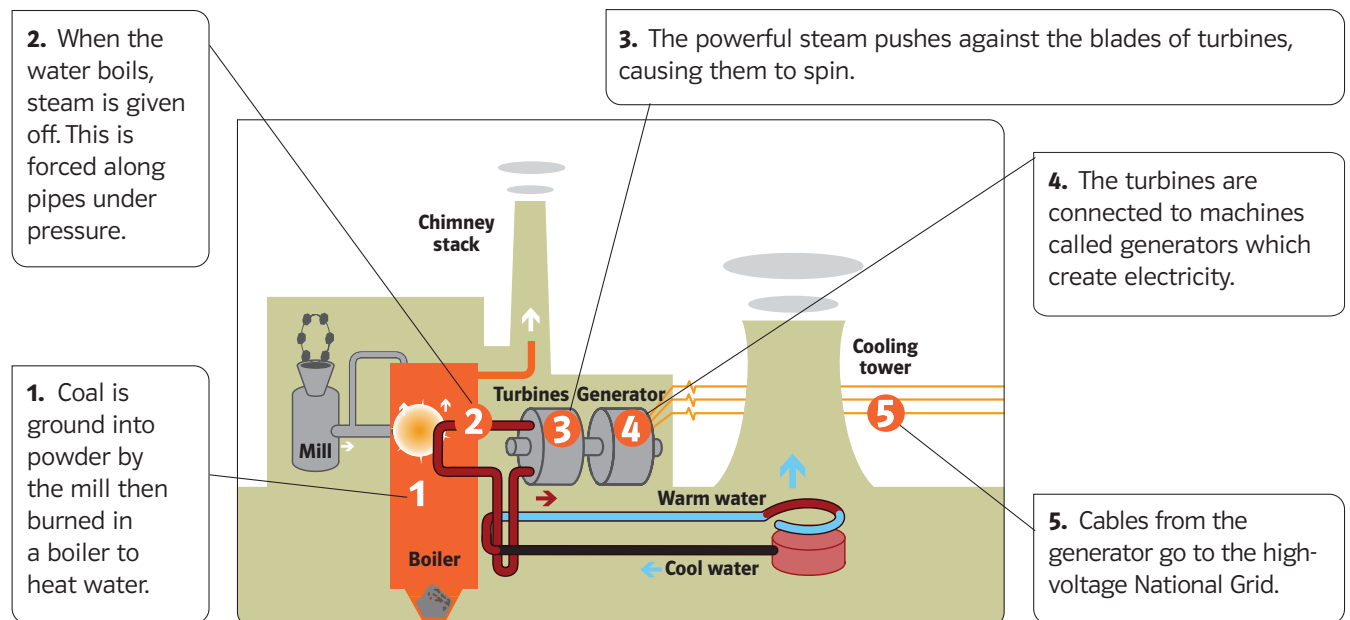


## Energy source: traditional coal

### What is coal?

Coal is a fuel that supplies a lot of our country's energy needs. It is dug out of mines, usually deep below the Earth's surface. Coal can be burnt to heat homes and to supply heat for industries like steel-making, but most of the UK's coal is used to generate electricity in large power stations.

### How a coal-fired power station works



### Using coal to generate electricity

#### Advantages

- Burning coal is one of the cheapest ways to generate power at the moment.
- Coal power stations can be built anywhere where there are good transport links and where there is a plentiful supply of cooling water.
- The UK has large stocks of coal.

#### Disadvantages

- Burning coal produces carbon dioxide, a gas which makes it harder for the Sun's heat to escape into space. This makes the Earth's atmosphere warmer and can cause problems like making countries hotter and drier.
- Coal is not renewable. There are limited supplies which will run out one day.
- Coal is not easy to transport. It is heavy and has to be carried by rail, boat or truck.

### Facts

- There are 17 large coal-fired power stations in the UK (ie 100MW and above).
- Coal supplies 33.4% of the UK's electricity.
- Most coal-fired power stations are located near coal mines.
- A 2,000MW coal-fired power station boiler can burn around 800 tonnes of coal each hour.
- A typical large coal-fired power station can supply enough electricity for 1.5 million homes on average.

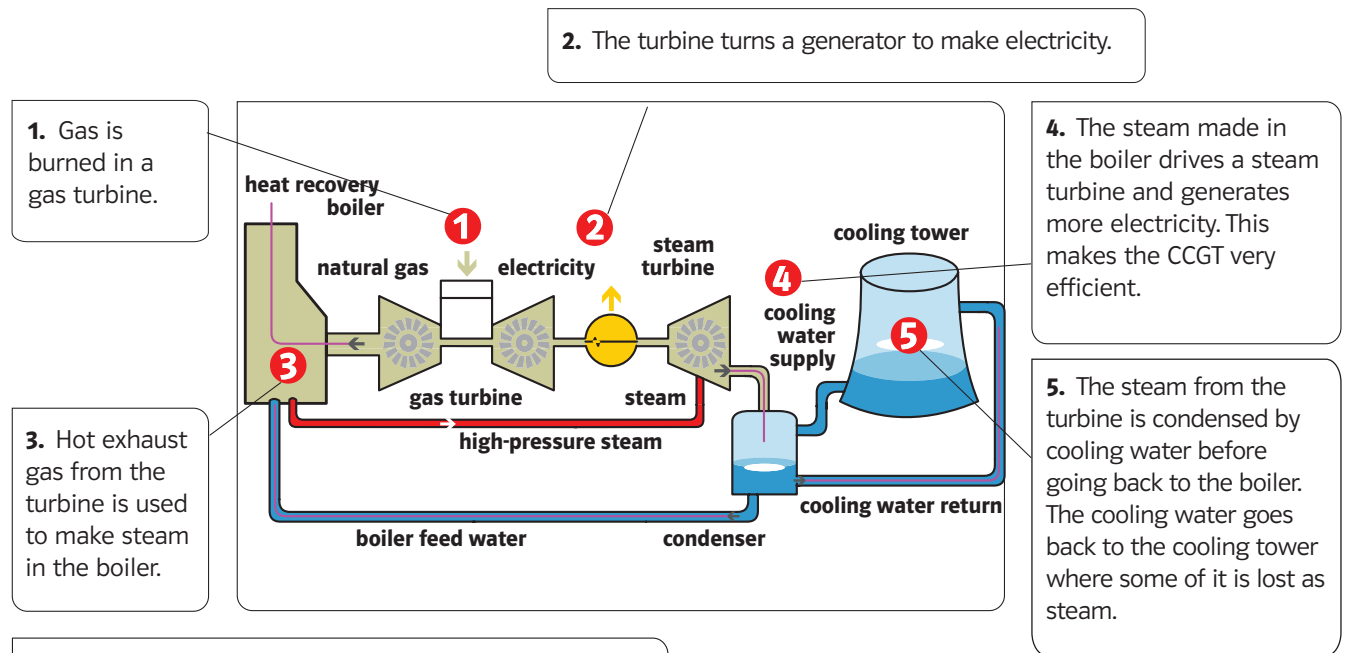


## Energy source: gas

### What is gas?

Natural gas is a fuel found underground, often under the sea bed. It is collected by drilling and is used in many homes for heating and cooking. Gas is transported through pipelines to where it is needed, such as power stations where it is burned to generate electricity.

### How a Combined Cycle Gas Turbine (CCGT) power station works



#### Using gas to generate electricity

##### Advantages

- Gas is light and easy to transport by pipeline.
- Large amounts of electricity can be generated from one gas-fired power station.
- Gas-fired power stations are normally built near rivers and the gas pipeline network but they can be built anywhere.

##### Disadvantages

- Gas is a fossil fuel and burning it produces carbon dioxide, a gas which makes it harder for the Sun's heat to escape into space. This makes the Earth's atmosphere warmer and can cause problems like making countries hotter and drier.
- Gas is not renewable. There is a limited supply, which will eventually be used up.
- The UK is importing most of its gas. This means that our energy supplies may become quite costly if wholesale prices rise.

#### Facts

- There are 36 large gas-fired power stations in the UK (ie 100MW and above).
- Gas supplies 39.5% of the UK's electricity.
- The newest combined cycle gas turbine power stations produce power with low levels of waste and carbon dioxide.
- Each gas-fired power station can supply the annual average electricity needs of over one million homes.

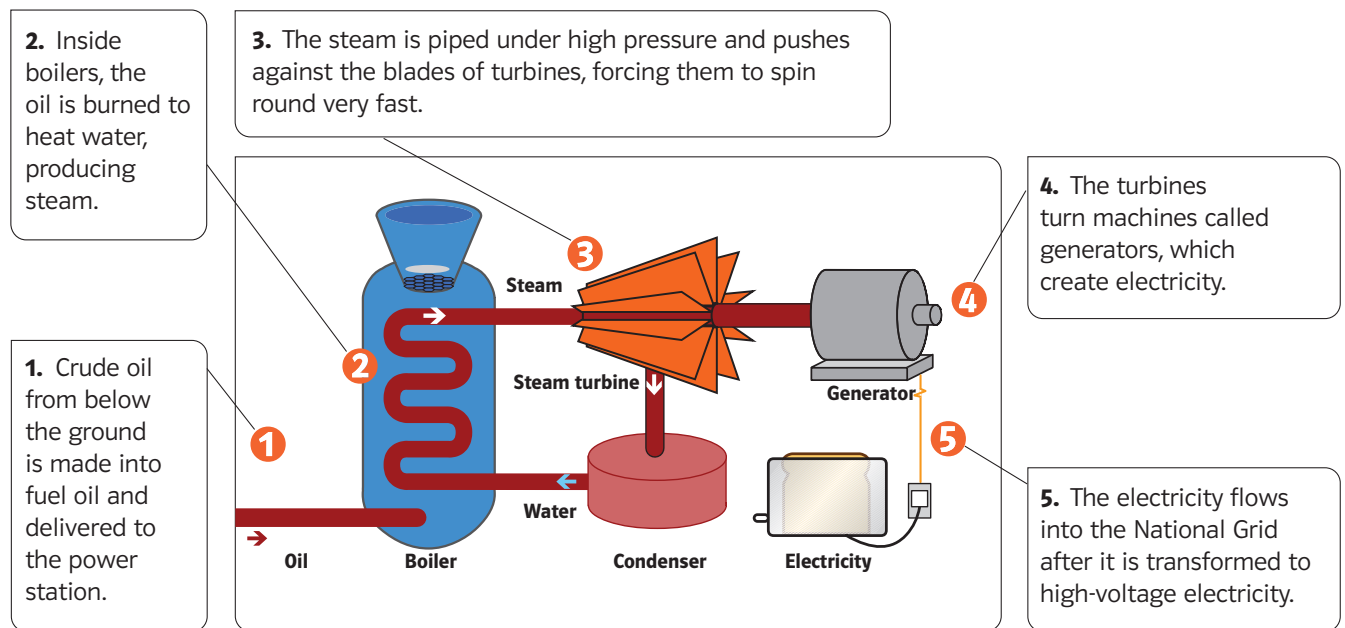


## Energy source: oil

### What is oil?

Oil is a fuel found underground. It is very valuable because it can be made into many useful things, like petrol and plastics. Oil is sometimes used to heat homes and businesses, and it is also burned to generate electricity - although not in the same quantities as other fossil fuels.

### How an oil-fired power station works



#### Using oil to generate electricity

##### Advantages

- Oil is easy to transport by pipeline or ship.
- Oil-fired power stations can be built anywhere where there are good transport links and where there is a plentiful supply of cooling water.
- A large amount of electricity can be generated from one power station quickly.

##### Disadvantages

- Burning oil produces carbon dioxide, a gas which makes it harder for the Sun's heat to escape into space. This makes the Earth's atmosphere warmer and can cause problems like making countries hotter and drier.
- It also produces other emissions eg sulphur dioxide.
- Oil is not renewable. The world's supply of oil is running out quickly.
- Using oil is very expensive compared to coal and gas.

#### Facts

- There are just two large oil-fired power stations in the UK (ie 100MW and above).
- Oil supplies 1.2% of the UK's electricity.
- Each oil-fired power station can supply the annual average electricity needs of around 1.8 million houses.

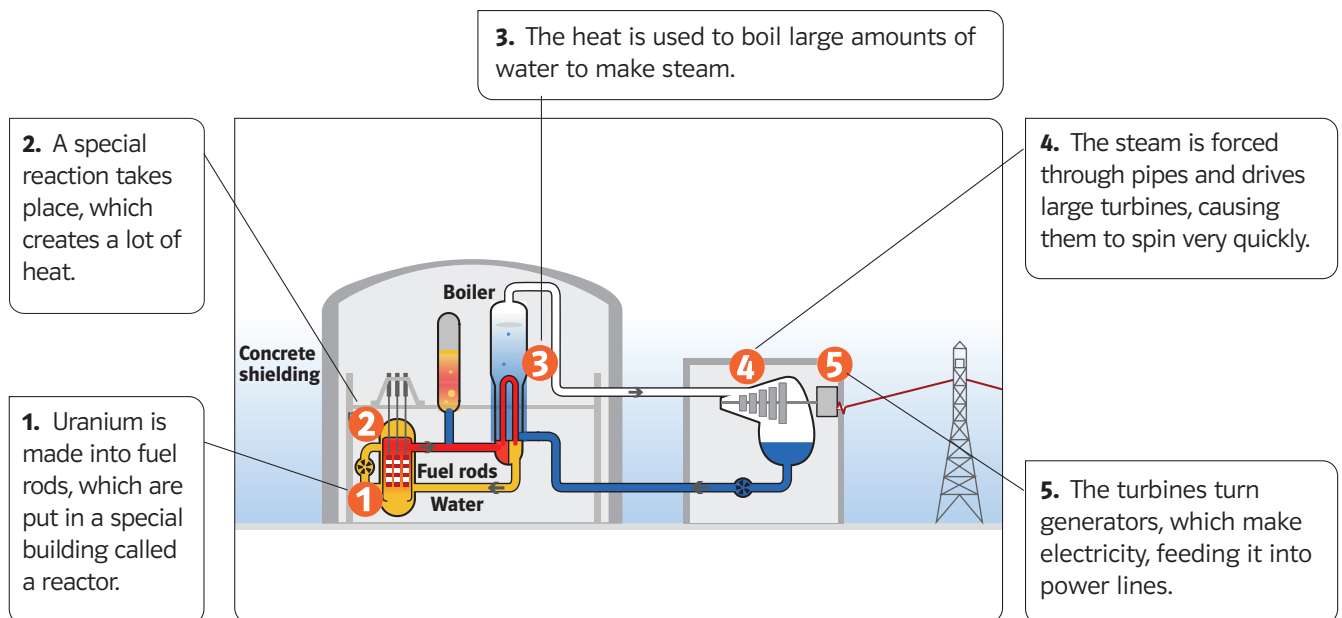


## Energy source: nuclear

### What is nuclear energy?

Nuclear energy uses a special fuel made from a rare metal called uranium. Nuclear energy produces heat, which is used to generate electricity. It can also be used to power big ships and submarines.

### How a nuclear power station works



#### Using nuclear to generate electricity

##### Advantages

- A small amount of nuclear fuel produces a lot of electricity.
- Nuclear fuel is readily available and easily stored.
- Nuclear power stations do not produce any carbon dioxide.

##### Disadvantages

- Nuclear power stations may be unpopular with people who are concerned about how safe they are.
- Nuclear energy is not renewable. When uranium runs out it cannot be replaced.
- Nuclear energy produces dangerous radioactive waste which must be buried in sealed containers for a long time.
- Nuclear power stations cannot be switched on and off easily.

#### Facts

- There are currently 11 nuclear power stations in the UK.
- Nuclear energy supplies 20.2% of the UK's electricity.
- The UK's nuclear power stations are built along the coast and use sea water for cooling.
- Each nuclear power station can supply electricity to 1.6 million homes on average.



## Energy generation

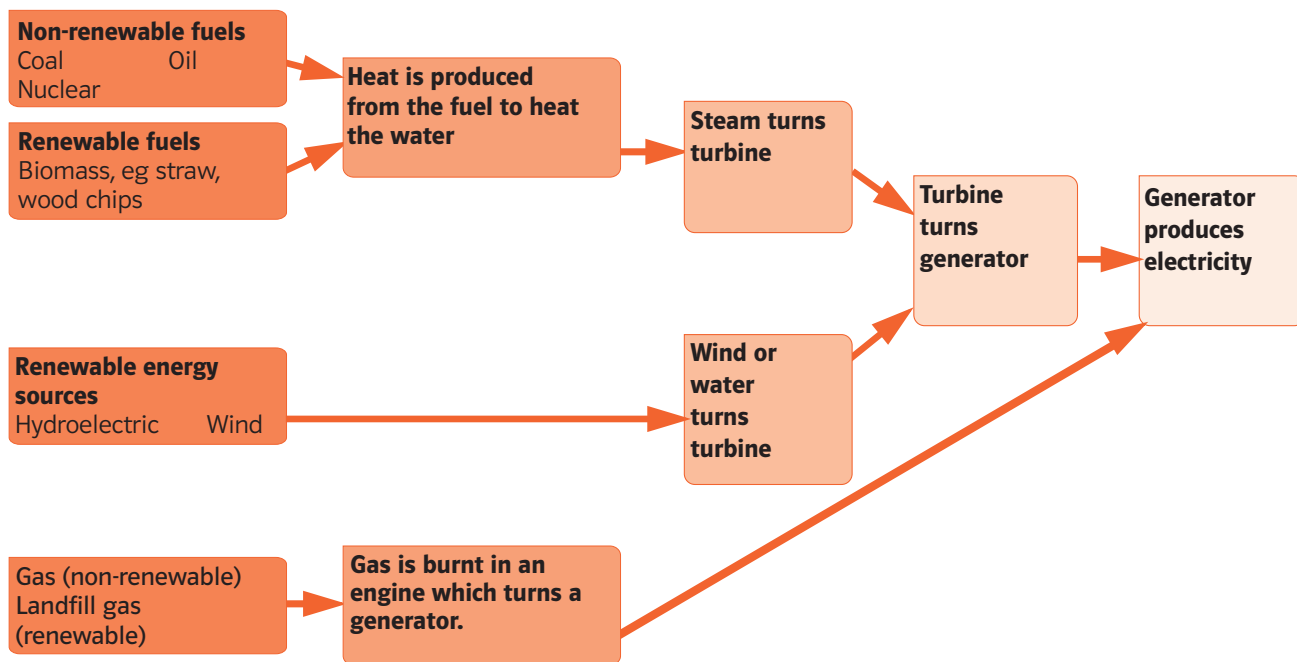
In 1831, an English scientist called Michael Faraday found out that moving a magnet inside a coil of wire created electricity. He had discovered the generator!

Modern electricity generators work in the same way but on a much larger scale. Giant electromagnets are rotated inside huge coils of wire at high speed. Power station generators can generate 22,000 volts (22kV) of electricity.

### Power stations

The buildings where electricity is generated on a large scale are called power stations. A lot of energy is needed to turn an electricity generator in a power station.

### How most electricity is generated



Energy source	%
Gas	39.5%
Coal	33.4%
Nuclear	20.2%
Hydroelectric	1.2%
Oil	1.2%
Wind	0.5%
Biomass	2%
Solar	less than 0.1%

The amount of electricity supplied to the UK from these energy sources



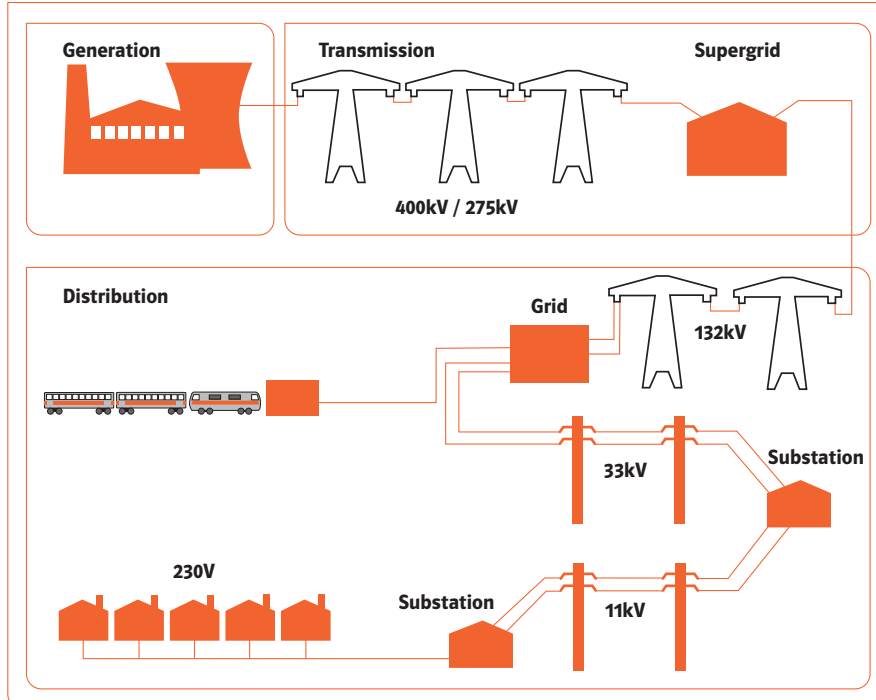
## Electricity distribution

When electricity leaves the power station, it is transformed upwards to 400,000 volts (400kV) so it can travel long distances efficiently. All of the electricity generated by large power stations in the UK is fed into a national supply network that covers the whole country, called the National Grid.

The National Grid is a giant network of overhead lines and underground cables used to transport all of the electricity supplies around the country. It is made up of thousands of miles of overhead power lines and underground cables connected to electricity substations.

The voltage is transformed downwards by a series of substations and then supplied to homes at 230 volts by local distribution companies.

### How electricity is distributed through the National Grid



**Key words**

**Generation**  
This means making electricity, mainly in power stations.

**Transmission**  
Transporting high-voltage electricity around the country to where it is needed using a giant network of cables (the National Grid).

**Distribution**  
Taking electricity to homes, businesses and schools in towns and cities in different areas.

**Supply**  
Charging households, businesses and schools for the amount of electricity they use.

There are several electricity companies that distribute electricity to the different parts of the UK. Do you know which company distributes your electricity?

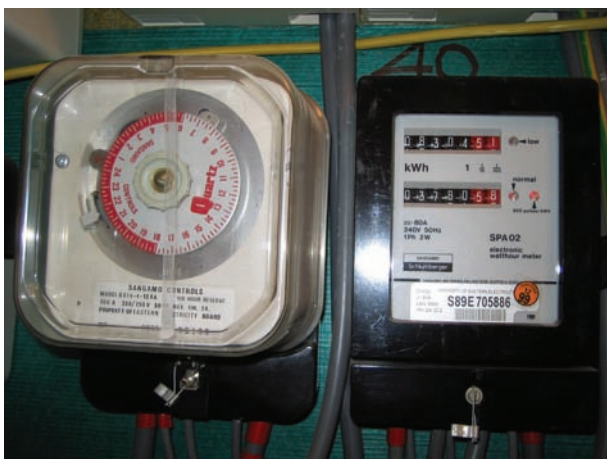
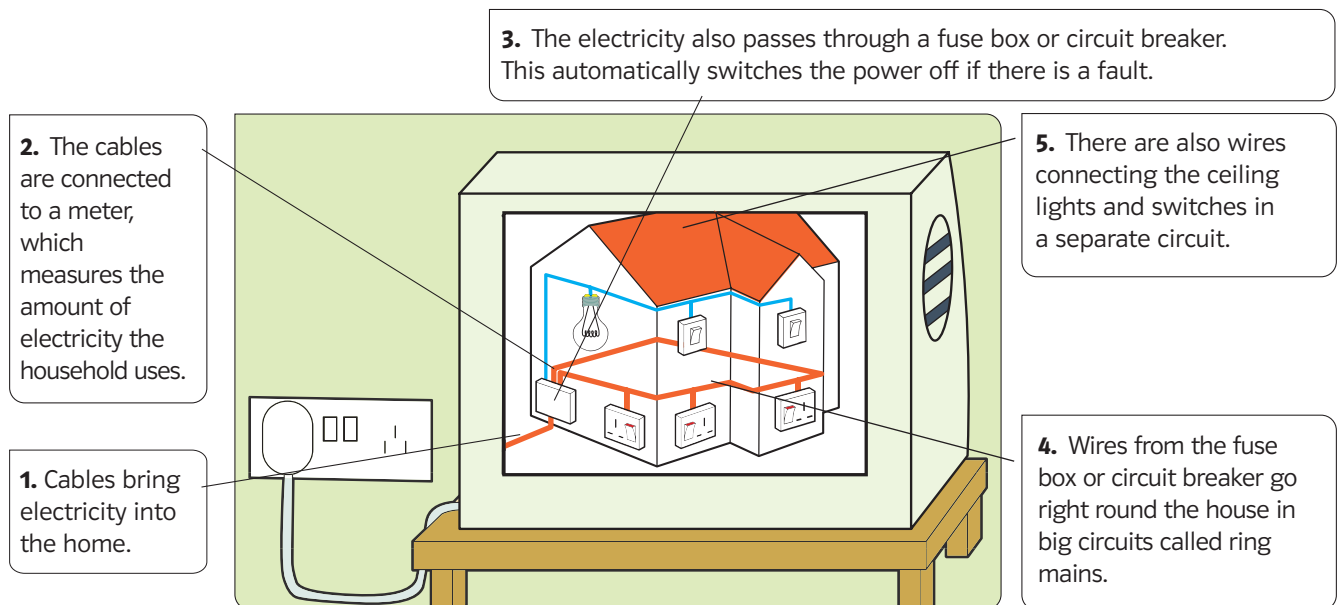




## Energy in the home

Most homes have lots of things that use electricity. Some things like mobile phones, torches and remote controls use batteries to supply their energy. Larger equipment such as televisions, washing machines and computers use mains electricity. Mains electricity is distributed to each home by the local electricity distribution company for that particular area. It is much more powerful than the electricity from batteries because it has a greater voltage, or force. A single battery or cell is 1.5 volts and mains electricity is 230 volts.

### How electricity gets around a house



These electricity meters show how much electricity is used in homes. Electricity is measured in kWh, which stands for kilowatt hours. A kilowatt is 1000 watts. A 100W light bulb uses 1kWh of electricity every 10 hours it is on.



## Energy and the environment

### Fossil fuels

Most of the UK's energy (74% at present) is generated by burning fossil fuels: coal, gas and oil. These fuels were created millions of years ago from dead plants and animals. When they are burnt in power stations, fossil fuels give off carbon dioxide. This gas makes it harder for the heat from the Sun to escape into space, which makes the Earth's atmosphere warmer. This could cause problems like making the sea levels rise and making some countries hotter and drier, which could affect people, plants and animals. This climate change could turn some land into desert and the ice caps at the North and South Poles could melt.



A rise in temperature could lead to more famine in hot countries and animals dying out around the planet.



If the polar ice caps were to melt then many coastal cities around the world would be flooded.

Improvements in technology have made power stations cleaner, but many people think that other ways should be found to generate electricity. Many people believe that nuclear power, which is not renewable but does not produce carbon dioxide, should also continue to be used.

### Renewable energy

The race is on to find new ways to generate electricity without producing carbon dioxide. A lot of people believe that we need to use renewable sources of energy to do this because non-renewable fossil fuels such as gas are running out.

Renewable energy sources include:

- Solar energy
- Wind energy
- Hydroelectric energy
- Biomass



## Energy safety 1: Out and about

High-voltage electricity is all around us and can be dangerous if misused. Touching or even going near it can give a person an electric shock and may even kill them. Stay safe around electricity by following these rules.

### Overhead power lines

You should never:

- touch power lines
- go fishing or fly a kite near overhead power lines
- climb trees that are close to power lines
- try to get a toy or a balloon that is stuck in power lines. Your local electricity distribution company will be able to get it for you safely
- climb a wooden pole or a pylon
- go near power lines especially if they have been damaged in a storm or accident. Ask an adult to call your local electricity distribution company if you see a damaged power line. The telephone number can be found in the telephone directory under 'electricity'

### In the street

You should never:

- try to remove the covers from street lights - the wires inside could electrocute you
- mess around with bollards in the street - they have electricity inside
- play on building sites or go in holes dug in the road - they may contain live electric wires

### Substations

Substations can be dangerous places for people who are not qualified engineers. The warning signs on them make this very clear.

You should never:

- try to get a ball or anything else from inside a substation. Always ask an adult to call the local electricity distribution company who will get it back safely for you
- play near a substation
- throw things at a substation. You might damage the equipment inside the substation, making it even more dangerous



**Remember, high-voltage electricity can jump gaps.**



## Energy safety 2: In the home

Every home contains cables and wires carrying mains electricity. Mains electricity is powerful and dangerous if misused - it can give electric shocks that can injure or even kill. Stay safe around electricity by following these rules:

- 1.** A socket is designed for one or two plugs. An extension cord can take more plugs but you should not try to plug lots of equipment into one socket - it can get very hot, causing danger.
- 2.** There are over 100 metres of electric cables in the walls of nearly every house. You cannot see them but if they are touched by making a hole in the wall, they can give a deadly electric shock.
- 3.** Only plugs should be put into an electric socket, nothing else. Pushing a finger or anything else into them could lead to serious injury or worse.
- 4.** Water conducts electricity, so if it is raining, all electrical equipment should be brought inside right away.
- 5.** Always dry wet hands before touching anything electrical, such as a switch.
- 6.** Do not take radios or any other electrical equipment into a bathroom because water conducts electricity.
- 7.** Never poke metal objects into toasters. There is electricity flowing inside toasters and this can be dangerous. Many people have had an electric shock from poking objects such as knives into them. If something gets stuck in a toaster, switch it off and let it cool, then either tip it up or use a wooden spoon to get the object out.
- 8.** Leave electrical equipment to the experts. Never try to take appliances apart or you could receive a very dangerous electric shock.
- 9.** Electric power cords or leads can get damaged. The bare wires in them can be deadly if touched so an appliance with a damaged cord should not be used at all - get a new one.
- 10.** Do not pull on the cord when you are unplugging a device, hold onto the plug itself.