



Traditional coal

How was it formed?

Most coal deposits were formed around 300 million years ago during the Carboniferous period. The world was covered in tropical forest then. In some swampy places, plants died and fell into water and mud where there was not much oxygen. This meant the bacteria that would normally rot the vegetation away could not do so. Instead, over millions of years the wood and other plant matter physically and chemically changed into coal.

How is it used to generate electricity?

Coal is burned to heat water. This produces steam which pushes against the blades of the turbines, causing them to spin. The turbines are connected to generators, which create electricity.

Advantages and disadvantages of 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 world has many coal reserves

Disadvantages

- Burning coal produces carbon dioxide, which contributes to the greenhouse effect. It also produces sulphur dioxide, a gas found in acid rain
- Coal is not renewable. There are limited supplies which will run out one day
- Coal-fired power stations need huge amounts of fuel

FACT

Coal

Status

Non-renewable

Where can you find it?

Wales, Scotland, northern England. China, USA, India, South Africa, Australia, Russia, Poland, Columbia and the Ukraine are the major producers

How many power stations in the UK?

17 (100MW and above)

How much does it cost to produce?

2.5p to 3p/kWh

What is the carbon cost?

700kg/mWh

The future?

Coal reserves should last until the end of the 22nd century. The existing coal-fired power stations are all quite old and most will need to close or fit new emission control equipment in the next 8-10 years



Oil

How was it formed?

Scientists are still not completely sure of the origins of oil. The leading theory suggests it formed millions of years ago, in places where dead organic material built up on the bottom of oceans, riverbeds or swamps, and was mixed with mud and sand. Over time, more sediment piled on top, and the resulting heat and pressure changed the organic layer into a dark and waxy substance known as kerogen.

The molecules in kerogen eventually break up into shorter and lighter molecules composed of mostly carbon and hydrogen atoms. Depending on how liquid or gaseous this mixture is, it will turn into either crude oil or natural gas.

How is it used to generate electricity?

Oil is burned to heat water. This produces steam which pushes against the blades of turbines, causing them to spin. The turbines are connected to generators, which create electricity.

Advantages and disadvantages of 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, which contributes to the greenhouse effect
- 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

FACT

Oil

Status

Non-renewable

Where can you find it?

North Sea, but there are also small fields in south England

How many power stations in the UK?

2 (100MW and above)

How much does it cost to produce?

About 4.8p to 6p/kWh

What is the carbon cost?

580kg/mWh

The future?

Oil reserves should last until the middle of the 21st century



Gas

How was it formed?

Scientists are still unsure about the source of gas. It is usually found with oil deposits and the leading theory suggests that they both formed millions of years ago in places where dead organic material built up on the bottom of oceans, riverbeds or swamps, and got mixed with mud and sand. Over time, more sediment piled on top, and the resulting heat and pressure changed the organic layer into a dark and waxy substance known as kerogen.

The molecules in kerogen eventually break up into shorter and lighter molecules composed of mostly carbon and hydrogen atoms. Depending on how liquid or gaseous this mixture is, it will turn into either crude oil or natural gas.

How is it used to generate electricity?

Gas is burned in a turbine, like a jet engine on a plane, but bigger. This turns a generator, producing electricity. The hot exhaust gases are then used to heat water to make high pressure steam, which is fed into a steam turbine, which turns another generator, making even more electricity. It is very efficient!

Sometimes, the steam from the back end of a turbine can be used to provide heat to houses or offices. It can also be used for processes such as making paper or chemicals.

Advantages and disadvantages of 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

- Burning gas produces carbon dioxide, which contributes to the greenhouse effect
- 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

FACT

Gas

Status

Non-renewable

Where can you find it?

North Sea and Irish Sea. It is also found in Russia, Eastern Europe, Norway, the Middle East and Africa

How many power stations in the UK?

36 (100MW and above)

How much does it cost to produce?

2p to 3p/kWh

What is the carbon cost?

370kg/mWh

The future?

Gas reserves will last until late in the 21st century



Nuclear energy

What is it?

Nuclear power is generated by splitting atoms of uranium into lighter elements by firing neutrons at them. This process is called nuclear fission. As the atom splits, it releases more neutrons, which then split more uranium atoms, releasing more neutrons and so on. This is a chain reaction which produces lots of heat energy.

In a nuclear reactor, this reaction is controllable because the uranium fuel is not highly concentrated. The speed of the reaction is precisely controlled by inserting rods that absorb neutrons into the reactor.

How is it used to generate electricity?

The heat produced by nuclear fission is used to heat water. This produces steam, which pushes against the blades of turbines causing them to spin. The turbines are connected to generators, which create electricity. The steam generated in modern nuclear power stations is lower pressure than coal and oil stations.

Advantages and disadvantages of using nuclear power to generate electricity

Advantages

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

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 radioactive waste which must be buried in sealed containers for a long time
- Nuclear power stations cannot be switched on and off easily

FACT

Nuclear

Status

Non-renewable

Where can you find uranium?

Several places across the world. Canada is the largest exporter, but Australia has the most uranium

How many stations in the UK?

11

How much does it cost to produce?

Between 2.5p and 4p/kWh

What is the carbon cost?

Nuclear fission does not produce carbon dioxide

The future?

All but one of the UK's nuclear power stations will be shut down by 2023



Hydroelectric energy

What is it?

Hydroelectric energy is generated by the flow of water and like most other renewable energy sources, it is actually indirect solar power which drives the Earth's water cycle.

The Earth receives 1.5 billion TWh (terawatt hours) of solar energy every year. Nearly a quarter of this is consumed in the evaporation of water from the surface of oceans, lakes and rivers. This means that water vapour in the atmosphere is actually a massive store of solar energy. When the vapour condenses, most of this energy is released as heat. However, a tiny fraction, about 0.06%, is retained as gravitational potential energy by the rain that falls on mountains and hills. As this water flows downstream, its gravitational potential energy is transformed into kinetic energy.

How is it used to generate electricity?

The kinetic energy of flowing water spins a turbine which is connected to a generator which creates electricity.

Advantages and disadvantages of using hydroelectric energy to generate electricity

Advantages

- Once the plant is built, operating costs are very low, so the energy produced is virtually free
- It does not produce any carbon dioxide, which can lead to global warming which makes countries hotter and drier
- It is sustainable - the rain that fills the reservoir never runs out
- Dams store water so we can control when electricity is made
- Power output can be increased very quickly to meet sudden demand
- Electricity can be generated constantly as long as there is enough water

Disadvantages

- Dams are very expensive to build
- 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

FACT

Hydroelectric energy

Status

Renewable

Where can you find it?

Hydroelectric power stations need to be near large lakes, reservoirs high above sea level or where a lot of water can be dammed

How many power schemes in the UK?

7 (50MW schemes)

How much does it cost to produce?

Between 2p and 7p/kWh

What is the carbon cost?

Generating hydroelectric energy does not produce any carbon dioxide

The future?

It is unlikely that there will be a huge increase in hydroelectric power as all large-scale sites are being used, but some small-scale sites are being developed

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Energy Experience



Wind energy

What is it?

Wind is created by the uneven way the Sun heats the Earth's atmosphere. Winds blow wherever warmer air in the atmosphere rises due to the fact that it is less dense than surrounding cooler air. When cooler air rushes in to fill the partial vacuum (low pressure) that is what we know as wind.

Prevailing winds in the UK are from the south-west but when a low pressure weather system comes off the Atlantic onto land it can bring rain as well as strong winds from any direction.

How is it used to generate electricity?

The blades of a wind turbine work in the same way as an aeroplane's wings. When air flows around an aeroplane's wings, it creates low pressure above that lifts the aeroplane. Similarly, when air flows around the blades of a wind turbine, it creates low pressure that turns it round. The blades are linked to a generator, and as it rotates it generates electricity.

FACT

Wind energy

Status

Renewable

Where can you find it?

Anywhere it is windy. These tend to be hilly areas or offshore

How many wind farms in the UK?

Over 135 wind farms generating over 1900MW in total, of which over 20 are greater than 25MW each

How much does it cost to produce?

Electricity from a large-scale onshore wind farm costs 4.2p-5.2p/kWh. It costs 6.2p-8.4p from an offshore wind farm

What is the carbon cost?

Wind power does not produce any carbon dioxide

The future?

There is huge potential for development of wind power in the UK. The British Wind Energy Association estimates that wind power could supply 3.3 million homes by 2010 which is about 8% of total UK demand

Advantages and disadvantages of using wind energy to generate electricity

Advantages

- Once the wind turbine is built, running costs are very low
- It does not produce any carbon dioxide, which contributes to the greenhouse effect
- The land occupied by a wind farm can still be used for farming
- Wind is a renewable source so it will not run out
- 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

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Energy Experience



Solar energy

What is it?

Solar energy is energy from the Sun. The Sun is a star that produces energy on a massive scale. Nuclear fusion reactions in its core turn 4.3 million tonnes of hydrogen into energy every second. This energy eventually radiates into space, in all directions. Travelling at the speed of light, a small fraction of it reaches the Earth about eight minutes after it leaves the Sun.

How is it used?

There are two ways to use solar energy:

Solar photovoltaic (PV) cells convert light energy directly into electricity. They can be arranged in panels and fitted to roofs and the sides of buildings.

Active solar water heating is an easy source of hot water. Fluid inside a black panel, tilted to face the Sun, heats up and is then circulated to the hot water tank inside the house.

There, the heat is transferred to the household water system for use in the home.

Advantages and disadvantages of using solar energy to generate electricity

Advantages

- Solar energy is renewable and the Sun's heat and light are free
- Solar energy can be used to generate electricity in remote places where other electricity supplies are hard to come by
- It does not produce any carbon dioxide, which contributes to the greenhouse effect
- Energy is usually generated at or near to the location it will be used. This keeps transmission and distribution costs to an absolute minimum

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, so its use is therefore limited

FACT

Solar energy

Status

Renewable

Where can you find it?

Large-scale solar plants are only cost effective where there is lots of sunshine

How many systems in the UK?

There are over 100,000 small solar heating systems in the UK, but very few houses have solar PV cells

How much does it cost to produce?

It costs around £6,000 to install a solar PV system in a typical house in the UK. The active water heating costs £2,500-£4,000. On average it costs less than 10p/kWh

What is the carbon cost?

Generating electricity with solar PV panels does not produce any carbon dioxide

The future?

Our climate (in the UK) is not really suitable for it to become a major source, but it could still play a role in water heating systems and electricity generation for the home

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Energy Experience



Biomass

What is it?

All of the Earth's living material or 'biomass' exists in a thin layer around the surface of the planet called the biosphere. It is a huge store of energy that is continually replenished by the Sun through photosynthesis. Biomass is any plant or animal matter, including plant and animal waste and human sewage. Energy crops are plants grown specifically for fuel.

How is it used to generate electricity?

Biomass is burnt directly in boilers to produce steam which turns a turbine and generator to make electricity. In more advanced plants, biomass can be converted to gaseous or liquid fuels through gasification or pyrolysis so that the derived fuels can be used in more efficient gas turbine driven generators.

FACT

Biomass

Status

Renewable

Where can you find it?

It is all around us

How many power stations in the UK?

Most coal-fired power stations now co-fire a percentage of biomass in the fuel. A number of dedicated biomass power plants up to 44MW are currently generating in the UK

How much does it cost to produce?

Electricity produced using biomass burnt in traditional coal-fired power stations costs 4.0p–6.1p/kWh

What is the carbon cost?

Biomass is carbon neutral. This means the amount of carbon dioxide released when the fuel is burned is the same as the carbon dioxide absorbed by the plant when it was growing

The future?

As it becomes easier to collect, process and convert, biomass will become an increasingly popular option

Advantages and disadvantages of 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

Disadvantages

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

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Energy Experience



Hydrogen fuel cells

How do they generate electricity?

Water is a compound made from hydrogen and oxygen. If you pass an electric current through water, it can break the bonds in the molecules and split them into separate hydrogen and oxygen molecules. The oxygen and hydrogen are released as gases and can be collected in separate containers. This process is known as electrolysis.

A fuel cell is a device that uses electrolysis in reverse. It converts hydrogen and oxygen into water, producing electricity and heat in the process. This is all done without the need to burn the hydrogen.

Advantages and disadvantages of using hydrogen fuel cells to generate electricity

Advantages

- The only wastes produced are water and some heat, which can be reclaimed
- Operation is entirely silent
- Fuel cells can be built in a huge range of sizes to suit almost any use

Disadvantages

- Fuel cells rely on hydrogen fuel, which may be produced using non-renewable energy sources
- It will be some time before hydrogen is as freely available as petrol is at the moment
- Hydrogen is highly flammable

FACT

Hydrogen fuel cells

Status

Renewable if the hydrogen fuel is created from renewable sources

Where can you find it?

In theory, it is possible to use the oxygen in the air, and the hydrogen in water

How many plants in the UK?

There are a handful of small-scale plants that supply single or small groups of buildings

How much does a hydrogen fuel cell cost to produce?

It is difficult to say

What is the carbon cost?

If the hydrogen is generated by renewable means, the carbon emissions could be zero

The future?

It has great potential for small-scale use, but it is unlikely the UK will develop large-scale plants in the near future



Geothermal energy

What is it?

Geothermal energy is a form of renewable energy that is not dependent on the Sun, but on heat that comes from deep below the surface of the Earth in the layer called the mantle. Molten rock from the mantle can rise in places bringing the mantle's heat nearer the surface and can sometimes even erupt onto the surface as volcanoes. In certain places, like Bath with its famous hot spring baths, natural mineral water can percolate deep down beneath the surface until it gets near to hot areas, is heated up and then returns to the surface as natural hot springs.

How is it used to generate electricity?

These natural hot waters can be used for geothermal energy. More often though man-made holes are drilled down to a hot area beneath the surface so that water can be pumped down, where it is heated and then drawn up again, and used to heat homes or (if really hot) to drive steam turbines and generate electricity.

Advantages and disadvantages of using geothermal energy to generate electricity

Advantages

- Geothermal energy does not produce any pollution
- Running costs for a geothermal power station are very low

Disadvantages

- It is difficult to find suitable sites to put a geothermal power station
- If not carefully managed, a borehole can 'run out of steam' and may not be useable for several decades
- Dangerous gases and minerals can come out of a borehole, which may be difficult to dispose of

FACT

Geothermal energy

Status

Renewable, but overuse can damage boreholes for many years

Where can you find it?

Volcanic places, like Iceland

How many plants in the UK?

There are none that produce electricity, but one in Southampton supplies heat

How much does it cost to produce?

No reliable figures are available at present

What is the carbon cost?

The process does not produce any carbon dioxide

The future?

The potential for electricity generation is limited because the UK is not volcanic, but geothermal energy may be used for heating on a small scale



Ground source energy

What is it?

Ground source heat is a type of solar energy as it relies on the Sun warming the ground. It can be extracted from the low temperature heat (10–20°C) found at shallow depths within the Earth's crust. This heat source stays at a relatively constant temperature and can be taken from the ground itself or from groundwater.

In many shallow coil systems, a looped pipe is buried just below the surface of the ground. At this depth, the soil temperature is kept reasonably stable by indirect solar power, which this system uses.

How is it used?

There is a circuit of underground pipes outside the house, and a heat pump inside the house.

Anti-freeze circulates in the pipes, absorbing the heat from the soil around it.

This heat is transferred into a liquid where it is boiled, compressed and vaporised and passed through the system to make heat.

The system can be run in reverse so it takes heat from the house and transfers it to the ground.

Advantages and disadvantages of using ground source energy

Advantages

- It does not produce any pollution
- Running costs are very low
- It reduces heating bills and consumption of other, non-renewable, energy resources
- All pipe-work is below ground so there is minimal effect on the environment

Disadvantages

- The effectiveness of the system will vary with the seasons. However, installing the correct amount of pipe should make up for this variation

FACT

Ground source energy

Status

Renewable as it is indirect solar power

Where can you find it?

Anywhere you could lay a pipe just below the surface of the ground. Some systems also use boreholes and heat pumps to raise the temperature to 40–50°C for under-floor heating and radiators

How many systems in the UK?

About 250 systems are installed every year in the UK

How much does it cost to produce?

The heat pumps cost £2,000 per coil, and the 60-metre boreholes cost around £3,000 each to drill

What is the carbon cost?

The process does not produce any carbon dioxide

The future?

The use of ground source energy for individual homes is likely to increase as installation prices drop



Wave energy

What is it?

Waves are the movement of water near the surface of the sea, and are created by the wind blowing across it. It is estimated that waves have a total power of 90 million gigawatts worldwide – that is a lot of energy!

How is it used to generate electricity?

There are several different ways to capture wave energy: from trapping waves to bobbing buoys. Wave energy devices can be fixed to the shoreline or placed out at sea. These are two of the devices:

Oscillating water columns contain a turbine.

The waves below act like a piston when they move, pushing air up and down making the turbine rotate. It is attached to a generator which produces electricity.

Point absorbers capture energy as different parts of them move in sympathy with the waves. This movement can be used to pump air or liquid through a turbine, which is attached to an electricity generator.

Advantages and disadvantages of using wave energy to generate electricity

Advantages

- It is a huge potential resource for the UK
- It is a more predictable energy source than wind
- There are no fuel costs, unlike conventional power generation

Disadvantages

- Equipment needs to be designed to survive bad weather conditions such as storms
- There may be high maintenance costs, because the devices can be far out at sea
- There is no leading device at the moment

FACT

Wave energy

Status

Renewable

Where can you find it?

Almost anywhere in the world. The UK has some very good places off north-west Scotland, Wales and south-west England

How many systems in the UK?

There are dozens of devices under development

How much does wave power cost?

It is difficult to calculate a cost for wave-generated electricity as there is still no overall agreement on the best types of generators and the best locations

What is the carbon cost?

Wave power does not produce any carbon dioxide

The future?

It has great potential. 3% of the UK's energy could be generated from wave power by 2020. That is almost the same as all renewable sources at the moment. It is a promising alternative



Tidal energy

What is it?

Tides are caused by the gravitational effects of the Sun and the Moon on our oceans. In the UK, this creates a rise and fall in sea height, twice a day. Tidal streams are fast-moving currents caused by the movement of water where tidal height differs. The amount of energy available depends on the size and speed of the flowing stream. Because we know how the Sun and the Moon move around our planet, it is possible to forecast fairly accurately the amount of energy that can be captured.

It is predicted that tidal energy across the world is capable of generating over 3000 gigawatts (GW), but only about 3% of that is in places where it would be easy to capture.

How is it used to generate electricity?

There are several different ways to capture tidal energy: from trapping tides in lagoons or reservoirs to underwater turbines, like propellers in tidal streams. Here are three types of devices.

Artificial **tidal lagoons** or **reservoirs** trap water through turbines built into an artificial wall as the tide rises, generating electricity as they fill up. The water is released slowly through the turbines to generate power as the tide falls.

Tidal barrages can be built across an estuary. Like lagoons, they hold water back and create a difference in tidal height. Water is then released through turbines to generate electricity.

Devices are placed directly into **tidal streams** and extract energy as water flows through and over blades, like a wind turbine.

Advantages and disadvantages of using tidal energy to generate electricity

Advantages

- Tides are predictable
- Once the plant is built, operating costs are very low, so the energy produced is very cheap
- It does not produce carbon dioxide or waste
- It needs no fuel

Disadvantages

- The plants can only produce power when the tide is flowing in or out - around 20 hours a day
- Barrages can be very expensive to build
- There is no one leading tidal stream device at the moment

FACT

Tidal energy

Status

Renewable

Where can you find it?

Almost anywhere in the world but the best places are where water cannot flow easily like lagoons, around headlands or between islands. The UK has strong tidal streams and high tidal ranges

How many systems in the UK?

There are dozens of devices under development

How much does it cost to produce?

No reliable figures are available at present

What is the carbon cost?

Tidal power does not produce any carbon dioxide

The future?

The UK has some of the best locations for tidal energy - enough to make a significant contribution to the UK's energy needs. The UK is fast developing the industry and hopes to be the world leader in tidal technology



Generating electricity

We can use almost any source of energy to produce electricity and various processes are used to transform the energy into electrical power. Most methods involve using the energy source to create rotational energy which is used to turn an electrical generator. The generator produces the electricity.

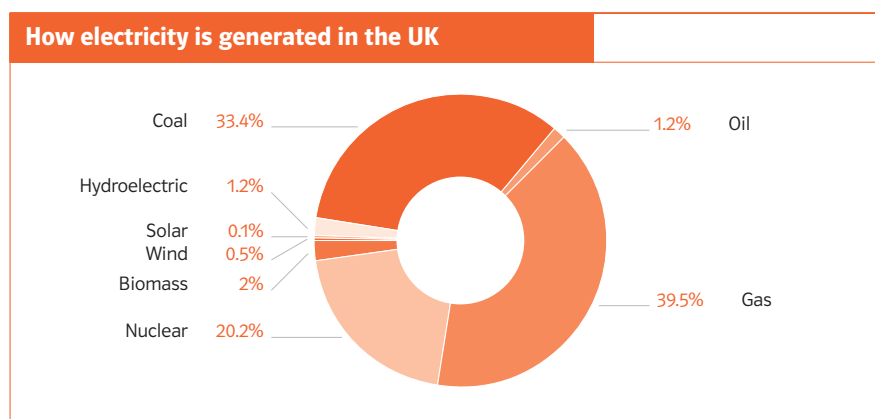
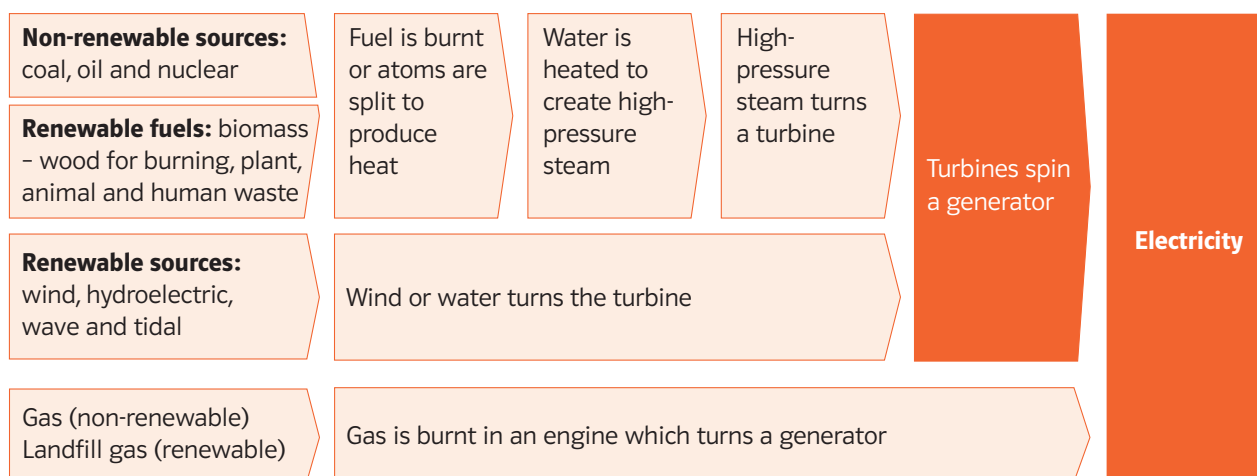
The exceptions are:

- **solar photovoltaic (PV) panels**, which convert the Sun's energy directly into electricity
- **hydrogen fuel cells**, which produce electricity by joining hydrogen and oxygen atoms together to produce water and electricity

These sources are only currently used on a small scale in the UK. They are ideal for 'micro-generation'. This is where individual homes and buildings produce their own electricity.

All large-scale power stations in the UK use generators to produce their electricity. These produce electricity by spinning powerful magnets inside large coils of wire. A large generator generally produces electricity at about 22,000 volts.

Turbines used in generating electricity can be spun by different means:



As there are no reliable figures for wave and tidal electricity generation, the figures in the chart do not quite add up to 100%



Distributing electricity

You know that the electricity you use at home is generated in a power station, but do you know how it gets to you?

The National Grid

Electricity generated in the UK is fed into the National Grid, a giant network of overhead lines and underground cables used to transport all of the electricity supplies around the country. The National Grid is responsible for forecasting how much electricity will be needed at different times. This is to ensure supply matches demand. This is very important because electricity cannot be stored.

The difficulty with distributing electricity is that the resistance of the wires causes them to heat up. Electricity is being transformed into heat before it even gets to where it is needed.

This lost energy is proportional to the square of the current. If current is reduced, we can reduce the amount of energy lost as heat. Transformers are used to alter the current and voltage. Step-up transformers reduce the current and increase the voltage for transmission over large distances and step-down transformers reduce the voltage so the electricity is suitable for homes and businesses.

The National Grid takes all kinds of things into account when predicting demand.

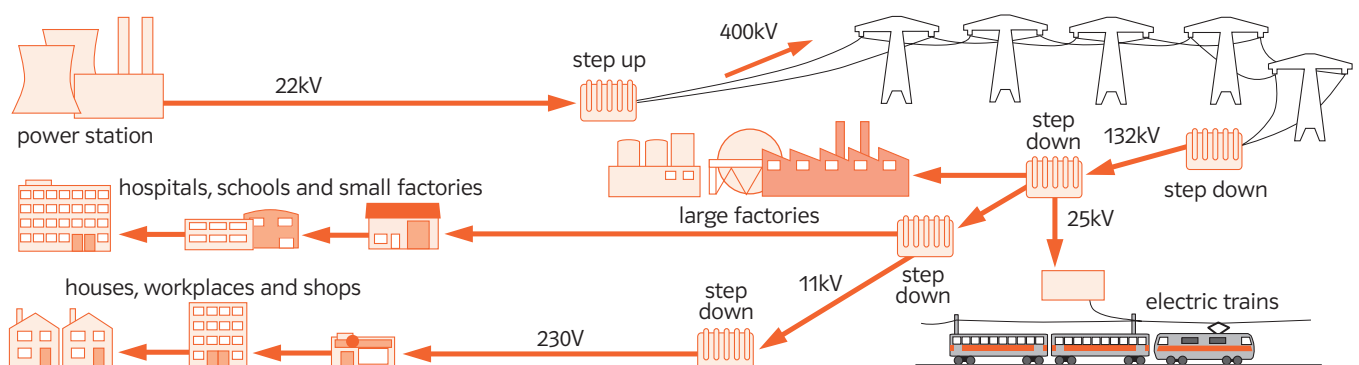
It looks at weather forecasts, as a cold night can mean high demand as people switch on electric fires and plug in electric blankets. It also checks TV guides. A film premiere, football match or a Big Brother eviction can mean that millions of people turn their kettles on for tea at the same time during the adverts!

The National Grid constantly manages supply and demand on a second by second basis. Local distribution companies manage the distribution of electricity to homes and businesses.

Importing power

If we cannot produce enough electricity to meet demand, we can import electricity from Europe. This is done through a large cable that runs under the English Channel and links the UK and France. The cable is called the UK-France Interconnector.

The Interconnector can also be used the other way around. If we have more electricity than we need in the UK, we can sell it to France.

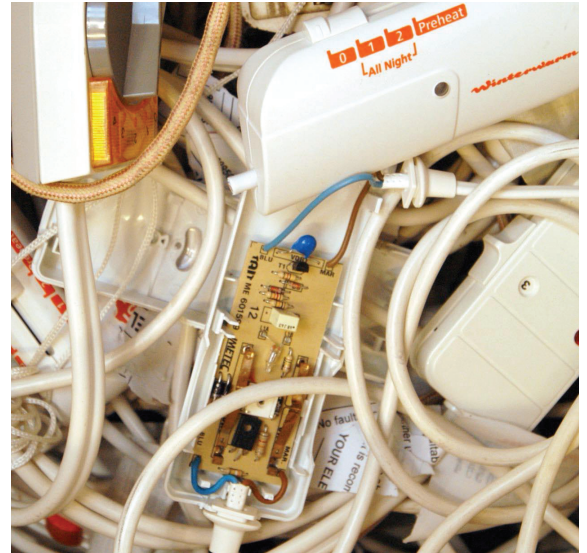




Electricity in the home

Think of all the things at home that use electricity. There are a lot! In fact, the only things that might not be powered by electricity are your central heating and hot water systems, which could be gas- or oil-powered (although with electrical timers), and your cooker, which may be gas-powered.

We can use electricity to power our lights, televisions, computers, heaters, fridges and much more because electrical energy is very easy to transform. We can transform it easily into light, heat, chemical, kinetic and sound energy. No other type of energy is quite this flexible. You can calculate the amount of electrical energy transformed by an appliance when it is used with the equation:



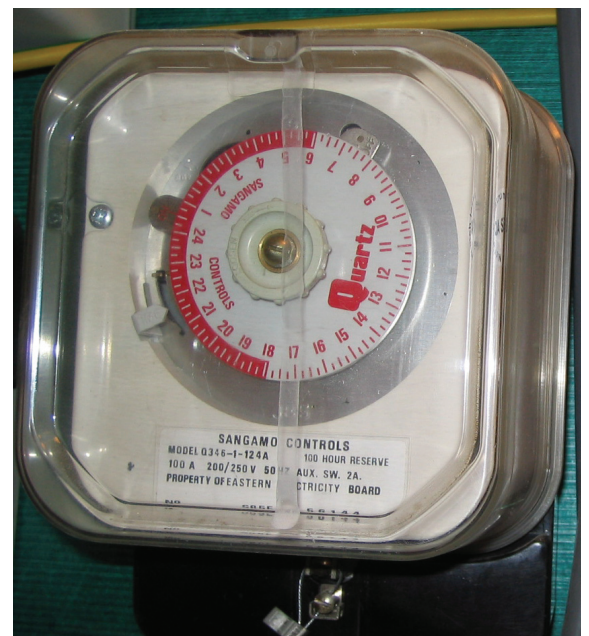
$$\text{Energy transformed (Joules)} = \text{power (Watts)} \times \text{time (seconds)} \text{ or } E = Pt$$

For example, if your 3kW electrical kettle takes three minutes to boil, this means **3000W x 180s = 540,000 Joules** of electrical energy are transformed into heat.

Just imagine how many Joules of energy you would use in the three-month period covered by your electricity bill. There would not be enough room on the paper to fit all the zeroes!

To make things easier, electricity companies use a unit of energy called the **kilowatt-hour (kWh)**. It is sometimes just referred to as a **unit** and is the amount of electrical energy transformed by an appliance of one kilowatt power kept on for one hour. This is the equivalent of **3,600,000 Joules**.

Of course, electricity is not free. The wires in your house are connected to the local electricity network. This electricity is more powerful than the electricity from batteries because it has a higher voltage. A battery is around 1.5 volts, while mains electricity is 230 volts. There is a meter installed somewhere in or around your house. The meter measures how much electricity you use. This energy is measured in units and you are charged for every **unit** you use. The cost varies but is currently around 9p per unit.





Climate change and the environment

What is the problem?

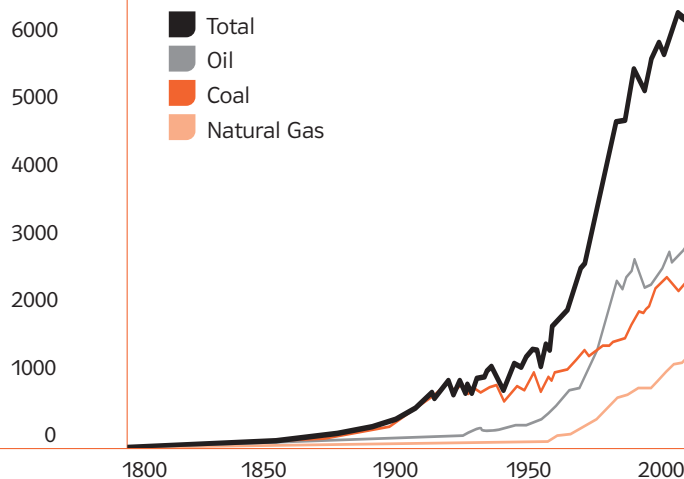
Scientists believe that the huge amount of fossil fuels we burn to produce electricity is damaging the environment.

Burning fossil fuels releases carbon dioxide into the air. It is a 'greenhouse gas' and traps heat in the atmosphere, in the same way as glass windows trap heat inside a greenhouse. The more carbon dioxide in the atmosphere, the more heat is trapped. This is called **the greenhouse effect**.

Scientists believe the greenhouse effect is causing the Earth's climate to change.

Global fossil carbon emissions*

Million metric tons of carbon / year



What could happen?

If climate change continues at the current rate, it will get much **warmer** and **wetter** in the UK within your lifetime.



Warmer

- Annual average temperatures across the UK may rise 2-3°C
- Warmer summers will be very common
- Very cold winters will be rare and snowfall in the UK will decrease



Wetter

- As it gets warmer, it will get wetter. As the polar ice melts, sea levels will continue to rise
- Around the UK sea levels could rise between 26cm and 86cm
- Flooding will be widespread and low-lying coastal areas like the Fens in Cambridgeshire and areas around estuaries like the Thames will be particularly at risk

What is being done?

Governments around the world are setting targets to reduce carbon dioxide emissions, and investing in renewable sources and new technologies that could lead to 'cleaner' electricity. These include hydrogen fuel cells and generating electricity through nuclear fusion - the same process that powers the Sun.

What can I do?

Small things like...

- turning your television off instead of keeping it on standby
 - only boiling the water you need when using the kettle
 - using energy saving light bulbs and other energy efficient appliances
 - insulating your home
- ...make a big difference if everyone does it!**

* Original data: Marland, Boden and Andres, 2003

"Global, Regional and National CO₂ Emissions" in *Trends: A compendium of Data on Global Change*
Carbon Dioxide Information Analysis Center, US Department of Energy, Oak Ridge, Tenn.



Safety first!

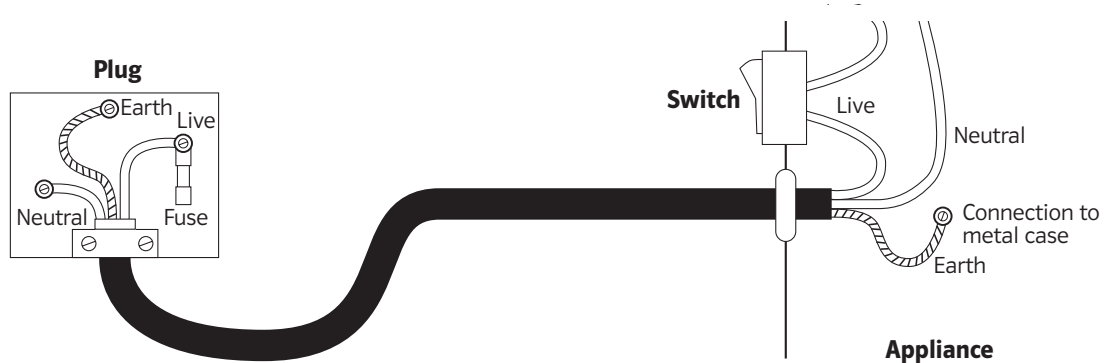
Electricity can kill if handled incorrectly. Every year people are seriously injured or killed when coming into contact with live electricity. We all need to know what the dangers are, and how to avoid them.





Safe as houses

We use electricity for many different things in our homes, so it has to be safe. Here are three common safety measures.



Fuses

A fuse is a thin piece of wire. If a too large current tries to pass through it, it will melt, and electricity can no longer pass through it.

Remember: the fuse is a safety device. If it breaks, there is a fault!

The consumer unit or 'fuse box'

Electricity enters your home through a very thick cable that can carry currents of 100A or more. The electricity is routed through a main fuse that protects the whole house from excessive currents which could cause the wiring to overheat and catch fire. It then passes through the electricity meter to the consumer unit or 'fuse box'.

The consumer unit connects the incoming live wire to the different power and lighting circuits in your home. Each one of these circuits is protected by a fuse and, in more modern units, a residual current device (RCD). RCDs detect if there is a difference in the current flowing into a circuit through the live wire and back out through the neutral wire. In a circuit that is working properly, there should be no difference. If there is a difference, it means that some electricity is leaking to earth through a fault and the RCD switches the circuit off immediately.

RCDs can switch a circuit off more quickly than a fuse can melt, so they are very effective safety devices.

The earth wire

Many of the electrical appliances we use have metal cases. If the live wire carrying electricity into the appliance frayed and touched the metal case, the case would become live. You might not know this until you touched it and got a shock as the current passed through you to get to earth. Connecting an earth wire to the case of the appliance can help to prevent this as it provides a low-resistance path to earth. If the case becomes live, a large current flows from the live wire to earth, blowing the fuse in the mains plug.

Appliances with plastic cases do not need an earth wire connected in this way and are said to be 'double insulated', as there is an extra level of insulation through the case. Plastic does not conduct electricity so there is no danger of the case becoming live.