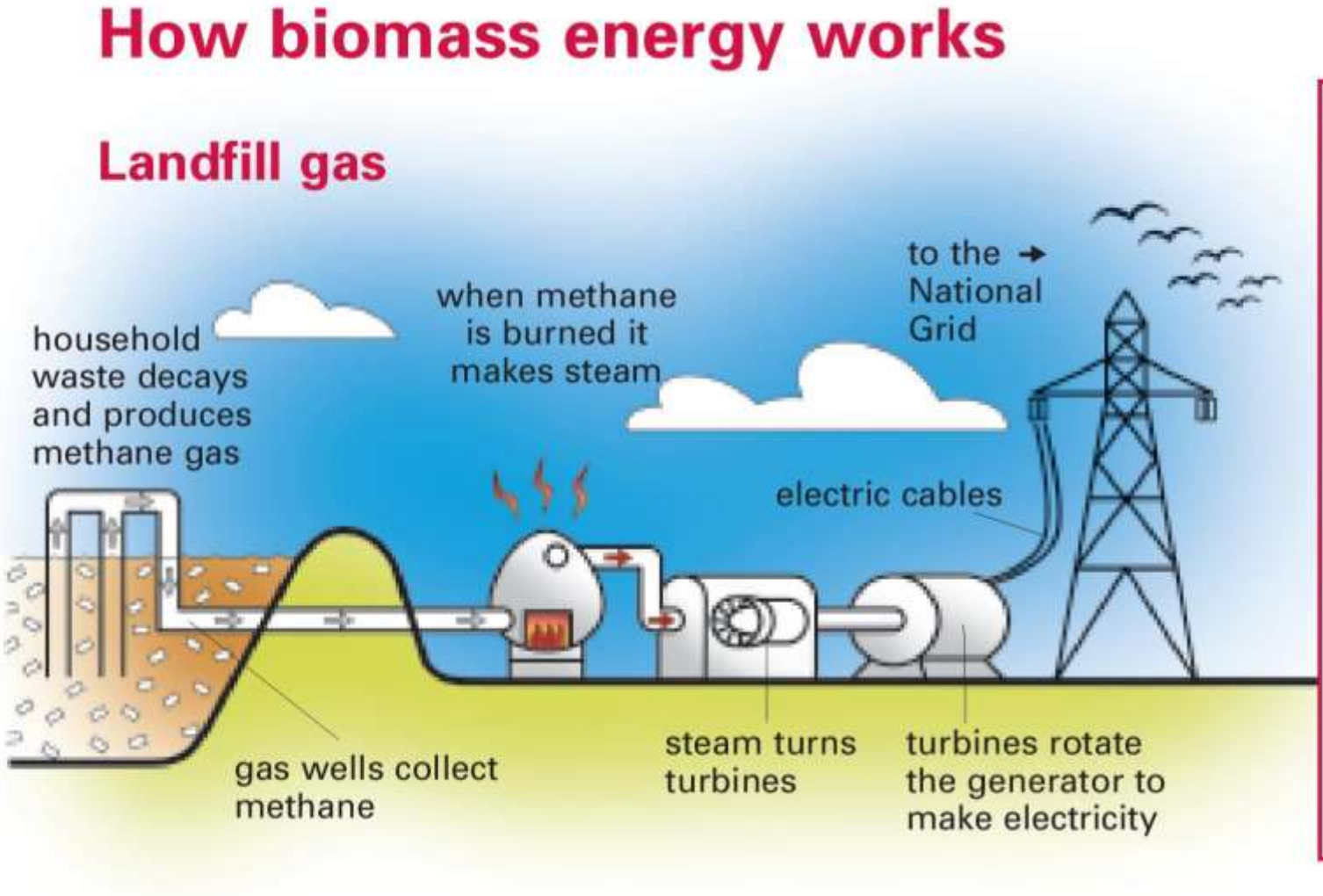
Biomass Energy

What is biomass energy?

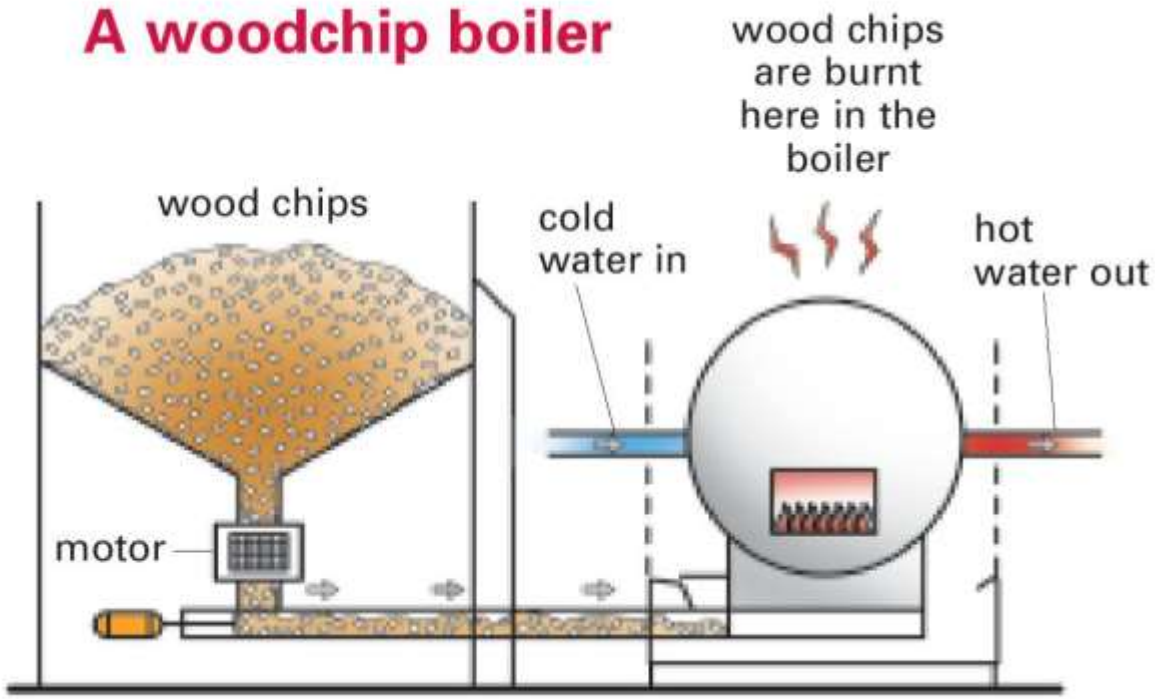
Biomass is plant and animal matter, such as wood, straw, sewage and waste food. We can burn these natural materials to produce heat and electricity, or use them to produce transport fuels such as biodiesel and bioethanol. This is called biomass energy.

Biomass Energy



- Some waste is recycled, but most of it is dumped in landfill sites.
- As the plant and animal material in the waste decays, it gives off methane gas.
- The gas is collected and used as a fuel to heat water and make steam. This turns a generator, which makes electricity.

Biomass Energy



- Trees grown specifically for fuel are felled, cut into wood chips and dried. New trees are planted.
- The wood chips are burned in a boiler to heat water, which can be used to heat buildings or make electricity.
- Household waste, animal and factory waste, and straw can also be used as fuel.

Biomass Energy

Advantages of biomass energy

- It does not use up limited resources such as coal. Biomass cannot run out!
- It stops landfill gas from going into the air, where it could damage the atmosphere.
- It does not rely on the weather, so it can provide energy all the time.

Possible disadvantages

- Waste materials have to be collected, which can be costly.
- Burning fuels (e.g. wood chips and rubbish) does cause some air pollution.

Biomass Energy

Courtesy of Weobley Primary School

Weobley Primary School in Hertfordshire is heated using wood chips. The wood is grown nearby and cut carefully from trees, so that they continue to grow. The school boiler uses about two tonnes of wood chips a week.

Biomass Energy

Courtesy of NRE Slide Library / DTI

The world's largest straw-burning power station is at Ely in Cambridgeshire. Thousands of tonnes of straw from local farms are burned to generate electricity. The power produced each year is enough for 80,000 homes.

Energy from rubbish?

Courtesy of NRE Slide Library / DTI

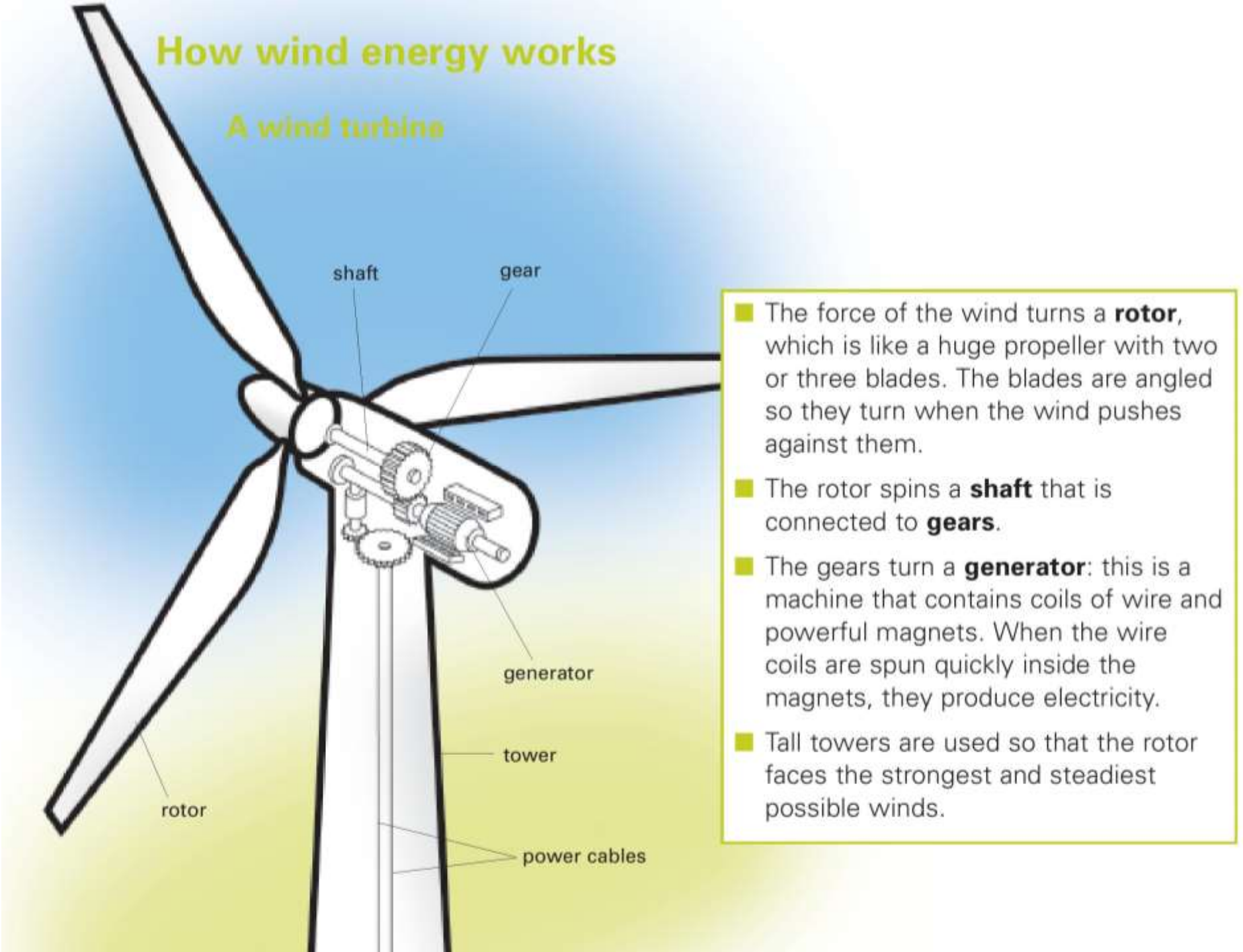
The UK produces 28 million tonnes of household waste every year. Only 11% of the UK's waste is used to make electricity at the moment.

Wind Energy

What is wind energy?

Humans have used wind energy to power machinery in windmills for hundreds of years. Today, electricity companies are building wind farms which use giant machines called wind turbines to make electricity for homes, schools and factories.

Wind Energy


How wind energy works
A wind turbine
shaft
gear
generator
tower
rotor
power cables
The force of the wind turns a **rotor**, which is like a huge propeller with two or three blades. The blades are angled so they turn when the wind pushes against them.
The rotor spins a **shaft** that is connected to **gears**.
The gears turn a **generator**: this is a machine that contains coils of wire and powerful magnets. When the wire coils are spun quickly inside the magnets, they produce electricity.
Tall towers are used so that the rotor faces the strongest and steadiest possible winds.

Wind Energy

Advantages of wind energy

- It is a renewable form of energy, which means it will never run out.
- Wind energy is clean. It causes no pollution.
- The land on which turbines are built can still be used for farming.
- It costs no more than coal energy and is cheaper than nuclear energy.

Possible disadvantages

- Some people are concerned about noise, although wind turbines are quieter than many people think.
- Wind turbines do not work in very weak or very strong winds.
- Some people think that wind farms spoil the look of the landscape, although others disagree – this is a matter of opinion.

Wind Energy

Courtesy of npower renewables

An onshore wind farm at Novar, Scotland
Onshore wind farms are built on land. A large farm can provide electricity for 25,000 homes. This site was chosen because it has strong winds, and is far away from houses and other buildings.

Solar Energy

What is solar energy?

Solar energy means energy from the sun. Although the sun is 150 million kilometres away from the Earth, it is amazingly powerful. We can capture some of the sun's energy and use it to heat buildings, provide light and generate electricity.

Solar Energy

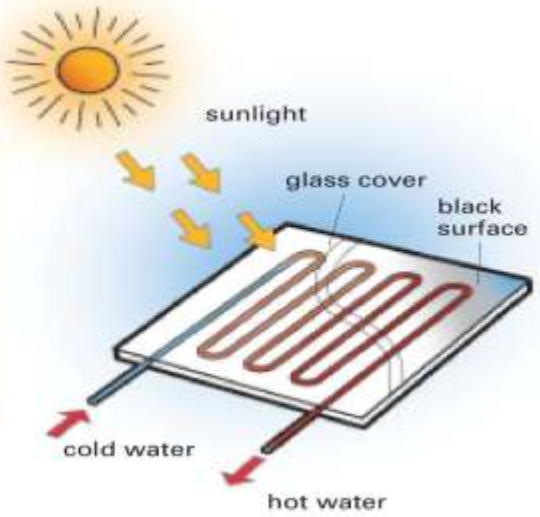
How solar power works

Passive solar design

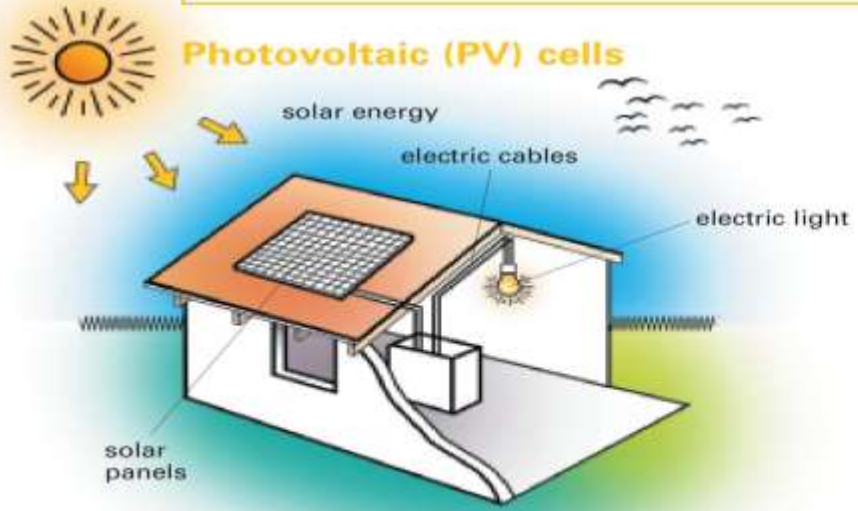
- Buildings can be designed to make the most of the sun's energy, e.g. large areas of glass allow more sunlight to come in, so less heating and lighting are needed.
- Houses built in this way have thick insulation to hold in the sun's heat.

Active solar heating

- The sun's energy heats up hot water for washing and heating.
- Water is pumped up through pipes into solar panels (or collectors) on the roof.
- The hot or warm water, which has been heated by the sun, is stored in a tank and can be used in the building.



Photovoltaic (PV) cells



- PV (photovoltaic) cells change light straight into electricity.
- Small PV cells are used to power calculators. Large panels of PV cells can be fixed to houses to power lights, computers, TVs, etc.
- PV panels are usually put on the roof of a building to capture sunlight.

Solar Energy

Advantages of solar energy

- It is renewable energy. The sun gives out 'free' power all the time.
- It is silent, causes no pollution and does not harm wildlife.
- It provides energy where it is used, so there is no need for large cables.
- It is useful in remote places, and works on a small or large scale.

Possible disadvantages

- Solar power does not work at night.
- At the moment, PV cells are expensive (but getting cheaper).

Solar Energy

Courtesy of Tesco Stores Ltd

This Tesco petrol station in Hucknall near Nottingham has 96 PV panels on its roof. By using solar energy to produce electricity in this way, the station uses less energy made by burning fuels, and so reduces pollution in the air.

Geothermal Energy

What is geothermal energy?

Coal miners know that the deeper you dig, the hotter it gets. This is because of the heat at the Earth's core. We call the Earth's natural heat geothermal energy ('geo' means earth and 'thermal' means heat). Water heated by geothermal energy can be used to heat buildings or generate electricity.

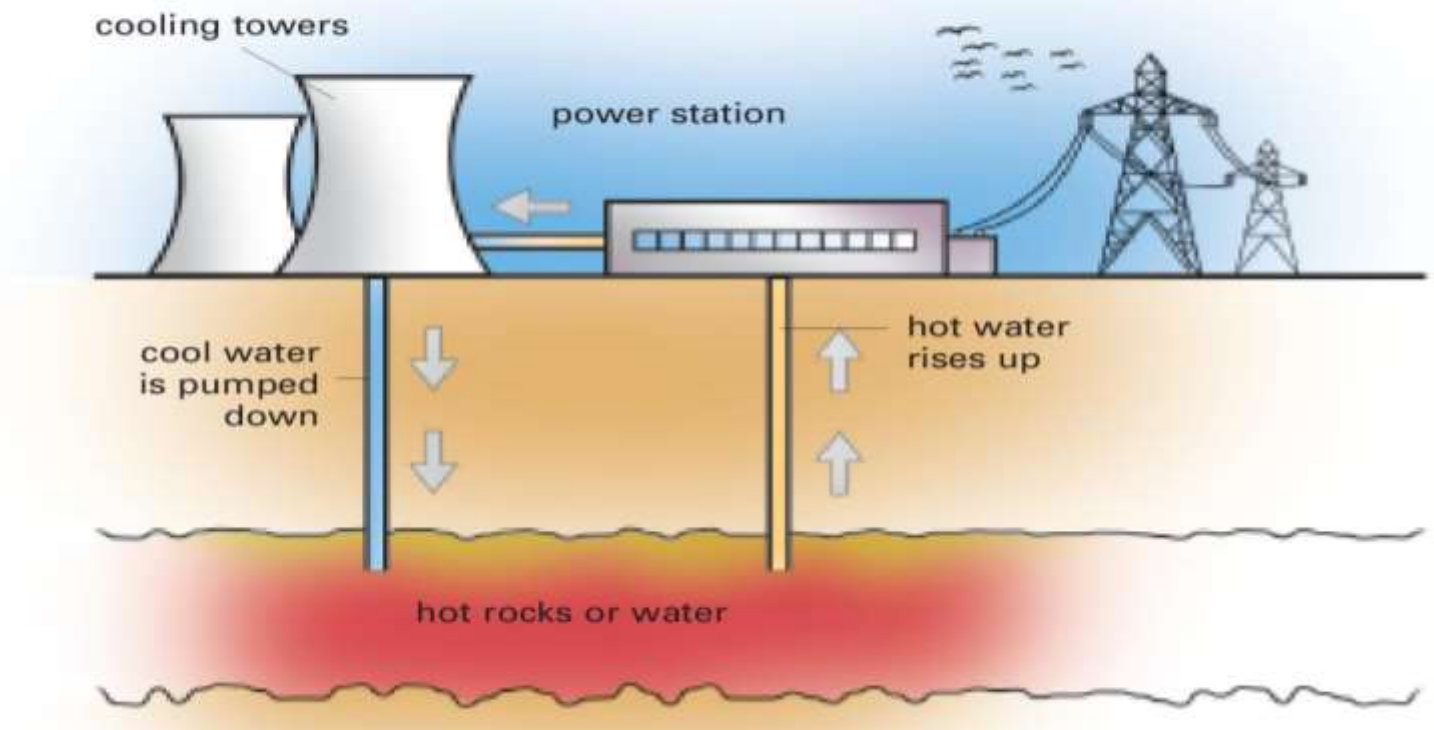
Geothermal Energy

How geothermal energy works

There are two main ways of using geothermal energy.

- In some areas of the Earth, naturally heated underground water rises to the surface as **steam** or **hot springs**. If the hot water doesn't rise to the surface on its own, we can drill **boreholes** to get to it.
- Another way of using the Earth's natural heat is to pump cold water deep underground, where it is heated by hot dry rocks and then returned to the surface. This process is explained below.

Geothermal power plant



- Engineers drill two shafts down into the Earth to reach hot rocks or a hot underground lake.
- Cold water is pumped down underground, where it is heated by the rocks or lake.
- The very hot water rises or is pumped up to the power station at the surface.
- The steam turns a generator to make electricity.

Geothermal Energy

Advantages of geothermal energy

- Geothermal power plants produce renewable energy. No fuel is used.
- There is very little pollution.
- Geothermal energy is quiet, and much of the technology needed is hidden underground.

Possible disadvantages

- Only a few parts of the UK have underground heat close enough to the surface for a geothermal power plant.

Geothermal Energy

Hot springs and geysers

Here are two examples of naturally heated underground water that has made its way to the surface. They are tourist attractions at Yellowstone National Park in the USA.

Photo courtesy of www.pdphoto.org

The Old Faithful geyser erupts high pressure steam from far below the Earth's surface every 45 minutes.

Hydroelectric Energy

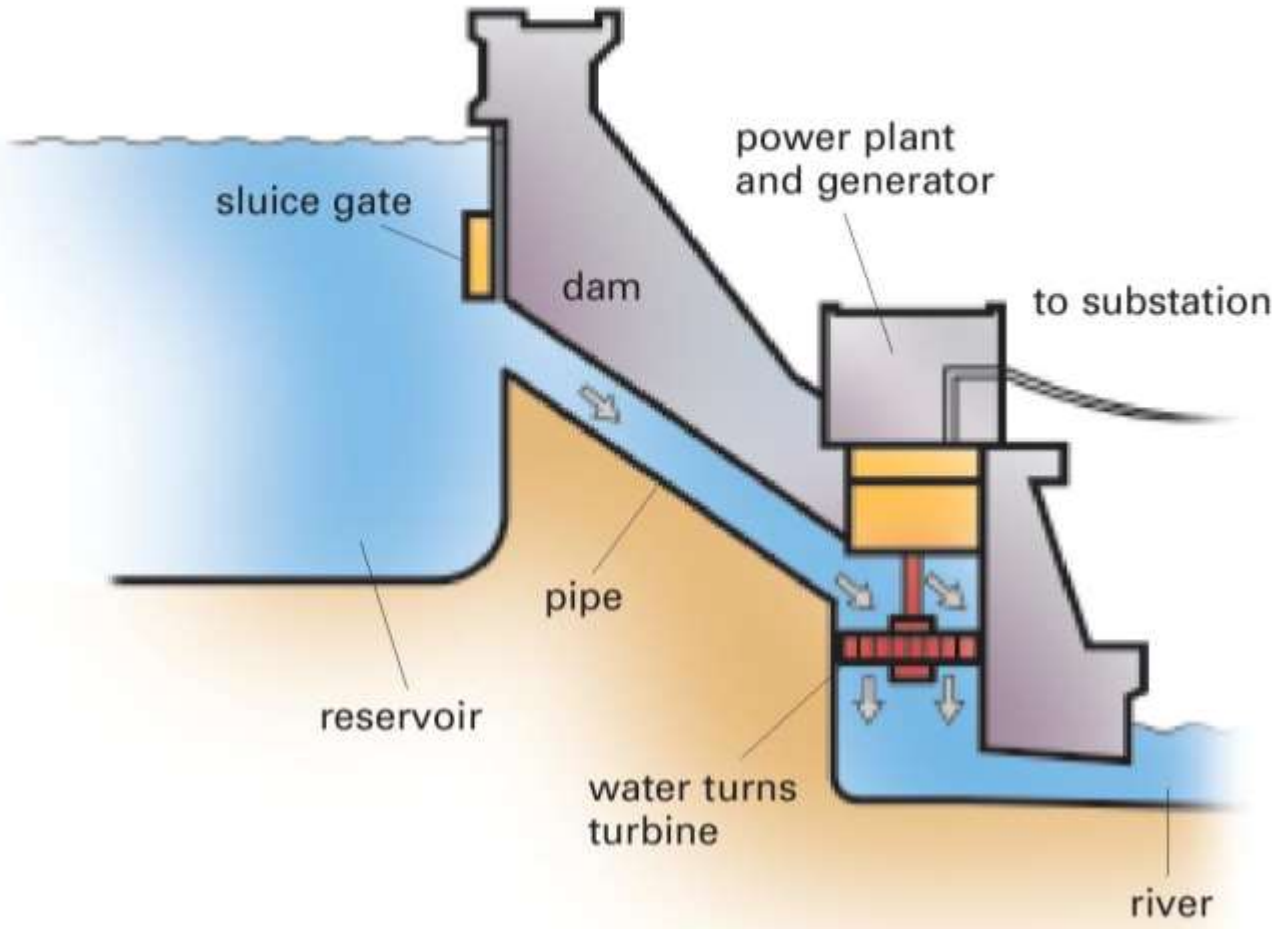
What is hydroelectric energy?

Hydro-energy means energy from moving water ('hydro' is from the Greek word for water). It is one of the oldest forms of power. Watermills have been used to grind corn for hundreds of years. Today, electricity can be generated by building dams, which force water to turn machinery. This is called hydroelectric energy.

Hydroelectric Energy

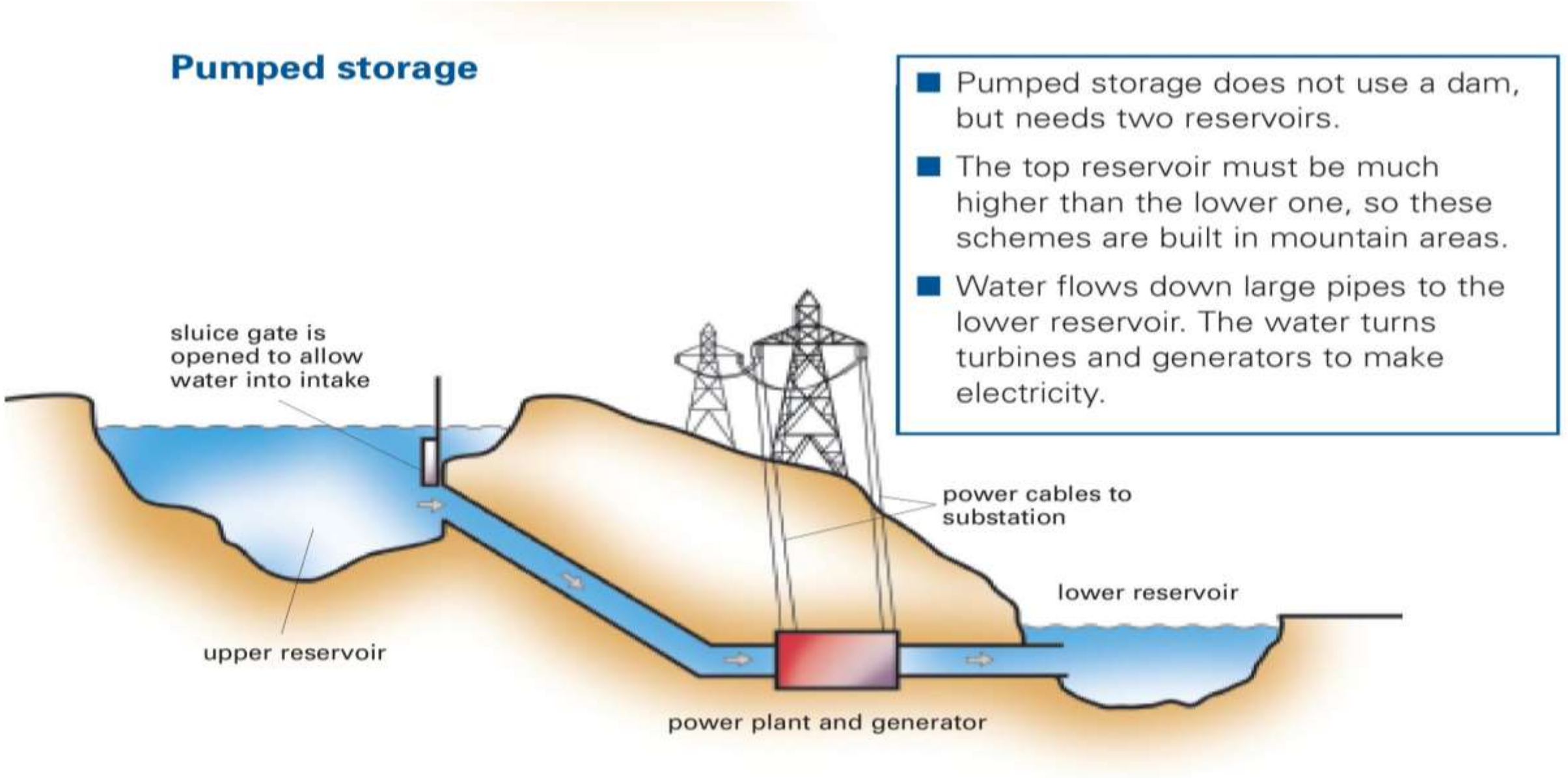
How hydroelectric energy works

A hydroelectric dam



- A river flowing through a valley is blocked by building a large concrete dam. The valley is flooded by the river, creating a reservoir, like a lake.
- Large pipes inside the dam allow water to flow through under pressure.
- The water turns turbines inside the pipes, which are connected to generators. The generators produce electricity as they spin.
- The water from the pipes flows away down the river.

Hydroelectric Energy



Hydroelectric Energy

Advantages of hydroelectric energy

- It is renewable, because rain keeps falling.
- It causes no pollution.
- It is more reliable than wind or solar energy, and can be switched on when needed.

Possible disadvantages

- Hydroelectric schemes are very expensive to build.
- There are few suitable sites, and land for homes may be lost when they are built.
- Wildlife habitats are lost when land is flooded to make reservoirs. River life can also be affected by dams.

Hydroelectric Energy

Courtesy of Roy Dyckhoff

Dams have to be extremely strong to hold the water pressing against them. This picture shows water being released under pressure, after it has turned the turbines inside the dam to generate electricity.

Tidal Energy

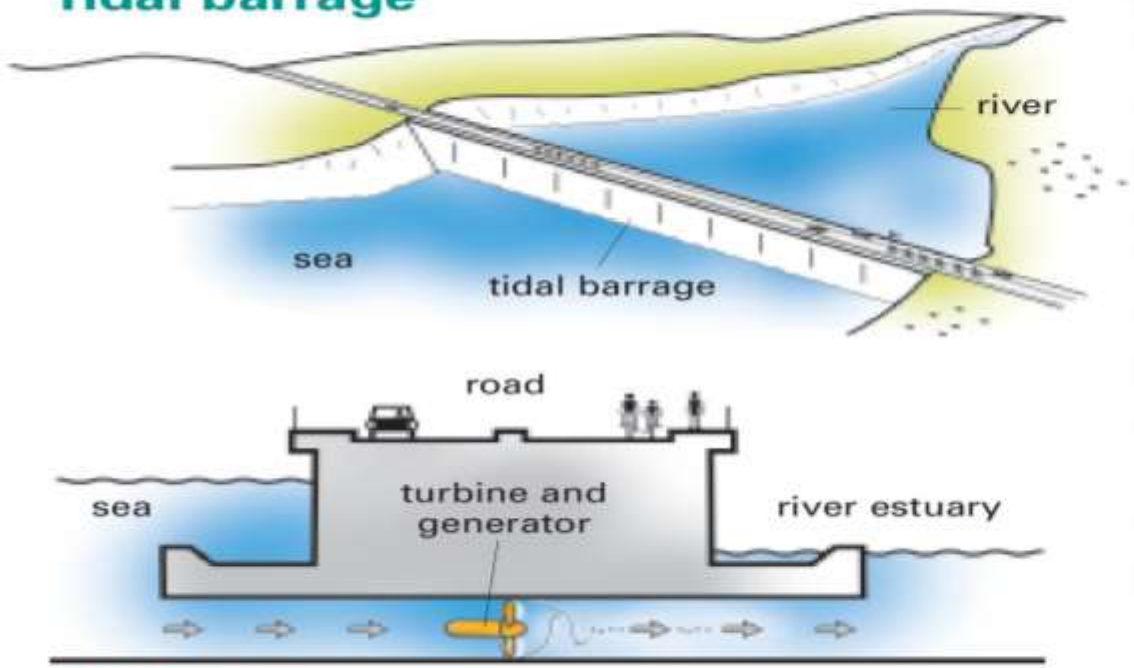
What is tidal energy?

Every day the tide at the seaside goes in and out – twice. This rising and falling of the sea is caused by the pull of the moon. We can use this powerful flow of water to generate electricity.

Tidal Energy

How tidal energy works

Tidal barrage



tide coming in

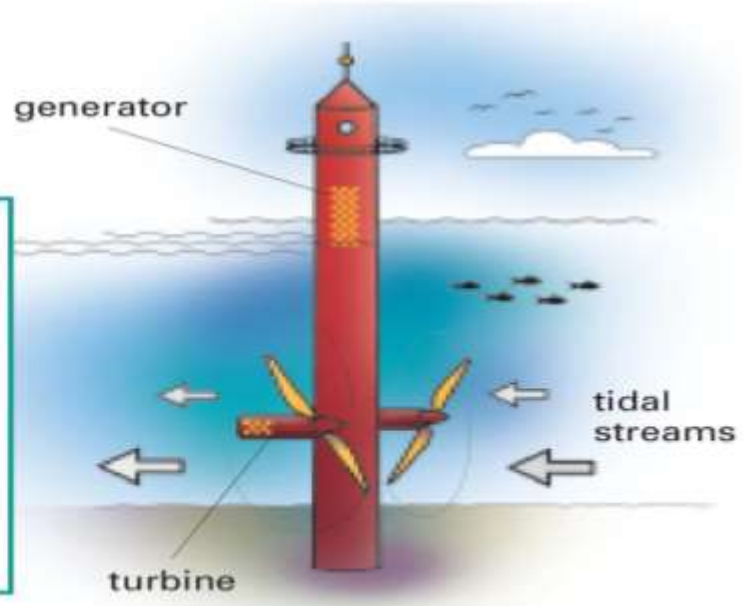
A **tidal barrage** is a giant dam that is built across a river estuary or a bay on the coast.

- As the tide comes in, the barrage holds back the sea, making a difference in the levels of water on each side.
- Gates are then opened, allowing the water to rush through and turn a turbine, to generate electricity.
- As the tide goes out, water flows the other way to turn the turbine.

Marine turbine

Tidal streams are fast sea currents that flow as tides move in and out. **Marine turbines** work like wind turbines, but are turned by sea currents.

- These turbines turn quite slowly but the sea is much more powerful than the wind.
- As the turbine turns, machinery inside it generates electricity, which is fed to shore by a cable.



Tidal Energy

Advantages of tidal energy

- Tides are more reliable than wind, waves or solar power.
- Tidal energy is renewable energy. It uses no fuel that can run out.
- Marine turbines do not affect sea life because they turn slowly.

Possible disadvantages

- There are very few good sites for tidal barrages.
- Barrages make it difficult for ships to pass through estuaries.
- Tidal barrages affect sea life, such as fish that migrate up rivers from the sea.

Tidal Energy

Courtesy of EDF Médiathèque / G Halary

Tidal barrage at La Rance, France

These special dams have to be built across a bay or estuary where the tide rises and falls by at least 5 metres. If tidal barrages like this were built in the UK, they could generate 15% of the country's electricity.

Tidal Energy

Courtesy of Marine Current Turbines Ltd

The Seaflow project, Devon
This is the UK's first marine turbine project, and is now being tested. The rotor will be lowered into the sea so that it is turned by strong tidal streams to produce electricity. Other turbines will be added later. There are about 30 sites in the UK suitable for these machines.

Wave Energy

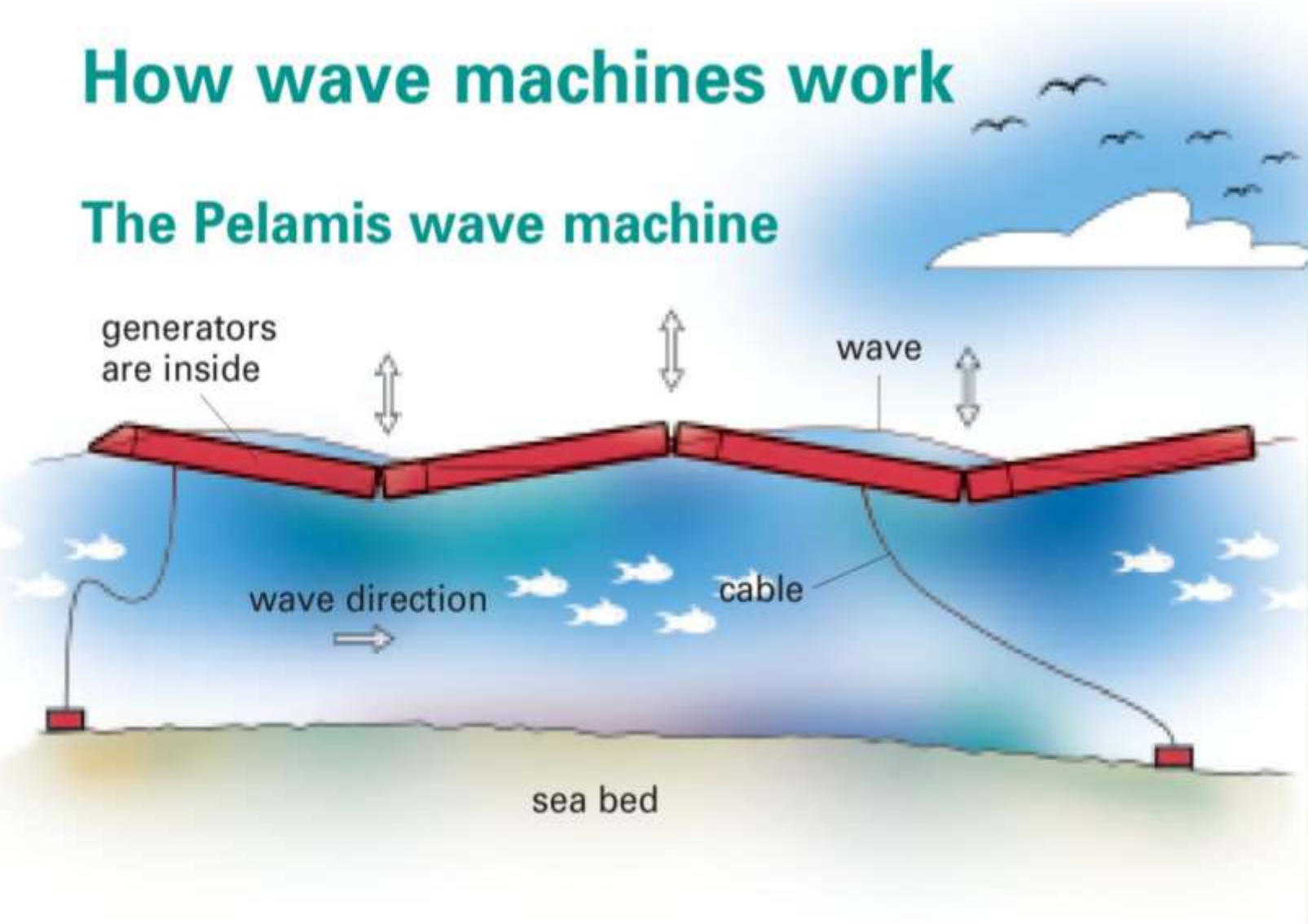
What is wave energy?

Waves are movements of water caused by the wind blowing across the sea. Every wave contains energy. We can use wave energy to make electricity. Waves are a source of ‘renewable’ energy. They will never run out, unlike fossil fuels such as coal and gas.

Wave Energy

How wave machines work

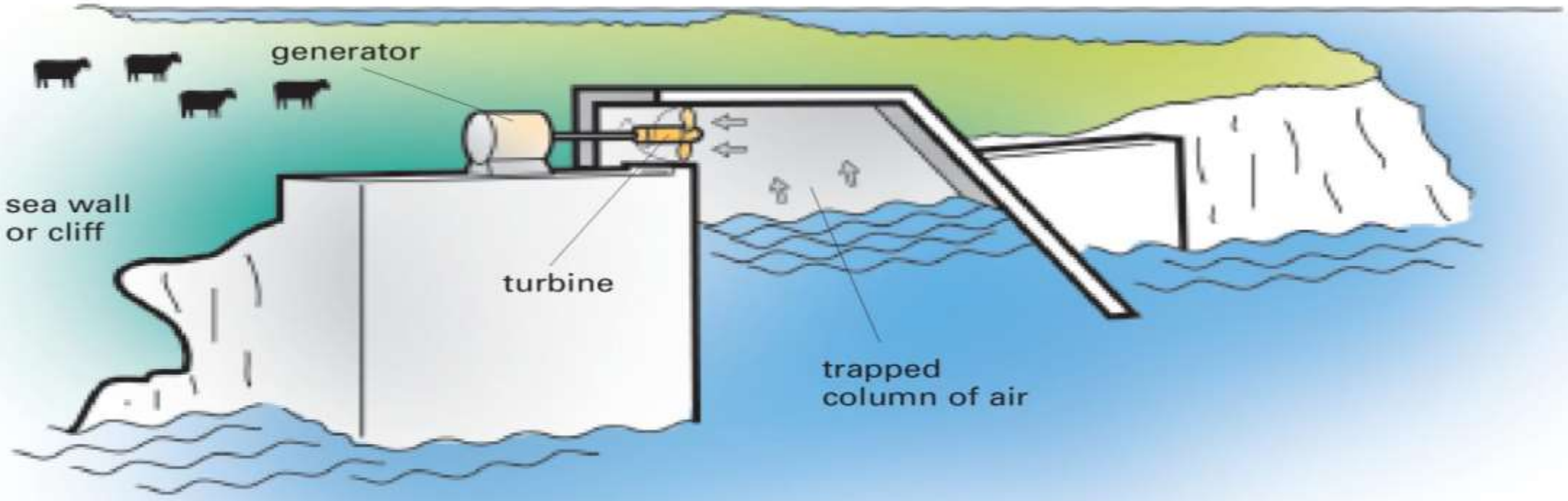
The Pelamis wave machine



- The **Pelamis** is made of four giant metal tubes with movable joints.
- The action of the waves causes the tubes to move up and down.
- As the joints move, oil is forced through generators, which produce electricity as they spin.

Wave Energy

The Limpet



- The **Limpet** is built into the shore, and has strong concrete walls.
- Incoming waves push against a column of air, which is trapped inside the machine. The air is forced upwards where it pushes a turbine (a set of spinning blades), making it turn very fast.
- As the wave retreats, air is sucked back through the turbine, causing it to spin again.
- The turbine works a generator, which makes electricity as it turns.

Wave Energy

Advantages of wave energy

- It is a renewable form of energy, caused by wind. It can't run out.
- The machines do not spoil the landscape and do not cause pollution.
- The UK has lots of coastline and big waves from the Atlantic Ocean.

Possible disadvantages

- Storms at sea can easily damage even strong machines.
- Warning systems have to be made so ships can keep clear.
- Rust, seaweed, and barnacles can cause problems with the machinery.

Wave Energy

Courtesy of Ocean Power Delivery

The Pelamis wave machine first began generating electricity from its position near Orkney in Scotland in 2004. Its location was chosen carefully for ideal waves, the best depth of sea, and to avoid passing ships.

Wave Energy

Courtesy of Wavegen

The Limpet (Land Installed Marine Powered Energy Transformer) is on the Scottish island of Islay. It can supply electricity to about 350 homes.

Hydrogen Fuel Cells

What is a hydrogen fuel cell?

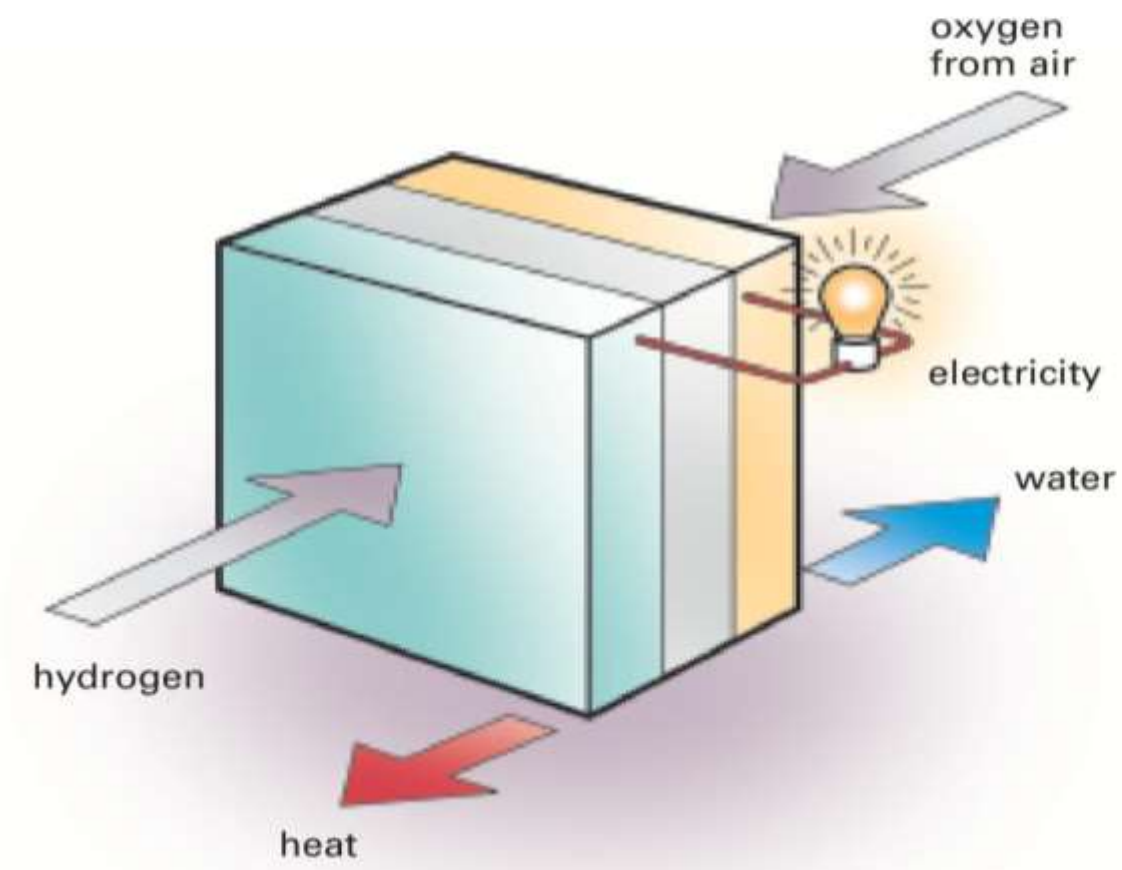
A hydrogen fuel cell uses hydrogen gas to make electricity. Unlike an engine, it does not burn fuel, and so it causes no pollution. It produces only water and heat as it works.

Hydrogen Fuel Cells

How a hydrogen fuel cell works

Hydrogen fuel cells keep producing power as long as they have a supply of hydrogen.

Hydrogen fuel cell



- Hydrogen gas (stored in a bottle or tank) and oxygen from air are fed into the fuel cell.
- The materials in the fuel cell are arranged in layers so that a chemical process takes place.
- In this chemical process, hydrogen is used to make electricity, which can be used to power lights, motors, etc.
- Water and heat are also given off.
- There are no moving parts, so the fuel cell is very quiet.
- Hydrogen fuel cells can be very small, e.g. to power a mobile phone, or very large, e.g. to work a power station.

Hydrogen Fuel Cells

Advantages of hydrogen fuel cells

- Fuel cells provide quiet, clean power.
- Hydrogen can store energy to be used when it is needed – something that can't easily be done with wind or solar power.
- Fuel cells can power very small equipment or supply electricity for very large projects.
- Only water and heat are given off, but no poisonous gases.

Possible disadvantages

- Hydrogen fuel cells are still expensive to make, although they will become cheaper in the future.
- Fuel cells need a supply of hydrogen. Today, most hydrogen is made from fossil fuels such as coal, which pollute the air. However, it can be made using renewable energy, such as wind power, or from nuclear electricity.
- It is difficult to store enough hydrogen on board a vehicle to allow it to travel long distances.

Hydrogen Fuel Cells

Courtesy of Woking Borough Council

Woking Park leisure centre
This is the first leisure centre in the UK to use hydrogen fuel cells for its energy needs. The fuel cells heat the swimming pool, provide clean water, and supply all the centre's electricity. The system even makes chilled water for the building's air conditioning.

Courtesy of Matthew Wooll

Fuel cell buses in London
London is one of several European cities testing how well electric buses powered by fuel cells work. The buses are quiet, and produce almost no pollution. They are refuelled with bottles of compressed hydrogen, which are stored on the roof of the bus.