

Energy Resources and their Uses

There are lots of energy resources available on Earth. They are either renewable or non-renewable resources.

Non-Renewable Energy Resources Will Run Out One Day

Non-renewable energy resources are fossil fuels and nuclear fuel (e.g. uranium and plutonium). Fossil fuels are natural resources that form underground over millions of years. They are typically burnt to provide energy. The three main fossil fuels are:

- 1) Coal
- 2) Oil
- 3) (Natural) Gas

- These will all 'run out' one day.
- They all do damage to the environment.
- But they provide most of our energy.

Renewable Energy Resources Will Never Run Out

Renewable energy resources are:

- 1) The Sun (Solar)
- 2) Wind
- 3) Water waves
- 4) Hydro-electricity
- 5) Bio-fuel
- 6) Tides
- 7) Geothermal

- These will never run out — the energy can be 'renewed' as it is used.
- Most of them do damage the environment, but in less nasty ways than non-renewables.
- The trouble is they don't provide much energy and some of them are unreliable because they depend on the weather.

Energy Resources can be Used for Transport...

Transport is one of the most obvious places where fuel is used. Here are a few transportation methods that use either renewable or non-renewable energy resources:

Electricity can also be used to power vehicles, (e.g. trains and some cars). It can be generated using renewable or non-renewable energy resources (p.32-36).

NON-RENEWABLE ENERGY RESOURCES

- Petrol and diesel powered vehicles (including most cars) use fuel created from oil.
- Coal is used in some old-fashioned steam trains to boil water to produce steam.

RENEWABLE ENERGY RESOURCES

Vehicles that run on pure bio-fuels (p.35) or a mix of a bio-fuel and petrol or diesel (only the bio-fuel bit is renewable, though).

...And for Heating

Energy resources are also needed for heating things like your home.

NON-RENEWABLE ENERGY RESOURCES

- Natural gas is the most widely used fuel for heating homes in the UK. The gas is used to heat water, which is then pumped into radiators throughout the home.
- Coal is commonly burnt in fireplaces.
- Electric heaters (sometimes called storage heaters) which use electricity generated from non-renewable energy resources.

RENEWABLE ENERGY RESOURCES

- A geothermal (or ground source) heat pump uses geothermal energy resources (p.33) to heat buildings.
- Solar water heaters work by using the sun to heat water which is then pumped into radiators in the building.
- Burning bio-fuel or using electricity generated from renewable resources can also be used for heating.

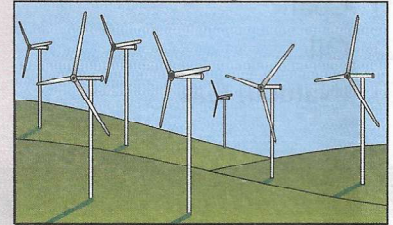
Wind and Solar Power

Renewable energy resources, like wind and solar resources, will not run out. They don't generate as much electricity as non-renewables though — if they did we'd all be using solar-powered toasters by now.

Wind Power — Lots of Little Wind Turbines

This involves putting lots of wind turbines (windmills) up in exposed places like on moors or round coasts.

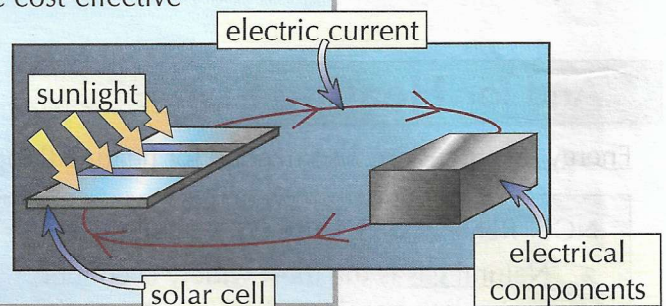
- 1) Each turbine has a generator inside it — the rotating blades turn the generator and produce electricity.
- 2) There's no pollution (except for a bit when they're manufactured).
- 3) But they do spoil the view. You need about 1500 wind turbines to replace one coal-fired power station and 1500 of them cover a lot of ground — which would have a big effect on the scenery.
- 4) And they can be very noisy, which can be annoying for people living nearby.
- 5) There's also the problem of the turbines stopping when the wind stops or if the wind is too strong, and it's impossible to increase supply when there's extra demand (p.55). On average, wind turbines produce electricity 70-85% of the time.
- 6) The initial costs are quite high, but there are no fuel costs and minimal running costs.
- 7) There's no permanent damage to the landscape — if you remove the turbines, you remove the noise and the view returns to normal.



Solar Cells — Expensive but Not Much Environmental Damage

Solar cells generate electric currents directly from sunlight.

- 1) Solar cells are often the best source of energy to charge batteries in calculators and watches which don't use much electricity.
- 2) Solar power is often used in remote places where there's not much choice (e.g. the Australian outback) and to power electric road signs and satellites.
- 3) There's no pollution. (Although the factories do use quite a lot of energy and produce some pollution when they manufacture the cells.)
- 4) In sunny countries solar power is a very reliable source of energy — but only in the daytime. Solar power can still be cost-effective in cloudy countries like Britain though.
- 5) Like wind, you can't increase the power output when there is extra demand.
- 6) Initial costs are high but after that the energy is free and running costs almost nil.
- 7) Solar cells are usually used to generate electricity on a relatively small scale.



People love the idea of wind power — just not in their back yard...

It's easy to think that non-renewables are the answer to the world's energy problems. However, they have their downsides, and we definitely couldn't rely on them totally at present. Make sure you know the pros and cons for wind and solar power because there are more renewables coming up on the next page.

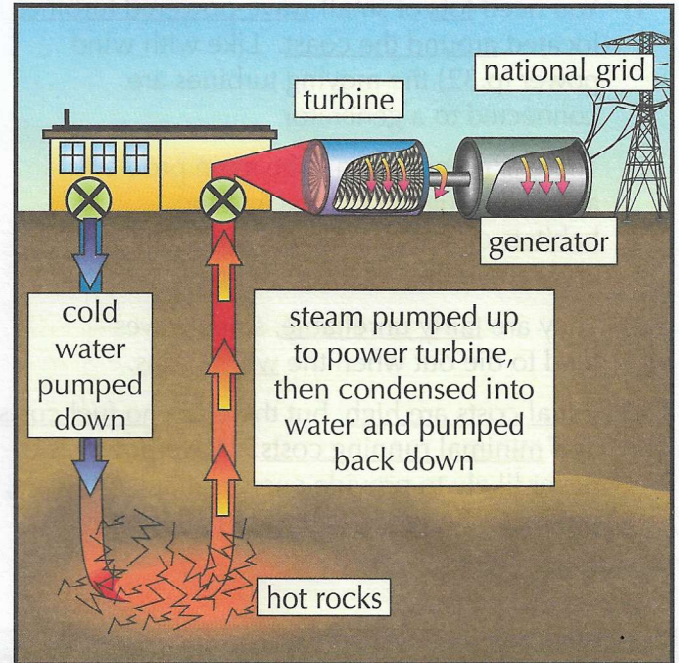
Geothermal and Hydro-electric Power

Here are some more examples of renewable energy resources — geothermal and hydro-electric. These ones are a bit more reliable than wind and solar — read on to find out why.

Geothermal Power — Energy from Underground

Geothermal power uses energy from underground thermal energy stores.

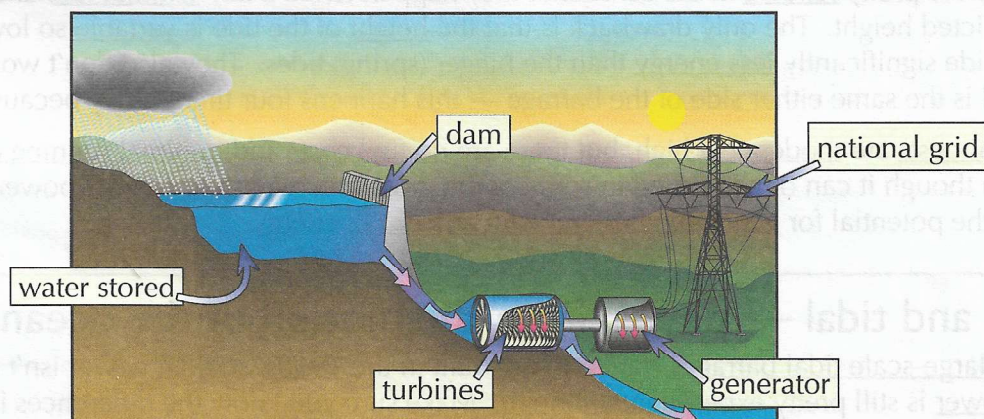
- 1) This is only possible in volcanic areas where hot rocks lie quite near to the surface. The source of much of the energy is the slow decay of various radioactive elements, including uranium, deep inside the Earth.
- 2) This is actually brilliant free energy that's reliable with very few environmental problems.
- 3) Geothermal energy can be used to generate electricity, or to heat buildings directly.
- 4) The main drawbacks with geothermal energy are that there aren't very many suitable locations for power plants and that the cost of building a power plant is often high compared to the amount of energy it produces.



Hydro-electric Power Uses Falling Water

Hydro-electric power transfers energy from the kinetic store of falling water.

- 1) Hydro-electric power usually requires the flooding of a valley by building a big dam. Rainwater is caught and allowed out through turbines. There is no pollution (as such).
- 2) But there is a big impact on the environment due to the flooding of the valley (rotting vegetation releases methane and carbon dioxide) and possible loss of habitat for some species (sometimes the loss of whole villages). The reservoirs can also look very unsightly when they dry up. Putting hydro-electric power stations in remote valleys tends to reduce their impact on humans.
- 3) A big advantage is it can provide an immediate response to an increased demand for electricity.
- 4) There's no problem with reliability except in times of drought — but remember this is Great Britain we're talking about.
- 5) Initial costs are high, but there are no fuel costs and minimal running costs.
- 6) It can be a useful way to generate electricity on a small scale in remote areas.

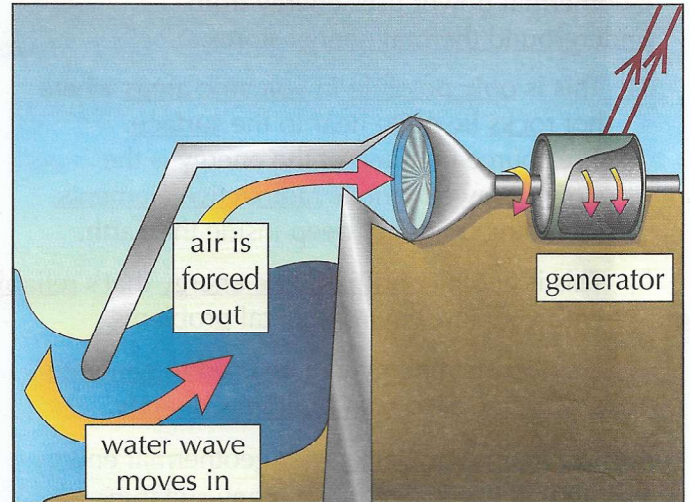


Wave Power and Tidal Barrages

Good ol' water. Not only can we drink it, we can also use it to generate electricity. It's easy to get confused between wave and tidal power as they both involve the seaside — but don't. They are completely different.

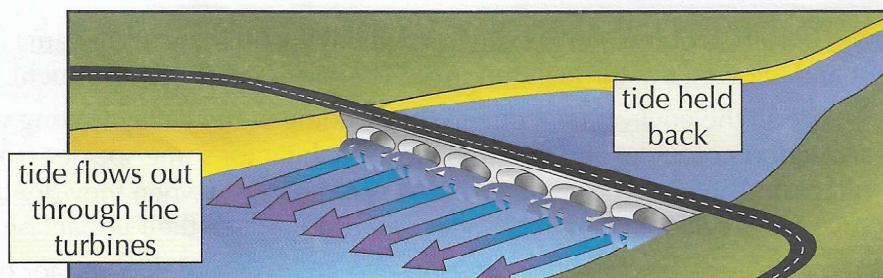
Wave Power — Lots of Little Wave-Powered Turbines

- 1) You need lots of small wave-powered turbines located around the coast. Like with wind power (p.32) the moving turbines are connected to a generator.
- 2) There is no pollution. The main problems are disturbing the seabed and the habitats of marine animals, spoiling the view and being a hazard to boats.
- 3) They are fairly unreliable, since waves tend to die out when the wind drops.
- 4) Initial costs are high, but there are no fuel costs and minimal running costs. Wave power is never likely to provide energy on a large scale, but it can be very useful on small islands.



Tidal Barrages — Using the Sun and Moon's Gravity

- 1) Tides are used in lots of ways to generate electricity. The most common method is building a tidal barrage.
- 2) Tidal barrages are big dams built across river estuaries, with turbines in them. As the tide comes in it fills up the estuary. The water is then allowed out through turbines at a controlled speed.



- 3) Tides are produced by the gravitational pull of the Sun and Moon.
- 4) There is no pollution. The main problems are preventing free access by boats, spoiling the view and altering the habitat of the wildlife, e.g. wading birds and sea creatures who live in the sand.
- 5) Tides are pretty reliable in the sense that they happen twice a day without fail, and always near to the predicted height. The only drawback is that the height of the tide is variable so lower (neap) tides will provide significantly less energy than the bigger (spring) tides. They also don't work when the water level is the same either side of the barrage — this happens four times a day because of the tides.
- 6) Initial costs are moderately high, but there are no fuel costs and minimal running costs. Even though it can only be used in some of the most suitable estuaries tidal power has the potential for generating a significant amount of energy.

Wave and tidal — power from the motion of the ocean...

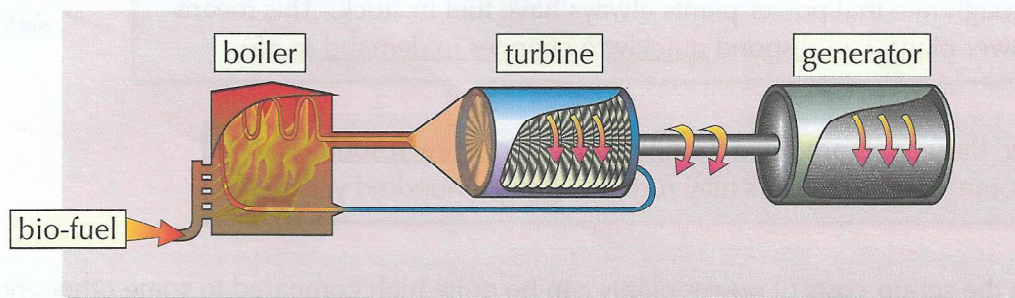
The first large-scale tidal barrages started being built in the 1960s, so tidal power isn't a new thing. Wave power is still pretty experimental though. Make sure you know the differences in how they work.

Bio-fuels

And the energy resources just keep on coming. It's over soon, I promise. Just a few more to go.

Bio-fuels are Made from Plants and Waste

Bio-fuels are renewable energy resources created from either plant products or animal dung. They can be solid, liquid or gas and can be burnt to produce electricity or run cars in the same way as fossil fuels.



They have Pros...

- 1) They are supposedly carbon neutral, although there is some debate about this as it's only really true if you keep growing plants at the rate that you're burning things.
- 2) Bio-fuels are fairly reliable, as crops take a relatively short time to grow and different crops can be grown all year round. However, they cannot respond to immediate energy demands. To combat this, bio-fuels are continuously produced and stored for when they are needed.

... and Cons

- 1) The cost to refine bio-fuels so they are suitable for use is very high.
- 2) Some people worry that growing crops specifically for bio-fuels will mean there isn't enough space or water to meet the demands for crops that are grown for food.
- 3) In some regions, large areas of forest have been cleared to make room to grow bio-fuels, resulting in lots of species losing their natural habitats. The decay and burning of this vegetation also increases carbon dioxide (CO_2) and methane emissions.



In theory, bio-fuels are carbon neutral...

Stuff you've learnt in biology may help you get your head around this one. When plants grow, they absorb CO_2 from the atmosphere for photosynthesis, but when you burn bio-fuels, you release CO_2 into the atmosphere. A bio-fuel is 'carbon neutral' if the amount of CO_2 released by burning it is equal to the amount absorbed by the plants you grow to make the bio-fuel.

Non-Renewable Resources

Renewable resources may sound like great news for the environment. But when it comes down to it, they don't currently meet all our needs so we still need those nasty, polluting non-renewables.

Non-Renewables are Reliable...

1) Fossil fuels and nuclear energy are reliable. There's enough fossil and nuclear fuels to meet current demand, and they are extracted from the Earth at a fast enough rate that power plants always have fuel in stock. This means that the power plants can respond quickly to changes in demand (p.55).

Nuclear power plants use fission to produce electricity (p.84).

2) However, these fuels are slowly running out. If no new resources are found, some fossil fuel stocks may run out within a hundred years.

3) While the set-up costs of power plants can be quite high compared to some other energy resources, the running costs aren't that expensive. Combined with fairly low fuel extraction costs, using fossil fuels is a cost effective way to produce energy (which is why it's so popular).

...But Create Environmental Problems

1) Coal, oil and gas release carbon dioxide (CO₂) into the atmosphere when they're burned. All this CO₂ adds to the greenhouse effect, and contributes to global warming.

2) Burning coal and oil also releases sulfur dioxide, which causes acid rain — which can be harmful to trees and soils and can have far-reaching effects in ecosystems.

3) Acid rain can be reduced by taking the sulfur out before the fuel is burned, or cleaning up the emissions.

4) Views can be spoilt by fossil fuel power plants, and coal mining makes a mess of the landscape, especially "open-cast mining".

5) Oil spillages cause serious environmental problems, affecting mammals and birds that live in and around the sea. We try to avoid them, but they'll always happen.

6) Nuclear power is clean but the nuclear waste is very dangerous and difficult to dispose of.

7) Nuclear fuel (e.g. uranium or plutonium) is relatively cheap but the overall cost of nuclear power is high due to the cost of the power plant and final decommissioning.

8) Nuclear power always carries the risk of a major catastrophe like the Fukushima disaster in Japan.



Radiation can be very dangerous to humans — see p.83 for more.

Currently we Depend on Fossil Fuels

1) Over the 20th century, the electricity use of the UK hugely increased as the population grew and people began to use electricity for more and more things.

2) Since the beginning of the 21st century, electricity use in the UK has been decreasing (slowly), as we get better at making appliances more efficient (p.28) and become more careful with energy use in our homes.

3) Most of our electricity is produced using fossil fuels (mostly coal and gas) and from nuclear power.

4) Generating electricity isn't the only reason we burn fossil fuels — oil (diesel and petrol) is used to fuel cars, and gas is used to heat homes and cook food.

Trends in Energy Resource Use

Non-renewables may be what we rely on for the vast majority of our energy needs at the moment. But the balance may soon start shifting...

The Aim is to Increase Renewable Energy Use

We are trying to increase our use of renewable energy resources (the UK aims to use renewable resources to provide 15% of its total yearly energy by 2020).

This move towards renewable energy resources has been triggered by many things:

- 1) We now know that burning fossil fuels is very damaging to the environment (see last page). This makes many people want to use more renewable energy resources that affect the environment less.
- 2) People and governments are also becoming increasingly aware that non-renewables will run out one day. Many people think it's better to learn to get by without non-renewables before this happens.
- 3) Pressure from other countries and the public has meant that governments have begun to introduce targets for using renewable resources. This in turn puts pressure on energy providers to build new power plants that use renewable resources to make sure they do not lose business and money.
- 4) Car companies have also been affected by this change in attitude towards the environment. Electric cars and hybrids (cars powered by two fuels, e.g. petrol and electricity) are already on the market and their popularity is increasing.

It's Not That Straightforward Though

The use of renewables is limited by reliability, money and politics.

- 1) There's lots of scientific evidence supporting renewables, but although scientists can give advice, they don't have the power to make people, companies or governments change their behaviour.
- 2) Building new renewable power plants costs money, so some energy providers are reluctant to do this, especially when fossil fuels are so cost effective. The cost of switching to renewable power will have to be paid, either by customers in their bills, or through government and taxes. Some people don't want to or can't afford to pay, and there are arguments about whether it's ethical to make them.
- 3) Even if new power plants are built, there are arguments over where to put them. E.g. many people don't want to live next to a wind farm, causing protests. There are arguments over whether it's ethical to make people put up with wind farms built next to them when they may not agree with them.
- 4) Some energy resources like wind power are not as reliable as traditional fossil fuels, whilst others cannot increase their power output on demand. This would mean either having to use a combination of different power plants (which would be expensive) or researching ways to improve reliability.
- 5) Research on improving the reliability and cost of renewables takes time and money — it may be years before improvements are made, even with funding. Until then, we need non-renewable power.
- 6) Making personal changes can also be quite expensive. Hybrid cars are generally more expensive than equivalent petrol cars and things like solar panels for your home are still quite pricey. The cost of these things is slowly going down, but they are still not an option for many people.