



CURRICULUM LINKS

TCH 2-02B: I can investigate the use and development of renewable and sustainable energy to gain an awareness of their growing importance in Scotland or beyond.

SCN 2-09A: I have used a range of electrical components to help to make a variety of circuits for differing purposes. I can represent my circuit using symbols and describe the transfer of energy around the circuit.

SCN 3-04B: By investigating renewable energy sources and taking part in practical activities to harness them, I can discuss their benefits and potential problems.

TIME

Ideal: 3 x 1 hour
Minimum: 1 hour

QUICK LINKS

Refer to Quick links sheet on DVD

RESOURCES

Reward map
Photocard 21
Activity Sheet 5

Student Investigation 3

Renewable Energy Sheets

Calculator with solar panel

15 x small solar panels; 15 x LEDs, 30 x wires; Battery

Technologies unit 'Building an Eco-home'

KEYWORDS:

Energy
Fossil fuels
Renewable energy
Solar power
Wind power
Hydropower
Tidal power
Wave power
Geothermal power
Biomass
Photovoltaic
Circuit
LED

OBJECTIVES

Most pupils will:

- identify the five sources of renewable energy;
- identify the two types of solar energy: heat and light;
- successfully build a circuit using a solar panel.

PRE-UNIT KNOWLEDGE

Understanding from Unit 2 that most of the UK's energy comes from fossil fuels but these will run out eventually.

STIMULUS

Ask pupils to imagine when they have felt the power of the earth: wind, sun, water, e.g. swimming at the beach, standing in the sunshine, flying a kite. Explain that there are ways of capturing this power to make energy. Use [Quick link 4.1](#) to explore renewable and non-renewable energy sources. Follow with the advantages and disadvantages activity.

What is energy (recap)?

What forms of non-renewable energy did we learn about? Coal, oil, gas, nuclear

What forms of renewable energy did we learn about? Wind, solar, hydro, tidal, wave, geothermal and biomass

Why are renewable energy sources better for the environment? They produce no pollution or carbon dioxide (or very little); the sources will not run out like fossil fuels; the capture of the energy is less harmful to the area where it is collected.



“ When making solar circuits, if your school has buzzers then use these as well as the LED bulbs. The varying sound levels are very good at demonstrating the effect of changing the amount of light on the panel. They love the noise, too! ”

Activity 1: What are some of the advantages and disadvantages of renewable energy sources?

Using the Renewable Energy Fact Sheets explore the different forms of renewable energy in groups. The groups could report back to the rest of the class on what they have found or make posters to educate the rest of the school. Follow this with a role-play discussion of a wind farm proposal: use Photocard 21 of a wind farm in the UK, setting the scene of a town council meeting where the proposal of a wind farm in their town is being discussed. Next, read the Newsround article at [Quick link 4.2](#). Assign roles to groups of pupils and hold a Town Council Meeting about whether they should build a wind farm or not. Suggested roles: town mayor, council members proposing the wind farm, farmers whose land it is near, local residents, business owners, environmental campaigners, newspaper journalists. Students could also investigate the first solar town in the UK - Wadebridge.

Activity 2: Building a solar circuit

Explain that there are two types of solar power: solar thermal energy (from heat) and solar electricity (from light). **What do we use to turn sunlight into electricity?** *Solar panels.* The technical name is Photovoltaic, PV for short. **Is there a solar panel in this room?** *Show them the solar powered calculator.* **Where does it get its power from?** *Demonstrate holding your finger over the panels in order to turn off the display.*

Recap how to make a circuit. **Where is the power coming from?** *Battery.* Remind pupils about its positive and negative ends. Demonstrate making a simple circuit and recap drawing with symbols. Discuss safety for electricity.

Show pupils the small panels. **What could it power?** *Size matters: a bigger panel = more electricity.* Show pupils the bulb and explain it is an LED, which stands for Light Emitting Diode, and it needs very little power. **How can we make this LED bulb light up with this panel?** *The panel is like a battery, providing power.* It also has positive and negative wires so they must take care to attach the bulb correctly. In pairs, ask pupils to make a circuit using Activity Sheet 5. Depending on the weather, test it outside in sunlight or underneath a lamp.

Plenary

Recap why alternative energy sources are needed and list some key advantages and disadvantages. Consider the average householder: **if solar panels are too expensive to install, what can be done instead?** e.g. switch provider/tariff to one which supports renewable energy production in the UK. Ideally, extend this with the practical D&T unit 'Building an Eco-home'.

NOW LET'S TAKE SOME ACTION!

Allow pupils to select an action from below. When it is completed they should colour in one of the continents on their reward map.

Sunny As a whole class, write a shared persuasive letter to the school council or Head teacher, lobbying for renewable energy use at school. Use Student investigation 3 to help your research.

Sunnier Try the fun 'Solar Cooking' activity on your DVD to explore the power of solar heat. Can you successfully melt some chocolate?

Sunniest Scenario: if your school was given £3,000 to become a greener school, how would you spend the money?



Schools with solar panels

Use the Solar Schools Supplement on your DVD to investigate your school's own electricity generation.

Energy use

Nearly 70% of our electricity comes from power stations which burn fossil fuels. This puts a lot of carbon dioxide into the air so we need to think carefully about how we use electricity. The less electricity we all use the more we can reduce our carbon footprint and help the planet.

Electrical appliances like TVs and computers use power which is measured in watts. When the number of watts gets bigger we use kilowatts instead: 1000 watts = 1 kilowatt.

Use the table below to work out how much energy is used per day and per year by different appliances. You will need to fill out how many hours you use them. The first two have been done for you.

Appliance	Power needs	Hours used per day	Energy used per day in watt-hours	Energy used per year in kilowatt-hours (kWh)
Washing machine	500 watts	1 hour	$500 \times 1 = 500$ watt-hours	$(500 \times 365) \div 1000 = 182.5$ kWh
TV	150 watts	3 hours	$150 \times 3 = 450$ watt-hours	$(300 \times 365) \div 1000 = \underline{\hspace{2cm}}$ kWh
Computer	225 watts			
Games console	175 watts			
Fridge	400 watts			

On average, 1kWh of energy costs 15p. So how much does it cost per year to run the washing machine?

$$182.5 \times 15\text{p} = 2738\text{p} = \text{£}27.38$$

How much does it cost per year to run the computer in your house?

$$\underline{\hspace{2cm}} \times 15\text{p} = \underline{\hspace{2cm}}\text{p} = \text{£}\underline{\hspace{2cm}}$$

How much does it cost to run the games console and the computer altogether?

And how much does it cost per year to run the fridge?

Extension: How much money would you save in a year if you used the TV for 2 hours a day instead of 3?

Stop Stand-by!

You may notice on some appliances we use, like TVs and stereos, that when you switch them off they have a little red or orange light shining. This is because the appliance is on **stand-by** and has not been **switched off properly**. This means it is still using energy. **What a waste!**

So let's work out how much energy we are wasting when we leave things on stand-by.

Use the table below to work out how much would be wasted if the item was left on stand-by for one day and one year, without being used. The first two have been done for you.

Appliance	Power used on stand-by	Energy wasted in one day (24 hours) in watt-hours	Energy wasted in one year (365 days) in kilowatt-hours (kWh)
TV	10 watts	$10 \times 24 = 240$ watt-hours	$(240 \times 365) \div 1000 = 87.6$ kWh
Games console	3 watts	$3 \times 24 = 72$ watt-hours	$(72 \times 365) \div 1000 = \underline{\hspace{2cm}}$ kWh
Computer	7 watts		
Stereo	10 watts		
Mobile phone charger	1 watt		

We know 1kWh of energy costs 15p. So how much money are we wasting by keeping things on stand-by? Let's work out how much it costs per year to leave a TV on stand-by:

$$87.6 \times 15\text{p} = 1314\text{p} = \text{£}13.14$$

*Wow, so we could save £13.14 a year
JUST by switching the TV off at the wall.*

But we're not just worried about the cost, we also need to think about carbon dioxide. On average, using fossil fuels to make 1kWh of energy creates 0.5kg of carbon dioxide.

Let's work out how much carbon dioxide is created by keeping a TV on stand-by for a year:

$$87.6 \times 0.5\text{kg} = 43.8\text{kg}$$

So how much carbon dioxide is created by leaving a computer on stand-by for a year?

$$\underline{\hspace{2cm}} \times 0.5\text{kg} = \underline{\hspace{2cm}}\text{kg}$$

And how much carbon dioxide is created by leaving a games console on stand-by for a year?

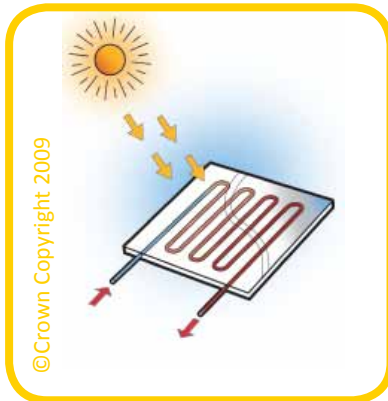
Brain teaser: How much carbon dioxide would you save if you switched off at the wall all of the appliances listed in the table?

SOLAR ENERGY



SOLAR ENERGY

Solar energy is energy from sunlight. Sunlight helps all living things grow and makes it possible for plants, animals and people to live on Earth. Solar energy is a type of renewable energy; it will never run out. It is not like fossil fuels such as coal, oil and natural gas, which are called non-renewable energy.

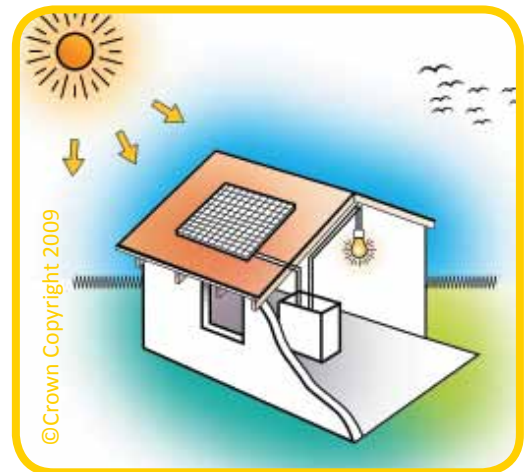


Solar heating

The sun's heat is used to warm water for washing and heating. The cold water is pumped into the solar collector on the roof where the sun warms it up. It is then pumped back down into the building where it is stored in a tank so the hot water can be used when it is needed.

Solar electricity

Solar Photovoltaic (PV) panels collect solar energy and convert it into electricity. The PV cells can be linked to a rechargeable battery which collects energy in the day to be used at any time, even at night when there is no sun.



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 Spain or Australia, there are large 'farms' of solar panels which can generate enough energy for a whole town. However, there are quite a lot of people in the UK who have small solar panels on their roofs to create electricity for their home.

Advantages of solar power	Disadvantages of solar power
<ul style="list-style-type: none">• The sun gives out 'free' power all the time.• It is silent, causes no pollution and does not harm wildlife.• PV panels are low maintenance because there are no moving parts to service and can be installed easily because there are hardly any wires.• It is useful in remote places, and works on a small or large scale.	<ul style="list-style-type: none">• Solar power does not work at night so electricity needs to be stored.• At the moment, PV cells are expensive (but getting cheaper).• Solar panels do not work as well in countries which do not have a lot of sunlight every day.

WIND ENERGY

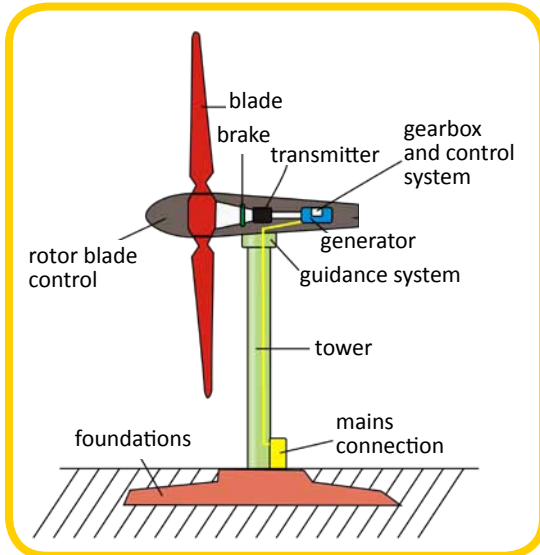
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WIND ENERGY

Wind power is one of the cleanest and safest of all the renewable methods of generating electricity. Humans have used wind energy to power machinery in windmills for hundreds of years.



The force of the wind turns the blades of the wind turbine which turn a motor inside. As the motor turns it powers a generator which produces electricity. Each large wind turbine can power 3000 households. Wind turbines can be built on land and in the sea (offshore).

Wind energy already supplies electricity for 5.4 million households in the UK, with 436 current wind farms and this figure is growing as more are constructed.

The first offshore wind farm in the UK was built in 2000. They are more expensive than land wind farms but contain much larger wind turbines which generate more power. The wind at sea also blows more steadily than on land.

Advantages of wind energy:	Disadvantages of wind energy:
<ul style="list-style-type: none">• 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.• Overall wind energy projects are simple, clean and cheap to maintain. Jobs are often created both in the short and long term in the building and maintenance of the turbines.	<ul style="list-style-type: none">• 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 not everyone agrees.

Source: BIS

GEOTHERMAL ENERGY

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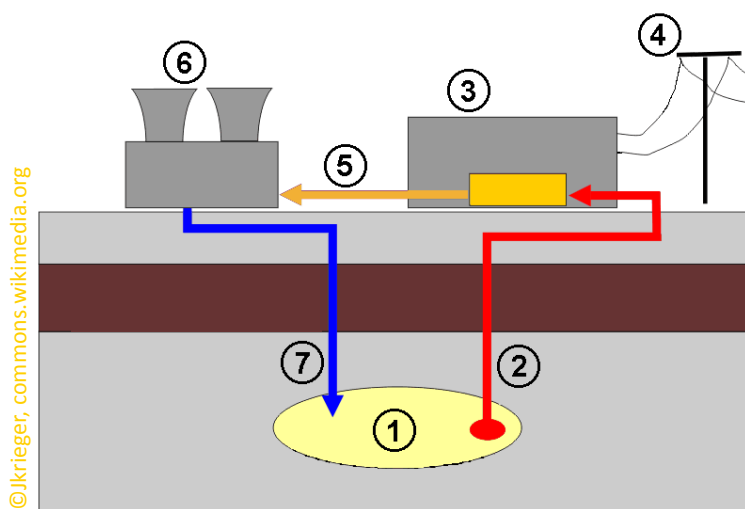
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GEO THERMAL ENERGY

There is a huge amount of heat at the earth's core which can be found by digging down towards the centre. We call the earth's natural heat geothermal energy ('geo' means earth and 'thermal' means heat). Water heated by geothermal energy can be used for heating or for generating electricity.

Humans have used geothermal energy for thousands of years, using hot springs initially for cooking and building reservoirs around springs to create shrines and bathing complexes such as those built at Bath by the Romans.



1. Hot water reservoir
2. Hot water pumped up from the earth
3. Electrical power generation (with generator)
4. The generated electricity is fed into the national grid
5. The rest of the hot water can be used for heating purposes
6. Thermal energy can be reused
7. Cold water is fed back to the cycle to be reheated by the earth

There are two main ways of using geothermal energy. In some areas of the world, such as Iceland, naturally heated underground water rises to the surface as steam or hot springs. In other areas we drill holes to get to it.



Hot springs in Iceland

There are not many places that can currently use geothermal energy in an efficient way. There are geothermal power stations in the USA, New Zealand and Iceland. In Southampton (UK) there is a district heating scheme based on geothermal energy.

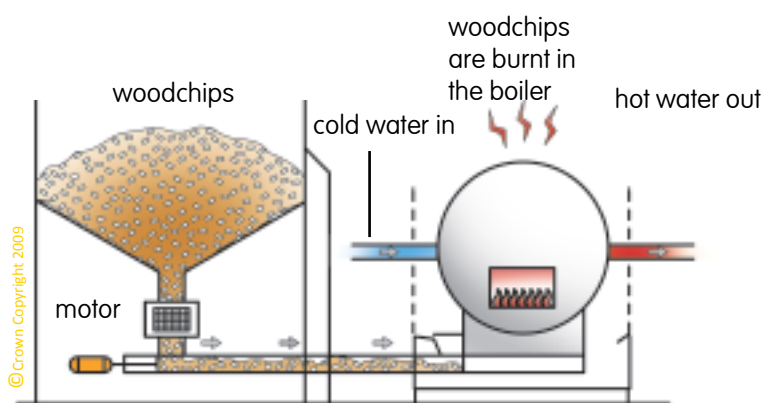
Advantages of geothermal energy	Disdvantages of geothermal energy
<ul style="list-style-type: none">• Geothermal power plants produce renewable energy. No fuel is used• There is very little pollution.• Geothermal energy is quiet, and much of the technology needed is hidden underground.	<ul style="list-style-type: none">• It can only be used in some areas around the world, where the earth's crust is thin.• Sometimes the hot water that is pumped to the surface contains pollutants such as sulphur.

BIOMASS



BIOMASS

Biomass is plant and animal matter such as straw, sewage, waste food and wood chips. We can burn these natural materials to produce heat and electricity. This is called biomass energy. We can also use them to create fuel called biodiesel which we can use in vehicles instead of petrol and diesel.



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.

Trees grown specifically for fuel are felled, cut into wood chips and dried. In order not to increase the amount of carbon dioxide in the atmosphere it is important that more trees are planted.

Landfill

Some of our 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 can be collected and used as a fuel to heat water and make steam. This turns a generator which makes electricity.



The UK produces 228 million tonnes of waste every year. Only 11% of the UK's waste is used to make electricity at the moment.

Advantages of Biomass	Disadvantages of Biomass
<ul style="list-style-type: none">• It does not use up limited resources such as coal.• 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.	<ul style="list-style-type: none">• Waste materials have to be collected, which can be costly and cause pollution.• Burning fuels does cause some air pollution.• Growing crops to use for biomass takes up a lot of land, which could otherwise be used to grow food, and requires a lot of local water. It also decreases biodiversity through loss of habitat.

HYDRO POWER

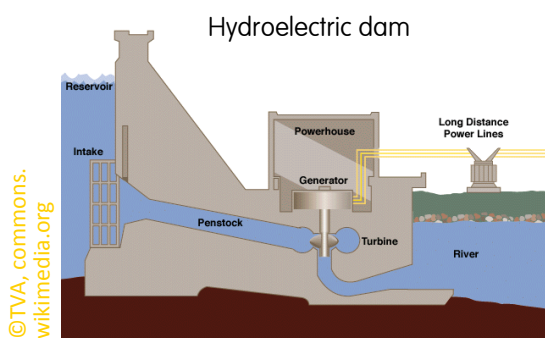
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HYDROPOWER

Hydropower means energy from moving water. Electricity can be generated using three sources of moving water: waves, tides and rivers.



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There are 200 hydroelectric power plants in the UK.

Hydroelectric energy is electricity generated by building dams across rivers which force water to turn generators.

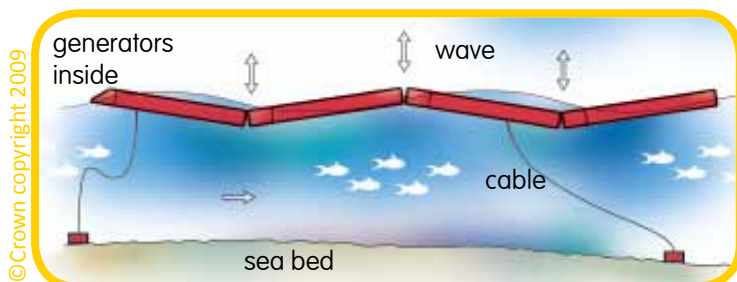
Dams can be built in mountainous areas where there are fast-flowing rivers. On flatter land rivers flow more slowly so large artificial dams have to be built to create reservoirs.

Advantages of hydroelectric energy	Disadvantages of hydroelectric energy
<ul style="list-style-type: none"> • It is renewable because rain keeps falling and rivers flow continually. • It is reliable because the water can be stored until it is needed. • It creates no pollution. • Once built, the supply of electricity is relatively cheap. 	<ul style="list-style-type: none"> • Dams are very expensive to build. • There are few good sites and land for homes may be lost when they are built. • Wildlife habitats can be lost when land is flooded to make reservoirs. River life can also be affected by dams.

Source: BIS

Wave and tidal energy are both still undeveloped. At the moment, there are no tidal energy projects that generate electricity in the UK. In fact, there are only 40 sites across the World that are suitable for large tidal barrages.

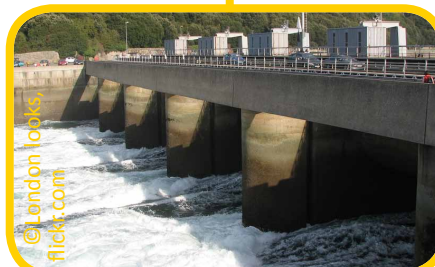
There are only two wave generators in the UK, one in Scotland (Pelamis) and one in Cornwall (Wavehub). It is a renewable source as waves will not run out but it is not always reliable because sometimes the waves are too big or too small to generate electricity. The UK has a big coastline so there is potential to expand wave power.



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The Pelamis wave machine is 120 metres long and made up of four large tubes which move up and down with the motion of the waves.

A tidal barrage is a giant dam built across a river or a bay on the coast. As the tide comes in or out water rushes through, turning a generator to create electricity.



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Research question 1: What is renewable energy?

Use the websites listed to help you find the information you need. There is a lot of information written on these pages – you will need to read and then summarise what you have found out.

Supporting inquiry 1a: Give 3 reasons why we should use renewable energy?

<http://tiny.cc/avtmyw>

Supporting inquiry 1b: Name the 5 main types of renewable energy and their sources.

E.g. Hydropower – the movement of water (powered by the tides, by the waves or dams)

<http://tiny.cc/cytmyw>

Supporting inquiry 1c: Name one advantage and one disadvantage for each of the forms of renewable energy.

<http://tiny.cc/nztmyw>

Research question 2: What is the future of renewable energy in the UK?

Use the websites listed to help you find the information you need. There is a lot of information written on these pages – you will need to read and then summarise what you have found out.

Supporting inquiry 2a: What percentage of the energy we use in the UK comes from renewable sources?

<http://tiny.cc/ywkv6>

Supporting inquiry 2b: How can we encourage the government to increase the amount of renewable energy produced in the UK?

Use the following website to help you find out who your local MP is: <http://tiny.cc/2urtl>

Now write a letter to your MP, explaining why you think they should encourage the government to increase the amount of renewable energy produced in this country.