EDF renewables

All about energy

A fun way to learn about renewable energy for 12-14 year olds!

www.edf-re.uk

Electricity

Why did the man eat the light bulb?
He was hoping it would give him a bright idea
(Don't do this at home folks!)

We use electricity every day, but how often do we think about where it comes from and how it gets to our houses and schools?

1879
First electric light bulb made commercially available.

1881
First public electricity supply powered by a water mill. It could power 400 houses.

1887
Electricity produced by wind turbines for the first time.

1918
By the end of the First World War, a few people had fridges and washing machines.

Challenge

Time yourself for 1 minute – how many electrical items in your home can you name?

100 years ago you might have had nothing on your list at all. It took a long time for electricity to be provided in the way that we are familiar with today.

The Grid Network

Electricity is made from fossil fuels of coal, oil and gas, low carbon uranium (nuclear) and renewable sources like wind, sunlight and water. Electricity is distributed around the UK using the Grid Network. This is a system of cables and equipment that link where power is generated, like a wind or solar farm, to streets, homes and buildings.

Measuring power

Power is measured in watts (W). A kilowatt (kW) is 1,000 watts. A Megawatt (MW) is 1,000 kilowatts. Megawatts can be used to measure the output of a power plant.

The energy mix

The energy mix is the combination of sources used to provide enough energy, and fulfilling energy demand requires a careful balancing of supply. More electricity is needed at peak times, while less is needed at night. One of the most important issues facing any country is the challenge of securing access to reliable energy resources that are sufficient to run its economy, feed and house its people.

Challenge

How much electricity is being used in the UK?

Visit the National Grid website **extranet.nationalgrid.com/RealTime**

Click 'Current Electricity Demand' to see how much electricity is being used now. Now click 'Demand Last 24 Hours'. You can see the peak time and when less electricity was needed.

Why is there more demand at peak times? How could the time of year make a difference?

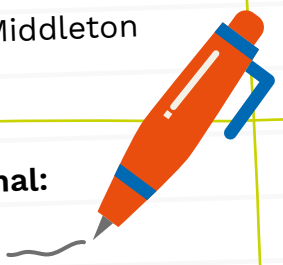
The highest demand for electricity in the UK was in 2005. In 2019 supply was 19% lower than in 2005. This is because of energy efficiency, economic and weather factors.

The National Grid plan carefully for spikes in demand, looking at weather forecasts and historical data, even what's coming up on TV. At the end of a popular TV programme, there is often a spike in demand for electricity as people stop watching and do something else, like make a cup of tea. This is called a **TV pick up**.

Challenge

Which of these TV pick ups in the UK used the most electricity? Draw lines to the correct boxes.

Programme	Extra power needed at the end in megawatts (MW)
EastEnders 'Who Shot Phil?' episode 5 April 2001	2,800 MW equivalent to 1,120,000 kettles boiled
Royal Wedding of Prince William and Kate Middleton 29 April 2011	2,290 MW equivalent to 916,000 kettles boiled
Football World Cup Semi Final: England v West Germany 4 July 1990	1,600 MW equivalent to 640,000 kettles boiled



It is also important to plan for the future. The UK needs to reduce greenhouse gases by huge amounts by 2050. **Future Energy Scenarios** study different reasons why we might need to use power and different ways we could get power in the next 30 years. This is important for decisions about where to invest and what research needs to be carried out.

During the 2020 coronavirus lockdown there was often a spike in demand on Thursday evenings after the clap for carers as everybody came back indoors.

Renewable energy

Renewable energy comes from natural sources such as wind, sun, waves and tides. These sources of energy will never run out, the renewable energy sector is growing as demand increases. Technology is being improved, making the electricity cheaper to produce. In 2021 renewable energy accounted for 39.7% of the UK's electricity mix.

WIND POWER

Wind has been used as an energy source for thousands of years to propel boats, pump water and grind grain.

Wind turbines use energy in wind to generate electricity. They don't emit carbon or produce pollution. Bigger turbines generate more electricity.

WIND TURBINES

Wind turbines start operating at wind speeds of around 10 miles per hour and reach maximum power output at around 30 miles per hour. At very high wind speeds of over 50 miles per hour wind turbines shut down.

Why are wind farms often on hills?

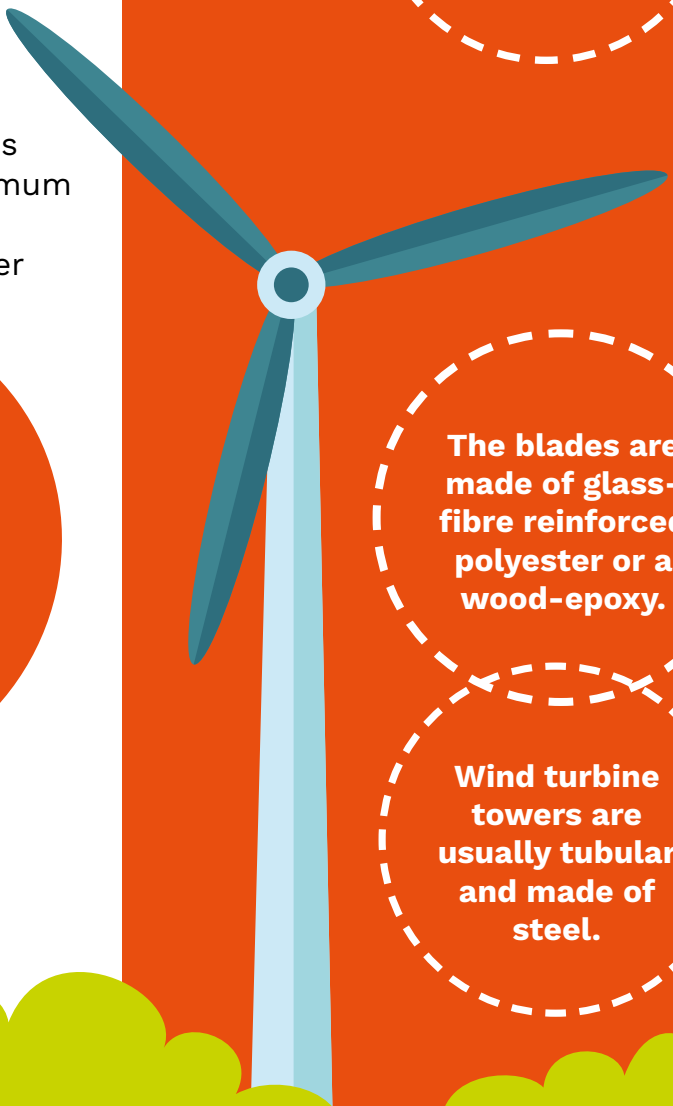
Because the higher you go, the greater the wind speed, which generates more electricity. That's why the turbine and the blades sit on a tall tower, too!

OFFSHORE AND ONSHORE

Wind turbines are operating in the sea and on land. Offshore wind farms can be larger as there is more space. In 2022 the largest onshore wind farm in the UK is Whitelee, in Scotland at 539 MW; the largest offshore wind farm is Hornsea 2 at 1,300 MW.

They are light grey, as this colour is least noticeable.

They are matt, not shiny, to reduce reflected light.



The blades are made of glass-fibre reinforced polyester or a wood-epoxy.

Wind turbine towers are usually tubular and made of steel.

Wind turbines

Turbine blades must point into the wind to work. Each blade of the wind turbine is angled to make it spin round.

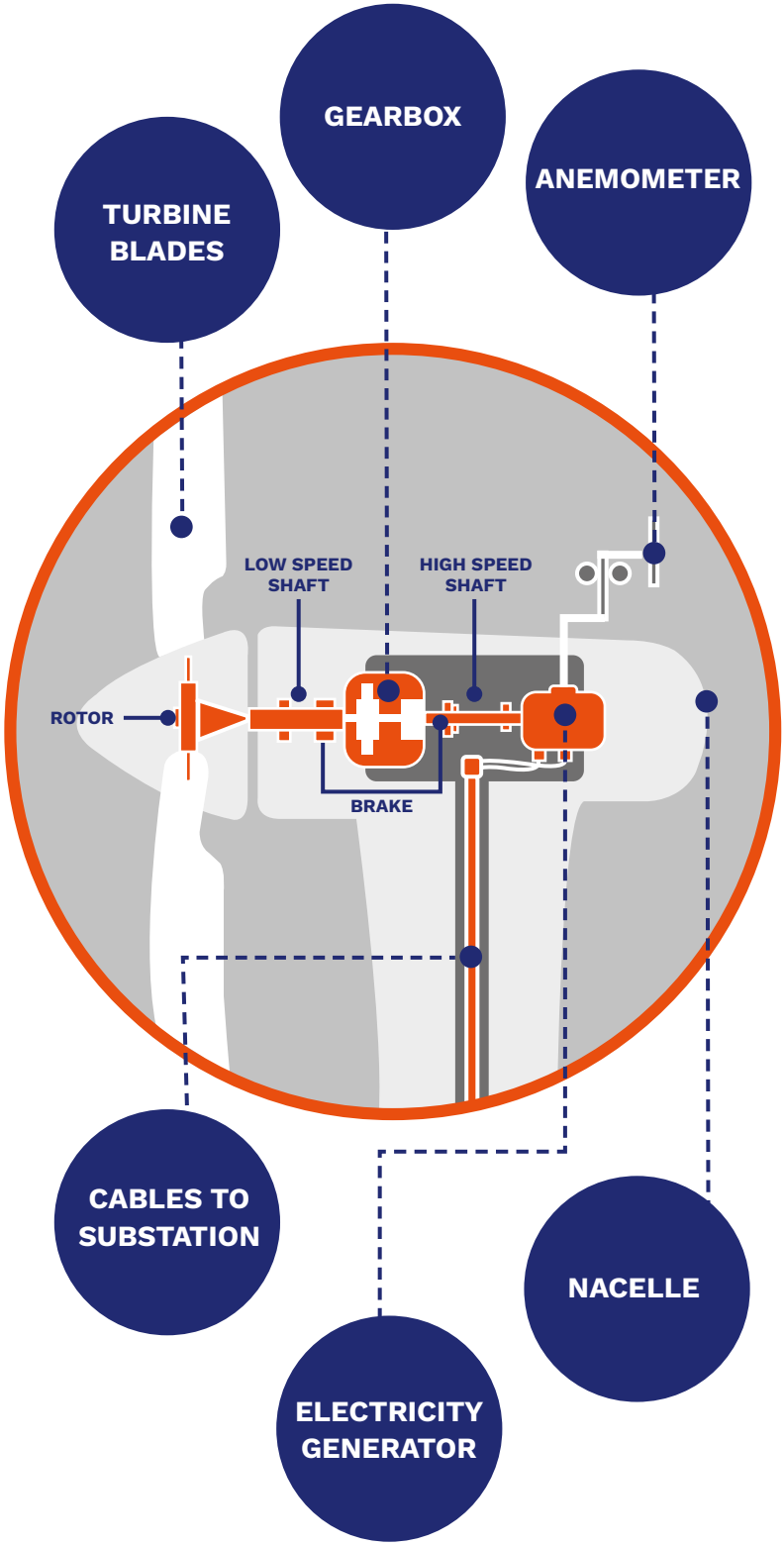
The **nacelle** is the case for the workings, when the wind direction alters, the nacelle rotates so that the blades face into the wind to maximise the energy captured.

The **anemometer** measures the wind speed, so that the turbine can brake to stop it going too fast.

The high-speed shaft in the generator needs to turn over 1,000 revolutions per minute. This is too fast for the blades of a wind turbine so the shaft going into the front of the **gearbox** turns at low speed and the shaft at the back turns much faster.

The shaft coming out of the gearbox is connected to the **electricity generator**. This converts mechanical energy into electrical energy.

Electrical energy is transmitted along **cables** to a **substation** where it is converted to a high voltage, before being delivered to homes and businesses.



How does a wind turbine actually work?

The wind turns the blades of the turbine, which is connected to a generator.

Challenge

Study the diagram above for one minute. Now cover it and draw it on another piece of paper. How much could you remember?

Other renewable energy sources

We need to start investing more in solar energy ... but it's not going to happen overnight!

The strongest ever winds in the UK have been recorded on mountains, and the strongest ever gust was 150.3 knots (173 mph) recorded at Cairngorm Summit on 20 March 1986.

SOLAR ENERGY

Photovoltaic (PV) cells in solar panels convert the sun's energy into electricity. They contain special chemicals which produce electricity when sunlight touches them. Panels can be fixed to roofs or mounted on the ground as a solar farm.

WAVE

Ocean waves are produced by wind blowing across the sea's surface. The movement of the waves is used to generate electricity. Generators convert the up and down movement of waves (kinetic energy) into electrical energy.

In 2000 the first commercial wave power station opened in Scotland, able to power 400 homes.

HYDROPOWER

Hydropower is one of the oldest and most reliable renewable power sources. Hydroelectric dams store water in higher ground behind dams. When water is released, it rushes down through pipes, turning turbines and producing electricity. Water can be released at almost any time to provide energy when there is peak demand, and this means that hydroelectric dams act as a store.

NUCLEAR POWER

Although it is not a renewable resource, nuclear power emits relatively low amounts of CO_2, so it's a low carbon energy source.

CASE STUDY

William Kamkwamba, from Malawi in Africa had no electricity in his home. When he was 14, he built a wind turbine from spare parts and scrap, using plans in a library book. The windmill powered four lights and two radios in his family home.

His story was turned into a film called 'The Boy Who Harnessed The Wind'.

Load factor

Wind and solar are variable power sources, meaning they do not produce electricity all the time. Solar will not produce electricity at night, and wind will not produce energy if there is no wind or too much wind.

The load factor compares the *actual* power generated, with the power that could have been generated if it ran on full power all the time. A wind turbine produces electricity 70% to 85% of the time, but it generates different outputs depending on wind speed.

For example, a five-megawatt (5 MW) wind turbine could produce 5 MW of power if it ran at full power all the time. It might only produce an average of 2 MW because sometimes it wasn't turning, and sometimes the wind wasn't very strong.

To work out the load factor:
2 (what it actually produced) divided by 5 (what it could produce) 2 ÷ 5 = 0.40
0.40 is the same as 40%.
The load factor for this turbine is 40%.

Challenge

WORK OUT THESE LOAD FACTORS

1. A 10 MW turbine that produced an average of 4 MW of power over a year.
2. A 7 MW turbine that produced an average of 3 MW of power over a year.
3. A 3 MW turbine that produced an average of 1 MW of power over a year.

Which is the most efficient turbine?

Challenge

Below are some statements about renewable energy sources. Show the **advantages (A)** and **disadvantages (D)**, by writing A or D next to them.

WIND TURBINE

- A variable power source. If there is no wind, there is no power. ____
- Once a turbine is built, running costs are low. ____
- Wind won't run out. ____

HYDROPOWER

- Less variable than wind or solar. ____
- Building a large dam will flood a very large area upstream, causing problems for wildlife and people. ____
- Act as electricity storage and turned on for a spike in demand. ____

SOLAR POWER

- Low cost. ____
- Easy to build. ____
- Doesn't generate at night. ____

What other advantages and disadvantages can you think of?

New Technologies

Scientists are continually working to improve renewable energy and how we use it.

Hydrogen is a gas, but it's mostly found in other substances, so it needs to be separated from them to be useful. It is used for making steel and cement, fertilizers and cleaning products, but it is usually separated using electricity from fossil fuels.

GREEN HYDROGEN

Water contains hydrogen and oxygen (H_2O). It is possible to separate water into hydrogen and oxygen in an electrolyser, using electricity from onshore wind, offshore wind or solar. This is called green hydrogen.

The hydrogen is stored in a hydrogen fuel cell, which produces electricity, without emitting any greenhouse gases. Projects are already being developed across the world to use green hydrogen, and in the future, fuel cells will be used in manufacturing, public transport, aviation and shipping.

Challenge

MATCH THE COLOUR HYDROGEN TO THE DEFINITION

Grey hydrogen **Blue** hydrogen

Green hydrogen

a This hydrogen is separated using renewable energy.

b Methane or coal is used to separate this hydrogen, and most of the carbon released is captured and stored underground.

c The most common way of separating hydrogen, using natural gas or methane.

The first hydrogen fuel cells were invented in 1839

BATTERY ENERGY STORAGE

Electricity from renewable energy sources can only be produced when the wind is blowing or the sun is shining. Due to this variability in supply, the electricity being generated on a very windy or sunny day, may not be required, because the demand isn't high enough. Storing this electricity means that it won't go to waste.

When there is high demand this electricity can be released into the national grid and distributed to where it is needed.

Batteries also help balance the electricity grid, so that when there is more demand for electricity - such as at the advert break in a popular TV show when people across the UK turn their kettles on - the extra electricity can be drawn from stored sources.

Smaller battery storage is available for homes with solar panels, so people save more money on energy bills.

Offshore wind farms

What did one raindrop say to the other?
Two's company, three's a cloud.

Wind farms that are on the land are called onshore wind farms. Wind turbines can also be out at sea, and these are called offshore wind farms.

It is windier out at sea which means there is a greater energy resource to be captured.

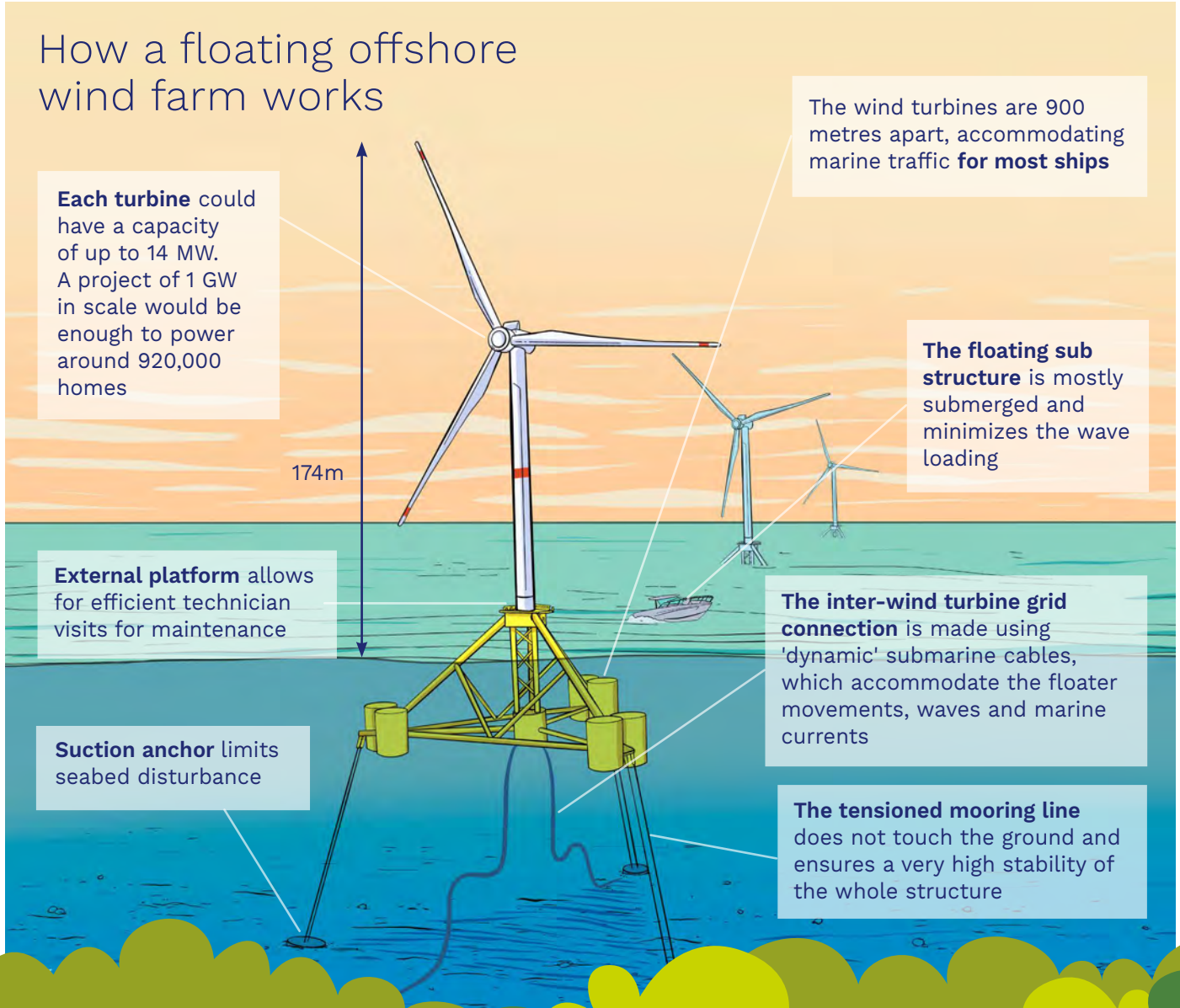
Turbines out at sea can also be bigger. The bigger the turbine is, the more electricity it can generate.

The UK Government has a target to increase the amount of electricity generated by offshore wind farms to 50 GW by 2030. At the moment, the capacity stands at around 8.4 GW.

Closer to shore, where the sea is shallower, the wind turbines are fixed to a foundation on the seabed. Newer, **floating offshore** wind technology is now being developed so that wind turbines can be located further out at sea where the water is much deeper. Floating wind turbines are positioned on a floating platform that is tethered to the seabed using strong cables.

The UK is leading the way in the development of this new technology.

How a floating offshore wind farm works



What is climate change?

Climate change is the long-term difference in average weather patterns across the world. The world is getting warmer, but why is this?

The Industrial Revolution began in the 18th century. People started manufacturing on a large scale, powering factories by burning coal, oil and gas. Today, we call these **fossil fuels**. What they didn't know then was that the burning of fossil fuels and the resulting release of carbon dioxide (CO_2) and other **greenhouse gases** into the atmosphere would have a harmful effect on the planet.

Now there are too many greenhouse gases in the atmosphere, so more heat is being trapped. This is called the greenhouse effect, and it causes global warming. Some greenhouse gases, such as water vapour, don't stay in the atmosphere long, but CO_2 stays for much longer. Since the Industrial Revolution started, CO_2 levels have risen by more than 40%.

Since the middle of the last century there has been a worrying increase in the earth's temperature. Burning fossil fuels that emit CO_2 and cutting down rainforests that absorb CO_2 are contributing to the warming of the atmosphere.

But if we didn't have greenhouse gases the earth would be too cold.

That's true, greenhouse gases trap some of the heat from the sun making it possible for life on earth.

More extreme heat, flooding and trees coming into leaf earlier are all signs of climate change seen in the UK.

Isn't a warmer planet better? We wouldn't have to burn so many fossil fuels to keep warm.

But on a warmer planet, seas become warmer and ice melts. There are more storms, floods and droughts. Crops don't grow, houses are damaged and plants and animals die.

Don't trees need carbon dioxide?

Yes, they do. CO_2 is a natural gas. Plants absorb it and we breathe it out. The problem is that now there is too much in the atmosphere because we are burning too many fossil fuels.

Impacts of climate change

Challenge

Scientists are constantly monitoring the temperature of the planet, and they release their findings every year.

These are the five coldest years recorded in the UK, with the coldest first.

1892, 1888, 1885, 1963, 1919

These are the five hottest years recorded in the UK, with the hottest first.

2022, 2014, 2006, 2020, 2011

What do you notice about these dates?

The top ten hottest years in the UK have all been since 2002. But this doesn't tell the whole story. The hottest day ever recorded in the UK was 19 July 2020 at 40.3°C in Coningsby in England, yet in December of the same year it was the coldest day for 10 years.

Challenge

Climate change impacts people and animals in different ways.

Draw different coloured circles round these boxes to sort them into drivers, changes and impacts.

Drivers What makes climate change **happen**

Changes What **changes** because of that

Impacts the effects that change has on **somebody** or **something**

- Melting glaciers and other ice
- Burning fossil fuels
- Damage to buildings
- People have to move house
- Heavy rainfall or less rainfall
- Higher temperatures
- More forest fires
- Some people do not have enough food
- More extreme weather
- Plants and animals become extinct
- Cutting down rainforests
- Flooding
- Rising sea levels

People in poorer countries experience the effects of climate change more than those in richer countries as they are less able to protect themselves from extreme weather.

Fossil fuels

How are fossil fuels made?

Coal, oil and gas formed over millions of years from the remains of dead trees and plants (coal) and marine organisms (oil & gas). As they became buried, temperature and pressure increased, slowly altering them chemically into coal, oil and gas.

Burning coal produces 3 times more CO_2 per unit of energy compared to burning gas.

In 2020, the UK **burned no coal at all** to produce electricity for almost 68 days. This was the longest time without burning coal for electricity since 1882.

Did that have anything to do with coronavirus lockdown?

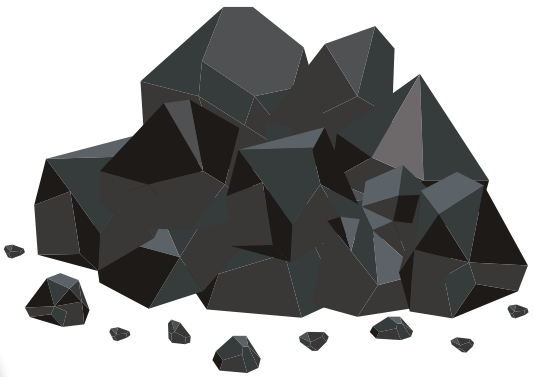
Yes, as demand for power dropped by 20% at the start of lockdown, all coal power stations producing electricity were shut down.

However, it was not all to do with coronavirus lockdown. The UK also burned no coal in 2019, but for a shorter time of just over 18 days.

Fossil fuels are non-renewable. This means there is only a certain amount under the earth and that they will run out if we continue to use them.

In the 1700s, the UK became the first country to mine coal on a large scale. The highest levels of mining in the UK were just before World War I. Production has reduced since then as gas, oil and renewable energy are also used.

Gas power stations use heat from burning gas to turn water into steam, which drives a turbine to produce electricity. Gas is a reliable and flexible way to generate lots of electricity. If there is an increase in demand for electricity, it can be met by burning more gas. But gas is also a fossil fuel, so generating electricity this way produces CO_2 and contributes to climate change.



Challenge

Write the chemical symbols for these gases

Carbon dioxide ☐

Methane ☐

Oxygen ☐

Nitrous oxide ☐

Water vapour ☐

Which of them is not a greenhouse gas? ☐

Why did the snowman have no eyes?
He was trying to reduce his dependence on fossil fuels!

Challenge

Advantages and disadvantages of fossil fuels

Sort these statements into the correct boxes

Fossil fuels ...

... are non-renewable so they will run out.

... can quickly generate extra electricity if there is increased demand.

... release CO_2 when they are burned, adding to the greenhouse effect.

... pollute the air.

... can generate a lot of electricity.

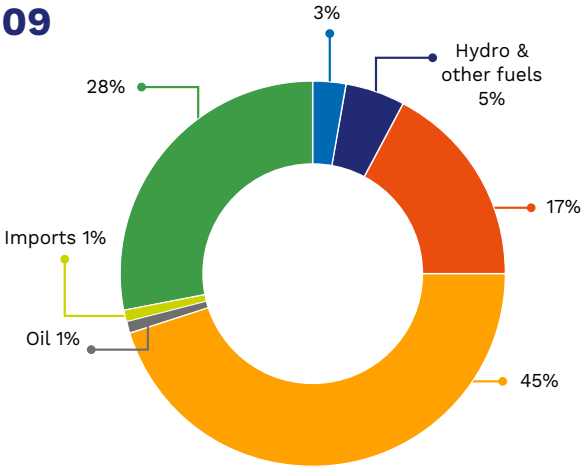
Disadvantages

Advantages

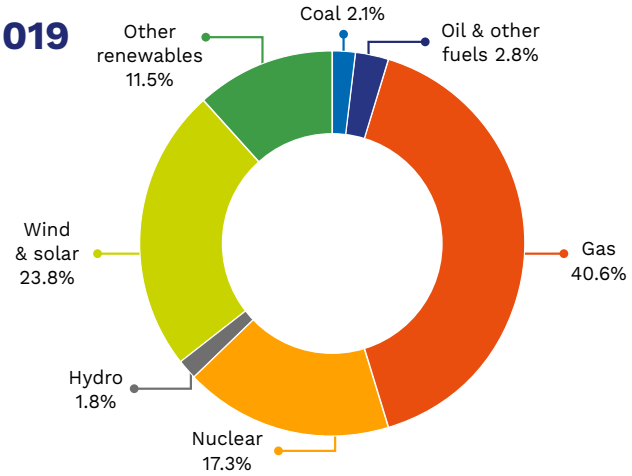
Where does our electricity come from?

Electricity generated by fuel type, 2009 and 2019

2009



2019



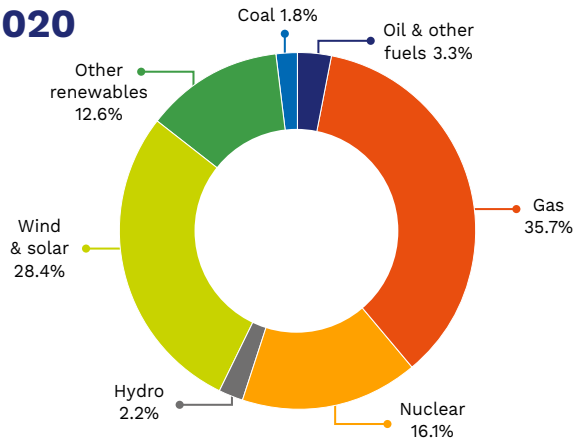
Challenge

Four of the energy sources are not labelled on the 2009 pie chart. Use the pie chart from 2019 and the sentences below to help you label them.

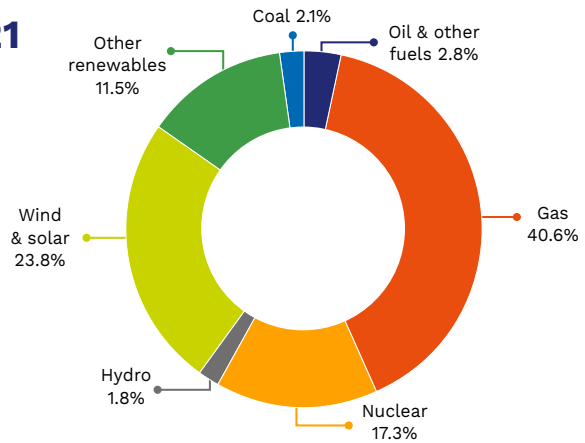
1. This energy source was used at roughly the same percentage in both years
2. There is only a 4.4 percentage difference in this fossil fuel use
3. This energy source has seen the biggest drop in ten years
4. In the last ten years there has been a lot of investment in this energy

Electricity generated by fuel type, 2020 and 2021

2020



2021



Challenge

These pie charts show the type of fuel used to generate electricity in the UK in 2020 and 2021

1. Less electricity was generated by wind, solar and other renewables in 2021. Why do you think this was? (This was still the second highest year of renewable generation ever recorded)
2. Can you see anything else that does not help reduce greenhouse gases?

Word search

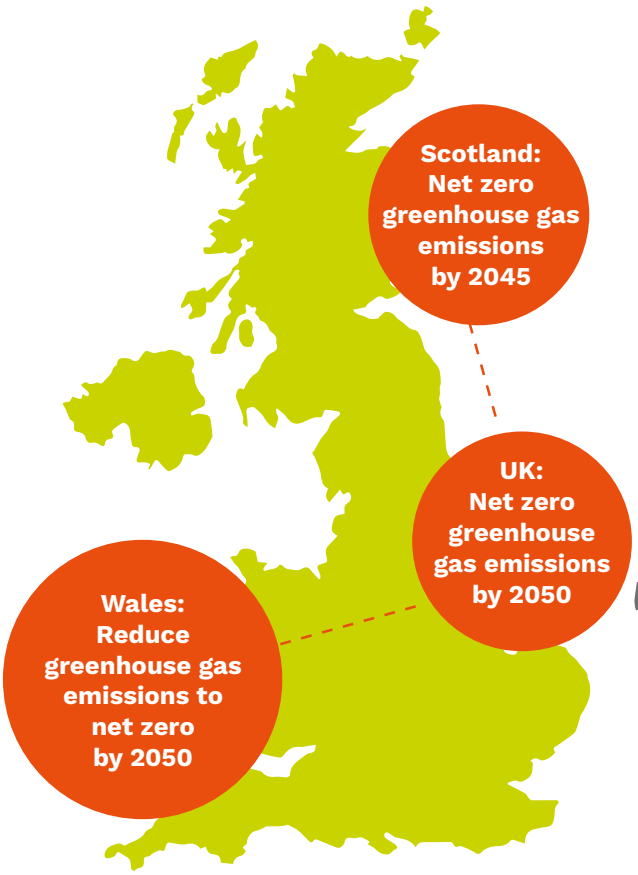
There is a skipping rope that uses kinetic energy to charge a battery!

M	R	A	L	O	S	Y	E	K	Y	G	R	E	N	E
E	X	X	R	K	E	T	A	M	I	L	C	I	R	Z
R	C	W	G	G	S	P	B	Y	J	R	A	N	A	S
O	C	I	N	Q	A	I	L	Y	K	D	N	Z	T	R
H	R	N	I	U	G	R	L	R	S	X	T	O	C	E
S	E	D	D	J	E	O	A	E	L	U	E	F	A	F
N	N	T	O	E	S	T	F	T	E	N	M	F	F	X
O	E	U	O	X	U	A	N	T	U	Q	P	S	D	H
W	W	R	L	I	O	R	I	A	F	P	E	H	A	Y
Y	A	B	F	M	H	E	A	B	L	F	R	O	O	D
P	B	I	S	W	N	N	R	Y	I	N	A	R	L	R
O	L	N	P	Q	E	E	N	J	S	P	T	E	D	O
W	E	E	C	M	E	G	J	K	S	E	U	E	I	G
E	P	P	J	G	R	R	I	U	O	F	R	L	W	E
R	K	L	Y	Y	G	X	C	P	F	C	E	R	L	N

Generator
Rainfall
Fossil fuels
Temperature
Flooding
Offshore
Onshore
Renewable
Power
Oil
Climate
Energy
Wind turbine
Greenhouse gases
Solar
Load factor
Battery
Hydrogen

A world view

These are the commitments from governments in the UK.



Governments are making commitments to reduce their greenhouse gas emissions. Wales aims to meet 100% of its electricity needs from renewable sources by 2035.

What are different countries doing about greenhouse gases and climate change?

Governments know that something needs to be done about climate change. They also know that one country can't do this on their own, so they've started working together.

1988

The **Intergovernmental Panel on Climate Change** (IPCC) is an important group of scientists who study climate change and produce a report every year.

1992

At the **Earth Summit** in Rio de Janeiro, Brazil, more than 178 countries agreed to work together to improve human lives and protect the environment.

Every year since 1995, representatives from countries across the world meet at the **Conference of Parties**, known as COP. They make decisions and seek to agree what to do to reduce climate change.

2022

At COP27 they adopted the Glasgow Climate Pact for climate action and support while continuing to try to keep the increase in average global temperature to less than 1.5°C above preindustrial levels.

What does below 2°C mean?

They looked at the average temperature before the Industrial Revolution and compared it to the average temperature now. Currently it is about 1°C higher, but rising fast.

Net zero means reducing CO_2 emissions to zero. This will mean planting more trees, reduce the cutting down of trees and possibly developing technology to take CO_2 out of the atmosphere as well as using renewable energy sources.

Challenge

You are in charge of reducing greenhouse gases in the UK. Choose your top three actions from this list, and the one you think would be least successful.

- **Encourage people to be more energy efficient.**
- **Spend more money on renewable energy research.**
- **Give grants to people to install renewable energy in their homes.**
- **Ban fossil fuel use altogether.**
- **Make a law that people can only use a certain amount of electricity per day.**
- **Make it compulsory for all new buildings to use renewable energy.**
- **Make all public transport run on renewable energy sources.**
- **Invest in changing all heating to electric.**

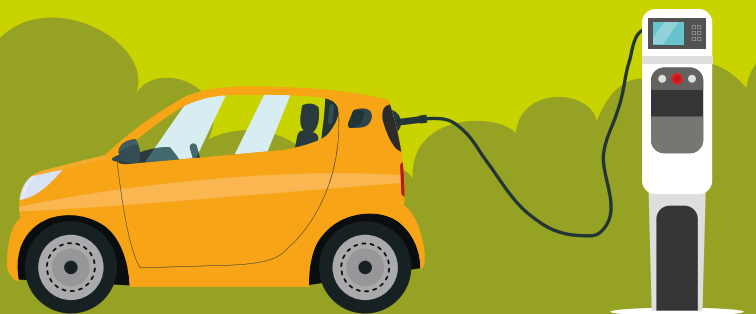
Did you know ...?

China has been developing its electric car manufacturing industry. Chinese people bought 4 million electric cars in 2022. This is more than all the other electric cars bought in the entire world that year.

Sweden has committed to reaching net zero by 2045. That's 5 years earlier than the UK!

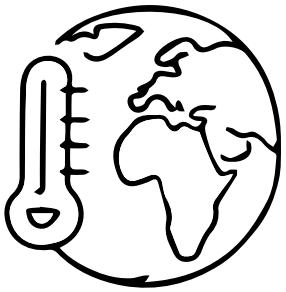
In the desert in Morocco there is a huge **concentrator photovoltaic** farm. This uses the sun in a different way to conventional solar panels. Curved mirrors concentrate radiation to heat tubes of fluid which are pumped to a power unit. The unit can hold the energy for a short while until night when demand is greater.

The New Zealand government has banned new offshore oil and gas exploration permits, committed to planting a billion trees by 2028, and told farmers to cut emissions by 2025 or face higher taxes.



Young people and climate change

What can young people do about climate change?
Read these teenagers' stories...



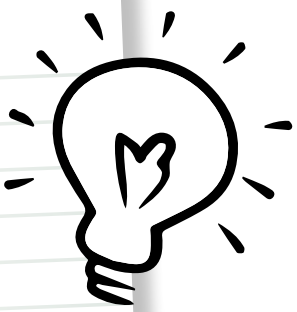
Greta Thunberg is Swedish. She has inspired an international youth movement. In 2019 she sailed to the USA and made a speech at the United Nations Conference on Climate Change in New York. She was awarded the Gulbenkian Prize for Humanity in 2020, and pledged to give away the one million euro prize to organisations helping people affected by climate change.

Football loving **Lesein Mutunkei** lives in Kenya. He plants a tree for every goal he scores. He persuaded his school to plant 11 trees for every goal, as there are 11 people in a team, and a goal is a team effort! Knowing he is doing something good for the planet if he scores motivates him to play better.

He raises awareness of climate change and deforestation on social media and even met the president of Kenya and planted a tree with him.

Alexandria Villaseñor lives in New York. She founded the climate change education group Earth Uprising. There are many people across the world committed to global action on climate change. They ask that world leaders urgently act to keep the planet below 1.5°C of warming.

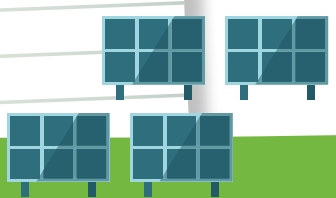
Challenge



You don't have to do something big and you don't have to do it alone. These young people had an idea which grew and now other people support them. **What could you do to help in the global fight against climate change? Write your ideas in the boxes below.**

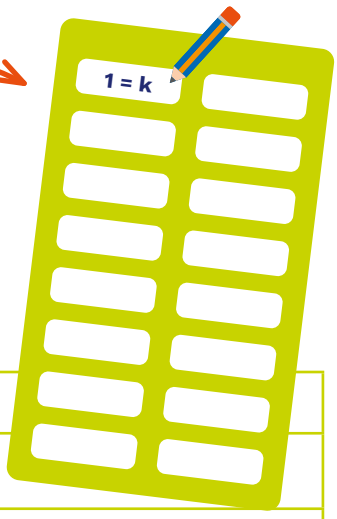
On my own I could ...

With my friends I could ...



What does it mean?

Put the letter in the box to match the word with the correct definition



1	Climate change
2	Greenhouse gases
3	Kilowatt
4	Paris agreement
5	Renewable Energy
6	Industrial Revolution
7	National grid
8	Kinetic energy
9	Green hydrogen
10	Energy mix
11	Deforestation
12	Load factor

a	A measure of energy
b	The network that delivers electricity in the UK
c	The different types of energy used to produce electricity in the UK
d	A measure of the difference between the actual energy produced and what could have been produced
e	Cutting down forests to use the land for something else
f	More of these in the atmosphere contribute to global warming
g	Energy that comes from natural resources
h	An agreement by most countries in 2015 to cut carbon emissions
i	When factories opened and began burning fossil fuels
j	The long-term difference in average weather patterns across the world
k	Energy produced because something is moving
l	Gas separated in an electrolyser using renewable energy

Energetic sudoku

Put letters in the empty squares so that every row, every column and thick-lined square contains each of the letters that spells out the word:

WIND

	N		D
	W		I
	D	W	

BLADES

	E			L	
		L	E		
			D	A	
D				E	S
L					B
	S	B	L	D	

CHANGE

	N	G	E		H
E	H				
	G	E	C		A
		H	G		N
	A				
H		C	A		G

WAVE

	A		
W			
		V	A
		E	

Energy choices

Draw arrows to match the people to the best choice for them.

We know that renewable energy is a good idea, but which one is the best choice?

What did the solar panel bring to the birthday party? A light snack!

It depends where you live. Read about these people and pick the best energy choice for them.

1

James and Amelia live in a hilly part of Scotland and use a lot of electricity to run their large farm business. They would like to use renewable energy but are not sure which to choose. They have space for a wind turbine or solar panels.

What would be suitable for them?

2

Gasore lives in Kigali, Rwanda. Just over half of homes have access to electricity in Rwanda. 51% are on the national grid, while 25% get their electricity from other sources. Gasore's home has no electricity but he needs to charge his mobile phone. What can he do?

3

Rhys lives in a city flat in Wales. He would like his energy to be more sustainable, but has nowhere to put a wind turbine or a solar panel.

What could he do?

A

Choose an energy tariff which supplies electricity from renewable and or low carbon sources. This means that some, most or even all of their energy would come from renewables.

B

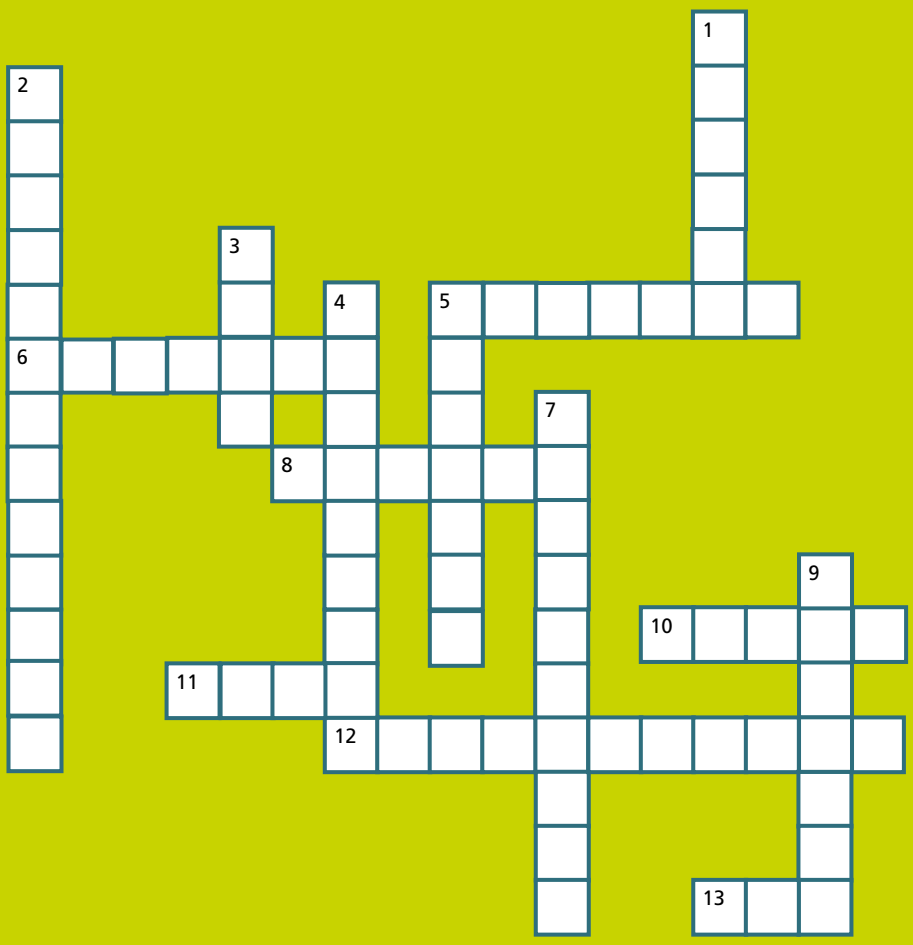
Go to the mobile charging station in town. It is a kiosk on wheels with solar panels on the roof where people can plug their phones in and pay to charge them. Solar panels are more efficient in sunny places.

C

In Scotland days are long in summer. Solar power would work well then, but would not give enough electricity in winter. Mountainous areas are windy, so wind turbines could be more efficient. A mix of both renewable energy sources could suit these people.

Electricity travels at the speed of light, which is more than 186,000 miles per second!

Energy crossword



ACROSS

5 Carbon ____ is a greenhouse gas (7)

6 A tall machine that generates wind power (7)

8 We need to do this to greenhouse gas emissions (6)

10 Energy from the sun (5)

11 When burned, this fossil fuel gives out 3 times more CO_2 than gas (4)

12 This can be made from renewable energy or fossil fuels (11)

13 More of this fossil fuel was used to make electricity in the UK in 2019 than in 2018 (3)

DOWN

1 When this goes up, more electricity needs to be made (6)

2 This happens because there are too many greenhouse gases in the atmosphere (7,6)

3 The National ___ delivers electricity to homes and buildings around the UK (4)

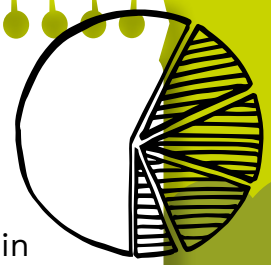
4 This energy will never run out (9)

5 One effect of climate change (7)

7 People started burning fossil fuels on a large scale in the Industrial _____ (10)

9 The conference of _____ meet every year to make decisions about reducing climate change (7)

Challenge



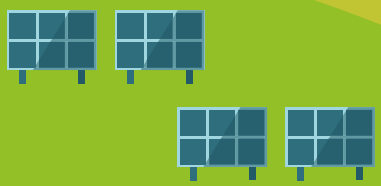
Electricity in the future

Draw a pie chart to show where **you think** our electricity will come from in **2030**. Think about where it comes from now, commitments by governments, young people taking action and the benefits and drawbacks of different energy sources.

On a separate piece of paper, draw a pie chart showing where **you would like** electricity to come from in **2050**. If this is different to the 2030 pie chart, write down three things that you think need to happen during those 20 years.

Go to page 12 for inspiration.

Notes



Answers

Page 3 - TV pick up
1. Football World Cup Semi Final, 2. Eastenders, 3. Royal Wedding

Page 7 - Load factors
1. 40%, 2. 43%, 3. 33%. Number 2 is most efficient

Page 7 - Advantages and disadvantages
Wind D A A
Hydropower A D A
Solar power D A A

Page 8 - Match the colour

Grey	c
Blue	b
Green	a

Page 11 - Drivers, changes and impacts
Drivers – burning fossil fuels, cutting down rainforests
Changes – melting glaciers and other ice, heavy rainfall or less rainfall, more extreme weather, higher temperatures, rising sea levels
Impacts – plants and animals become extinct, flooding, more forest fires, people have to move house, damage to buildings, some people do not have enough food

Page 13
carbon dioxide CO_2, Methane CH_4, Oxygen O,
Nitrous oxide N_2O, Water vapour H_2O,
Oxygen is not a greenhouse gas

Page 13 - Advantages and disadvantages of fossil fuels
Disadvantages
are non-renewable so they will run out
pollute the air
release carbon dioxide when they are burned, adding to the greenhouse effect

Advantages
can quickly generate extra electricity if there is increased demand
can generate a lot of electricity

Page 14 - Pie charts 2009 & 2019
1 Nuclear
2 Gas
3 Coal
4 Wind & solar

Page 14 - Pie charts 2020 & 2021
1 Weather in 2021 was not as good for wind, solar and hydro generators
2 More fossil fuels used in 2021

Page 19 - What does it mean?

1	Climate change	j
2	Greenhouse gases	f
3	Kilowatt	a
4	Paris agreement	h
5	Renewable energy	g
6	Industrial Revolution	i
7	National Grid	b
8	Kinetic energy	k
9	Green hydrogen	l
10	Energy mix	c
11	Deforestation	e
12	Load factor	d

Page 19 - Energetic sudoku

WIND

W	N	I	D
D	I	N	W
N	W	D	I
I	D	W	N

WAVE

V	A	W	E
W	E	A	V
E	W	V	A
A	V	E	W

BLADES

B	E	D	S	L	A
S	A	L	E	B	D
E	B	S	D	A	L
D	L	A	B	E	S
L	D	E	A	S	B
A	S	B	L	D	E

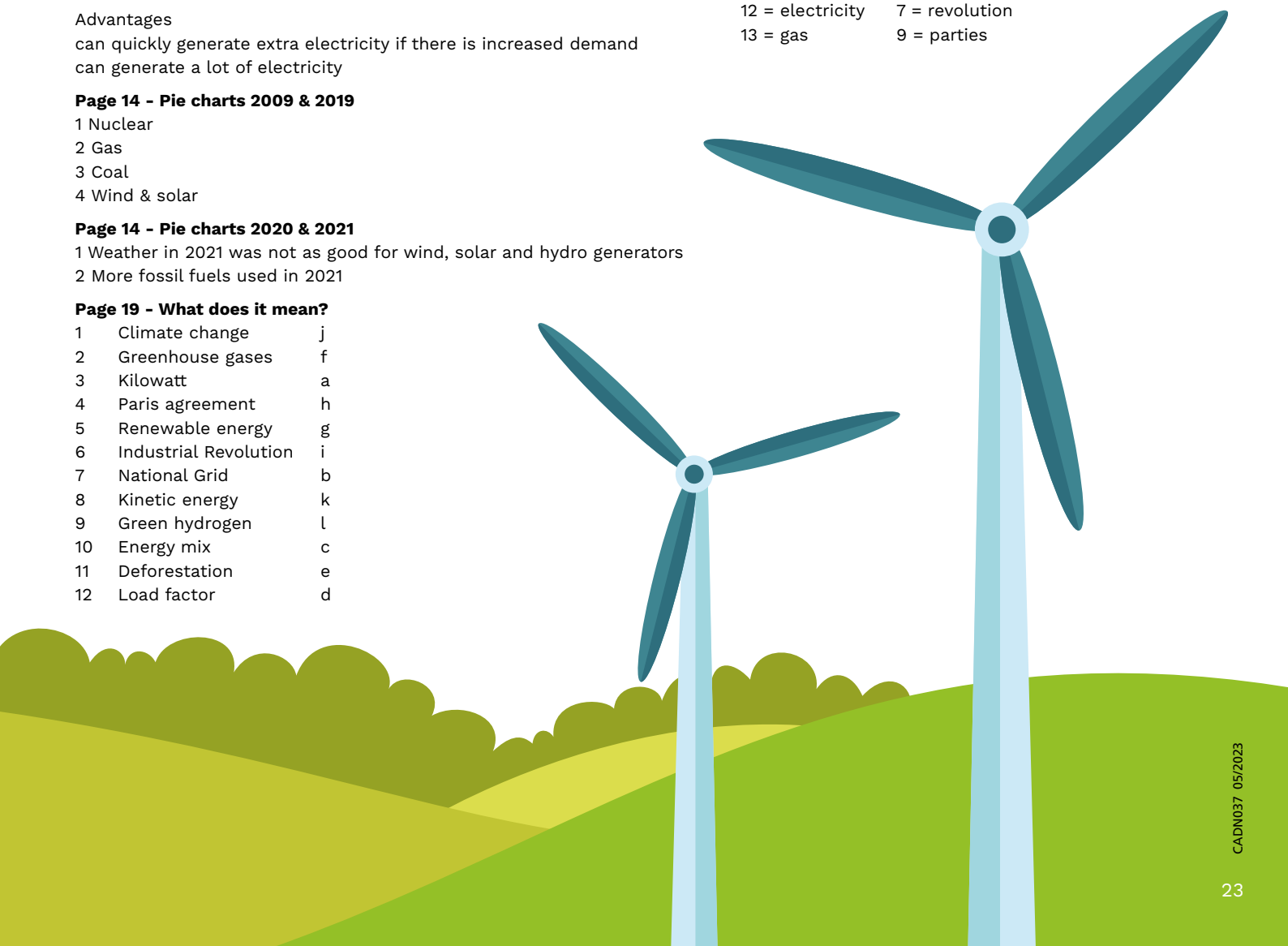
CHANGE

C	N	G	E	A	H
E	H	A	N	G	C
N	G	E	C	H	A
A	C	H	G	E	N
G	A	N	H	C	E
H	E	C	A	N	G

Page 20 - Energy choices
1 C, 2 B, 3 A

Page 21 - Energy crossword

Across	Down
5 = dioxide	1 = demand
6 = turbine	2 = climate change
8 = reduce	3 = grid
10 = solar	4 = renewable
11 = coal	5 = drought
12 = electricity	7 = revolution
13 = gas	9 = parties



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