Schools Information & Lesson Ideas





OUR SERVICES

Explore our Net Zero world

Link to Engineering Net Zero website



Learning outcomes

To understand what Net Zero means

To understand Energy terminology:

- Supply and Demand
- Renewable and non-renewable
- Fossil fuels
- Carbon footprint

To understand different types of Energy and the pros and cons of each

To understand the challenges of balancing energy security, cost and emissions





Introduction

What is Climate Change?

Greenhouse gases reached a record high in 2019 and continue to rise...

Global temperatures will continue rising to levels that impact our way of life, unless we change things...

At the current rate, temperatures are expected to rise 1.5 degrees Celsius by 2030-2050, and that means a lot more of this...











Australian Bush Fires

Droughts

Flooding

What other things can you think of?



How do we stop Climate Change?

We need to stop releasing Greenhouse Gases into the Atmosphere









What are Greenhouse Gases?

Carbon Dioxide (CO_2) is the primary greenhouse gas emitted through human activities.









What is a Carbon Footprint?

~

The amount of CO_2 released into the atmosphere because of your own energy usage.

We need to understand...



The causes of carbon emissions



How to reduce your carbon footprint







q

What things do you use that generate Carbon?

At Home At School	When going on holiday	That you might not realise
-------------------	-----------------------	----------------------------



10

Carbon Footprint & Net Zero

What things do you use that generate Carbon?

At Home

- Lights
- Fridge
- Oven
- TV
- Computer
- Phone
- PlayStation
- Shower
- Storing information

At School

• Lights

- Computers
 - Fridges Ovens

- When going on holiday
- Car
- - Boat

Plane

That you might not realise

- Factories that make your clothes or computers or furniture
- Shops that sell your food
- Transport to get your food to shops
- Electricity at hospitals

Pretty much everything!





What is your Carbon Footprint?

Currently an average yearly Carbon Footprint for a person in the UK between 8 – 10 tonnes of Carbon

Unlike Plastic waste it's very difficult to see how much Carbon Dioxide you generate because it's invisible.

Fill in the questionnaire below (you might need help from a parent) to see whether your carbon footprint is higher or lower than average.

https://footprint.wwf.org.uk/#/questionnaire

Discuss what things you could do to change your carbon footprint







Source of the UK's carbon footprint

All figures based on the total share of consumption-based emissions 2012

We are going to look at what we can do about this part of the UK's carbon footprint

And your own carbon footprint







What is 'Net Zero'?

A '**Zero' carbon** target would mean no more carbon would be emitted after 2050

A '**Net Zero' carbon** target means that any carbon that is emitted will be offset* or captured**

* This compensates for carbon that is produced by planting trees or investing in projects that remove carbon

**sometimes called 'sequestered'



What is 'Net Zero'?



Net Zero The UK's contribution to stopping global warming

May 2019

🗯 GOV.UK

News story

UK becomes first major economy to pass net zero emissions law

New target will require the UK to bring all greenhouse gas emissions to net zero by 2050.

June 2019





What can you do?

Look at your Energy Demand

How much energy you use What type of energy you use – in your home or when travelling



Look at your Energy Supply

Where your energy comes from







Energy Demand

Energy use in our homes

We use energy in lots of different ways in our homes with the average house uses between 3,500 -Heating 4,000kWh of energy per year. In America they use 3 x that amount! The average UK industrial wind turbine can produce 6 million kWh in a year – enough to power over 1,500 homes. Most homes are heated by natural gas, some by oil and some electricity. Heating can use anywhere between 5,000 kWh - 30,00 Showers kWh **Electric showers** use a lot of energy - as much as watching a TV for over 8 hours Kettle Uses about 2.5p of electricity each time it boils. In the UK, we make nearly 100 MILLION cups of tea each day! Fridge Freezer One of the biggest energy uses in the Toaster home is the Fridge Freezer, running 24 Uses about hours a day - 400KW 1,200 Watts each year per use Lighting Kitchens use a lot of energy, and

over half of the

cost of energy

goes on heating

and hot water

Makes up approximately 12% of household energy use. Energy efficient lights, such as LEDS can use up to 5x less energy **Games Console**

Uses up to 181

kWh per year and

they even use up

to 8.5 watts in

standby mode

List all the things you use electricity for at home

List all the things you use gas for at home





Measure your own energy

Q(1) Calculate your daily energy use of playing on a computer for 3 hours, watching TV for 2 hours, using a dishwasher for 2 hours or using an electric cooker for 2 hours each.

Q(1.1) Calculate the monthly (30 days) and yearly usage (12 months) of electricity. Give your answers in kilowatts (kW).

Electricity usage per hour:

- Computer 100watts
- TV 170 watts
- Dishwasher 1100 watts
- Electric cooker 3000 watts





Measure your own energy

A classic lightbulb uses 60 watts of electricity per one hour. In a family home there are 18 classic lightbulbs, that are used 5 hours per day.

Q(2) Calculate how much electricity the family is consuming (using) for their lighting in a month (30 days)

Q(2.1) How much CO₂ does that produce if the home uses: 1) Gas powered energy 2) Nuclear energy 3) Solar energy.







Save your own energy

If you change a classic 60 watts light bulb into a LED light bulb, you will use 6 times less energy per hour.

Q(3) Calculate how much electricity LED bulbs will use per month if they have the same consumption as Q1







Measure your own energy cost

Projected cost of 1000 watts of electricity is £0.20.

Q(4) How much money would you save in 1 year using LED lights instead of classic lights in the family's house?







Challenge Question

Q(5) One solar panel produces 300 watts of electricity per hour. How many hours of sunlight does the solar panel need in order to meet family's monthly electricity demand with a classic light bulbs installed?

Q(5.1) One solar panel can be fully charged for 10 hours per day. How many solar panels would they need to have to meet their monthly electricity demand in one month?



ENERGY-EFFICIENT HOME



TRADITIONAL HOME

£46.41 Flat Screen PG £123.76 Traditional light bulb (x8) £74.26 Plasma Television £58.79 Dishwasher £84.93 Electric Oven £41.77 Washing Machine £77.35 Tumble Dryer (C) £40.22 Ceramic Hob £77.35 Combi Fridge (C) 500 kWh / ymar





What can you do?

Look at your Energy Demand

How much energy you use What type of energy you use – in your home or when travelling



Look at your Energy Supply

Where your energy comes from







Energy Supply

Where your energy comes from:

Homework:

- Find out who your energy suppliers are at home for gas and electricity
- Find out how that company generates electricity
- Ask your parents why they chose that supplier









Energy Supply

Where your energy comes from:

Who are your energy suppliers?

Why did your parents choose them?







Energy Supply – at home

When your parents chose your energy supplier they probably considered these things:







Energy Supply – in the UK

When the Government decides what type of power stations to support they consider these things: It's very expensive to develop new power stations that don't generate carbon

Four good/bad for the environ

How much does it costs

Ez secure? Will you have power

cisth





Government decisions are now bound by Net Zero targets



Net Zero The UK's contribution to stopping global warming

May 2019



News story UK becomes first major economy to pass net zero emissions law

New target will require the UK to bring all greenhouse gas emissions to net zero by 2050.

June 2019

The Government have agreed to do this, so even if it costs more to generate power with lower carbon, they will have to do it.





To start with all our energy comes from...







Renewable sources continue forever Non-renewable sources will run out






Energy sources are turned into electricity by... Match the sources of energy to the types of power station





37

Each type of energy has different costs, security of supply and environmental impact – none are good at everything







Compare types of Electricity Generation

Fill in the table to compare the Energy types

Just guess for now

Type of electricity generation	Cost	Security of Supply	Carbon Generation	Total (highest score is best)
Fossil Fuel Power Station				
Nuclear Power Station				
Wind Turbine				
Solar Panels				
	Most expensive – 1 Medium - 2 Cheapest - 3	Intermittent - 1 Very reliable - 3	Generates carbon - 1 Doesn't generate carbon - 3	



Comparing Energy Sources

Understand Different Energy Sources

Divide into groups and each present back on one type of energy:

- Solar
- Fossil Fuel Coal
- Fossil Fuel Gas
- Hydrogen
- Wind
- Nuclear
- Tidal
- Hydro-electric
- Biomass

How is it used?

What is good about it?

What is bad about it?





Solar Energy

Zero emissions



£

Seasonal energy intermittent

Cheaper in long run







Fossil Fuels

Non-renewable



Generates carbon

Provides firm power

£

Cheapest to convert to electricity



Oil (Petrol)

Coal

Natural Gas





Oil (Petrol)



How is oil formed?



How we get oil



Uses



Emissions







Coal



How is coal formed?



Coal mining

Emissions



Forms & uses of coal









Natural Gas



How is Natural Gas formed?



Types of Gas



Mining & Transportation





Emissions

Uses







Combined Cycle Gas Turbine (CCGT)



Low specific cost



Complex to operate

Provide firm power



Lower emission levels than older Gas power stations







Hydrogen

What is it?



- How is Hydrogen made?
- Non-renewable production



X

H

 \mathcal{O}

Uses of Hydrogen



Emissions?









Wind Energy







Nuclear Energy

Non-renewable (but uses very small quantities of fuel)



Zero Emissions



Secure Energy Supply

Safe



X

Civil (not Nuclear Bombs)



Expensive up front







Compare types of Electricity Generation

Fill in the table to compare the Energy types

Change your answers from before now if you like.

Type of electricity generation	Cost	Security of Supply	Carbon Generation	Total (highest score is best)
Fossil Fuel Power Station				
Nuclear Power Station				
Wind Turbine				
Solar Panels				
	Most expensive – 1 Medium - 2 Cheapest - 3	Intermittent - 1 Very reliable - 3	Generates carbon - 1 Doesn't generate carbon - 3	



51

Compare types of Electricity Generation

Answers:

Type of electricity generation	Cost	Security of Supply	Carbon Generation	Total (highest score is best)
Fossil Fuel Power Station	3	3	1	7
Nuclear Power Station	1	3	3	7
Wind Turbine	2	1	3	6
Solar Panels	2	1	3	6
	Most expensive – 1 Medium - 2 Cheapest - 3	Intermittent - 1 Very reliable - 3	Generates carbon - 1 Doesn't generate carbon - 3	



Compare types of Electricity Generation - Discussion

- If you had to build a source of power, what type would you choose and why?
- Is cost as important as environmental impact and as security of supply?
- Which do you think is most important?
- What did your parents think was most important?
- If you applied an importance weighting which do you think would come out top?



53

Measure your own energy

A classic lightbulb uses 60 watts of electricity per one hour. In a family home there are 18 classic lightbulbs, that are used 5 hours per day.

Q(2) Calculate how much electricity the family is consuming (using) for their lighting in a month (30 days)

Q(2.1) How much CO₂ does that produce if the home uses: 1) Gas powered energy 2) Nuclear energy 3) Solar energy.









What is Energy Security?

What happens if you want to switch on your lights at home on a dark night when it's not windy and you only have renewable power supplier?

For renewable power to be used all the time it needs to be stored somewhere until you need it

- Batteries
- Reservoirs
- Underground (compressed air)







Batteries

Batteries are not great for storing large quantities of energy for a long time.

They can deal with daily variations (of 1 - 5 hours) but would not be able to store sun in the summer and use it in the winter.

Think about your battery in your mobile phone – it would last a few days, but you wouldn't expect to charge it one day and use it 1 month later.

Batteries also require elements – lithium, cobalt and nickel which are not renewable and have to be mined.



Batteries

- In 2012, Bristol's average electrical consumption over a 24-hour period was 5.2 GWH.
- This equates to 41 x the world's largest Lithium-Ion Battery facility constructed by Tesla in Hornsdale, Australia (129 MWh)
- It also equates to 130,220 x Nissan Leaf cars (40 kWh)
- The largest battery in the world could only power 30,000 homes for 1 hour.





Other Storage Options

Other storage options can be used in combination with renewable power generation.

- Hydroelectric Storage limited by the number of sites available in the UK to build reservoirs
- Compressed Air Storage look at Gravitricity.com a great idea but not yet tested at scale
- Subsea Storage another idea based on the Hydroelectric principle but on the seabed – another great idea in the early stages of development



Reaching Net Zero

How does the UK get to Net Zero? Energy Demand is forecast to increase

• Use the graph to work out the expected demand in 2050



World Energy Consumption Scenarios





How does the UK get to Net Zero? Energy Demand is forecast to increase





How does the UK get to Net Zero? Energy Demand is forecast to increase

- Electricity demand will increase due to moving from petrol to electric cars
- Increasing use and storage of data (all the files on your phone are probably stored in 'the cloud' somewhere using energy)
- Increasing use of digital devices





How does the UK get to Net Zero?

- We need to reduce our energy usage!
- We need to build the right mix of power stations
- We need to develop new technologies
 - Carbon capture
 - Hydrogen
 - Batteries and Storage solutions
 - Small Modular Nuclear Reactors
 - and lots of other new technology
- We need to develop new electric cars and planes and the infrastructure (charging points) to use them

This all needs lots of engineers, scientists, construction workers, planners, project managers and lots of other skills



How does the UK get to Net Zero?

YOU are important

You will be about 40 in 2050 and you will be working on the solutions to Net Zero when you go to work after you leave school – everyone will need to do something to help

Achieve Net Zero by 2050





More Great Resources

3 Great Online Resources

Each is explained on the next few slides, or just give them a go - they're fairly self-explanatory

Grid Watch <u>GB Fuel type power generation production</u> (gridwatch.co.uk)

Electricity Map <u>electricityMap | Live CO₂ emissions of</u> <u>electricity consumption</u>

Energy Mixer https://www.energymixer.uk/





Net Zero

Can you overcome low levels of wind and sun to create an affordable energy mix?

Create an energy mix that keeps Great Britain powered, reaches Net Zero and is affordable, using currently available, scalable technologies. The weather data used in this game includes a 'low wind, low sun' week which illustrates some of the challenges faced by the national grid recently.

<u>How the game works</u> Start \rightarrow



Change Footer here: Insert > Header and Footer (delete if none)

Grid Watch: UK Electricity Generation Site

<u>GB Fuel type power generation production</u> (gridwatch.co.uk)

Shows the total amount of electricity generated per energy type across the UK.

This period experienced low wind;

- What has happened to electricity generation by other means?
- Is there a better way to provide a stable supply?

Exercise: Monitor the electricity mix over the course of two weeks. How does it change? Why might that be?













Electricity Map: Global Emissions by Country

electricityMap | Live CO₂ emissions of electricity consumption

This website allows you to see how much CO₂ is emitted to produce your electricity in real time.

The colours on the map show carbon intensity:

- The greener the colour, the more climate friendly the electricity
- The browner the colour, the more CO₂ emissions produced

What types of generation do you think might be common in areas which are dark brown?

France has a high nuclear capacity, what colour do you think it will be?

Exercise: monitor every day for a week and see how the energy mix changes



70

Electricity Map

This website allows you to see how much **CO**₂ is emitted to produce your electricity in **real time.**

The colours on the map show carbon intensity:

- The greener the colour, the more climate friendly the electricity
- The browner the colour, the more CO₂ emissions produced

The arrows on the map indicate the flow of electricity between countries – this shows where your electricity comes from

Press the sun and wind buttons to show the real-time strength of wind and sunshine in the world – can you think how this might effect the colour of countries with a high proportion of renewables?











Electricity Map

YOUR TURN!

Link to electricity map: https://www.electricitymap.org/

What types of generation do you think might be common in areas which are dark brown?

What types of generation do you think might be common in areas which are dark green?

EXERCISE: Monitor the UK every day for a week to see how the energy mix changes






Electricity Map

Here are the electricity mixes for Germany, Ireland and France:

What colour do you think they might be?









Electricity Map

Here are the electricity mixes for Germany, Ireland and France:

What colour do you think they might be?





433g



28g





71g



Energy Mixer Game

Can you create an energy mix that keeps the UK powered, reaches Net Zero and is affordable, using currently available technologies?

You can select any amount of "capacity" from 4 power sources in the game; wind, solar, nuclear or gas.

Summer 2020 Energy Challenge

The high temperatures, low wind and the Covid-19 pandemic presented challenges for the UK energy system. This game includes a 'low wind, low sun' week which illustrates some of the challenges. Therefore, the sources you choose will not be able to produce at their maximum all the time.

https://www.energymixer.uk/





Purpose: Try putting all the lights ON using combination of Nuclear, Wind, Solar and Gas power. Your energy mix should be low carbon and cheap.



Using "+" and "-", amend how much electricity should be produced by each power generating source.





Check that the combination of power satisfies the demand.







Change Footer here: Insert > Header and Footer (delete if none)

Try achieving Net-zero while maintaining the lowest cost possible.





79

Change Footer here: Insert > Header and Footer (delete if none)

Congratulations!

You've beaten the challenging conditions and kept the lights on for both weeks! This is because you had a good mix of low carbon generating technologies.

	Score	Cost	Net Zero? YES				
	93%	LOW					
↓	Click to view the leaderboard and share your results Tell your colleagues and friends about the game and see if they can beat your score.				۱'n	IJ	ę
YOU							93%
ELIZABETH							86%
CHARLES							85%
CATHERINE							84%
WILLIAM							82%
MEGAN							80%

Well done if you managed to turn all the lights on while maintaining low cost and achieving Net Zero!

Your Energy Mix will be given a score, and you can compete against your friends in achieving the best mix.

Remember, that every energy source comes with its advantages and disadvantages. The challenge is to combine sources in a balanced way.



Change Footer here: Insert > Header and Footer (delete if none)

Benefits of Nuclear – Hinkley Point C

At Hinkley Point C, two new nuclear reactors are being built in the first in a new generation of nuclear power stations in the UK.

This will provide low-carbon electricity for **around six million homes**.

As well as supplying low carbon electricity, there are several other benefits:

Can you think of some of the types of jobs which Hinkley Point C might create?



£2.2 billion Spent with local companies



10,300 Jobs created



644 Apprentices trained so far



£199 million Community investment





Benefits of Nuclear - Sizewell C

There are many other benefits from nuclear generation apart from the supply of electricity.

Can you think what these might be? If you were to build a new power station, who might benefit from it?

- Jobs in sectors from construction to hospitality
- Training and education
- Link to other sectors such as hydrogen production to help the country progress to Net Zero.







References

https://kids.britannica.com/kids/article/coal/352974 https://climatekids.nasa.gov/fossil-fuels-coal/ https://www.kids.esdb.bg/coal.html https://www.funkidslive.com/learn/environment/e-is-for-energy/# https://ourworldindata.org/fossil-fuels https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf https://www.world-nuclear.org/nuclear-essentials/how-can-nuclear-combat-climate-change.aspx https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/790626/ 2018-provisional-emissions-statistics-report.pdf https://www.eia.gov/tools/faqs/faq.php?id=82&t=11 https://www.volker-quaschning.de/datserv/CO2-spez/index_e.php https://www.carbonindependent.org/17.html https://www.arcadia.com/energy-101/energy-efficiency/how-much-energy-does-a-light-bulb-use/ https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator https://deepresource.wordpress.com/2012/04/23/energy-related-conversion-factors/



Play Engine Ears Video

(More aimed at primary school kids) https://www.youtube.com/watch?v=HoHGChziqeE



84