

Starter: Carbon Footprint

- Write down on a post-it note 5 things you have done/used today that have caused CO₂ or any other greenhouse gas to be produced.
 - e.g. turning off your alarm in the morning – the alarm clock uses electricity, generated by burning fossil fuels
 - e.g. taking the bus to school – burning petrol



Carbon Footprint

- The carbon footprint is the total amount of CO₂ and other greenhouse gases emitted over the full life cycle of a product, service or event



Carbon Footprint

Optional Activity: Go to footprint.wwf.org.uk and calculate your carbon footprint.

A promotional banner for the WWF Footprint Calculator. The banner features a scenic background of a sunset over a body of water with reeds in the foreground. In the top left corner is the WWF logo. The main text is centered and reads "HOW BIG IS YOUR ENVIRONMENTAL FOOTPRINT?". Below this is a short paragraph: "Our lifestyle choices make up our environmental carbon footprint. Measuring yours takes less than 5 minutes and could change the way you live...". At the bottom center is an orange button with the text "GET STARTED NOW".

WWF

FOOTPRINT CALCULATOR

HOW BIG IS YOUR ENVIRONMENTAL FOOTPRINT?

Our lifestyle choices make up our environmental carbon footprint. Measuring yours takes less than 5 minutes and could change the way you live...

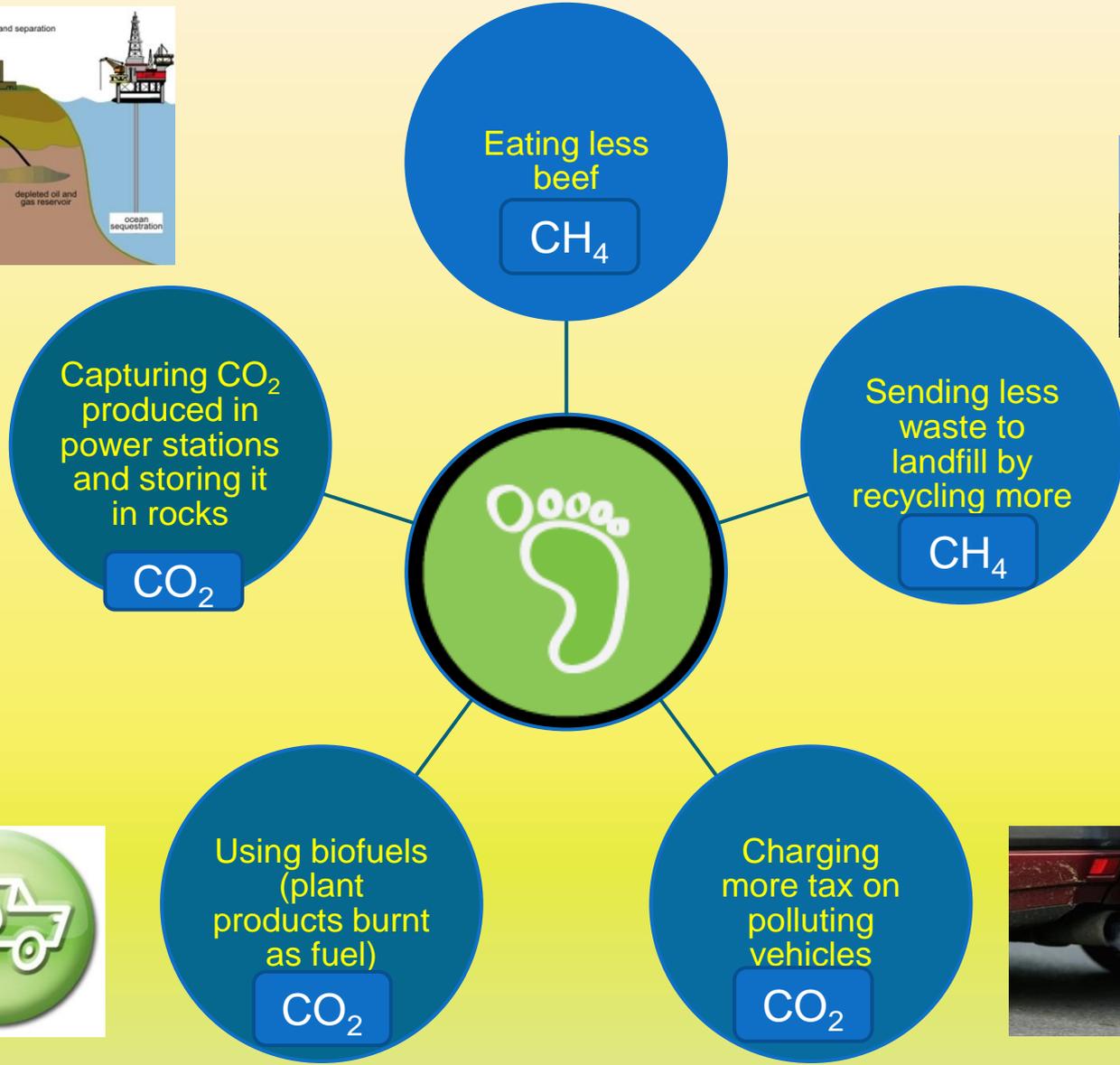
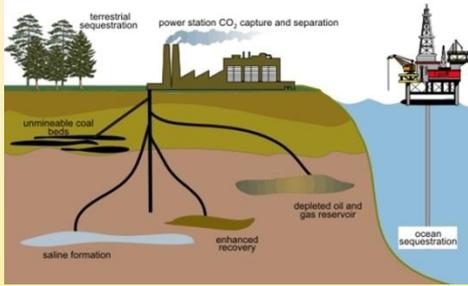
GET STARTED NOW

Carbon Footprint

- The carbon footprint of a product, service or event can be reduced by:
 - Reducing emissions of CO₂ and CH₄
- How could this be done?
- For each of the following, say whether CO₂ or CH₄ would be reduced:
- *Extension:* Explain **how** each method reduces greenhouse gas emissions



Reducing the Carbon Footprint



Reducing the Carbon Footprint

In your notes, choose two methods of reducing the carbon footprint (one for **each gas**). Explain **how** it reduces either methane or carbon dioxide emissions.

E.g. Charging more tax on polluting vehicles *discourages people from driving cars which produce CO_2 when hydrocarbon fuels are burned in the engine.*



Using biofuels
(plant
products burnt
as fuel)

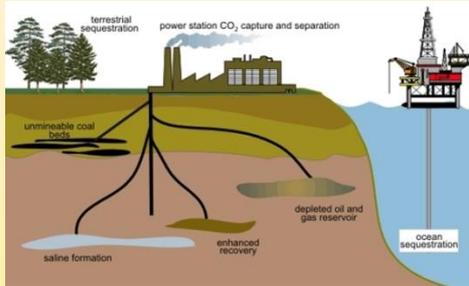
CO_2

Charging
more tax on
polluting
vehicles

CO_2



Reducing the Carbon Footprint



Eating less beef

Capturing CO₂ produced in power stations and storing it in rocks

Using biofuels (plant products burnt as fuel)



This is called Carbon Capture and Storage (CCS):

Can you think of 2 disadvantages of this method? Summarise in your notes:

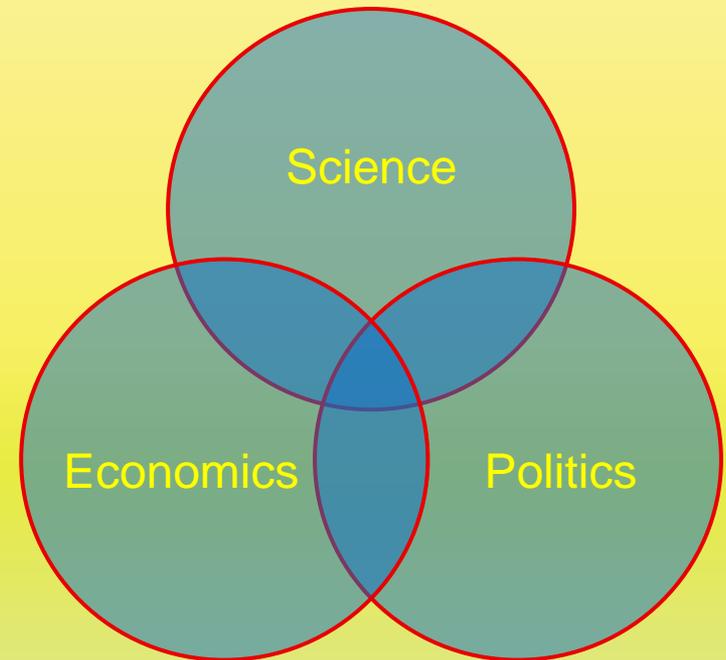
1. Expensive technology – why would a company choose to pay?
2. Depends on location – if you end up transporting the CO₂ are you actually reducing emissions?

<https://www.youtube.com/watch?v=ROEFaHKVmSs>

Video - CCS

Reducing the carbon footprint

- Why are actions to reduce emissions **limited**? Discuss.
- **Global** climate change is a **global** issue.
- It is difficult to get all nations in the world to **agree** to make the major changes needed.
- Fossil fuels drove the industrial revolution that led to **economic growth** in the West – is it fair to deny developing countries the opportunity to experience the same growth now that we know the impact of fossil fuels?



Reducing the carbon footprint

In your notes:

- Why are actions to reduce emissions limited? Discuss
- Actions to reduce emissions may be limited because:

- **Global** climate change is a **global** issue.
- It is difficult to get all nations in the world to **agree** to make the major changes needed.

- Fossil fuels drove the industrial revolution that led to economic growth in the West – is it fair to

https://www.youtube.com/watch?v=0aiE_hq-SXE

Flocabulary – Carbon Free Energy – New Innovations

Opportunity to experience the same growth now that we know the impact of fossil fuels?



Plenary: Why learn it?

- The press release below announced it's compulsory for all GCSE Science students to be examined on climate change.

PLANS IN THE NEW NATIONAL CURRICULUM TO PROVIDE PUPILS WITH A BETTER UNDERSTANDING OF ALL CLIMATE ISSUES, INCLUDING CLIMATE CHANGE.

Do you think there will be a similar requirement for students your age in the USA, now that Trump is president? Is this an issue?



Atmospheric Pollutants

Success Criteria

Aiming for...

4

- List some atmospheric pollutants
- Describe how carbon monoxide and soot (carbon) are made from incomplete combustion
- Use word equations to describe how atmospheric pollutants are made

6

Same as 4 **and**:

- Explain how sulphur dioxide and nitrogen oxides are made when fossil fuels are combusted
- Describe the health impacts of atmospheric pollutants
- Use balanced symbol equations to show how atmospheric pollutants are formed

8

Same as 6 **and**:

- Predict the products of combustion of a fuel given information about the composition of the fuel and conditions it's used in
- Evaluate the negative consequences of atmospheric pollution

Atmospheric Pollutants

Combustion of fuels is a major source of atmospheric pollutants

Key Point

Most fuels, including coal, contain carbon and/or hydrogen, and may also contain some sulfur (S)



Atmospheric Pollutants

Key Point

Most fuels, including coal, contain carbon and/or hydrogen, and may also contain some sulfur (S)

These gases and solids may be released into the atmosphere when a fuel is burned:

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

Atmospheric Pollutants

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

For each pollutant you have to memorise:

1. How it is produced

2. Its effects

<http://www.bbc.co.uk/education/clips/zw8fj6f>

Video – Air Pollution

Atmospheric Pollutants

1. How they're produced

CO_2
carbon dioxide

H_2O
water vapour

CO
carbon monoxide

SO_2
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

?

Use your knowledge from C9

Atmospheric Pollutants

1. How they're produced

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

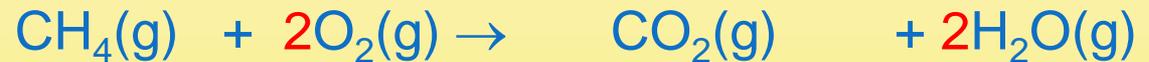
NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

Produced by complete combustion of hydrocarbon fuels

e.g. complete combustion of methane:

methane + oxygen → carbon dioxide + water



Atmospheric Pollutants

1. How they're produced

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

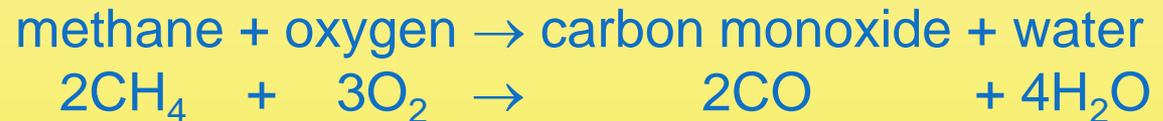
SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

Produced by incomplete combustion of hydrocarbon fuels
This occurs when the fuel is burned in **insufficient oxygen**

e.g. incomplete combustion of methane:



Compare with complete combustion:



Atmospheric Pollutants

1. How they're produced

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

Recall the key point:

Key Point

Most fuels, including coal, contain carbon and/or hydrogen, and may also contain some **sulfur (S)**

The sulfur reacts with oxygen during **combustion** to produce sulfur dioxide. Equation:
$$\text{S(s)} + \text{O}_2\text{(g)} \rightarrow \text{SO}_2\text{(g)}$$

Atmospheric Pollutants

1. How they're produced

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

The **high temperature** of the engine causes the nitrogen in the air to react with the oxygen in the air. Equation:



Atmospheric Pollutants

1. How they're produced

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot



Looks like a dark-coloured gas – is actually solid particulates

If **diesel** does not burn completely (**incomplete combustion**) then tiny solid particles of carbon (**soot**) and **unburnt fuel** are produced. Together these are called **particulates**.

Atmospheric Pollutants

2. Their effects

CO_2
carbon dioxide

H_2O
water vapour

CO
carbon monoxide

SO_2
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

Greenhouse gases.

Enhance the **greenhouse effect**.

Cause **global warming**.

Global warming causes **climate change**.



Atmospheric Pollutants

2. Their effects

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot

A **toxic** gas. It's **colourless** and **odourless** so not easily detected.

It binds to the haemoglobin in your red blood cells in place of O₂.

Less O₂ = less respiration = health problems

Atmospheric Pollutants

2. Their effects

CO₂
carbon dioxide

H₂O
water vapour

CO
carbon monoxide

SO₂
sulfur dioxide

NO_x
nitrogen oxides

solid particulates
Unburned fuel / soot



Both cause:

- Respiratory problems
- Acid rain – kills wildlife and damages buildings

Atmospheric Pollutants

2. Their effects

Acid Rain

CO₂
carbon dioxide

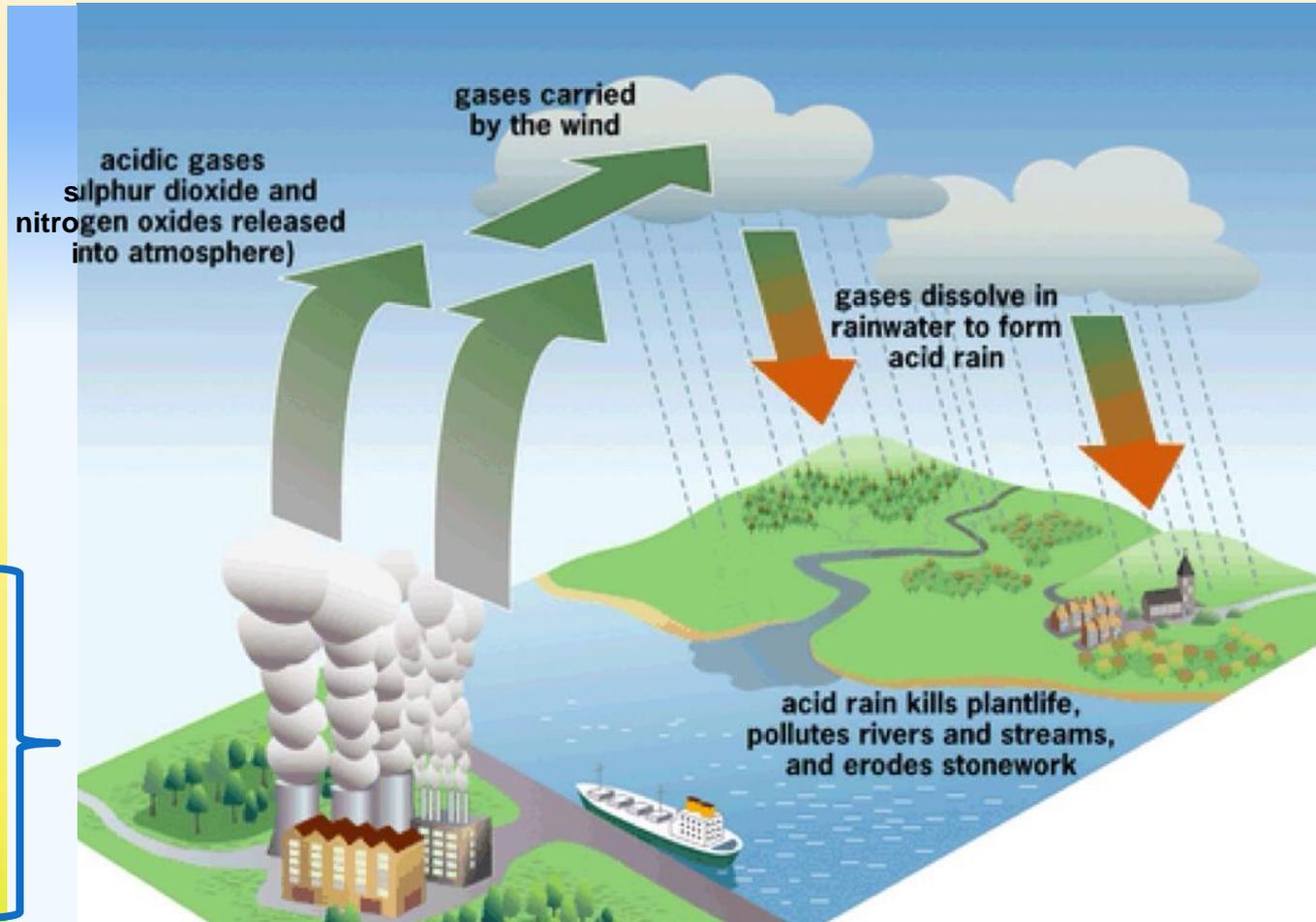
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Atmospheric Pollutants

2. Their effects

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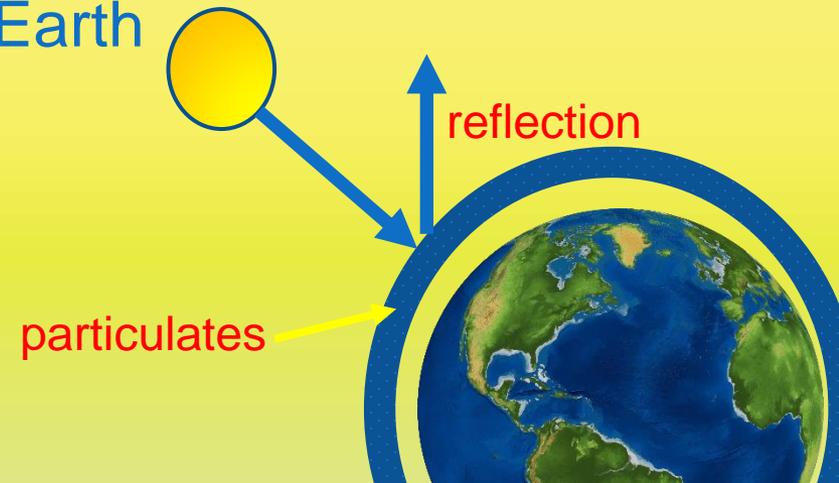
Particulates cause health problems:

- Lung damage



AND cause global dimming:

- Particulates in the upper atmosphere reflect sunlight back into space – less reaches the Earth



Plenary: London's Toxic Air

THE BIG SMOKE London's air pollution in numbers

an
of the year

King's College London found that Oxford Street's nitrogen dioxide pollution levels are the worst in the world.

Video: London Air Pollution

<https://www.youtube.com/watch?v=ix3HBR2BU8c>

Discuss: Given all these facts, would you choose to stay in London?