

Climate Change, Science and Action!

Post-Primary

Introduction

The following notes are to accompany the prezi resource found here: <https://tinyurl.com/y87pck8j>

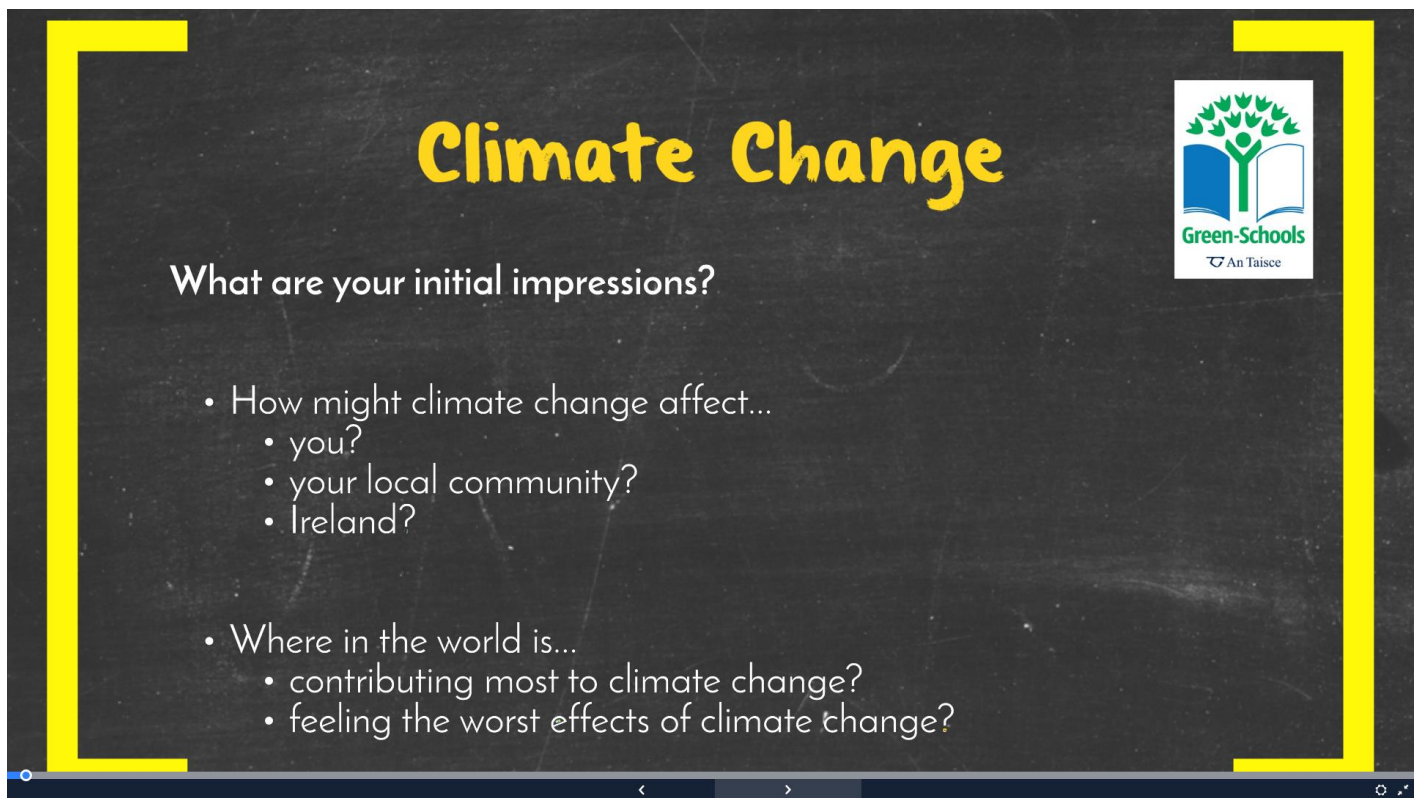
The presentation and accompanying notes have been developed by the Climate Action Team at An Taisce's Environmental Education Unit for use by secondary school teachers engaged in the Green-Schools programme. The hope is that climate change will become a common discussion point and cross-curricular theme throughout post-primary education in Ireland, not just in Science, Geography, Environmental Social Studies, Politics and Society, and Agricultural Science lessons, but also in Maths, Art, Business, C.S.P.E., Home Economics, S.P.H.E., Music, P.E., and all of the language subjects.

Outline

1. Climate Change
2. Climate Science
3. Climate Action



Climate Change



Baseline Activity

Using scrap paper, jot down the first thing that pops into your head when you hear '**climate change**'?

1. What are your initial impressions? What images, words or phrases come to mind?

There are no wrong answers, just varying impressions. After a minute or two, ask someone to share one word that they wrote down. Then ask the rest of the class to raise their hand if they had the same word or something similar. Record the most common words, phrases or images and come back to this later. As your class learns more about climate change, they may wish to add some words to a wider layer around the baseline.

Further Questions

2. How might climate change affect you?

- Think about what is really important to you and how climate change could affect it.

3. How might climate change affect your school community?

- Think about any extreme weather that has already affected your school or local community.

4. How might climate change affect Ireland?

- Warmer summers, wetter winters, more extreme weather (such as Storm Ophelia).
- More flooding in the North and West.
- Drought in the South and East.
- Water shortages and water quality issues, especially around Dublin.
- Possible extinction of vulnerable species and alterations in migration and hibernation of others; bees, butterflies, bats, birds, hare, red squirrel...
- Farmers, fisheries, tourism and the local economy could all be negatively affected.

5. Where in the world is contributing most to climate change?

- The intensive burning of fossil fuels is one of the primary causes of man-made climate change. The Global North, or developed countries, are vastly responsible for excessive fuel use since the Industrial Revolution.

6. Where in the world is feeling the worst effect(s) of climate change?

- Climate change is resulting in an increased number of extreme weather events and it is largely affecting the Global South, or developing countries, where the economy and infrastructure is hit hardest by disaster.

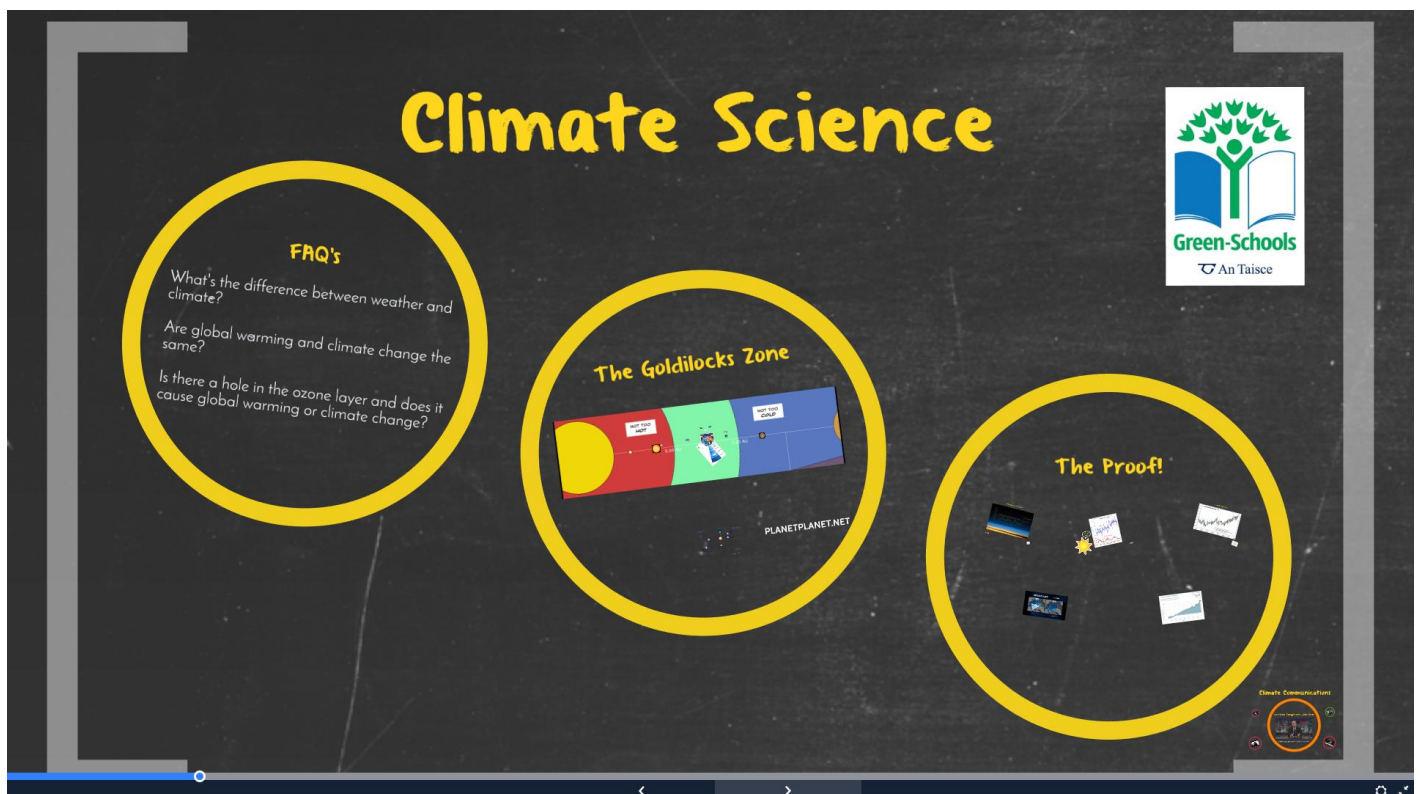
7. Who is at risk of climate change?

- Pretty much everybody! Since 2008, over 20 million people have been forcibly displaced every year by weather-related disasters such as floods, storms, wildfires and extreme temperatures. As Obama said in 2015, climate change is happening now. These are climate refugees.

These questions could be revisited at the end of your lesson(s) on climate change, to see what your students have learned since the initial baseline impressions.

Climate Science

Before we delve into climate science, we're going to have a quick look at some of the most frequently asked questions. Then we'll consider why the Earth is so special and take a look at some of the scientific proof of anthropogenic (human-caused) climate change.



FAQ's

1. So what's the difference between weather and climate?

Quite simply, **weather** is what we are experiencing NOW (minutes to weeks, like what Evelyn Cusack presents) and **climate** refers to an average of weather patterns over a much longer period of time (years to centuries, like what climatologists predict). Scientists are often asked how they can accurately predict the climate 30 years from now if tomorrow's weather forecast is wrong.

A simple way of understanding this is by looking at a comparison; we know the average life expectancy for men and women in Ireland is about 81.4 years, slightly higher for women and lower for men, but we can't predict the exact date each individual person will die.

The weather is constantly changing whereas climate is much more gradual and easier to predict.

2. Are global warming and climate change the same thing?

The short answer is no! **Global warming** refers to the increasing average surface temperature of Earth (which we'll look at more later), whereas **climate change** encompasses global warming, changing rates of precipitation, and evaporation, rising sea levels plus all of the extreme weather events such as **flooding**, drought and storms or hurricanes.

Ireland had its fair share of flooding in 2009 with most of the country shutting down, unable to respond to such unprecedented floods. Here we have a couple of photo's from:

- Ballyhaunis, Co. Mayo
- Graiguenamanagh, Co. Kilkenny
- Douglas, Co. Cork

It's not that the phrase 'global warming' is wrong; it's just that climate change is more accurately describing what is happening in the bigger picture.

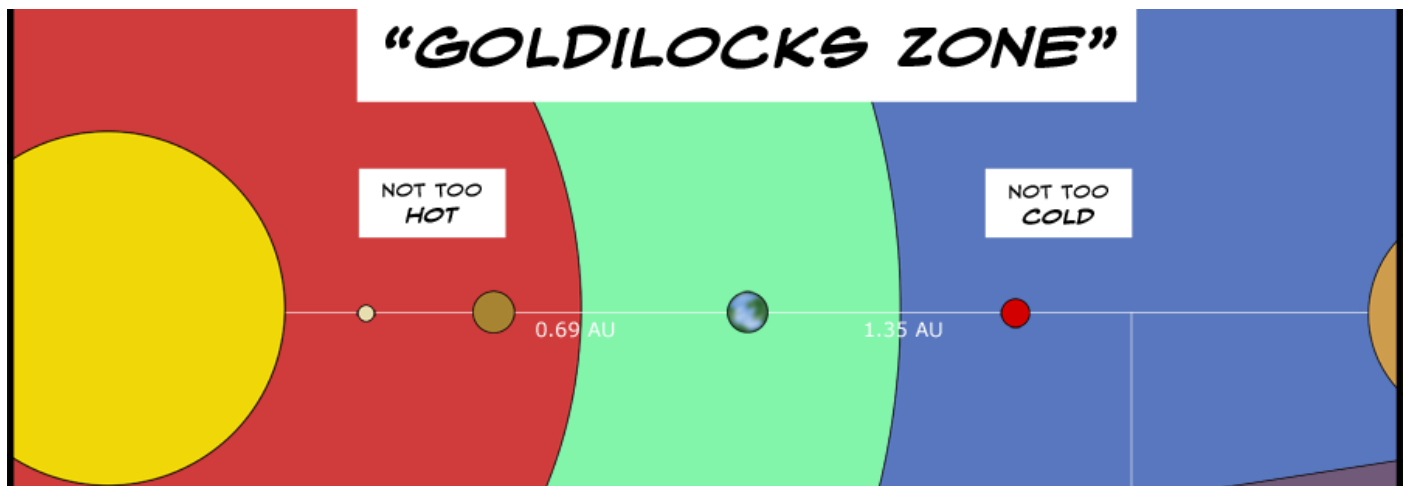
3. Is there a hole in the ozone layer and does it cause global warming or climate change?

The **thinning** in parts of the ozone layer is caused by a group of man-made chemicals, the most well-known being **CFC's** or chlorofluorocarbons. These were banned in **1987** when world leaders first agreed to the **Montreal Protocol**. CFC's are found in things like refrigerants, solvents, foams and **aerosol sprays**. The ozone layer has a very important job of protecting us on Earth from too much UV radiation from the sun.

Thinning in parts of the ozone layer does not cause global warming or climate change; however, global warming could actually slow the natural repairing process of the ozone layer – so kind of the opposite of what everyone thinks.

While global warming heats the atmospheric layer closest to Earth, it causes the ozone layer to cool and thereby worsening ozone loss.

The Goldilocks Zone



Much like the childhood story, Earth sits in what is known as the **Goldilocks Zone**. Similar to Goldilocks' porridge, the temperature on Earth is just right; not too hot and not too cold. This is extremely important because it allows liquid water to exist on this planet. Venus and Mars are technically in this habitable zone too, and both of them also had water once upon a time. "However, **Venus** now has a **runaway greenhouse effect**...with a surface temperature of **over 460 degrees Celsius**, which has boiled away all its liquid water". In contrast, **Mars'** once abundant rivers, lakes and oceans now form "a freeze-dried desert, with a thin carbon dioxide atmosphere" and **99 times less atmospheric pressure than sea level on Earth**. "The lack of both a significant atmosphere and a global magnetic field - thanks to its mostly solidified core - means the Martian surface is constantly being **irradiated** by the Sun".

<https://tinyurl.com/y9ry6u82>

What else do we know about the Earth's positioning relative to the Sun?

It changes! The distance between the sun and the earth varies as the earth **orbits** the sun every **365.24 days** (hence why we have a leap year every 4 years), and the pathway is not a perfect circle, but **elliptical**. In July, the earth was approximately **5,000,000km** further away from the sun than in January.

<https://tinyurl.com/y8647e93>

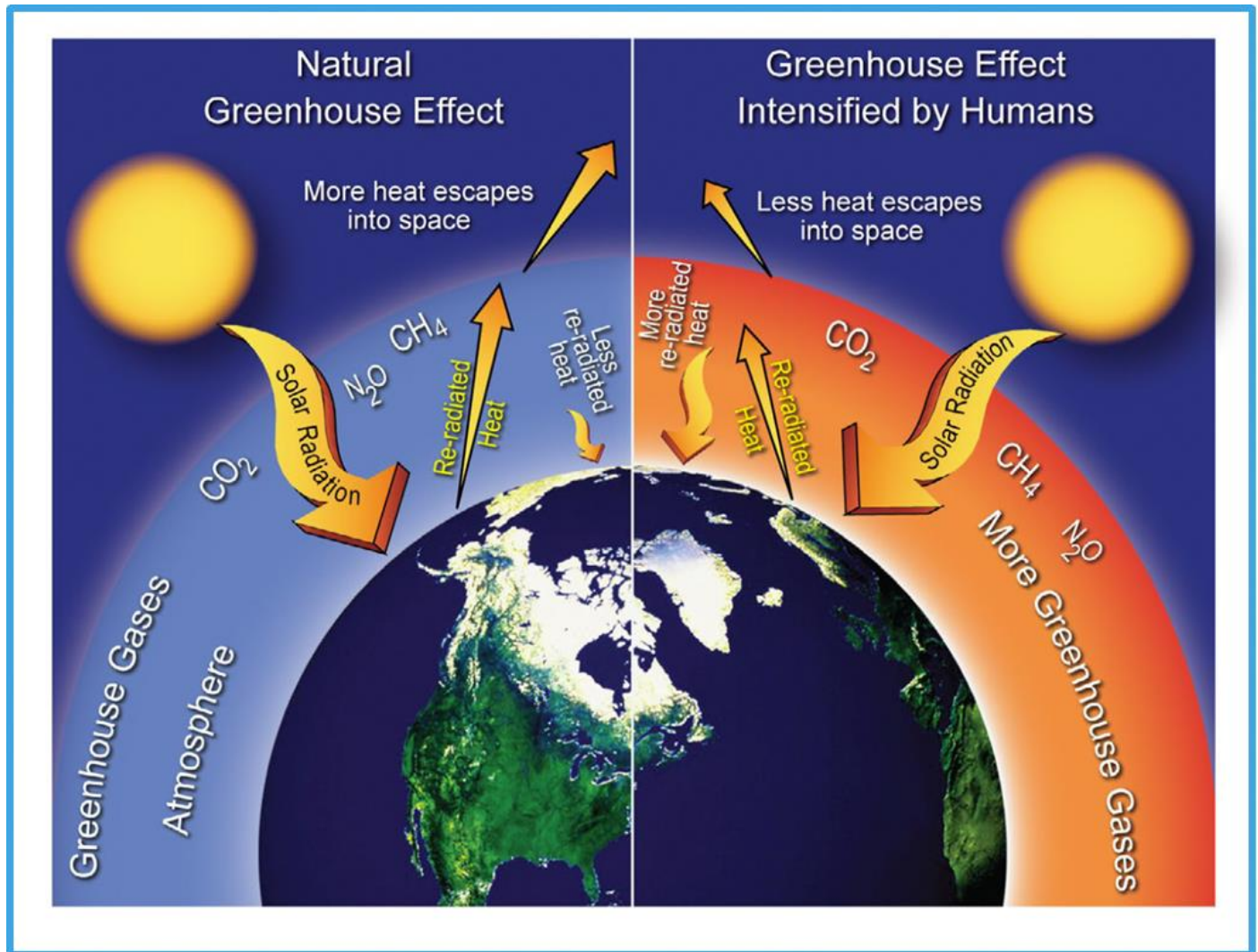
Take a closer look.

Anyone who has seen a mounted globe in a classroom will know that the Earth's **axis** is tilted. This **23.5 degree tilt** is responsible for the **seasons** we experience; when the Northern hemisphere is tilted towards the sun in July, we experience summer and the Southern hemisphere is tilted away from the sun and so experiences winter.

<https://climate.ncsu.edu/edu/Tilt>

The Greenhouse Effect

Earth's atmosphere keeps the surface of the planet about **30 degrees Celsius warmer** than it would be, this is called the **natural greenhouse effect**. As the **sun's solar or shortwave radiation (energy)** reaches earth, about **30% is reflected** back into space, **20% is absorbed by the atmosphere** and the rest is absorbed by land and oceans; but this depends on the reflectivity of the atmosphere and the surface (otherwise known as **Earth's albedo**).

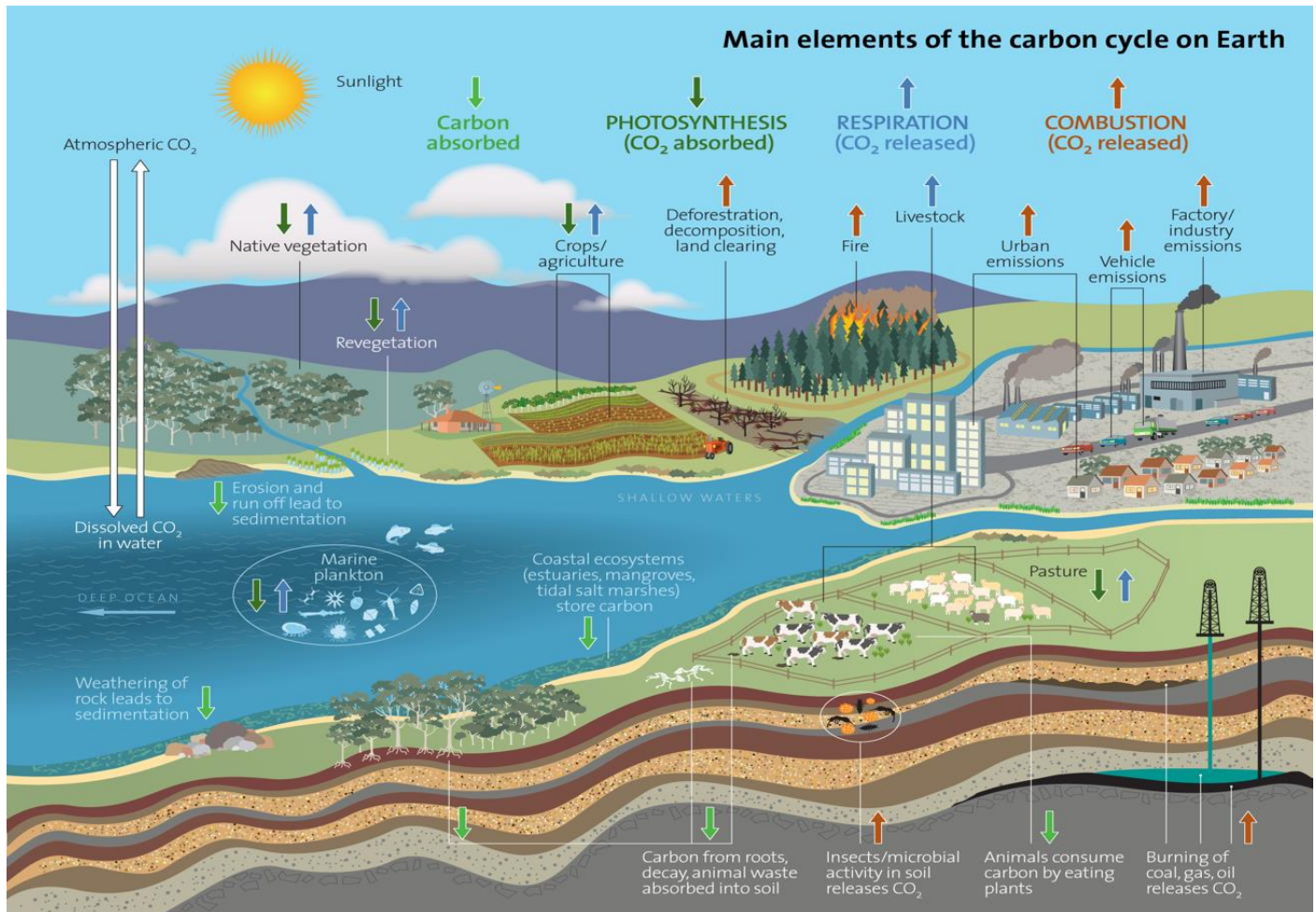


For example, **bright white ice, deserts and clouds will reflect** whereas **dark forests, bogs and deep oceans will absorb** (these are also known as carbon sinks because they can store vast amounts of carbon for longer periods of time).

Going back to the natural greenhouse effect, the **earth cools itself by emitting longwave radiation** back into space, in a stable but delicate state of **equilibrium**; but only about **10% of this passes through the atmosphere**. The rest is absorbed by clouds and Greenhouse Gases (which we'll explore more later) and is then re-emitted in all directions, with about **50% directed back down** towards the earth's surface again, leading to the **natural greenhouse effect** and a warmer surface temperature on Earth. The problem is that this greenhouse effect is being massively **intensified by humans** as we burn up tonnes of fossil fuels and release unprecedented volumes of greenhouse gases; the last 6 years alone have broken previous records for global CO₂ emissions every single year.

The Carbon Cycle

Here we can see the main elements of the carbon cycle on Earth, both natural elements that would exist without humans (such as photosynthesis and respiration), and the intense release of CO₂ emissions as the burning of fossil fuels takes place. Other human activity that results in an increased or unnatural greenhouse effect includes rearing livestock and deforestation.



So now we know that carbon is moving all over Earth's atmosphere, what do you think the atmosphere is actually made up of?

Earth's atmosphere is made up of **5 main layers** extending above the surface, thinning out the higher you go: troposphere, stratosphere, mesosphere, thermosphere and exosphere. It consists of the permanent gases 78% nitrogen, 21% oxygen, 0.9% argon as well as greenhouse gases in varying amounts.

<https://earthobservatory.nasa.gov/IOTD/view.php?id=84499>

Greenhouse Gases

Water vapour (H₂O) is the most abundant greenhouse gas followed by carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and then synthetic fluorinated gases (like the CFC's we mentioned earlier).

Water vapour is unique in that its concentration varies from 0-4% of the atmosphere depending on where you are and what time of the day it is. In the cold, dry arctic regions water vapour usually accounts for less than 1% of the atmosphere, while in humid, tropical regions water vapour can account for almost 4% of the atmosphere.

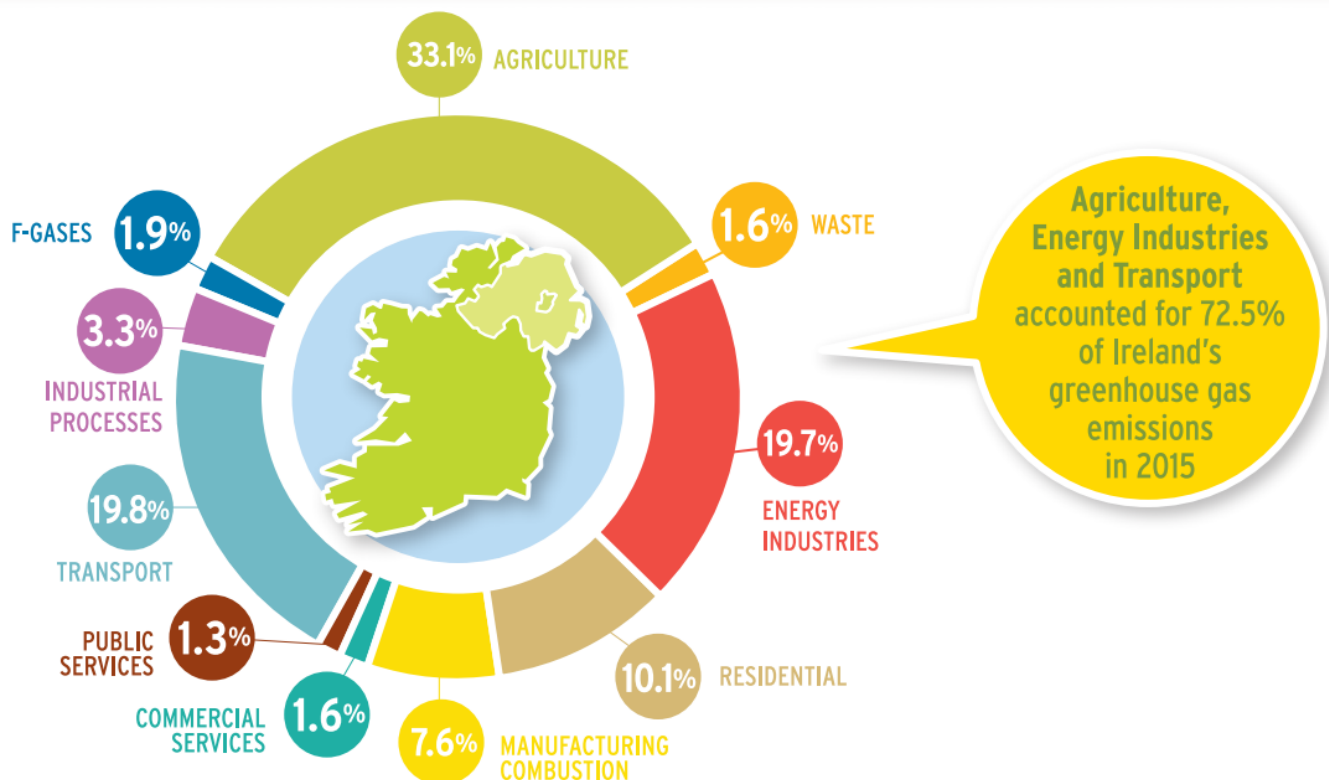
Greenhouse gases whose percentages vary daily, seasonally, and annually have physical and chemical properties which make them interact with the shortwave and longwave radiation (or heat) given off from the earth which affects the energy balance of the globe. This is why scientists are watching the observed increase in greenhouse gases like carbon dioxide and methane carefully, because even though they are relatively small in volume, they can strongly affect the global energy balance and temperature over time. Methane is about 25-30 times more potent and effective at trapping heat than carbon dioxide!

<https://climate.ncsu.edu/edu/Composition>

So where do they come from?

In Ireland, the vast majority of our GHG emissions arise from the **agriculture** industry (33% which is significantly higher than the EU average), closely followed by **transport** (20%) and **energy** (20%). Commercial industry then accounts for 11% while the residential sector emits 10% and waste accounts for 2% (EPA 2015). **Carbon dioxide** mainly comes from burning fossil fuels (such as coal, oil, gas and peat/turf). It is also released through the processes of deforestation and urbanisation. The main sources of **methane** and **nitrous oxide** are farm animals, manure and fertiliser.

SOURCES OF GREENHOUSE GASES

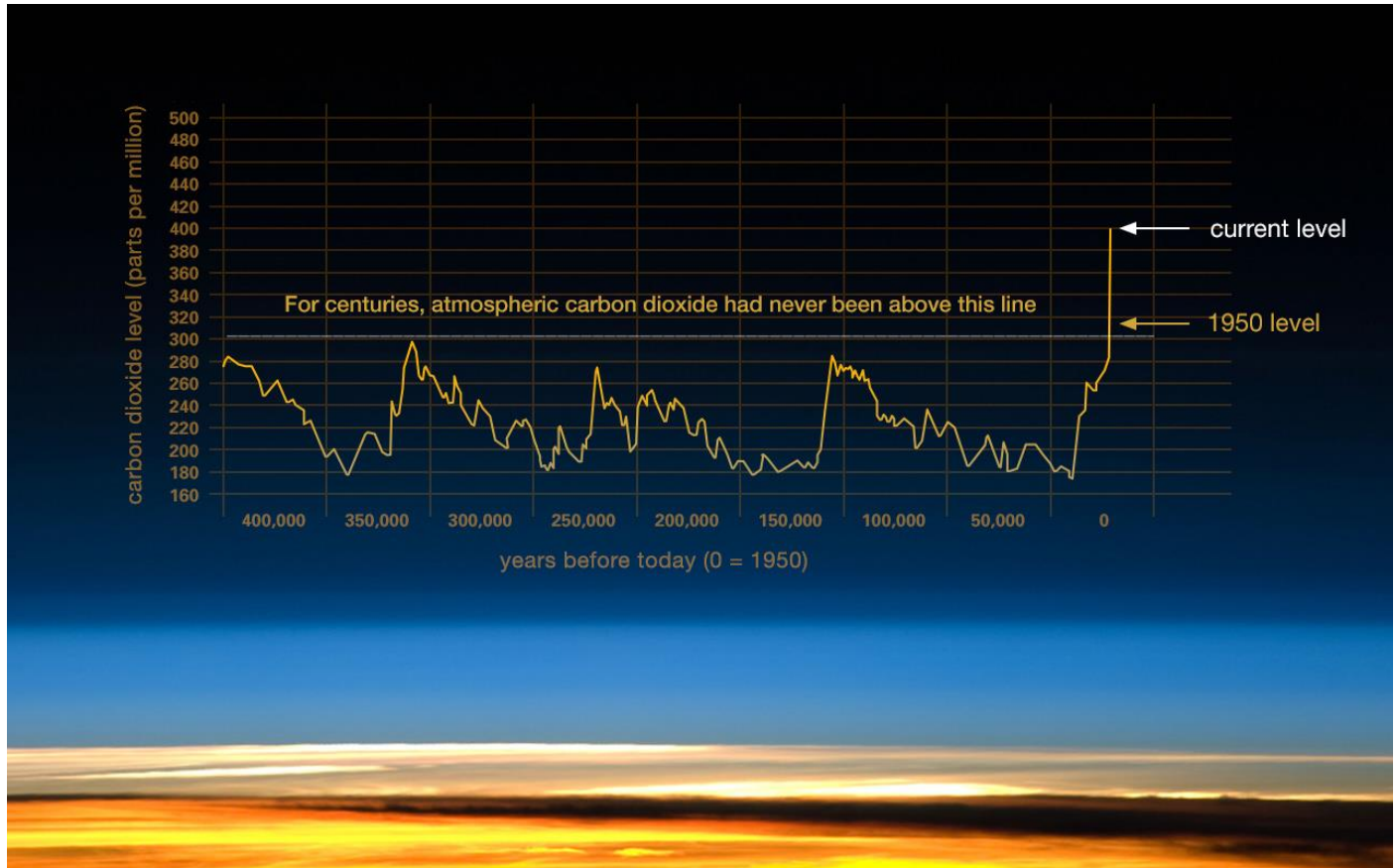


Now we've looked at why the Earth is so special; from its positioning in the Goldilocks' Zone, its elliptical orbit, axis tilt, and the greenhouse effect, the carbon cycle, Earth's atmosphere to greenhouse gases and Ireland's main sources of emissions. It's time to have a look at some of the scientific evidence that proves the negative impact that humans are having on Earth's delicate climate system.

www.epa.ie/media/infographic_climate_July2017.pdf

The Proof!

Firstly, let's look at the Atmospheric CO₂ levels going back 400,000 years. **Can you all see the pattern occurring roughly every 100,000 years? Why do you think that is happening?** Think about the Earth's elliptical orbit and how it changes...this is roughly in line with our ice-ages. **And what do you think caused the steep and never-before-seen rise before 1950?** The intense fossil fuel exploitation and combustion since the Industrial Revolution has soared CO₂ levels to well over 400ppm.



- Take a closer look at Atmospheric GHG levels from the last 2000 years. "Over the last 200 years, the concentrations of the main heat-trapping greenhouse gases have increased significantly in our atmosphere; **carbon dioxide is up by 40%, methane is up by 150% and nitrous oxide is up by 20%.** These three gases are now higher than they have been for at least 800,000 years".
- The next graph shows us a clear Temperature Anomaly from 1880 to the present day from 4 of the most prestigious centres Worldwide. This data represents a **global scientific consensus** that the Earth's surface has increased in temperature by 0.85 degrees Celcius. If we look at this spike in temperature, alongside the increased GHG levels, we can determine a clear correlation.
- Next we have a simple visual representation gif of the clear **Temperature Anomaly** of all countries from 1900 to 2016.
- Some climate deniers or sceptics try to blame the **Sun** but the average energy output has remained relatively stable from 1980-2005, therefore, this is not the cause of the increasing global surface temperature.
- This stark image comparison details the **Arctic sea ice loss** from 1990 – 2015
- A combination of melting sea ice and increased ocean temperatures is causing the water to expand and resulting in a noticeable **sea level rise** as we can see here from 1993 – 2016 which is illustrating an annual rate of 3.41mm.

Climate Communications



Now that you've seen some of the proof supporting anthropogenic climate change, let's have a look at how it can be communicated!

Often the media portrays climate change as a debate, with one 'scientist' on either side. The issue with this is that it's not representative of the scientific community and the overwhelming consensus they have reached. **Watch 'Last Week Tonight with John Oliver: A Statistically Representative Climate Change Debate'.**

Unfortunately the 3% of climate deniers have a loud voice, deep pockets and aren't on their own. **Watch 'Late Night with Seth Meyers: Sceptic Senator Ted Cruz terrifies a 3-year-old girl'.**

It's not just American politicians, and Presidents that are climate deniers... Watch 'The Dail: Danny Healy Rae denies climate change'.

Some governments are taking a novel approach to engaging the public in climate change. **Watch 'Save the PIZZA!' produced by Bensimon Byrne for Ontario MOECC.**

Thankfully there are some intelligent celebrities that are using their voice and influence to raise awareness of climate change! **Watch 'Leonardo DiCaprio's Oscar Award Speech' as he talks about climate change in 2016.**

How could you best communicate climate change to a friend or sibling?

Climate Action

Climate Action

- 1992 Rio Earth Summit
- 1997 Kyoto Protocol
- 2015 Paris Agreement

Ireland is unlikely to meet its 20% target of reducing GHG emissions by 2020

National Mitigation Plan (July 2017)

National Adaptation Framework (Draft currently available)

Over to YOU!

1. Have a Climate Conversation...
2. Host a Climate Action Day during Climate Action Week!
3. Apply to become a Climate Ambassador or nominate a colleague or student!
4. Come to the Climate Expo! Save the date February 22nd 2018.

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www.climateambassador.org

NATIONAL MITIGATION PLAN

FORESTS

- 8,800 ha of new forests each year
- 20 million trees planted
- 2.8 million tonnes CO₂ absorbed
- Wood for 140,000 houses

BUILT ENVIRONMENT

- Government investment of € 4,000m has to date spent under 300,000 energy efficiency upgrades supporting 2,700 jobs
- New buildings after 2020 = 70% improvement in energy performance compared to 2005
- Our Public Sector has improved energy efficiency by 21% and cut carbon emissions by 845,000 tonnes, saving €144m in 2015
- SEAI supported Large Industry Energy Network improved energy efficiency, saving €28m in energy spend and cutting 147,000 tonnes of carbon emissions in 2015

ELECTRICITY GENERATION

- Renewable energy = avoided 630m in fossil fuel imports in 2015
- Renewable electricity = 25.3% of electricity generation = avoided GHG emissions of 3.2 MtonCO₂ in 2015

TRANSPORT

- Lusk Cross City will increase capacity on the LUAS network by an additional 70 million journeys annually
- All new cars and vans sold in Ireland from 2020 = zero emission or zero emission capable
- Busways - more transport fuel will come from renewable sources with planned increases to the Biofuels Obligation Scheme and more gas/biofuel fuelled vehicles

AGRICULTURE

- Farm knowledge transfer groups on sustainability and nutrient management planning = 20,000 participants
- Beef Data and Efficiency Programme = 24,000 equivalent to 1,000,000 animals brought in 4.5% greater carbon efficiency per animal by 2020
- Organic Green = 137,000 Carbon Footprint Audits

Now you know all about climate science and hopefully feel comfortable talking about climate change, let's look at climate action! Avoiding dangerous levels of climate change is still possible, but will require massive effort and coordination from governments, businesses, citizens and scientists in the next couple of years.

World leaders met in **1992** at the **Rio Earth Summit** to form the UNFCCC (The United Nations Framework Convention on Climate Change).

In **1997** they met again and the **Kyoto Protocol** was agreed upon, committing developed countries to legally binding measures that would lower their GHG emissions, but many wealthy nations, such as the USA and Canada dropped out of the Kyoto Protocol because it let developing nations, including China, off the hook.

More recently, in **2015**, the **Paris Agreement** was adopted and out of 197 Parties to the UNFCCC, 194 signed in agreement. As of August 2017, 159 Parties had ratified the agreement. The EU has agreed to a binding target of 40% lower GHG emissions by 2030 compared to 1990 levels.

For Ireland, this means a **20% reduction by 2020** and a **30% reduction by 2030** compared to our 2005 levels. Ireland is unlikely to meet our 2020 target, we'll more likely achieve about 6%. Ireland is in fact expected to increase emissions in two key areas that we mentioned earlier, **transport** and **agriculture**.

So let's take a closer look at the **National Mitigation Plan**, where the government is focusing on 5 key areas:

1. 8,000 hectares of new **forests** every year; this equates to 20 million trees planted and would sequester about 2.8 million tonnes of CO₂ (to put that in perspective we'd currently need about 1.5 billion trees to offset our 60 million tonne CO₂ equivalent emissions every year).
2. It is envisaged that new **buildings** after 2020 will be 70% more energy efficient than our 2005 levels.
3. There will be a focus on **renewable** energy.
4. All new **vehicles** sold in Ireland after 2030 will be zero emission or capable of being zero emission.
5. 1 million animals reared for **livestock** will be 4.5% more carbon efficient by 2020.

What else would you like to see the government implement to lower Ireland's emissions and take action on mitigating climate change?

The key difference between mitigation and adaptation is that mitigation addresses the causes of climate change whereas adaptation addresses the effects of climate change. Check out the **National Adaptation Framework** and compare some of the measures suggested.

Over to YOU!

Now comes the part where you can really make a difference. Here's a couple of climate actions that you can take as an individual, a class or even an entire school!

1. Have a Climate Conversation
 - Use our 3-step guide to hosting a climate conversation or follow the steps in the Green-Schools Climate Action resource pack (chapter 3).
2. Host a Climate Action Day
 - Check out what other schools did by searching for #ClimateActionWeek on facebook or twitter.
 - Take a look at www.greenschoolsireland.org for more ideas, resources and inspiration.
3. Become a Climate Ambassador
 - Do you have what it takes to become a Climate Ambassador for your school community? Join people from all walks of life in this prestigious programme where you will be given the training and a platform to engage your peers in climate change. Or if you don't want to be a CA yourself, why not find out who your local CA is and ask if you can join in the next activity or climate campaign?
 - Check out www.climateambassador.ie

Lastly, we'll wrap up with this quote from Ban Ki-moon, United Nations Secretary-General, speaking to Irish youth about the Sustainable Development Goals:

"Yours is not only the largest generation of young people the world has ever known.

You are also the first generation that can end poverty.

And you are also the last generation that can avoid the worst impacts of climate change.

The world needs you to step up this year and beyond – for people and the planet."