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e-Learning Anaesthesia

Sustainability: **International agreements**

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Module Learning Outcomes

- International agreements and protocols(Montreal, Kyoto, Kigali, Paris, Osaka, Glasgow 2021)
- Greenhouse gas protocol.
- Climate Change Act.
- Healthcare without harm
- Other government Acts and policies, as well as UK and global strategies for climate change

Climate change is increasingly being recognised as one of the biggest threats to the planet. International cooperation is fundamental to attenuate the impact of climate change on global health. Since the first Conference of the Human Environment in 1972, there have been multiple international climate change agreements (see figure 1 below), each identifying areas where improvements need to be made in order to prevent climate change and protect the world. In this module we will look at some of the international agreements and UK policies which may impact on the global issue of climate change and offer strategies to tackle it.

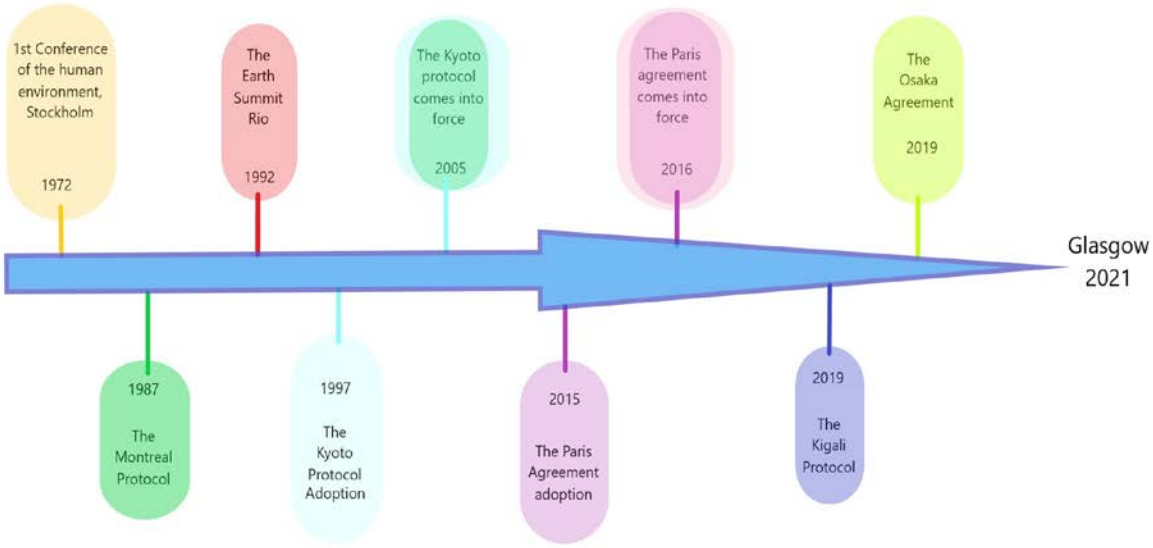

Figure 1: Timeline of international climate change agreements. Designed by authors.

International agreements and protocols

The Montreal Protocol (1987)[1]

At the Vienna Convention in 1985, scientific discoveries were discussed which exposed the effect of human activity on the integrity of the ozone layer. Holes in the ozone layer had been discovered over the Antarctic, and this prompted international action. Two years later, the Montreal Protocol was established and universally ratified. The agreement aimed to phase out substances found to be contributing to ozone depletion, such as chlorofluorocarbons (CFCs). It banned the production and use of CFCs and also exposed the scale of their illegal trade.[a]

The Montreal Protocol set out a timetable of targets for the phase out of 96 specific known ozone depleting substances (ODS).[1] It is reviewed regularly as further scientific knowledge becomes available and with technological advances[2]. Six amendments throughout the years have added to the substances controlled under this protocol. Since its implementation, the atmospheric concentrations of CFCs have not risen.

The Kyoto Protocol (1997-2005)[3]

This international agreement aimed to reduce the emissions of 6 main greenhouse gases (GHGs):[4]

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PCFs)
- Sulphur hexafluoride (SF_6)
- Nitrogen Trifluoride (NF_3)[b]

The Kyoto Protocol was adopted in Kyoto in December 1997, and became international law in February 2005. It recognised that developed countries were principally responsible for the majority of GHG emissions, and bound them to emission reduction targets. The aim was to reduce emissions by 5.2% below pre-industrial levels with a deadline of 2012. These emissions represented 29% of the world's total GHGs. Each nation had its own individual target to reach by this date. Unfortunately,

the USA left this agreement in 2001, concerned it would harm the US economy, and Canada withdrew in 2011.

In 2012, delegates at the Doha conference chose to extend the Kyoto Protocol into a second commitment period, until 2020, and added nitrogen trifluoride (NF_3) to the list of GHGs covered in the agreement.

The Kyoto Protocol aimed to use natural carbon 'sinks', such as trees, to remove GHGs from the atmosphere. It also introduced the Clean Development Mechanism, whereby a country committed to an emission reduction could invest in countries and projects developing clean energy, sustainable infrastructure and technology. This would allow the committed country to gain carbon credits towards its targets, and developing countries to improve their sustainable footprint, mutually benefitting both countries. Penalties, such as economic and political sanctions, were introduced for countries which failed to meet their targets.

The Paris Agreement (2015-2016)[5]

The Paris Agreement was the first ever legally binding global climate change agreement, which replaced the Kyoto protocol. Its long term, holistic approach to climate change recognised wide-ranging goals:

- To prevent global temperatures from rising above 2˚C higher than pre-industrial levels, while striving towards limiting the increase to 1.5%
- To pass peak emissions as soon as possible
- Net GHG neutrality within this century
- To have a 20% reduction in CO_2 emissions, a 20% increase in renewable energy and a 20% increase in energy efficiency by 2020
- Establishing binding commitments for Nationally Determined Contributions (NDCs) from each country, reviewed every 5 years
- Encouraging the use and preservation of natural carbon sinks and reservoirs
- Providing funds for developing parties to meet their commitments
- Developed countries to support and finance developing countries
- Long term sustainable technology development

It entered into force in 2016 and every 2 years, all countries must present their emissions inventories as a way of tracking progress towards their targets.

The Kigali Protocol (2019)[6]

The Kigali Protocol is an amendment of the Montreal Protocol, which aims to avoid the production of 70 billion tonnes of CO_2 equivalent emissions.[7] It focuses on the recovery and destruction of banks of hydrochlorofluorocarbons (HCFCs) used in refrigeration, hydrofluorocarbons (HFCs), used as refrigerants, insulation and aerosols, and ozone depleting substances (ODS) as well as tackling the illegal trade of HCFCs and HFCs. The phasedown of HFCs is expected to avoid up to 0.5°C of global temperature rise. Countries involved are expected to reduce their use of HFCs by 80-85% before the late 2040s. Medical HFCs (MDI propellants and inhalation anaesthetic agents) are excluded from this agreement.[c]

The Osaka Agreement (2019)[8]

This recognised the US withdrawing from the Paris agreement, and focused on investing in good quality infrastructure and providing access to health education and training. It discussed investment in sustainable growth and financing business innovation to help combat climate change.

The Greenhouse Gas Protocol

The GHG protocol is a standardised method for companies, governments and cities to comprehensively calculate their greenhouse gas emissions.[9] Globally, it is the most widely used tool for quantifying emissions of the 7 greenhouse gases named in the Kyoto Protocol.

The GHG Protocol's 'Corporate Standard' tool separates greenhouse gas emissions into 3 'scopes':

Scope 1 – Emissions from a source that you, or your organisation, directly own or control, for example, gas boilers, or fossil fuels for company vehicles.

Scope 2 – Indirect emissions from generation of electricity purchased from a provider (where the emissions occur at the provider's facility).

Scope 3 – Any other indirect emissions, from sources not owned or controlled by the company. For example, production of materials purchased by the company.

Benefits of a global, standardised way of producing an accurate and comprehensive inventory of emissions are that it:

- Reduces the cost of assessing emissions and makes it accessible to all
- Allows easy identification of focal points for reduction
- Allows investment in lower carbon strategy to be guided to the areas where it will be the most effective
- Facilitates comparison over time and between companies or products.

UK: The Climate Change Act (2008)

The Climate Change Act is an Act of Parliament that obligates the Secretary of State for Energy and Climate Change to ensure that the net UK carbon account for 2050 is at least 100% lower than the 1990 baseline, to avoid 'dangerous climate change'.

The Committee of Climate Change (CCC) is an independent body of expert advisors, established by the Climate Change Act. They advise the government on emissions targets and progress towards meeting them, carrying out analyses of science, politics and economics related to climate change.

The initial figure set in law was 80% lower than the 1990 baseline, with the aim to keep atmospheric carbon dioxide concentration below 550 particles per million (ppm). This was thought at the time (incorrectly) to be enough to avoid an increase in global average temperature of more than 2°C.[10]

The target was increased to 100% in 2019 by the Climate Change Act (2050 Target Amendment) Order 2019, following guidance from the Committee on Climate Change in their 'Net Zero Technical Report',[11] which was in turn informed by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.[12] The Intergovernmental Panel on Climate Change (IPCC) is a UN body which analyses scientific evidence relating to climate change. The report showed that global heating can be limited to 2 degrees only if carbon dioxide levels are kept to less than 450 ppm. Carbon dioxide levels were 300ppm or less for more than a million years prior to the industrial era.[13] Levels for 2020 are forecast to be 414ppm at the time of writing, increasing by around 2.5 to 3ppm each year.[14]

The 2019 revision of the Climate Change Act is essential if the UK is to honour the Paris Agreement. The challenge is for net-zero, rather than gross-zero. This means that there will still be emissions, but they will be offset by forests and oceans -natural carbon sinks.

How the Climate Change Act Works

For each five-year period until 2050, a maximum quantity of greenhouse gas emissions or 'carbon budget' is set. This occurs at least 12 years ahead of each five-year period to allow adequate preparations. When each carbon budget is set, the government must respond by publishing strategy and policies which enable the budget to be met. It is recognized that the process is dynamic and that proposals must be constantly measured and adapted. Strategy, progress, shortfalls and predictions are monitored continuously by the CCC who then advise the government on the best course of action, considering emerging scientific research and evidence, and cost effectiveness. The government are obliged to consider but not to follow the

advice from the CCC, but meeting the budgets is enshrined in law. See table 1 below for more details.

Table 1: UK carbon budgets 1-6

Budget number	Time period	Target $MTCO_2e$	% below 1990 baseline	Further details
1	2008 – 2012	3018	25	Outperformed by 1%
2	2013 – 2017	2782	31	Outperformed by 14%
3	2018 - 2022	2544	37	Shortfall predicted
4	2023 – 2027	1950	50	Implemented via carbon budgets order 2011
5	2028 - 2032	1725	57	Implemented via carbon budgets order 2016
6	2033 - 2038	Delayed due to COVID-19	Not yet known	First budget to incorporate net zero legislation

The first 3 carbon budgets (covering the time period from 2008 to 2022) were set in 2008 when the Climate Change Act was made. The 4th carbon budget (2023-2027) was set in 2011 and the 5th in 2016 – 12 years ahead. The Climate Change Act 2008 requires government strategy to be published 'as soon as is reasonably practicable' after setting the carbon budget.

The Clean Growth Strategy 2017[15] sets out plans for how the 5th carbon budget (2028-2032) will be met. The government came under criticism for the 16-month wait for this plan following the publication of the carbon budget. At the time of writing, the 6th carbon budget, due to be set in April 2020, remains to be determined. It has been delayed on account of COVID-19.

UK progress towards a carbon-zero future

The UK has shown clearly that the economy can grow whilst emissions diminish. It was the first country to legislate greenhouse gas emissions targets and to enshrine net-zero in law. Its first three carbon budgets were outperformed. Total CO_2 emissions are currently around 40% lower than they were in 1990, and the country is decarbonizing more rapidly than any other G20 country.[16] A few UK milestones and projections are outlined in figure 2.

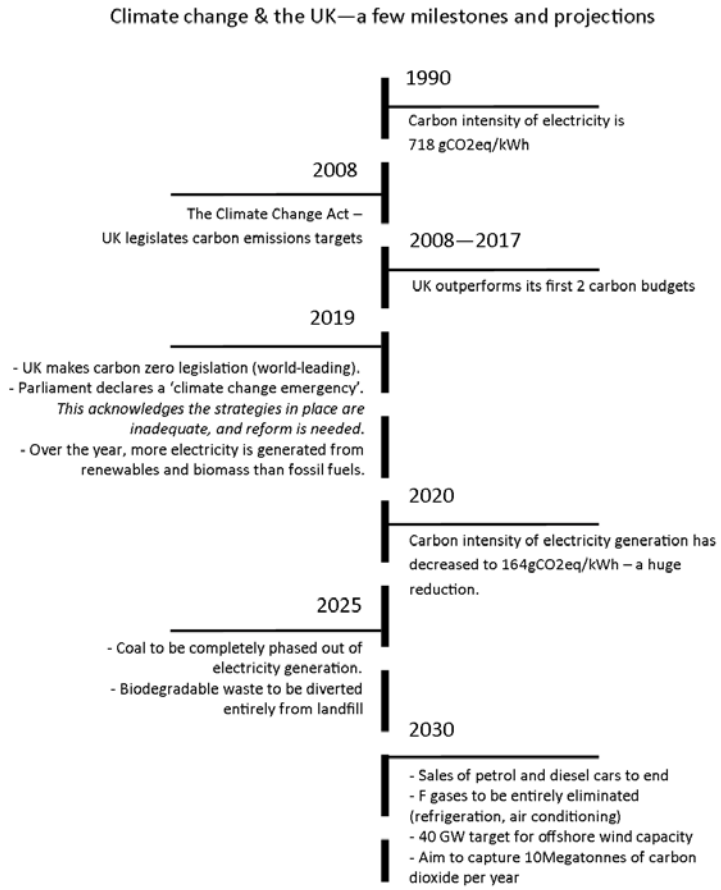

Figure 2: Climate change and the UK - a few milestones and projections

The move away from coal and towards gas and renewables (wind, biomass, solar and nuclear) for electricity is the main player in the reduction in total emissions observed. The carbon intensity of electricity generation has decreased dramatically. It compensates to an extent for growth or stagnation in other major areas. Clean electricity and the electrification of other areas, such as transport and industry, forms a major component of ongoing carbon reduction strategy. The impact of this on total emissions is large but will not be enough to achieve carbon neutrality. Changes beyond electrification require major investment, innovation, and lifestyle changes. Emissions are rapidly rising in the transport, business, domestic and agricultural sectors.

The UK's government's Committee on Climate Change (CCC) predict that the fourth and fifth carbon budget targets will not be met, and that the net zero target is not credible unless major reform takes place. Some of the major cuts in emissions have been attributable to outside factors rather than strategy; the move from coal to gas, the economic recession in 2008, and a large increase in imported goods from China, for which the carbon footprint is not accountable by current means.

UK Climate Change Strategy

The CCC in their Net Zero Technical Report[17] break the challenges down into eight major areas. Below are some of the ways that these areas will be addressed. This is not an exhaustive list.

1.Power and hydrogen production

- Increased development of renewables – nuclear, wind, solar, green hydrogen
- Carbon capture and storage (CCS) – construction of 4 major UK CCS centers by 2030
- Closure of coal stations

Power emissions from burning coal and gas for electricity form about 15% of total emissions in the UK. About half of the reduction in total emissions from the 1990 baseline have come from reduction in energy supply emissions. This is due to increased development of renewables, and closure of coal stations.

CCS forms a major part of the plan going forward – but currently there are no carbon capture facilities in the UK, and the price of carbon capture is very high.

2.Buildings

- New buildings are to be entirely carbon neutral by 2025
- Existing homes will have improvements in efficiency such as wall insulation and low carbon heating.

3.Industry

- Eight industrial sectors (cement, ceramics, chemicals, food and drink, glass, iron and steel, oil refining, and pulp and paper) currently emit around 2/3rds of industrial carbon emissions. Investment from government will allow major changes – for example, energy efficiency of commercial buildings and electrification of heating.

- **Green GB and NI** - A campaign running over a week each year, dedicated to businesses, government and civil societies to explore how to tackle climate change, and how clean growth will affect our futures.

- **London Green 500** - A carbon mentoring program to reduce London's emissions by 60% by 2025, making businesses sustainable and creating tailor made plans for lower carbon alternatives, whilst remaining lucrative.

4.Surface Transport

- Legislation will terminate sales of new petrol or diesel cars and vans by 2030
- By 2035, all vehicles sold are to have zero tailpipe emissions.
- Investment in EV charging capability.
- Systematic changes to public transport.
- Infrastructure changes to make cycling, walking and working remotely easy.

5.Aviation and Shipping

- Operational measures (air traffic management and efficiency)
- Fuel efficiency
- Sustainable biofuel
- Constrained growth
- Carbon offsetting (for example, planting compensatory trees)

International shipping and aviation are not included formally in the carbon accounts, a subject of considerable contention. Greta Thunberg has accused the government of 'very creative carbon accounting' with regard to this. Aviation and shipping emissions are addressed by UN agencies, but there is growing doubt, as the sectors continue to grow, that these have the ability or power to curb this major source of carbon emissions. Strategy relies heavily on carbon offsetting, which many believe not to be a solution moving forwards. The net zero legislation however does include emissions from shipping and aviation, so it remains to be seen how this will be achieved.

6.Agriculture, land use, forestry

- Planting trees – a new forest network including forests on farmland. Boris Johnson pledged to plant 30,000 hectares of new woodland by 2025.
- Restoring peatland
- Carbon Capture and Storage

The CCC and government are careful about suggesting changes in diet. It is well established scientific fact that a plant-based diet has a drastically lower carbon footprint than one that includes meat and dairy. 78% of global farmland is used to raise animals, which provide 18% of calories eaten.[18] Over half of all land farmed in the UK is for animal fodder. Only a fraction of this would be needed to grow crops for direct human consumption. This has massive implications regarding climate change, and has a gross detrimental effect on global biodiversity.

Despite overwhelming evidence, the CCC cautiously suggests only a 20% reduction in beef, lamb and dairy in their most ambitious projection. Government strategy for emissions reduction in agriculture fails to address this.

7.Waste

- Divert biodegradable waste from landfill
- Limit emissions from waste combustion
- Investment to reduce food waste by 20% by 2025

8.F gas emissions

- Completely move away from F gas emissions (by 2030)

The Green Recovery Plan

In November 2020, the UK government published a summary document laying out plans for a 'Green Industrial Revolution' following the COVID-19 pandemic. It breaks the areas down into 10 points.[19] The shortfalls, ambitions, feasibility, optimism and inadequacy of the ten-point plan have been dissected at length by the media and scientists worldwide.

1. Offshore wind – 40GW by 2030
2. Low carbon hydrogen production – 5GW by 2030
3. Nuclear – a large scale nuclear plant is suggested, and the potential for jobs it would create is praised, but there are no solid proposals other than investment in targeted nuclear research.
4. Shift to electric vehicles – no new petrol or diesel cars to be sold after 2030, all new vehicles to be carbon-zero by 2035.
5. Green public transport, cycling and walking – for example, thousands of miles of cycle lanes and 4000 electric buses
6. Jet zero and green ships – operational measures and investment in sustainable aviation fuel
7. Greener buildings – 600,000 heat pumps installed per year by 2028, investment in decarbonizing the public sector, carbon-zero new homes and extended grants to make improvements to existing homes.
8. Carbon capture and storage – Aim to capture 10Mt of carbon dioxide per year by 2030
9. Protecting natural environment – Creation of new National Parks, Landscape Recovery projects.
10. Enhancing green finance and innovation

Climate Change and Healthcare

Healthcare Without Harm (HCWH)

This is an international Non-Governmental Organisation (NGO) of healthcare systems and professionals, which works within the healthcare sector to reduce its negative effects on the environment.[20]

Their main targets include:

- Dangerous chemicals (e.g. Mercury and Endocrine Disrupting Chemicals)
- Greenhouse gas emissions
- Antimicrobial resistance
- Sustainable procurement of goods and services by the healthcare sector

In 2019, HCWH in collaboration with ARUP released a report – "Health Care's Climate Footprint'[21] which stated that 'If the health sector were a country, it would be the fifth-largest emitter on the planet'. The report:

- was the first report to estimate emissions from global healthcare.
- shows that healthcare, which exists only to improve health, is itself a king pin in the greatest threat to global health - the climate crisis.
- establishes comparisons between areas – estimating that Europe's healthcare footprint is disproportionately high and combined emissions from healthcare in the US, China and Europe form 56% of the global total.
- breaks down the relative contributions according to the greenhouse gas protocol: Scope 3 forms 71% of emissions.
- makes recommendations which compel the sector to address their emissions and work towards meeting the terms of the Paris Agreement.

NHS Net Zero Carbon

On 1st October 2020, The NHS published the first world document to commit to net zero carbon by 2050.[22]
This summary outlines the stages in a patient's care pathway where action must be focused to achieve that goal.

1. Developing a framework to evaluate carbon reduction associated with new models of care . See e-module within this series entitled '*Processes, pathways and journeys*' for further details and examples.
2. To work with NHS suppliers to ensure that all of them meet or exceed the commitment on net zero emissions before 2030. See e-module within this series entitled '*Procurement, supply chain and carbon costing'* for further details and examples.

3. Working towards road-testing for what would be the world's first zero-emission ambulance by 2022, with a shift to zero-emission vehicles by 2032 feasible for the rest of the fleet. For example, rewards for staff driving carbon neutral vehicles.
4. Ensuring the digital transformation agenda aligns with the ambition to be a net zero health service, that it reduces wastage and replication of visits, tests and investigations.
5. Construction of 40 new 'net zero hospitals' as part of the government's Health Infrastructure Plan
6. Completing a £50 million LED lighting replacement program
7. Building resilience and adaptation into the health and social care network – can our health service function in the setting of severe weather events be they floods or heat waves
8. For a greener NHS, and ensure that every NHS organisation has a board-level net zero lead, making it clear that this is a key responsibility for all staff.

UK Net Zero and Anaesthesia

Many of the above areas of carbon reduction can be favourably influenced by changes in perioperative and anaesthesia practice. Considering specifically reducing the effect of inhalational anaesthetics and nitrous oxide, please see section 3.4.2 within 'Delivering a net zero NHS'[22] as well as to the e-module within this series entitled *'Medical gases'*.

Global strategies for climate change

Throughout the world, countries are working to meet targets and form strategies to slow global heating. The United Nations Framework Convention on Climate Change (UNFCCC) is a driving force behind many policies. It was founded in 1992 and has 197 member countries.[23] The ideas it promotes aim to reduce GHG emissions and avoid a dangerous temperature increase by reporting national emissions, funding climate action in its member countries and unifying global action. Only through global policy will GHG emissions be substantially reduced and climate change be tackled effectively. The UNFCCC recognises this and although there is a long way to go, its strategies have had a positive impact on global awareness of climate change, and the fight to prevent it.

The enormity of the problem may seem daunting but everyone in every stage of their daily lives can make a difference. It is only by working together that we can pull back from the precipice and preserve the planet for the future generations.

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[a] Ozone depleting substances generally contain chlorine. One ODS molecule is capable of destroying tens of thousands of molecules of stratospheric ozone. Importantly ODS also have significant global warming potentials. For example, the GWP of CFC-11 (CCl_3F) is 4660.

[b] Nitrogen Trifluoride added in the Doha Amendment in 2012, treaties.un.org/doc/Publication/CN/2012/CN.718.2012-Eng.pdf (Accessed September December 2020)

[c] The propellants in MDI inhalers are mainly HFC-134a (tetrafluoroethene GWP 100 1430) and to a lesser extent HFC-227ea (heptafluouropropane GWP 100 3220). There is a well-established, though perhaps not so well advertised, MDI recycling scheme operated through pharmacies. Any residual propellant is recycled minimising the immediate environmental effect and sold to other industries as general manufacture is phased out as part of the Kigali Agreement. All MDI users are encouraged to make use of the inhaler recycling scheme. The value of the scrap aluminium in an inhaler is about 1p.

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Climate change is one of the biggest threats to the planet. International cooperation is essential to limit anthropogenic global heating. Since the first Conference of the Human Environment in 1972, there have been multiple international climate change agreements (see Figure 1 below), each identifying areas where changes must be made to reduce climate change and protect the world. In this module we will look at some of the international agreements and UK policies which may impact on the global issue of climate change and offer strategies to tackle it.

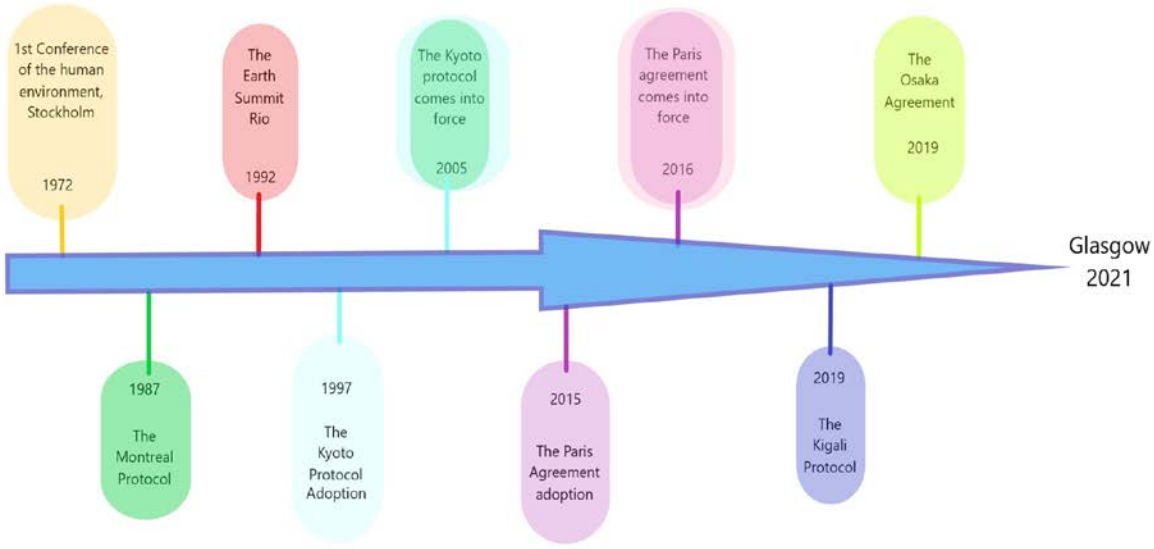

Figure 1: Timeline of international climate change agreements. Designed by authors.

International agreements and protocols

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The Osaka Agreement (2019)[7]

This recognised the withdrawal of the US from the Paris agreement, and focused on investing in good quality infrastructure and providing access to health education and training. It discussed investment in sustainable growth and financing business innovation to help combat climate change.

C The propellants in MDI inhalers are mainly HFC-134a (tetrafluoroethene GWP 100 1430) and to a lesser extent HFC-227ea (heptafluouropropane GWP 100 3220). There is a well-established, though perhaps not so well advertised, MDI recycling scheme operated through pharmacies. Any residual propellant is recycled minimising the immediate environmental effect and sold to other industries as general manufacture is phased out as part of the Kigali Agreement. All MDI users are encouraged to make use of the inhaler recycling scheme. The value of the scrap aluminium in an inhaler is about 1p.

The greenhouse gas protocol

The GHG protocol is a standardised method for companies, governments and cities to comprehensively calculate their greenhouse gas emissions.[8] Globally, it is the most widely used tool for quantifying emissions of the 7 greenhouse gases named in the Kyoto Protocol.

The GHG Protocol's 'Corporate Standard' tool separates greenhouse gas emissions into 3 'scopes':

Scope 1 – Emissions from a source that you, or your organisation, directly own or control, for example, gas boilers or fossil fuels for company vehicles.

Scope 2 – Indirect emissions from generation of electricity purchased from a provider (where the emissions occur at the provider's facility).

Scope 3 – Any other indirect emissions, from sources not owned or controlled by the company. For example, production of materials purchased by the company.

Benefits of a global, standardised way of producing an accurate and comprehensive inventory of emissions are that it:

- Reduces the cost of assessing emissions and makes it accessible to all
- Allows easy identification of focal points for reduction
- Allows investment in lower carbon strategy to be guided to the areas where it will be the most effective
- Facilitates comparison over time and between companies or products.

UK: The Climate Change Act (2008)

The Climate Change Act is an Act of Parliament that obligates the Secretary of State for Energy and Climate Change to ensure that the net UK carbon account for 2050 is at least 100% lower than the 1990 baseline, to avoid 'dangerous climate change'.

The Committee of Climate Change (CCC) is an independent body of expert advisors, established by the Climate Change Act. They advise the government on emissions targets and progress towards meeting them, carrying out analyses of science, politics and economics related to climate change.

The initial figure set in law was 80% lower than the 1990 baseline, with the aim to keep atmospheric carbon dioxide concentration below 550 particles per million (ppm). This was thought at the time (incorrectly) to be enough to avoid an increase in global average temperature of more than 2°C.[9]

The target was increased to 100% in 2019 by the Climate Change Act (2050 Target Amendment) Order 2019, following guidance from the Committee on Climate Change in their 'Net Zero Technical Report',[10] which was in turn informed by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.[11] The Intergovernmental Panel on Climate Change (IPCC) is a UN body which analyses scientific evidence relating to climate change. The report showed that global heating can be limited to 2 degrees only if carbon dioxide levels are kept to less than 450 ppm. Carbon dioxide levels were 300ppm or less for more than a million years prior to the industrial era.[12] Levels for 2020 are forecast to be 414ppm at the time of writing, increasing by around 2.5 to 3ppm each year.[13]

The 2019 revision of the Climate Change Act is essential if the UK is to honour the Paris Agreement. The challenge is for net-zero, rather than gross-zero. This means that there will still be emissions, but they will be offset by forests and oceans -natural carbon sinks.

How the Climate Change Act works

For each five-year period until 2050, a maximum quantity of greenhouse gas emissions or 'carbon budget' is set. This occurs at least 12 years ahead of each five-year period to allow adequate preparations. When each carbon budget is set, the government must respond by publishing strategy and policies which enable the budget to be met. It is recognized that the process is dynamic and that proposals must be constantly measured and adapted. Strategy, progress, shortfalls and predictions are monitored continuously by the CCC who then advise the government on the best course of action, considering emerging scientific research and evidence,

and cost effectiveness. The government are obliged to consider but not to follow the advice from the CCC, but meeting the budgets is enshrined in law.
See table 1 below for more details.

Budget number	Time period	Target $MTCO_2e$	% below 1990 baseline	Further details
1	2008 – 2012	3018	25	Outperformed by 1%
2	2013 – 2017	2782	31	Outperformed by 14%
3	2018 - 2022	2544	37	Shortfall predicted
4	2023 – 2027	1950	50	Implemented via carbon budgets order 2011
5	2028 - 2032	1725	57	Implemented via carbon budgets order 2016
6	2033 - 2038	Delayed due to COVID-19	Not yet known	First budget to incorporate net zero legislation

Table 1: UK carbon budgets 1-6

The first 3 carbon budgets (covering the time period from 2008 to 2022) were set in 2008 when the Climate Change Act was made. The 4th carbon budget (2023-2027) was set in 2011 and the 5th in 2016 – 12 years ahead. The Climate Change Act 2008 requires government strategy to be published 'as soon as is reasonably practicable' after setting the carbon budget.

The Clean Growth Strategy 2017[14] sets out plans for how the 5th carbon budget (2028-2032) will be met. The government came under criticism for the 16-month wait for this plan following the publication of the carbon budget. At the time of writing, the 6th carbon budget, due to be set in April 2020, remains to be determined. It has been delayed on account of COVID-19.

UK progress towards a carbon-zero future

The UK has shown clearly that the economy can grow whilst emissions diminish. It was the first country to legislate greenhouse gas emissions targets and to enshrine net-zero in law. Its first three carbon budgets were outperformed. Total CO_2 emissions are currently around 40% lower than they were in 1990, and the country is decarbonizing more rapidly than any other G20 country.[16] A few UK milestones and projections are outlined in Figure 2.

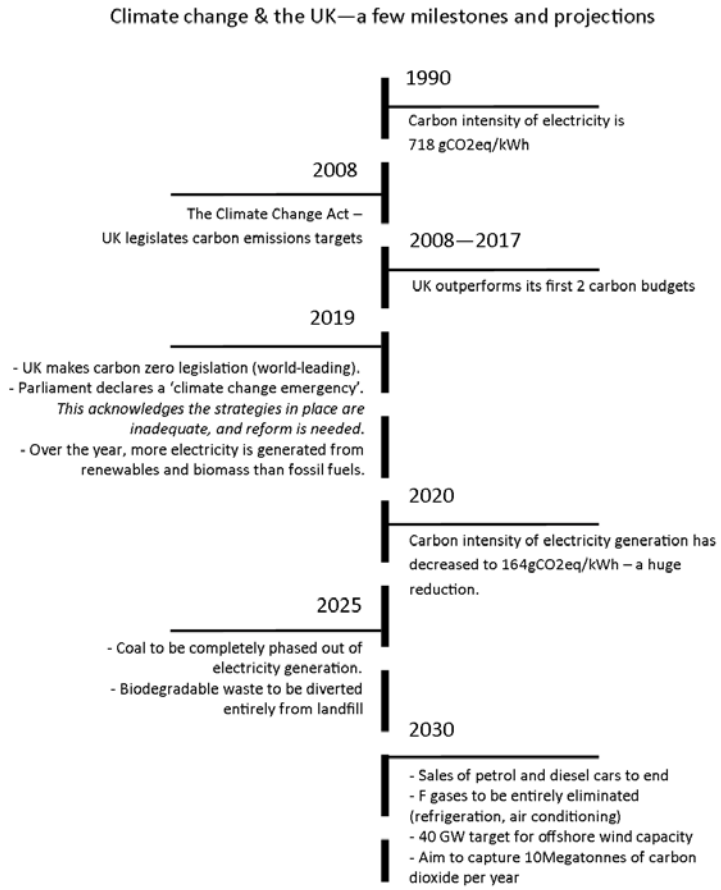

Figure 2: Climate change and the UK - a few milestones and projections

The move away from coal and towards gas and renewables (wind, biomass, solar and nuclear) for electricity is the main player in the reduction in total emissions observed. The carbon intensity of electricity generation has decreased dramatically. It compensates to an extent for growth or stagnation in other major areas. Clean electricity and the electrification of other areas, such as transport and industry, forms a major component of ongoing carbon reduction strategy. The impact of this on total emissions is large but will not be enough to achieve carbon neutrality. Changes beyond electrification require major investment, innovation, and lifestyle changes. Emissions are rapidly rising in the transport, business, domestic and agricultural sectors.

The UK's government's Committee on Climate Change (CCC) predict that the fourth and fifth carbon budget targets will not be met, and that the net zero target is not credible unless major reform takes place. Some of the major cuts in emissions have been attributable to outside factors rather than strategy; the move from coal to gas, the economic recession in 2008, and a large increase in imported goods from China, for which the carbon footprint is not accountable by current means.

UK climate change strategy

The CCC in their Net Zero Technical Report[16] break the challenges down into eight major areas. Below are some of the ways that these areas will be addressed. This is not an exhaustive list.

1.Power and hydrogen production

- Increased development of renewables – nuclear, wind, solar, green hydrogen
- Carbon capture and storage (CCS) – construction of 4 major UK CCS centres by 2030
- Closure of coal stations

Power emissions from burning coal and gas for electricity form about 15% of total emissions in the UK. About half of the reduction in total emissions from the 1990 baseline have come from reduction in energy supply emissions. This is due to increased development of renewables, and closure of coal stations.

CCS forms a major part of the plan going forward – but currently there are no carbon capture facilities in the UK, and the price of carbon capture is high.

2.Buildings

- New buildings are to be entirely carbon neutral by 2025
- Existing homes will have improvements in efficiency such as wall insulation and low carbon heating.

3.Industry

- Eight industrial sectors (cement, ceramics, chemicals, food and drink, glass, iron and steel, oil refining, and pulp and paper) currently emit around two thirds of industrial carbon emissions. Investment from government will allow major changes – for example, energy efficiency of commercial buildings and electrification of heating.

- **Green GB and NI** A campaign running over a week each year, dedicated to businesses, government and civil societies to explore how to tackle climate change, and how clean growth will affect our futures.

- **London Green 500** A carbon mentoring program to reduce London's emissions by 60% by 2025, making businesses sustainable and creating tailor made plans for lower carbon alternatives, whilst remaining lucrative.

4.Surface Transport

- Legislation will terminate sales of new petrol or diesel cars and vans by 2030
- By 2035, all vehicles sold are to have zero tailpipe emissions.
- Investment in EV charging capability.
- Systematic changes to public transport.
- Infrastructure changes to make cycling, walking and working remotely easy.

5.Aviation and Shipping

- Operational measures (air traffic management and efficiency)
- Fuel efficiency
- Sustainable biofuel
- Constrained growth
- Carbon offsetting (for example, planting compensatory trees)

International shipping and aviation are not included formally in the carbon accounts, a subject of considerable contention. Greta Thunberg has accused the government of 'very creative carbon accounting' with regard to this. Aviation and shipping emissions are addressed by UN agencies, but there is growing doubt, as the sectors continue to grow, that these have the ability or power to curb this major source of carbon emissions. Strategy relies heavily on carbon offsetting, which many believe not to be a solution moving forwards. The net zero legislation however does include emissions from shipping and aviation, so it remains to be seen how this will be achieved.

6.Agriculture, land use, forestry

- Planting trees – a new forest network including forests on farmland. Boris Johnson pledged to plant 30,000 hectares of new woodland by 2025.
- Restoring peatland
- Carbon Capture and Storage

The CCC and government are careful about suggesting changes in diet. It is well established scientific fact that a plant-based diet has a drastically lower carbon footprint than one that includes meat and dairy. 78% of global farmland is used to raise animals, which provide 18% of calories eaten.[17] Over half of all land farmed in the UK is for animal fodder. Only a fraction of this would be needed to grow crops for direct human consumption. This has massive implications regarding climate change and has a gross detrimental effect on global biodiversity.

Despite overwhelming evidence, the CCC cautiously suggests only a 20% reduction in beef, lamb and dairy in their most ambitious projection. Government strategy for emissions reduction in agriculture fails to address this.

7.Waste

- Divert biodegradable waste from landfill
- Limit emissions from waste combustion
- Investment to reduce food waste by 20% by 2025

8.F gas emissions

- Completely move away from F gas emissions (by 2030)

The green recovery plan

In November 2020, the UK government published a summary document laying out plans for a 'Green Industrial Revolution' following the COVID-19 pandemic. It breaks the areas down into 10 points.[18] The shortfalls, ambitions, feasibility, optimism and inadequacy of the ten-point plan have been dissected at length by the media and scientists worldwide.

1. Offshore wind – 40GW by 2030
2. Low carbon hydrogen production – 5GW by 2030
3. Nuclear – a large scale nuclear plant is suggested, and the potential for jobs it would create is praised, but there are no solid proposals other than investment in targeted nuclear research.
4. Shift to electric vehicles – no new petrol or diesel cars to be sold after 2030, all new vehicles to be carbon-zero by 2035.
5. Green public transport, cycling and walking – for example, thousands of miles of cycle lanes and 4000 electric buses
6. Jet zero and green ships – operational measures and investment in sustainable aviation fuel
7. Greener buildings – 600,000 heat pumps installed per year by 2028, investment in decarbonizing the public sector, carbon-zero new homes and extended grants to make improvements to existing homes.
8. Carbon capture and storage – Aim to capture 10Mt of carbon dioxide per year by 2030
9. Protecting natural environment – Creation of new National Parks, Landscape Recovery projects.
10. Enhancing green finance and innovation

Climate change and healthcare

Healthcare Without Harm (HCWH)

This is an international Non-Governmental Organisation (NGO) of healthcare systems and professionals, which works within the healthcare sector to reduce its negative effects on the environment.[19]

Their main targets include:

- Dangerous chemicals (e.g. Mercury and Endocrine Disrupting Chemicals)
- Greenhouse gas emissions
- Antimicrobial resistance
- Sustainable procurement of good and services by the healthcare sector

In 2019, HCWH in collaboration with ARUP released a report – "Health Care's Climate Footprint'[20] which stated that 'If the health sector were a country, it would be the fifth-largest emitter on the planet'. The report:

- was the first report to estimate emissions from global healthcare.
- shows that healthcare, which exists only to improve health, is itself a king pin in the greatest threat to global health - the climate crisis.
- establishes comparisons between areas – estimating that Europe's healthcare footprint is disproportionately high and combined emissions from healthcare in the US, China and Europe form 56% of the global total.
- breaks down the relative contributions according to the greenhouse gas protocol: Scope 3 forms 71% of emissions.
- makes recommendations which compel the sector to address their emissions and work towards meeting the terms of the Paris Agreement.

NHS net zero carbon

On 1st October 2020, The NHS published the first world document to commit to net zero carbon by 2050.[21]
This summary outlines the stages in a patient's care pathway where action must be focused to achieve that goal.

1. Developing a framework to evaluate carbon reduction associated with new models of care. See e-module within this series entitled '*Processes, pathways and journeys*' for further details and examples.
2. To work with NHS suppliers to ensure that all of them meet or exceed the commitment on net zero emissions before 2030. See e-module within this series

entitled '*Procurement, supply chain and carbon costing*' for further details and examples.

3. Working towards road-testing for what would be the world's first zero-emission ambulance by 2022, with a shift to zero-emission vehicles by 2032 feasible for the rest of the fleet. For example, rewards for staff driving carbon neutral vehicles.
4. Ensuring the digital transformation agenda aligns with the ambition to be a net zero health service, reducing wastage and replication of visits, tests and investigations.
5. Construction of 40 new 'net zero hospitals' as part of the government's Health Infrastructure Plan
6. Completing a £50 million LED lighting replacement program
7. Building resilience of our healthcare system to severe weather events such as floods and heatwaves.
8. Ensure that every NHS organization has a board level net-zero lead, providing leadership and guidance towards green NHS targets.

UK Net zero and anaesthesia

Many of the above areas of carbon reduction can be favourably influenced by changes in perioperative and anaesthesia practice. Considering specifically reducing the effect of inhalational anaesthetics and nitrous oxide, please see section 3.4.2 within 'Delivering a net zero NHS'[21] as well as to the e-module within this series entitled *'Medical gases'*.

Global strategies for climate change

Throughout the world, countries are working to meet targets and form strategies to slow global heating. The United Nations Framework Convention on Climate Change (UNFCCC) is a driving force behind many policies. It was founded in 1992 and has 197 member countries.[22] The ideas it promotes aim to reduce GHG emissions and avoid a dangerous temperature increase by reporting national emissions, funding climate action in its member countries and unifying global action. Only through global policy will GHG emissions be substantially reduced and climate change be tackled effectively. The UNFCCC recognises this and although there is a long way to go, its strategies have had a positive impact on global awareness of climate change, and the fight to prevent it.

The enormity of the problem is daunting, but everyone in every stage of their daily lives can make a difference. By working together, it may be possible to pull back from the precipice and preserve the planet for the future generations.

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