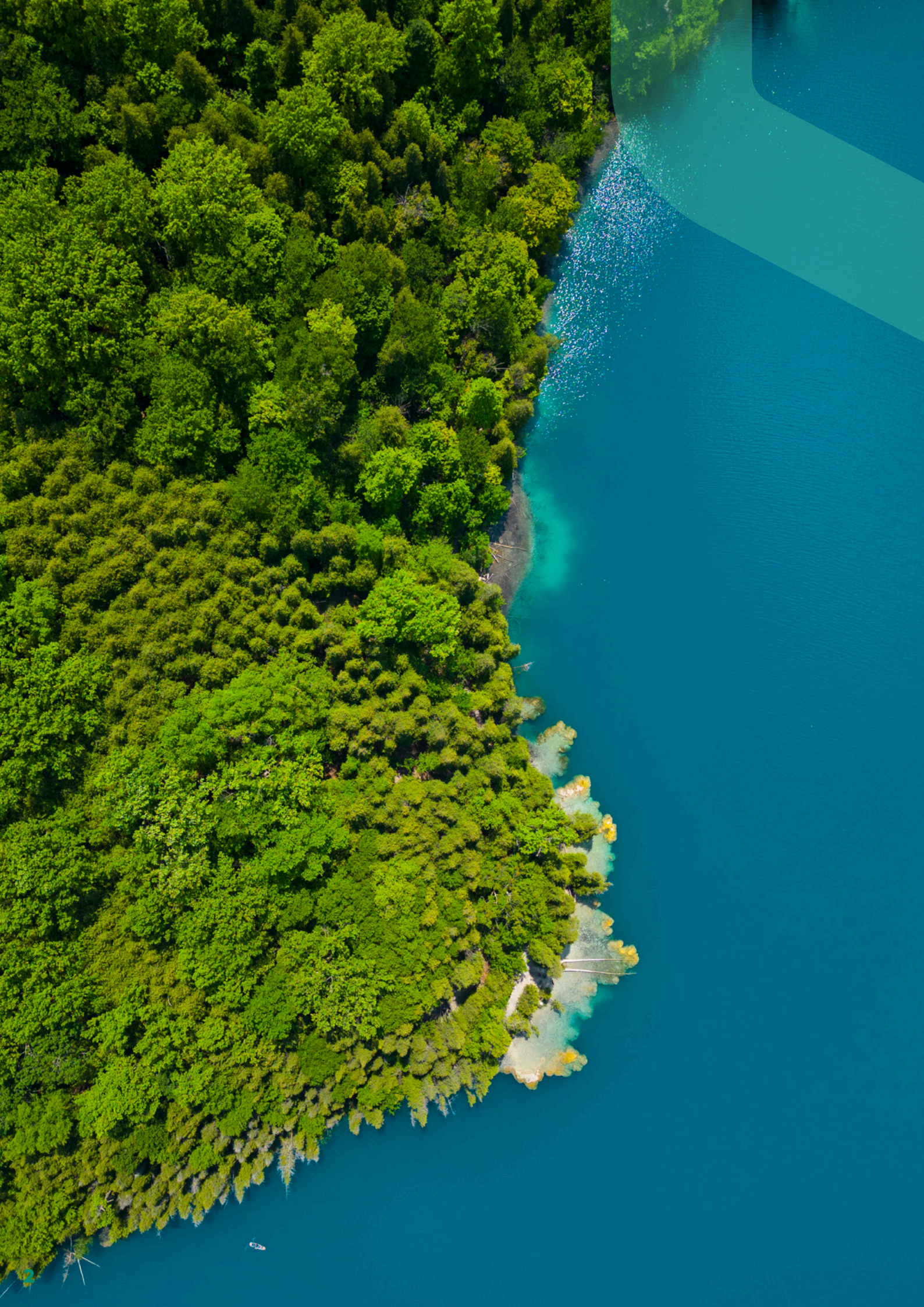
The Parliamentarians' Guide to Climate Change

University of Exeter

Peers for the planet



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The Rt Hon Baroness Hayman GBE
Chair, Peers for the Planet

Professor Lisa Roberts FRSA FRSB
President and Vice Chancellor, University of Exeter

Foreword

This publication aims to provide authoritative scientific evidence and analysis to help guide politicians and decision makers in this crucial decade for delivery of our vital climate and nature targets.

The guide has been produced by the University of Exeter - home to more of the world's top one hundred climate scientists than any other institution - in partnership with Peers for the Planet, a cross-party group which includes many parliamentarians active on climate and nature.

Climate change is an area fraught with disinformation, creating a vital need for reliable, accessible and trusted data and analysis. This guide has therefore been authored by a group of eminent scientists and policy leaders to provide MPs, peers and others in national and local government with an overview of the fundamentals of key aspects of climate science.

The consensus for climate action built amongst scientists, business, the public and politicians gives us the solid foundations needed for action. It is the basis on which we can work together to seek out the solutions and the opportunities that lie within what is an era defining challenge.

The assessments put forward underline how perilously close we are to irreversible tipping points in the natural world and the earth systems we rely on for a thriving planet. We hope that this analysis will inspire policy makers to act now, by delivering changes that we know can tackle climate change, reverse nature decline, catalyse exciting economic change and renewal, and recognise the need for fairness in the course of this transition.

It does not mean we will all agree on a single uncontested pathway to achieve our goals, or that there will not be difficult choices to be made. But we can show national and local leadership, across party lines, drawing on the power of innovation and the diversity of thought at our disposal, to get the job done, working in partnership with the scientific community.

We hope you will find the guide a useful reference, now and through the crucial years ahead.

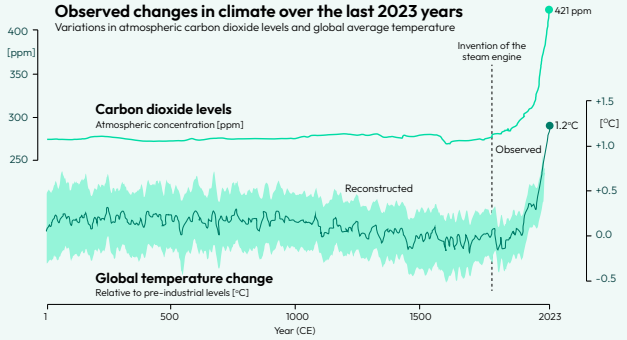
Professor Penny Endersby CBE FREng
Chief Executive, Met Office

Introduction

The fundamentals of climate change

We have known for more than 100 years that carbon dioxide and methane are greenhouse gases which trap energy within the earth's atmosphere

These gases occur naturally in the atmosphere, but we have been adding to them through burning fossil fuels. These fuels were laid down over aeons as plants stored carbon, but by burning 30 billion barrels of oil a year we have put that carbon back into the atmosphere in just a few decades. Carbon dioxide is now at a higher concentration than at any time since humans evolved.



Carbon dioxide levels and global temperature over the past 2023 years. Carbon dioxide data from air bubbles enclosed in Antarctic ice. Global temperature data from the PAGES2k project. Credit: Professor Ed Hawkins, National Centre for Atmospheric Science.

While climate has always changed, the rate of change produced by this high level of greenhouse gases over recent decades is completely unprecedented compared to natural climate cycles.

Levels of certainty

That a warming planet is chiefly the result of human carbon emissions is extremely well understood. The greenhouse effect has been known about since the 19th Century and the first detection of human-caused warming was in the 1930s. In their 2023 assessment report the Intergovernmental Panel on Climate Change (IPCC), representing a consensus view among scientists of all nations, states: "Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming..." Climate models have been able to predict warming with increasing accuracy since around 1970.

(Top row) A paper by Eunice Newton Foote, published in the American Journal of Science and Arts in 1856, presented the first description of atmospheric warming caused by carbon dioxide. (Bottom row) Guy Callendar published a paper in 1938 presenting the first definitive proof of rising global temperatures and linked this effect to rising atmospheric carbon dioxide levels. Image credits: Carlyn Iverson, NOAA, Climate.gov and University of East Anglia Archive.

Net Zero

It is also a fact that the climate will go on warming until we reach net zero emissions, that is: absorb as much warming gas as we emit. Some of the impacts of warming will continue to worsen long after this, for example sea level will rise as deep oceans warm and icecaps melt.

The Importance of 2°C

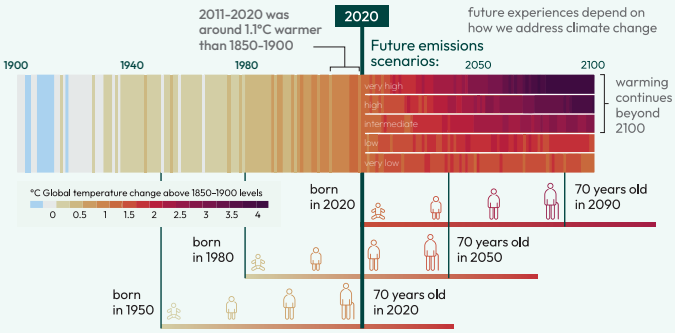
The threshold set by the Paris climate agreement is to stay well below a rise of 2°C since pre-industrial times, and to pursue efforts to limit that even further to 1.5°C. This threshold was chosen as a combination of achievability and what is believed to be necessary to avoid dangerous irreversible climate change, especially so-called tipping points. The thresholds for passing different tipping points are far from certain, but our understanding is growing because of improved modelling, observations and the long palaeo record. Global temperatures continue to rise rapidly and we have recently seen the first 12 month period with an average temperature rise above 1.5°C. In Chapter 1, we see that the Paris threshold is getting ever closer.

Impacts of climate change

Globally

We know that an average rise of 1.5°C produces many more weather and climate extremes. A warmer atmosphere can hold more water, as well as more energy. This means we will see more rainfall as well as temperature extremes. We are already observing increased floods, hurricanes, fires, droughts, heatwaves, biodiversity loss, and movement of plant,human and animal pathogens into new areas.

Predicting societal impacts is more complex but we can expect to see loss of food, water and energy security, leading to increased global conflict. If we don't act fast to reduce emissions, billions of people across the globe may be living in areas which are moving outside the window of human habitability to date, driving mass involuntary migration. The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term



Observed (1900–2020) and projected (2021–2100) changes in global surface temperature (relative to 1850–1900), which are linked to changes in climate conditions and impacts, illustrate how the climate has already changed and will change along the lifespan of three representative generations. Credit: IPCC AR6 Synthesis Report, 2023.

In the UK

We know we will see warmer wetter winters, and hotter drier summers, but with more intense rain when it does fall. Snow and ice days will become rarer. We will see more droughts, wildfires and worse flooding. Attribution of individual events to climate change is a scientific area of growing skill. The 40°C UK heatwave in July 2022 was almost impossible without climate change. The run of exceptionally wet months from October 2023 to March 2024 was around four times more likely and 15% wetter than in a pre-industrial climate.

What should we do?

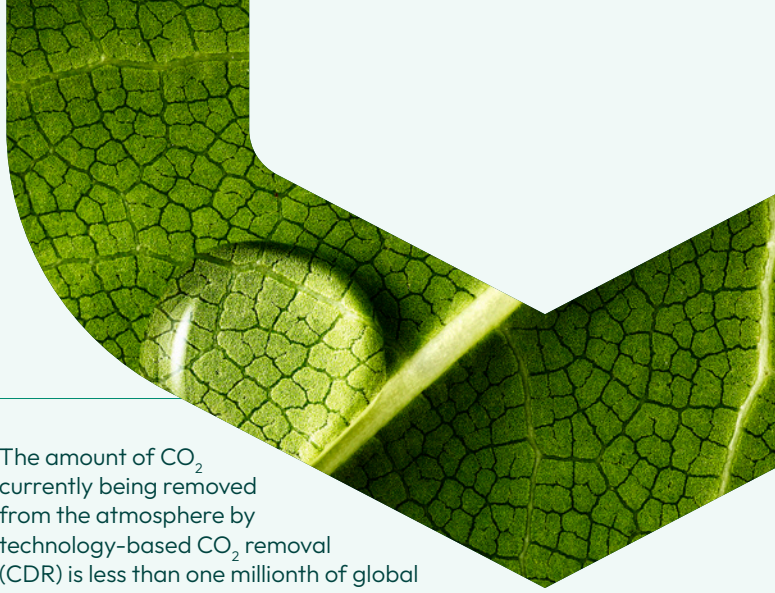
To stabilise the climate, we have to act fast to reduce emissions to get to net zero. The pace of reduction is as important as the eventual date where net zero is achieved, because it is cumulative emissions which determine global temperature rises.

We are already in a changed climate with long-term average warming of around 1.3°C. It is changing so fast that we have not yet seen all the impacts even today's climate can bring. Therefore, we can be sure we need to adapt to the impacts we are already experiencing and the greater ones which are on the way. There is still work to do to find the optimum paths to a net zero, adapted world, but that should not prevent us from taking the obvious steps now.

Professor Pierre Friedlingstein FRS
Chair in Mathematical Modelling of
the Climate System, University of Exeter

The case for net zero

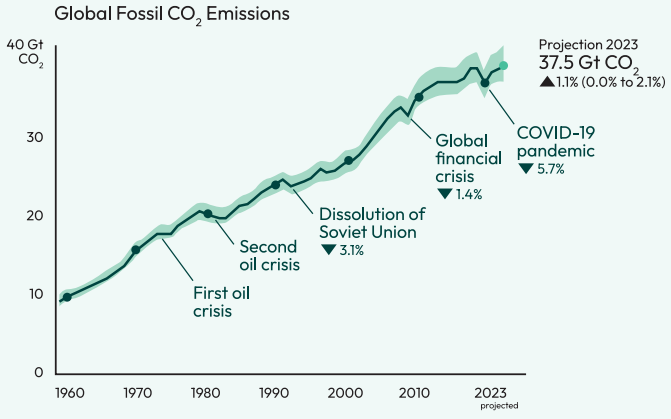
Leaders must make a positive case for net zero. Too often, this transition is framed in terms of economic cost – ignoring the economic gains from creating new jobs and industries, the health gains of reducing pollution, and the massive costs of inaction.



UK emissions are going in the right direction – but there is much more work to be done. To reach net zero by 2050, the recent rate of decarbonisation must continue for the next 25 years. The path ahead involves tackling sources of emissions that are harder to eliminate. This will require political leadership, intelligent public and private investment and a clear and continuous narrative about net zero.

As well as reducing the UK's significant emissions (per capita emissions here are four times higher than in India), this could allow the UK to be a powerful example of a successful transition – opening economic opportunities as others look to follow. The UK also has an important role on the international stage, including through the G7, the G20, and the Commonwealth.

Time is running out. At the Global Carbon Budget, we provide the most comprehensive annual assessment of global sources of carbon emissions, and the land and ocean "sinks" that absorb some of that carbon. Our latest assessment, published to coincide with COP28 in Dubai, showed fossil CO_2 emissions reached a record high in 2023 (36.8 billion tonnes, up 1.1% from 2022). A further 4.1 billion tonnes was emitted in 2023 through land-use change – mostly deforestation.



Global carbon emissions from fossil fuels increased by 1.1% in 2023. With the exception of a temporary reduction due to COVID-19 lockdowns, there is no sign of the rapid reduction that is urgently needed to prevent dangerous climate change. Credit: Friedlingstein et al 2023; Global Carbon Project 2023

The amount of CO_2 currently being removed from the atmosphere by technology-based CO_2 removal (CDR) is less than one millionth of global annual emissions. The land and ocean are absorbing around half of humanity's CO_2 emissions. The rest remains in the atmosphere, where it causes climate change. Atmospheric CO_2 levels reached 419 parts per million in 2023, more than 50% above pre-industrial levels.

To keep global warming below 1.5 °C, we estimate that the remaining carbon budget (the amount of CO_2 humanity could still emit before breaching this level) is now around 275 billion tonnes. This is equivalent to seven years at the current emissions level. Even keeping warming below the critical 2 °C threshold will now require a rapid, sustained drop in global emissions. Global efforts to achieve this are not yet visible in either global fossil or deforestation emissions, despite progress in individual countries.

The UK is leading the way and can continue to do so. The UK can show leadership through a more ambitious National Determined Contribution (a commitment to reduce greenhouse gas emissions) which will need to be submitted to the UNFCCC early in 2025. In addition, the UK needs a more detailed plan to meet its net zero commitment. This must also include CO_2 embedded in trade, which currently amounts to 166 million tonnes, bringing the UK's annual total to 513 million tonnes (based on latest full figures for 2021). If the Net Zero plan includes natural or technological carbon capture, these must also be designed in detail and delivered in time. All of this will require strong policies and investments, enabling the UK's green transformation.

Achieving this will bring vast benefits to the economy, public health and many other areas – driving hope for a greener future both here and around the world.

Professor Richard Betts MBE
Chair in Climate Impacts, University of Exeter,
Head of Climate Impacts Research, Met Office
Hadley Centre

The worst climate impacts are avoidable, but we must already adapt

We are already seeing many impacts of climate change, and more are inevitable. We therefore urgently need to adapt to make ourselves more resilient and limit the damage.

Even more importantly, without urgent action to cut global emissions to net zero, further ongoing climate change will bring increasing severe risks with profound and potentially devastating consequences. Our previous greenhouse gas emissions have already heated the world by about 1.3 °C relative to the late 19th Century. This has made heatwaves more frequent, intense and long-lasting. Between May 2023 and May 2024, 6.3 billion people (about 78% of the global population) experienced at least 31 days of extreme heat – which have become over twice as likely due to human-caused climate change.

The heat is also melting ice around the world: glaciers are shrinking, and parts of the Greenland and Antarctic sheets are losing mass. Along with the expansion of sea water as it warms, this has caused sea levels to rise by about 20cm since 1900 (half of which has occurred in the last 30 years). As a result, high-tide flooding events now occur more often – those that happened five times per year in 1960-1980 were seen eight times per year in 1995-2014.

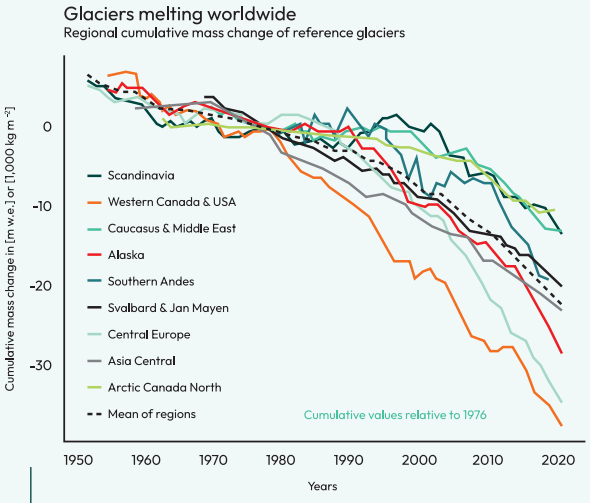


Figure 1. *Melting of glaciers. Reducing mass of reference glaciers in regions worldwide. Sources: www.worldviewofglobalwarming.org; World Glacier Monitoring Service*

Many parts of the world are seeing more prolonged or heavier rainfall, while others are seeing decreased rainfall. Nearly half a billion people now experience unfamiliarly wet conditions compared to 50 years ago, while over 160 million live with unfamiliarly dry conditions. Droughts are being made even more severe by hotter conditions drying the landscape. For example, in the USA in 2017, a drought causing $2.5 billion of agricultural losses and a record-breaking wildfire season was made 50% more likely by increased evaporation due to climate change, even though rainfall had not changed.

Adaptation to avoid or limit the damage is therefore already necessary. Buildings and infrastructure need to be built or retro-fitted to cope with more severe extremes. For example, homes, office buildings, schools and hospitals need to be better able to keep their occupants comfortable during heatwaves. Railway tracks, which in the UK were not built with hot weather in mind, need to be replaced since they expand and buckle in high temperatures. Drainage systems and flood defences need improvement to cope with higher volumes of water and higher river and sea levels.

Some further increases in impacts in the coming decades and even centuries are already inevitable and will therefore require additional adaptation. Even if no further warming occurred, glaciers and ice sheets would continue to shrink, as they take a long time to fully respond to higher temperatures. This means sea levels will continue to rise to some extent for the rest of this century and beyond. Risks of coastal flooding will therefore continue to increase. Half a billion people worldwide will be at increased risk of coastal flooding by the mid-century.

But until global warming is brought to a halt, ever higher rises in sea level will become locked in, and there will be an increasing risk of triggering tipping points that cause the melting of ice sheets to become self-reinforcing. This would commit the world to even larger long-term sea level rises – potentially 7m or more over the next three centuries.

Unchecked global warming would also mean that severe heat stress conditions will continue to become more widespread and long-lasting. At 2 °C global warming, approximately 1 billion people would be exposed to severe heat stress conditions for more than 10 days per year, if population remained at current levels and distributions. This would rise to about 3.5 billion for 4 °C global warming, which is possible by the end of the 21st Century if feedbacks in the climate system are at the high end of the uncertainty range, especially if further tipping points such as Amazon forest dieback or permafrost thaw accelerate the build-up of greenhouse gases.

Heavy rainfall, flooding, drought and water scarcity are also all projected to continue to increase with ongoing warming, bringing ever increasing risks to people and ecosystems. Up to nearly 20% of species could be at high risk of extinction at 2 °C global warming, rising to nearly 40% at 4 °C global warming.

Crucially though, the severity of future impact can still be limited by stopping the build-up of greenhouse gases in the atmosphere and meeting the Paris Agreement goal of limiting global warming to well below 2 °C.

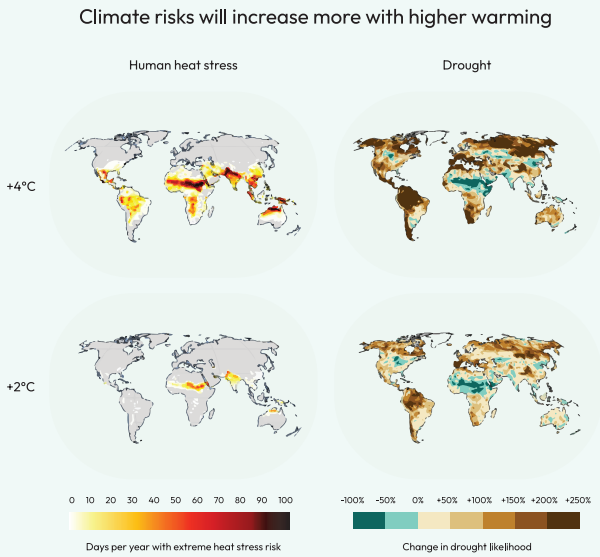


Figure 2. *Key climate hazards at 2°C and 4°C global warming. Left column: number of days per year with extreme heat stress risk (Wet Bulb Globe Temperature > 32°C). Right column: change in likelihood of extreme agricultural drought (driest 10% of years) relative to 1995-2014. Sources: Met Office; IPCC (2022)*

CHAPTER THREE

Professor Kevin J. Gaston
Chair in Biodiversity and Conservation,
University of Exeter

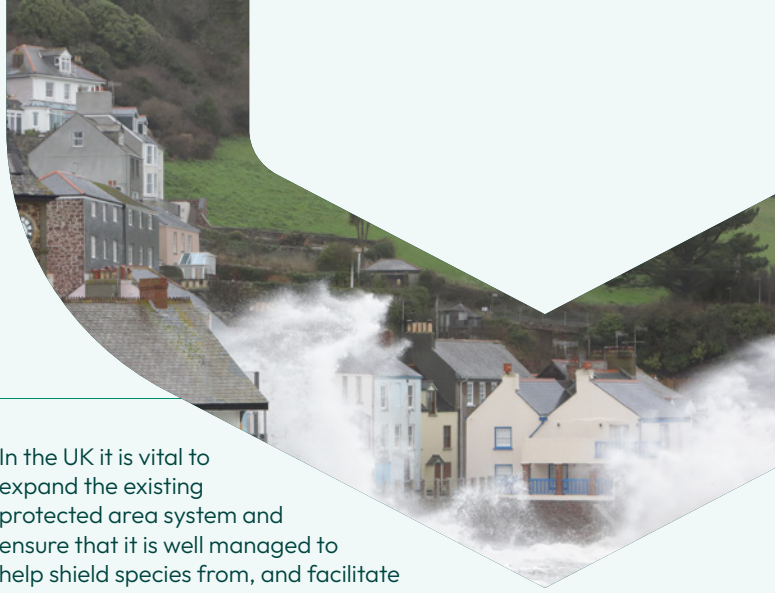
Nature and biodiversity loss: Why this matters and how it links to climate change

Although modern urbanised lifestyles might give the impression otherwise, we are all utterly dependent on biodiversity.

It sustains economies and livelihoods and plays a vital role in the creation of a good quality of life. It provides key resources (e.g. food, energy, materials) and underpins multiple functions (e.g. oxygen production, pollination, pest control, coastal protection, artistic inspiration), even when we might seem distanced from these by human-built infrastructure and supply chains. Failure to respect planetary boundaries (the limits to sustainable living), or to recognise the intrinsic value of many other species, has led to human activities causing steep losses in biodiversity across much of the globe; the UK has one of the most depleted biotas (the sets of naturally occurring organisms) in the world, with the loss of biodiversity continuing across land and sea.

Globally, the primary pressures on biodiversity stem from land- and sea-use change, direct overexploitation of natural resources, pollution, the spread of invasive species, and fossil-fuel driven climate change. The last of these is gaining proportionally ever greater significance as warming continues.

All species are evolutionarily adapted to a restricted range of climate conditions – that is one reason why different kinds of organisms occur in different places. In the face of climate change, some further adaptation and evolution is possible – but these capabilities are always limited and often severely so. Thus, species face the challenges of a loss of suitable climate, and the need to disperse to reach those places where this remains or has become available. Their responses are documented in shifts in phenology (the timing of events such as leaf-burst, flowering, breeding and migration), changes in abundances and shifts in distributions; the UK has been a leader in documenting the biological effects of climate change, as exemplified through the responses of its own flora and fauna. These effects don't act in isolation, but are often occurring in the context of, and influencing the ability to respond to, the multiple other pressures on biodiversity.



As well as terrestrial ones, the populations of many marine species around the UK are projected to decline markedly as a consequence of climate change. Image credit: pixabay.com.

Many species will become regionally extinct as a consequence of climate change. In extremis, they will become globally extinct, with the magnitude of these effects and the likelihood of crossing thresholds for rapid species losses increasing with the rapidity and magnitude of temperature change. A recent synthesis tentatively estimates that 3-6 million plant and animal species may potentially experience climate-related global extinction in the next 50 years (i.e., within the lifetime of many of today's children), even under intermediate climate change scenarios.

As well as being a victim of climate change, biodiversity can also contribute to its mitigation, through so-called nature-based solutions. Around half of greenhouse gas emissions are absorbed by terrestrial and marine ecosystems. Halting the loss of these ecosystems will both help protect the biodiversity they contain and retain their role as carbon sinks. Restoration activities that expand these ecosystems will both help restore biodiversity and increase their ability to absorb emissions. Unfortunately, restoration will almost invariably be a second-best option to protecting intact ecosystems because the former seldom attains the structure, function and diversity of the latter. The balance of the two that is required will depend on the degree to which biodiversity has been depleted.

In the UK it is vital to expand the existing protected area system and ensure that it is well managed to help shield species from, and facilitate their adaptation to, anthropogenic pressures. But this will not be sufficient. A step-change is also required in restoring previously degraded ecosystems, particularly if we want biodiversity to be resilient and to play a role in climate mitigation; existing government nature recovery targets provide impetus in this direction. The UK also needs to play a role in supporting international initiatives to protect and restore biodiversity, in part as a matter of global responsibility, in part as a matter of national dependence, and in part because through its supply chains the UK is exporting overseas much of its negative impact on biodiversity.

Multiple areas are being restored for biodiversity in the UK, including Helman Tor Nature Reserve in Cornwall. Image credit: Ben Watkins.

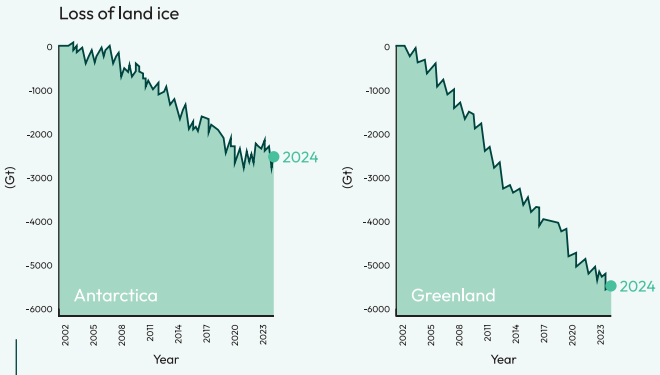
Professor Gail Whiteman
Hoffman Impact Professor for Nature and Climate,
University of Exeter, Founder, Arctic Basecamp

Address the polar crisis to prepare for a liveable future for humanity

The Polar regions are in crisis. These beautiful places might seem remote, but the poles are the control centre for our climate system.

Of great concern is that both the Arctic and Antarctic are experiencing rapid change due to global carbon emissions: the Arctic is warming at approximately four times the global rate and the Antarctic about twice as fast. The resulting changes to polar glaciers and sea ice cover and the increasing threat of abrupt permafrost thaw have serious knock-on effects that are driving global risks for all of us, no matter where we live.

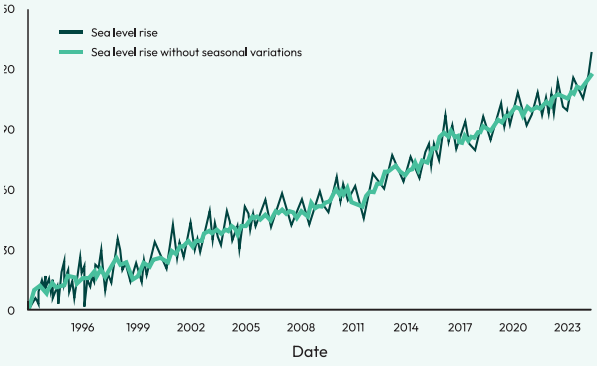
In the last 50 years, we have lost about half of Arctic sea ice by surface area, and about 75% of its volume. Sea ice is a major insurance policy against runaway climate change. Ice reflects sunlight back into space, cooling the planet, while seawater is darker and absorbs more heat.



Graphs highlighting the loss of land ice in Antarctica and Greenland over a period of twenty four years.

On land, the polar ice sheets and glaciers are melting rapidly in both the Arctic and Antarctic. Evidence suggests we are approaching several "tipping points" that could lead to irreversible change. These include the melting of the Greenland and West Antarctic ice sheets. As well as further accelerating warming, such tipping points could lead to as much as a metre of sea-level rise by 2100 (NASA) and much more thereafter, with impacts to coastal regions and communities around the world. There is unavoidable, locked-in sea level rise of at least 27 cm from the melting of the Greenland ice sheet based on current $C^{O}2$ in the atmosphere. This is the new baseline for global adaptation needs.

Global mean sea level is rising at the rate of 3.4mm/yr



Graph showing the changes in sea level rise globally, and the difference in sea level rise, with and without seasonal variations.

The Arctic is also home to vast areas of frozen ground called permafrost – and this too is at risk of a tipping point that would cause abrupt, widespread thaw. Permafrost contains methane and about twice as much carbon as is currently in the atmosphere, which will be released as it thaws, so this too has the potential to accelerate warming.

Across the vast boreal forests in the far north, scorching summer temperatures are leading to wildfires – also driven by, and contributing to, climate change. By affecting atmospheric and oceanic circulation systems, polar change is also causing extreme weather worldwide, from freezing conditions to more powerful storms and flooding. In the UK, prominent weather systems are impacted directly by Arctic conditions. Under current policies, the total cost of climate change damages to the UK are projected to increase from 1.1% of GDP at present to 3.3% by 2050 and 7.4% by 2100.

The Polar regions are also experiencing extreme temperature events – indeed the largest heatwave recorded on Earth occurred in East Antarctica in March 2022, when temperatures rose by over 38 °C above their normal value.

As a social scientist and business school professor, my focus is on the global risks coming from all of this. Together with Arctic Basecamp (arcticbasecamp.org), a not-for-profit science communicator which runs a flagship event at Davos every year, we have created a unique digital platform that links climate risks around the world back to polar change. Further amplified by another online tool, Climate Risks Daily, gives users a daily dose of climate information on extreme weather, polar change and health (in development). The aim is to emphasise a crucial message: what happens at the poles affects the entire planet.

The UN's Sustainable Development Goals are already on thin ice. If polar change continues to accelerate, these goals will be unachievable. The way we live our lives is under threat. The way we work, grow our food, get our water, live in cities – all could face extreme pressure and growing risks due to polar change. People are already fleeing the worst-affected places.

Global businesses are also experiencing material risks driven in part by polar change. For example, droughts, flooding and storms cause major and costly disruptions to supply chains. Highlighted in 2022 in Germany where searing heat and drought caused water levels on the Rhine to be too shallow for many vessels to operate safely. Cargo ships were forced to reduce transport volumes causing delays and the average shipping costs on the Rhine rose from US$20 to US$96 per ton.

But it's not all bad news. If we leave the current path and rapidly move towards a low-emissions future, we can prevent a host of risks and even start to see some glacier regrowth as early as the first part of the 22nd century. The 'zero emissions commitment' – or what we are committed to after 'net zero' is good news – with little to no overshoot of +1.5 °C, the climate will likely stabilise within 20 years after reaching and sustaining net zero, reducing further polar change. However, sea level rise is likely to continue for some time due to ice-sheet dynamic processes unlocked by heating to date. We therefore need strong adaptation plans for coastal countries including the UK.

If we can understand and unpack the polar crisis, we can find the path to a thriving, liveable future for people, business, nations and our world as a whole. The future of humanity depends on re-stabalising the polar regions, and the UK has a critical role to play.

Professor Tim Lenton
Chair in Climate Change
and Earth System Science,
University of Exeter

Threats and opportunities from tipping points

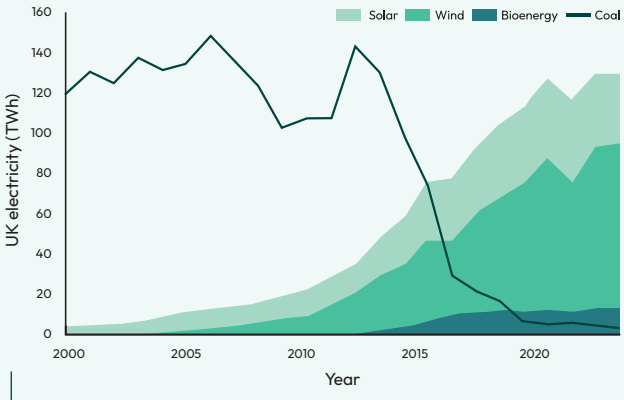
Tipping points could determine our future. Earth system tipping points could cause drastic, irreversible change, accelerating some of the most damaging impacts of climate change. However, positive tipping points in our societies and economies could lead to a thriving, sustainable future.

What is a tipping point?

A tipping point happens when a small change "tips" a system into a new state. Such changes are often abrupt and irreversible.

For example, the Atlantic Meridional Overturning Circulation (AMOC) has tipped between two alternate on/off states over twenty times during the last ice age. Triggered by changes in freshwater input to the North Atlantic, this radically altered European climate and tropical monsoons in the space of a decade or two. Positive tipping can happen abruptly too. For example, electric vehicle sales accelerated exponentially in Norway once the enabling conditions for triggering a tipping point (cost, performance, convenience) were achieved by 2012. Over 90% of new cars sales in Norway are now electric.
Right now, rapid environmental changes – especially global warming – are raising the risk of crossing multiple Earth system tipping points. For example, widespread mortality in warm-water coral reefs, and the dieback of the Amazon rainforest.

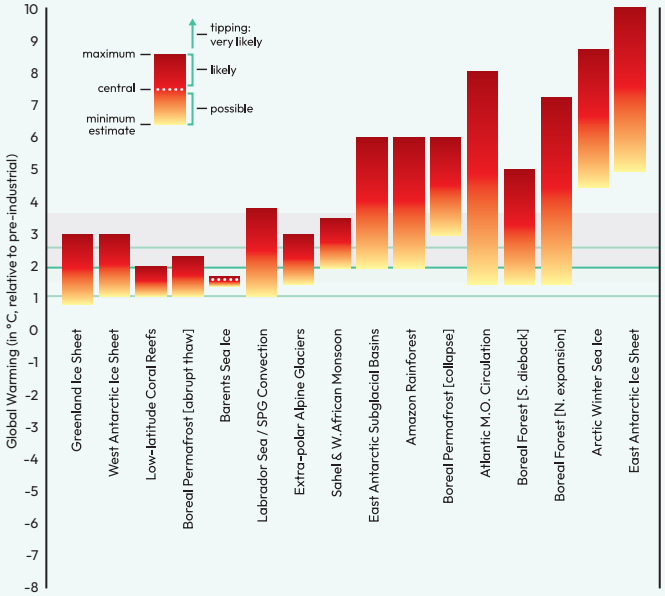
The same logic applies to positive tipping points. For example, the falling cost of low-carbon technologies such as renewable energy and electric vehicles can enable tipping points towards them and away from fossil-fuel alternatives. Coal has already been tipped out of UK energy generation. Social, political, and behavioural tipping points may also transform the way people, organisations, and societies act – driving rapid action to tackle the climate and environmental crisis.



Coal has already been tipped out of UK energy generation, while energy from renewables has increased dramatically. Data from OWID whose sources are Ember (2024) and BEIS (2023). Chart created by Tim Lenton.

How close are we to Earth system tipping points?

With global warming now on course to breach 1.5 °C, at least five Earth system tipping points are likely to be triggered – including warm-water coral reef die-offs, widespread abrupt thaw of permafrost, and abrupt change in the North Atlantic Subpolar Gyre. Five more are possible at this level of warming. We are working to improve our early warning systems, but it's clear that the risks increase with each tenth of a degree.



Earth system tipping points become possible, likely or very likely at varying levels of global warming. Credit: Armstrong McKay et at, "Exceeding 1.5°C global warming could trigger multiple climate tipping points", published in Science, 2022.

What happens if we cross Earth system tipping points?

Crossing Earth system tipping points could transform our world. Impacts are typically large, often irreversible, and unfold at different rates. Collapse of monsoon systems can happen fast and could devastate food production for hundreds of millions of people. Loss of the Greenland or West Antarctic ice sheets takes centuries but together could eventually add around 10m to global sea level.

Tipping point impacts are relatively under-assessed compared to other climate change impacts. The best studied is a collapse of the AMOC, which would fundamentally change European climate, raise sea levels in the North Atlantic region by up to a metre, and disrupt monsoons around the tropics. If we fail to avoid tipping points, radical adaptations may be needed – for example, retreat from coastal megacities and massive resettlement of people.

What can we do about this risk?

To minimise the risk of passing multiple, interacting Earth system tipping points, we need to meet the Paris Agreement goal to limit global warming to well below 2 °C. This means reaching global net zero greenhouse gas emissions by around the middle of this century. To help achieve this, the risk from tipping points needs to be included in economic analysis of climate change to capture the true social cost of carbon emissions.

Which positive tipping points would be most effective?

Just as with Earth system tipping points, positive tipping points can combine to form a "cascade" of transformative change. Tipping points in favour of renewable energy and electric vehicles are already happening and can help eliminate 37% of global greenhouse gas emissions. Policy mandates can further accelerate change, and trigger tipping points in other sectors, such as heat pumps. They help reduce costs and improve technology. Mandates for green ammonia in agricultural fertilisers and public procurement of plant-based proteins could also be "super leverage points" that support other positive tipping points.

Now is the moment to unleash a cascade of positive tipping points to ensure a safe, just, and sustainable future for humanity.

CHAPTER SIX

Dr. Mahmoud Mohieldin
UN Special Envoy for Financing the 2030 Sustainable Development Agenda, UN Climate Change High-Level Champion for Egypt

Three priorities to empower developing economies in the climate crisis

The world is off track in almost every measure and target related to climate action. Recent progress on mitigation, the first line of defence against climate change, is still not enough to catch up with emission reduction targets to meet Paris Agreement goals.

Adaptation, the increasingly vital second line of defence, has been left woefully underserved, specifically in terms of finance, which needs to at least be quadrupled to close the gap, according to the UN Environment Programme (UNEP). Subpar efforts on the first and second lines of defence have left the world vulnerable and exposed to climate-induced natural disasters, alongside which has come the urgent need to provide funding arrangements for losses and damages. While COP27 and COP28 have made serious strides in the establishment and operationalisation, respectively, of the new Loss and Damage Fund, current contributions to the fund are around $700 million, far below the estimated $140 billion incurred annually in climate-related losses and damages.

Countries of the Global South find themselves in the troubling position of being barely responsible for the climate crisis but forced to bear the brunt of its impacts. Africa, for example, contributes a mere 3% of global emissions, but countries in Eastern and Western Africa could lose upwards of 5% of their GDP at 2°C of warming. Developing countries disproportionately suffer from the consequences of climate change. They also continue to face crippling setbacks, specifically when it comes to financing climate action, including the fact that many developing economies still cannot meet their basic energy needs.

Reversing this concerning trend must put developing economies at the heart of climate action as the world steps into the most critical juncture in the race to achieve the Sustainable Development Goals (SDGs) at large and meet Paris climate goals. The Global South is both the biggest victim of inaction on the SDGs and a potential powerhouse for achieving them, if tools and means of implementation are adequately accessible. At the heart of any meaningful action for the Global South and the world at large is reviving and reforming multilateralism and international cooperation for our common good to address global 'public bads', most notably climate change. To succeed at this effort, an effectively enhanced multilateral cooperation framework needs to target three key areas: finance, technology and capacity building.

First, finance is the backbone of any successful effort on development and climate goals. Many developing countries are incapable of adequately providing and mobilising finance for development purposes without incurring even more debilitating and expensive debts that take too long to be disbursed, and further cripple the fiscal capacities of the already highly burdened treasuries of Global South countries.

To fix the finance problem, the three most salient facets of the current landscape of climate and development finance need to be addressed: inefficiency, insufficiency and unfairness. This means less reliance on debt and more on investments. Furthermore, we need to make debt, when needed, cheaper. Concessional finance must become more widely available and, crucially, much quicker. This would all need to feed into finance being orders of magnitude higher than it is today. According to the Independent High-Level Expert Group, Emerging Markets and Developing Economies bar China need $5.4 trillion a year to 2030 to achieve the SDGs, including $2.4 trillion a year for climate action. Current figures for SDG finance comprise a mere fraction of this goal.

In addition to that, finance flows are lopsided towards mitigation, ignoring the increasingly pressing need to finance climate adaptation. About 80% of multilateral climate finance goes towards mitigation but – with global warming now very likely to exceed 1.5 °C – Global South nations need to fund adaptation.

Secondly, and coupled with finance, is the need for technology transfers. The current trend of increasing fragmentation and protectionism is blocking many essential climate-related technologies from becoming mainstream and is further leaving Global South countries behind in the adoption of necessary climate technologies for mitigation and adaptation. For example, while solar photovoltaic (PV) costs have dropped by upwards of 90% since 2012, thanks to extensive Research and Development and production at scale, storage costs still remain high across the globe. And while drastic cost reductions in battery production have been achieved, trade protectionism is keeping these technologies from making their way to many places in the world. Opening the space for technology transfers, specifically with climate related technologies, is for our common good. Parallel to that, we need to streamline the process of matchmaking demand and supply for climate-related projects, an effort currently taking place on both the regional and local levels through the Regional Platforms for Climate Projects and, for example, the National Initiative for Smart Green Projects, which provides a deep dive in a specific country case.

Third, developing economies require capacity building for design of policies, development of projects and effectively implementing them. At the core of such need is the requirement for more open and granular data. Data is imperative because the current lack of adequate data is both hindering better finance flows and causing inefficiencies in resource allocations. Developing economies and emerging markets still significantly lag behind advanced economies in data collection and statistical capacity. The provision of adequate technical assistance and capacity building will help bridge this gap, and consequently make way for better data and information ecosystems on climate and development. The newly launched and continuously developing Global Capacity Building Coalition aims to tackle this disparity and enhance effective implementation developing economies.

The world cannot approach climate change or sustainability as isolated entities, as the nature of these issues is global and not bound by geographical borders. As we approach the summit of the future and start the road to Spain towards the Fourth Finance for Development forum in June 2025, we must continuously remind ourselves that cooperation is not a luxury, but a must, if we are to enact the changes that would put us on the right track.

These changes can happen with the right leadership. In the UK, the Parliament has just been elected with many new faces, as well as old ones that have gained the trust of the general public, and therefore new opportunities arise. We need visionary leaders at local, national and international level. We need to realise we are in a crisis, and that leaders can make the needed change. We can choose to pursue effective policies – or we can continue to rely on wishful thinking. I join the hope that the Members of Parliament will use every power they have, as representatives of the public, to push for change in the right direction.

Professor Lord Stern CH FRS FBA
IG Patel Professor of Economics and Government, Chair of the Grantham Research Institute on Climate Change and the Environment, London School of Economics

The economics of climate change

It is now 18 years since the publication of 'The Economics of Climate Change: The Stern Review', and it is clearer than ever that the loss and damage resulting from inaction would be far greater than the investments required to make the transition to a sustainable, inclusive and resilient global economy.

Further, those investments would generate a new form of sustainable and resilient growth, far more attractive than the dirty destructive paths followed in the past.

Since 2006, the science has grown ever more worrying, with many impacts already occurring with a greater intensity than we expected. Here in the UK, climate scientists were shocked two years ago by heatwave temperatures that topped 40 °C for the first time. All around the world, lives and livelihoods are being damaged by extreme weather events of unprecedented severity and frequency.

Poor people in every country are proving to be the most vulnerable to these growing impacts, and economic development is under increasing threat as tropical storms destroy villages, floods sweep away homes, infrastructure and businesses, and droughts wipe out crops.

And scientists warn that far worse awaits us if we do not stop emissions of greenhouse gases. Thresholds in the climate system could lead to unstoppable and irreversible effects, such as destabilisation of the land-based polar ice sheets in Greenland and West Antarctica.

These impacts could trigger the displacement of human populations on a scale not seen before, with the risks of conflict and war. Climate change is a profound threat to peace, security and prosperity.

Unfortunately, the models used by economists to project the impacts of climate change fail to capture many of the worst consequences, and paint a deceptively mild picture compared with scientific assessments.

While our assessments of the risks are now much more severe, we have made even greater technological progress than we expected in 2006. The costs, for instance, of producing solar panels, wind turbines and other renewables have plummeted, such that they are now the cheapest form of energy in many parts of the world, given a manageable cost of capital.

The rapid roll-out of electric vehicles has also been faster than anticipated, and across all sectors we are seeing new technologies, including heat pumps, rapidly developed and deployed, at ever lower cost, to provide an alternative to fossil fuels.

Models used by some economists have failed to project these rapid cost reductions because they do not take account of learning by doing and other dynamic processes that accelerate progress.

Some economists have over-simplified the problem of generating the needed green investment, by claiming that an end to greenhouse gas emissions can be achieved solely through carbon pricing to correct the market failure resulting from emitters imposing costs on others through climate change.

But policymakers need a wide range of tools that address a whole range of market failures, including those associated with research and development, capital markets, networks, information, and air pollution.

Countries are now increasingly recognising that this transition not only reduces the immense risks of climate change but can also generate good jobs and economic growth. But all this requires strong investment and can only be achieved if governments provide strong and clear policies that unlock private investment.

The returns on these investments will include, for instance, cities where it is possible to breathe, move and be productive. And ecosystems that are healthy, robust and fruitful.

While the economic case for stopping greenhouse gas emissions and moving to a new and cleaner path of growth and development is now overwhelming, it is also clear that we need to invest in adaptation to make ourselves more resilient to those impacts of climate change that cannot be avoided.

Investments in nature are particularly valuable. The restoration of mangrove forests in the tropics, for instance, removes carbon dioxide from the atmosphere and provides coastal communities with protection against destructive cyclone winds and storm surges, and fosters fishing and wildlife.

The economics evidence is clear. The transition to a sustainable, inclusive and resilient global economy is the growth story of the 21st century.

Nigel Topping CMG
UN High-Level Climate Champion COP28,
Honorary Professor, University of Exeter

What is COP and why does it matter?

COP (Conference of the Parties) has two main functions. Firstly, it is the formal, multilateral negotiation process between nearly 200 countries under the United Nations Framework Convention on Climate Change (UNFCCC).

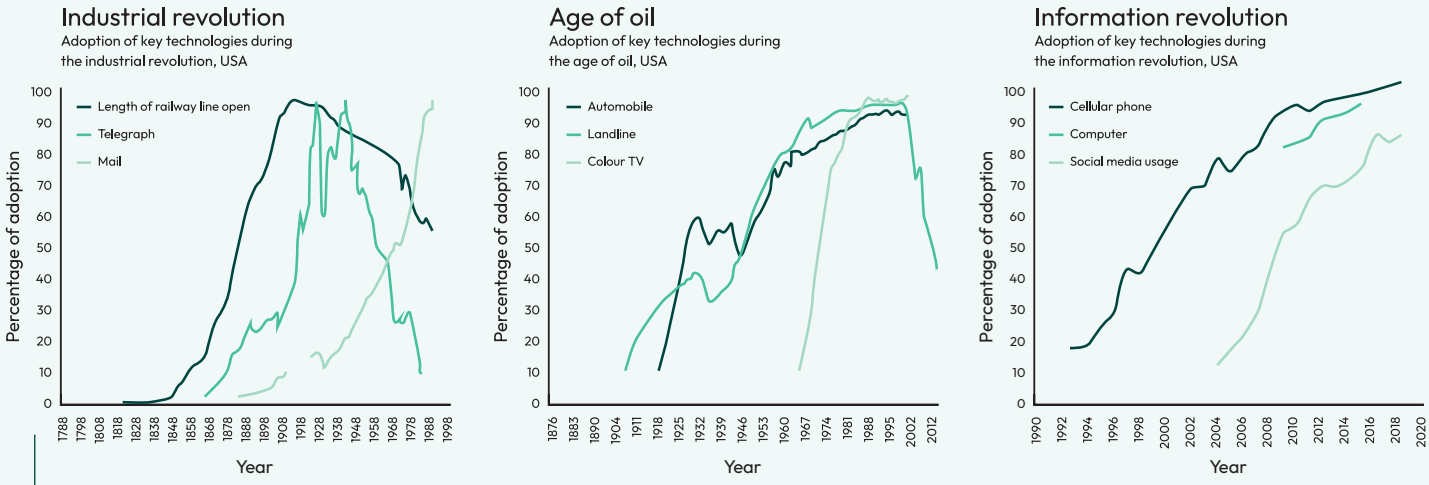
COP is normally led by environment ministers, and is attended by a wide range of others including civil society organisations and indigenous groups. It is the supreme decision-making body of the UNFCCC, and decisions require a very high bar – consensus on all decision texts.

Secondly, COP is a real economy gathering which drives forward implementation of the Paris Agreement – delivery of a net zero economy by mid century as well as action on adaptation, resilience, loss and damage and the mobilisation of the finance needed. Line ministers from industry, economy, agriculture and finance as well as "non-state actor" leaders from finance, industry and sub-national governments play a key role in this function of COP.

These two functions are equally important: both are vital to limiting climate change. The formal negotiations are backed up by Nationally Determined Contributions (NDCs) from each country, submitted to the UNFCCC every five years, specifying that country's plan to cut emissions and adapt to climate impacts. The next set of NDCs are due to be submitted in early 2025, ahead of COP30 in Brazil. This could be a significant moment for the UK to re-assert climate leadership.

In terms of real economy, the architecture of action was largely set at COP26 in Glasgow, where a series of 2030 breakthroughs for each sector were defined. This is to be delivered through the UN Climate Change High-Level Champions, along with a network of collaborators. The UK Presidency responded to this with the launch of the Breakthrough Agenda, now a coalition of over 50 countries with a secretariat led by the UK. The aim is to drive exponential change, new international standards and investment in the first industrial-scale examples of technologies such as green steel and green hydrogen. This architecture was extended to adaptation and resilience at COP27 with the launch of the Sharm el Sheikh Adaptation Agenda. And the finance needs were spelled out by Nick Stern, Vera Songwe and Amar Bhattacharya in their paper "Finance for Climate Action" commissioned by the COP26 and COP27 Presidencies.

The strength of COP is that we now have a collective goal and a process for getting there. It has led to real clarity about what needs to happen in every sector of the economy. This continues to bring down the likely maximum global warming reached by the end of this century. As awareness of the exponential nature of technology transitions grows, countries and industry become more comfortable with targets that would have seemed impossible just a few years ago, such as the COP28 commitment to triple renewables by 2030. The race to net zero is now a competitive one among developed countries.



From the construction of railways to uptakes of smartphones, major technologies have grown exponentially. As awareness of this grows, countries and industry become more comfortable with targets that would previously have seemed impossible, such as the COP28 commitment to triple renewables by 2030. Credit: RMI and Ahead of the Curve.

The main challenge is the need to mobilise trillions of dollars of climate finance that will be required to support the global transition, especially in the least developed countries. The majority of countries at COP are considered to be vulnerable to climate change. These include the least developed countries and small island nations. There is a strong expectation that leading economies – including the UK – will demonstrate the most ambitious plans to deliver across the three pillars of the Paris Agreement: mitigation (cutting emissions), adaptation and resilience, and providing financial means for all countries to make the net zero transition. And there is a great opportunity for leading financial centres like the City of London to be at the heart of the mobilisation of the trillions of dollars of private capital needed.

By setting ambitious and credible NDCs, backed up by national policies, the UK can play a significant role in the perceived success of COP30 in Brazil – and the ongoing power of the COP process to avert dangerous climate change.

Further Information

For further information and reading on both the wider topic of climate change and the areas discussed in this booklet, please use the below QR code or alternatively visit greenfutures.exeter.ac.uk/parliamentarians-guide-to-climate-change/


12 research subjects in the UK's top 10 for world-leading impact
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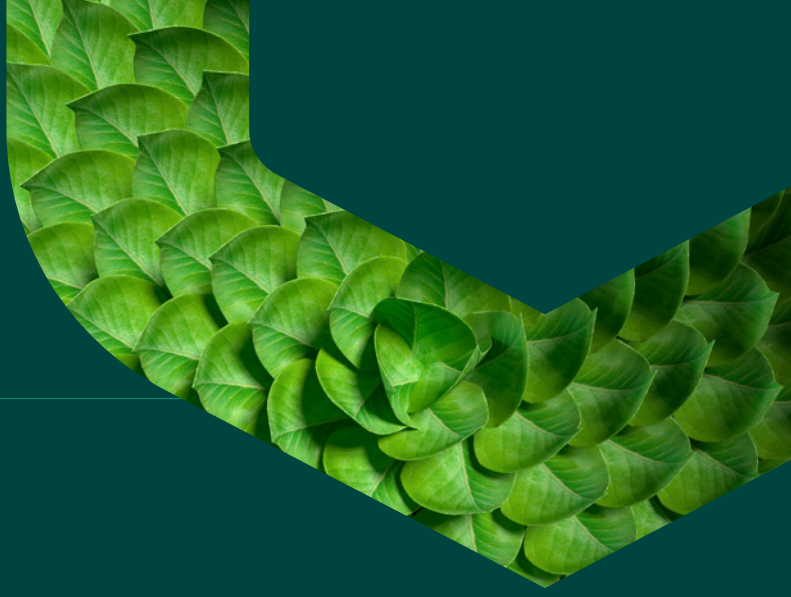

About Us

Peers for the Planet

Peers for the Planet is the House of Lords climate and nature action group. We bring together diverse legislators in the Lords who want to put systemic environmental threats, and associated socio-economic challenges, at the top of the political agenda. We focus on urgent, ambitious but practical action, with an emphasis on fairness and the well-being of future generations.

Since launching in 2020, the grouping has spearheaded a step-change in debate on climate change and nature in the House, and secured world-leading policy and legislative changes in areas as diverse as financial markets, pensions, energy, health, skills, research and development, built environment and much more.

The University of Exeter

The University of Exeter is using the power of education and research to create a sustainable, healthy and socially just future.

Our key priorities include leading meaningful action against the climate emergency and ecological crisis.

We are renowned for our environmental expertise, with over 1,500 people (including 5 of the world's top 21 climate scientists) working to deliver game-changing solutions. Through Green Futures Solutions we are bringing insights from leading researchers to organisations around the world.

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