# The Parliamentarians' Global Guide to Climate Change and Climate Solutions

University of Exeter
Arizona State University
Inter-Parliamentary Union
For democracy. For everyone.

# Contents

# Youth Foreword

**“As young people, we often look to our elders for guidance. From you, we develop our values, our ethics, and our worldview. We owe you our opportunities and privileges. We share your values of security, prosperity, and opportunity.**

But it’s a strange time to be young. “Go to school, get a job, work towards your future”. We wonder, what will our futures look like?

The 1.5°C threshold is passing, 2.0°C is fast approaching. We call on you to follow through on the climate goals that you set, to be transparent and accountable. Our futures are at stake.

Human well-being depends on planetary health. Indigenous wisdoms have maintained for millennia the belief that humanity and the natural world are intimately connected. Our futures depend upon combining these ancient wisdoms with modern day technological capabilities, environmental stewardship, and a decisive political will.

The science is clear. The technologies exist. The challenge that remains is a lack of implementation. The IMF estimates there is an astounding $7.1 trillion per annum in fossil fuel subsidies. We need new economic structures and incentives to scale global solutions, and we need to act now. This is no longer a distant warning, we are living in the age of consequence.

The International Court of Justice is on our side, affirming what young people across the globe have been saying for years: our governments have a legal obligation to act on climate change. As the current leaders and policymakers, we require your brave and authentic leadership to navigate this age of complexity and uncertainty, to chart a sustainable path forward.

This must be done together, across disciplines, countries, genders, and generations.

One concrete step parties can take to align international commitments with intergenerational justice is to adopt the Universal Youth Clause into their updated Nationally Determined Contributions. We call on all governments to honour our right to a healthy environment and a climate just future for generations to come.

As young people, we often look to our elders for guidance. Do they know that they can look to us, too?”

**Endorsers of the Youth Foreword can be found on page 26.**




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we

CARE ABOUT CLIMATE

YOUTH NEGOTIATORS ACADEMY



# 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.**

Greenhouse gases such as carbon dioxide (CO2) and methane occur naturally in the atmosphere, but we have been adding to them mainly through burning fossil fuels. These fuels were laid down over aeons as plants and fauna stored carbon. By burning fossil fuels that release 37 billion tonnes of CO2 a year, we have put that carbon back into the atmosphere in just a couple of centuries. CO2 is now at a higher concentration than at any time since humans evolved, threatening Earth system stability.

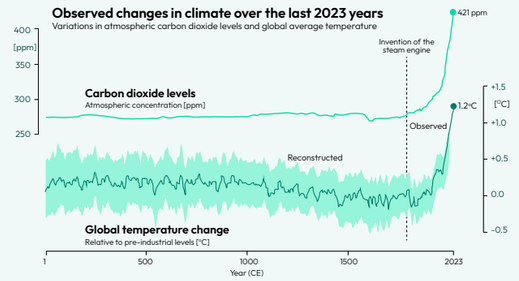
While the climate has always changed, the rate of change produced by this high level of CO2 and other greenhouse gases over the historical period is unprecedented compared to natural climate cycles. We should be in a cooling period, but instead the climate is warming rapidly. 2024 was the hottest year on record and – for the first time – the world exceeded 1.5°C above pre-industrial levels.

Climate TRACE is a global, not-for-profit coalition with the goal to reduce climate pollution by creating actionable data tools:

- An open-access database tracking 660+ million sources of greenhouse gas emissions like power plants, landfills, and oil refineries
- Recognising that many sources of greenhouse gases also release health-harming pollutants, Climate TRACE models air pollution from these sources and shows how these pollutants disperse and affect local communities
- Climate TRACE is launching a new tool that will allow policymakers everywhere to create a bespoke decarbonisation plan that provides mitigation solutions for every sector and every facility in their jurisdiction

Climate TRACE offers free technical support to governments to create and implement emission reduction projects.

Contact: coalition@ClimateTRACE.org




*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.*

## Consensus view

The fact that a warming planet is chiefly the result of human activity is well researched and documented. The "greenhouse effect" – the trapping of heat by certain gases in the atmosphere – has been known about since the 19th Century and the first detection of human-caused warming was in the 1930s. The 2023 assessment report of 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.

Currently, about half of our CO2 emissions are absorbed by the ocean and land ecosystems. The rest of our emitted CO2 remains in the atmosphere, driving climate change. To meet global goals and reach a safe and sustainable future, we need a rapid, sustained strong decline in global emissions. Currently, technology-based CO2 removal (CDR) is less than one millionth of global annual anthropogenic emissions.

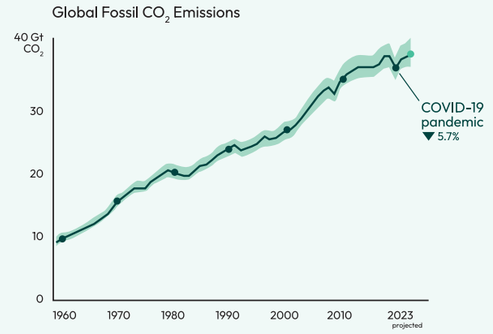
It is also a fact that the climate will keep warming until we reach "net zero" – meaning that any remaining anthropogenic greenhouse gas emissions are balanced by equal anthropogenic greenhouse gas removals. Even then, while global temperature would stabilise, some of the impacts of warming – such as sea-level rise – would continue to worsen for a long time.

## Risks rise

The threshold set by the Paris Climate Agreement was 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. These thresholds were chosen as a combination of achievability and what is believed to be necessary to avoid dangerous irreversible climate change, especially "tipping points" that could cause drastic, irreversible change – with enormous costs for nature, people and economies. The risks rise as the global temperature increases.

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 are already seeing loss of food, water and energy security, and this could lead to increased global conflict. If we don't act fast to reduce emissions, adverse impacts will continue to intensify. The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term.




Source: Global Carbon Project

# Nature and biodiversity loss

**Halting the loss of ecosystems will both help protect the biodiversity they contain and retain their role as carbon sinks.**

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 in land and sea across much of the globe. On average, in 2020, the biodiversity intactness of terrestrial areas (the percentage of the original number of species that remain and their abundance) has been estimated to be less than 60%.

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.

Current conservation efforts are not adequately protecting land areas of highest biodiversity importance (only 22% of critical ecosystem services fall within officially protected areas). As a result, rapid and more effective public-private action is needed to meet the commitments made under the UN's Global Biodiversity Framework. Countries must adapt the framework to their specific national circumstances, priorities, and biodiversity needs, integrating them into their National Biodiversity Strategies and Action Plans (NBSAPs). These national plans are crucial for achieving global biodiversity goals like protecting 30% of land and sea by 2030 in order to maintain or restore ecosystem integrity and function and protect significant value at risk. WWF's NBSAP Tracker can be used to check different countries' progress:

## Multiple pressures

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 even if other requirements are met, and the need to disperse to reach those places where this remains or has become newly 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. These effects don't act in isolation, but often occur in the context of the multiple other pressures on biodiversity. Likewise, those other pressures can limit the abilities of species to respond to climate change.

Many species will become regionally extinct due to 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, even under intermediate climate change scenarios.

## Step-change

As well as being a victim of climate change, biodiversity can also contribute to its mitigation, through so-called nature-based solutions. Around a 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.

Alongside the direct mitigation of climate change, multiple steps are required to respond to the biodiversity crisis. Many are reflected in the Convention on Biological Diversity, and need also to be captured in national policies. It is vital to expand the existing global 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 and the delivery of other benefits. Countries also need 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 supply chains many negative impacts on biodiversity are in effect exported overseas.

### Distribution of mammals on Earth

Mammal biomass is measured in tonnes of carbon, and is shown for the year 2015. Each square corresponds to 1% of global mammal biomass.


Source: Our World in Data. Licensed under CC-BY by the authors Hannah Ritchie and Klara Auerbach.

# Poles and oceans

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

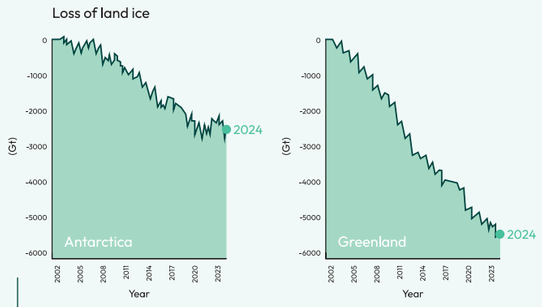
## Protect the poles to preserve global climate

The Arctic and Antarctic are changing rapidly due to global greenhouse gas 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. 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. In the last 50 years, we have lost about half of Arctic sea ice by surface area, and about 75% of its volume. In the last few years, Antarctic sea ice has retreated to historical summer lows.

On land, 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 dynamic collapse of the West Antarctic ice sheet, and the irreversible melting of the Greenland ice sheet. As ice sheets lose mass, they decant water into the ocean – either via floating ice (that displaces its weight in water) or by land ice melting directly into the ocean.

## Rising seas

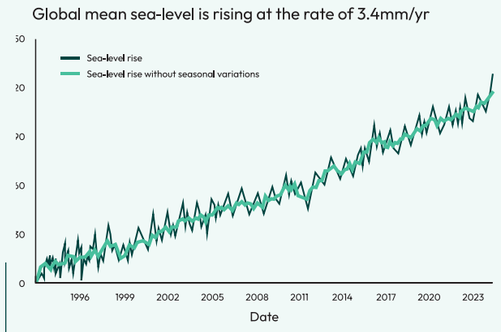
Over 20cm of sea-level rise has occurred since industrialisation, half of which has happened in the last 30 years – with the rate of change doubling over that time. The polar ice sheets have contributed little to that; half coming from thermally expanded ocean water, the other from small glaciers. However, today, their contribution to sea-level rise is growing, and when ice sheets start to drive sea-level rise we can start to consider several metres of change. Under strong warming – with continued fossil fuel emissions – the IPCC does not rule out over 2m by 2100, and 5m by 2150.




*Graphs highlighting the loss of land ice in Antarctica and Greenland over a period of 24 years.*



Such sea-level rise would transform our world – submerging many of our coastal cities and island nations. We have a duty to current and future generations to reduce global emissions to protect the poles. By doing so, we protect the entire planet.




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

## Ocean under fire from multiple threats

Earth's most powerful climate regulator, the ocean absorbs 90% of excess heat from greenhouse gas emissions, and sequesters 30% of global CO2, making it critical to stabilising our climate and planetary systems.

Three interconnected threats are destroying this climate lifeline: ocean warming, acidification, and deoxygenation, which amplify one another in a destructive feedback loop. Warming – driven by greenhouse gas emissions – triggers coral bleaching, rising sea levels, changing currents, and extreme marine heatwaves that disrupt weather patterns and coastal protections and livelihoods. Acidification – caused by oceans absorbing excess fossil-fuel generated CO2 – lowers pH and depletes carbonate, harming shell-building species and fish stocks vital to food security. Deoxygenation from warming, water stratification, and pollution shrinks habitable zones and alters ecosystems, reducing biodiversity and undermining ocean resilience. Meanwhile, fossil fuel industries pollute the ocean with plastics, sewage, and agricultural runoff from petrochemical fertilisers, while ship noise interferes with marine life's communication and migration. These pollutants intensify climate stress by disrupting carbon-storing species and degrading the ocean's ability to buffer warming.

## Precautionary principle

Overfishing (aided by $27 billion in harmful subsidies) and unsustainable forms of fish farming contribute to climate breakdown by destroying carbon sinks, generating methane-rich bycatch, and accelerating ecosystem collapse. Bottom trawling releases more CO2 than many countries annually, while deep seabed mining – an unproven, unnecessary industry – threatens ancient carbon stores and irreplaceable ecosystems (formed over millions of years) that regulate ocean chemistry.

Despite the ocean's central role in climate regulation, governance is fragmented and thus not as effective as it could be. To protect the ocean requires applying the precautionary principle with science-based mandatory standards, independent monitoring, economic sanctions for violations, and criminal liability for environmental destruction.

By reducing fossil fuel emissions, plastic and chemical production, ending destructive subsidies, applying strict pollution controls, and recognising the ocean ecosystem as a rights-bearing entity, we can effect massive, rapid change for a healthy ocean. Current GDP measures count ocean destruction as positive growth, ignoring trillion-dollar ecosystem services.

# Adaptation

**Adaptation is the increasingly vital second line of defence in the climate crisis, but finance is lacking and implementation of current plans is uneven.**

We are already seeing many impacts of climate change, and more are now inevitable. We must therefore urgently adapt to make ourselves more resilient and limit the damage. Adaptation is the second line of defence in the climate crisis.

The first and most important priority is to cut global emissions to net zero. If we fail to do this, further climate change will bring increasingly severe risks, with profound and potentially devastating consequences. Our previous greenhouse gas emissions have already heated the world by about 1.3/1.4°C relative to the late 19th Century (and in 2024, for the first time, we surpassed the critical threshold of 1.5°C for a full year). This has made heatwaves more frequent, intense and long-lasting. At 2°C global warming, approximately a 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.

Reducing health risks from extreme heat requires increasing adaptive capacity through city-to-person-level adaptation strategies, from increasing heat-resilient infrastructure, shade cover, and new technologies (e.g., passive cooling) to effective personal-level behavioural changes (e.g., adjusting activity, seeking cooling), augmented by improved health status and thus lower heat susceptibility.

## Growing risks

The heat is also melting ice around the world: glaciers are shrinking, and parts of the Greenland and Antarctic ice sheets are losing mass. Along with the expansion of seawater 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. 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.

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.

## Adaptation gap

Adaptation to avoid or limit the damage is therefore already necessary. Buildings and infrastructure need to be built or retrofitted 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. Drainage systems and flood defences need improvement to cope with higher volumes of water and higher river and sea levels. Investments in nature are particularly valuable.

The 2015 Paris Agreement established the Global Goal on Adaptation to enhance adaptive capacity, strengthen resilience, and reduce vulnerability to climate change. A framework was adopted at COP28 in Dubai, including water management, food security, health, infrastructure development, ecosystem conservation, poverty alleviation and preservation of cultural heritage. Indicators are due to be agreed at COP30.

The UNEP Adaptation Gap Report 2024 indicated that climate adaptation planning has progressed in most countries (with estimates that up to 87% of all nations, or 170 states, have now developed some form of a plan). However, the implementation of these plans remains uneven, with the poor and marginalised remaining most vulnerable to climate impacts.

## Hard limits

Adaptation has been woefully underserved, specifically in terms of finance. Despite growing recognition of the need for urgent adaptation, current finance flows fall far short of what is required. According to the UNEP Adaptation Gap Report 2023, developing countries need between $215 billion and $387 billion annually this decade to adapt effectively. This means that current adaptation finance needs to at least be quadrupled to close the gap.

Research also indicates that hard limits to adaptation are already being experienced – particularly in tropical, coastal, polar and mountain ecosystems. Hard limits are barriers to climate preparedness that cannot be overcome by financial, policy or governance action and result in irrevocable losses and damages.

While reducing emissions must remain the top global priority, improving adaptation – especially in low-income countries on the front line of the climate crisis – is critical to protect people, livelihoods and ecosystems.

Photo: Kadir van Lohuizen / NOOR

# Climate finance

**Almost half of humanity – 3.4 billion people – live in countries now spending more on debt servicing than education and health. We must lay the foundation for unlocking long-term, affordable financing to enable sustainable development.**

The world is off track in almost every measure and target related to climate action, and developing countries are suffering disproportionately. Fossil fuel investment levels remain vastly misaligned with pathways required to fulfil Paris Agreement goals. The International Energy Agency (IEA) predicts $2.2 trillion will be invested in clean energy in 2025, but fossil fuel investments will exceed $1 trillion – roughly double the levels deemed consistent with the IEA's Net Zero Emissions by 2050 Scenario.

The International Monetary Fund (IMF) estimates $7 trillion in annual fossil fuel subsidies (explicit and implicit), equivalent to about 7% of global GDP. The IMF also predicts that eliminating these subsidies would lead to a 34% drop in emissions by 2030. These figures underscore the enormity of public and private financial support locking in a carbon-intensive energy system – despite commitments under the Paris Agreement and mounting evidence such subsidies and investments drastically undermine climate goals.

Transforming subsidies is a major focus of the Villars Framework for a Sustainable Trade System – a WTO reform agenda developed by a network of researchers and policymakers operating under the banner of the Remaking Trade Project. Rather than focusing on whether governmental support to a particular industry is trade-disruptive – as the current trade regime does – the Remaking Trade Project team suggests that the right first question would be: What is the purpose of the subsidy? This shift clarifies that there is an important distinction between enhancing sustainability and diminishing it.

GCF

The Green Climate Fund (GCF) – a key element of the Paris Agreement – is the world's largest climate fund, with $18 billion already programmed for funding proposals. It is mandated to support developing countries to raise and meet their climate goals – known as Nationally Determined Contributions (NDCs). GCF operates through a country-driven approach, with each developing country appointing a Nationally Designated Authority or focal point to coordinate relations with GCF. Some GCF funding is used to help mobilise financial flows from the private sector to compelling and profitable climate-smart investment opportunities.

## Loss and Damage

Adaptation finance is woefully underserved, and needs to at least be quadrupled to close the current gap. The scaling-up of public and private investment, improved access to concessional finance, and stronger integration of adaptation into national development planning and budgeting must be prioritised. Subpar efforts on mitigation and adaptation finance 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. Securing adequate and predictable funding for the Loss and Damage Fund is essential to support vulnerable countries facing the irreversible impacts of climate change.

The Fourth International Conference on Financing for Development (FfD4), held in Seville in July 2025, underscored the urgent need to reshape the global financial architecture to better serve the UN Sustainable Development Goals and the Paris Agreement and affirmed the value of inclusive, rules-based multilateral cooperation as the cornerstone of sustainable development finance.

## Finance gap

The conference highlighted the imperative of reforming global debt mechanisms to build essential fiscal space in developing countries to invest in climate-resilient infrastructure and just transitions. Eleven policy priorities have been identified by the UN Expert Group on Debt appointed by the UN Secretary-General in December 2024 to not only assist in breaking the cycle of debt distress but lay the foundation for unlocking long-term, affordable financing to enable sustainable development. The climate finance gap must be bridged through stronger international alignment, addressing perverse subsidies not consistent with Paris Agreement goals, greater concessional financing, and improved access for developing countries. Innovative financing mechanisms such as debt-for-climate swaps and blended finance instruments were endorsed at the FfD4. These approaches reflect a growing recognition that climate finance and development finance must work in synergy rather than in silos.

The climate crisis has a profound gender dimension that must not be overlooked. It disproportionately affects women and girls, especially in vulnerable communities, who often bear the brunt of climate-related disruptions—such as water scarcity, food insecurity, and displacement—while having less access to resources, decision-making power, and adaptive opportunities. In 2022, only 3% of official development assistance on climate had gender equality as a stated objective (principal and secondary objective), while only around 0.01-0.04% of global climate finance explicitly supported women's rights or gender equality as a principal objective. Addressing climate change effectively requires integrating gender-responsive policies that empower women as agents of resilience, innovation, and leadership in climate action.

# The economics of climate change

**It is clearer than ever that the costs of inaction on climate change will be far greater than the investments required to make the transition to a sustainable, inclusive and resilient global economy.**

Those investments can generate a new form of sustainable and resilient prosperity, far more attractive than the extractive, destructive and polluting paths followed in the past.

The science has grown ever more worrying, with many impacts already occurring with a greater intensity than expected just a few years ago. 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. Economic development is under increasing threat as tropical storms destroy villages, floods sweep away homes, infrastructure and businesses, wildfires devastate huge areas, and droughts wipe out crops. And scientists warn that far worse awaits us if we do not now radically reduce and soon halt emissions of greenhouse gases.

## Profound threat

Tipping points in the climate system could lead to unstoppable and irreversible effects, such as destabilisation of ice sheets in Greenland and West Antarctica. These impacts could trigger the displacement of human populations on a scale not seen before, with risks of conflict and war. Climate change is a profound threat to peace, security and prosperity.

Unfortunately, traditional 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 of economic impacts. The Planetary Solvency report 2025 estimates the global economy could face a 50% loss by 2090. But the risks are broader and deeper than measured simply by output. For many, development, on all its dimensions, could be put into reverse and lives lost on a massive scale. The right policy action today can mitigate both economic harm and threats to human lives. While assessments of the risks are now much more severe, we have made much greater technological progress than we expected. The costs, for instance, of producing solar panels, wind turbines and other renewables have declined much more rapidly than predicted – they are now the cheapest forms of energy in many parts of the world, given a manageable cost of capital.



## Economic opportunities

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, providing a more affordable alternative to fossil fuels. Models used by some economists have failed to project these rapid cost reductions because they do not take significant account of learning-by-doing and other self-reinforcing processes that accelerate technological progress. And the processes of discovery and diffusion are being strongly augmented by AI.

The case can now also be made that phasing out the use of oil can drastically improve economic performance in oil-dependent countries via reduced expensive imports – money that could be spent on domestically produced technologies and on economic development, with the additional benefit of enhanced energy security Countries are now increasingly recognising this transition not only reduces the immense risks of climate change but can also generate good jobs and economic prosperity. In 2025, an OECD report found that tackling climate change through enhanced NDCs could – by 2050 – increase GDP per capita growth by up to 60% in the most advanced economies, and 124% in lower-income countries.

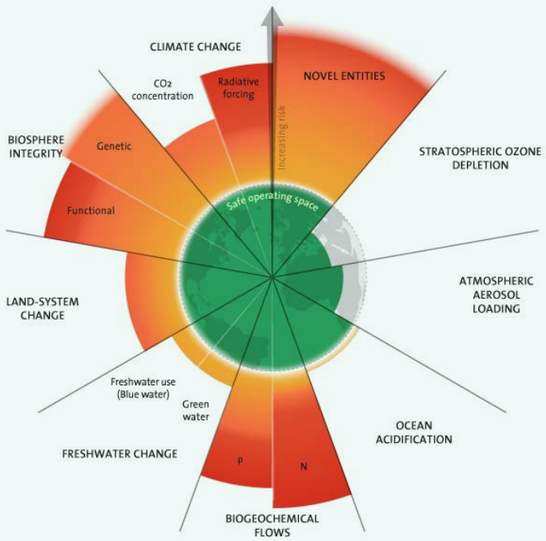
## Multiple tools

But all this requires strong investment in technologies and in domestic production capabilities of countries for those technologies, which can be achieved only if governments provide 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. Successful examples include: policies for feed-in tariffs for solar energy (Germany), contracts for differences for onshore and offshore wind energy (UK), and mandates for electric vehicles (China, Norway, California). All of these instruments mitigated investment uncertainty. Policymakers need multiple tools that address a whole range of market failures too, including those associated with fossil fuel and farming subsidies, economic uncertainty, research and development, capital markets, insurance, networks, information, and air pollution.

While the economic case for stopping greenhouse gas emissions and moving to a new and cleaner path of growth and development is now overwhelming, we must also 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 economics evidence is clear. The transition to a sustainable, inclusive and resilient global economy is the growth story of the 21st Century.

### Nine boundaries assessed, seven crossed




The planetary boundaries were first proposed in 2009 by a group of 28 internationally renowned scientists. Combining insights from many fields of global environmental change research, the framework highlights nine global change processes where human activities affect Earth system functioning. Planetary boundaries are quantitative assessments of the safe limits for human pressure on these nine critical processes.

Source: Stockholm Resilience Centre, Stockholm University.

# Energy, transport and industry transition

**Outdated conventional wisdom suggests the low-carbon transition will be more expensive than fossil fuels. There is a better way.**

Reliable and affordable energy underpins the world's economy, driving economic growth over the last century. For most nations, the transition from fossil fuels to renewable energy now offers major opportunities – in terms of energy security, cost savings and economic growth.

Solar energy with battery storage is now cheaper and faster to deploy than fossil fuel technologies. In 2024, the global average electricity generation cost from solar PV was 41% cheaper – and onshore wind 53% cheaper – than the least-cost new fossil fuel-fired power plant. On average, project lead times for solar PV and onshore wind are one to three years (less for small-scale solar), whereas coal- and gas-fired power plants can take up to five years, and nuclear power plants 10-15 years.

In 2024, renewables made up 92.5% of all new electricity capacity additions. As a result of these tipping points in technology and price, a new clean energy economy is emerging, helping to decouple growth from emissions. Perverse policy headwinds and fossil fuel subsidies remain a threat, however.

## Outdated ideas

A central feature of the energy transition is a fundamental shift to electrification, replacing coal and thermal natural gas with renewable power and ending oil use in transportation. Meanwhile, chemical production will require a combination of carbon capture, bio-based feedstocks and green hydrogen.

**Strategic priorities for legislative action**

1. Consistent policy incentives for renewable power and decarbonised transport, fuels, chemicals and heat
2. Align policies for customer-level clean energy and large-scale infrastructure projects, so they reinforce each other
3. Mobilise finance at all scales and derisk investment
4. Reduce and repurpose fossil fuel subsidies to the energy transition

How we execute the energy transition matters greatly to its affordability and therefore its pace. Outdated conventional wisdom suggests that rising electricity demand, especially from data centres, means the low-carbon transition in the energy system will be at least $1 trillion per year more expensive than fossil fuels. This is true only if we use the traditional top-down, centralised energy system of the last century. Further, it ignores the $7 trillion per year the IMF estimates in annual fossil fuel subsidies, explicit and implicit. Centralised systems also remain vulnerable to man-made attacks or severe weather events. There is a better way.

When we reimagine the energy system from the consumer's perspective, we start with energy efficiency and advanced design in homes, industry and data centres to reduce the absolute demand for power – vastly lowering the overhyped forecasts for new power generation. Data centre energy efficiency will continue to improve by 50% or more per year from a combination of hardware, software and cooling design. For customers, a distributed energy system (solar panels and battery storage) will become the next ubiquitous residential appliance – the third largest purchase after the home or vehicle – with adoption based on supportive policies and consumer finance.

## Price parity

When the energy system relies on distributed power and battery storage from people's homes and electric vehicles, the total system cost of the energy transition is 20-30% lower than relying solely on utility owned assets – and it is more resilient. When energy access and affordability is increased, the system is also more equitable.

As we come to rely more on wind and solar, our electrical architecture must evolve – creating a flexible and adaptive grid. In transmission, interconnectivity from national and cross-border super grids will be needed to move vast amounts of renewable energy from the windy plains and sunny deserts to urban demand centres.

Some sectors – air travel, ocean logistics, heavy transport, steel and chemicals – remain hard to decarbonise using electricity. These require different technology solutions, including carbon capture and green hydrogen. Most of these solutions will reach price parity with conventional approaches within a decade. Therefore, most – but not all – of the technology already exists to achieve the energy transition.

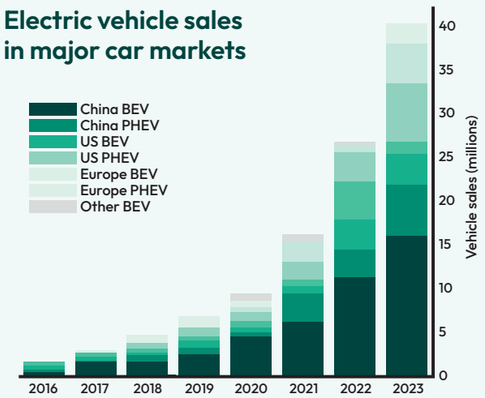
## Decisive action

Public-private partnerships are needed to invest and scale emerging technologies and deploy solutions faster. Policies and markets that align the utility sector to consumers, by supporting the bi-directional flow of energy to and from the consumer, underpin the pace of change and capital mobilisation necessary. Political will to site major new energy infrastructure is needed for energy security now.

Energy infrastructure takes time to deploy. Policy coherence, clarity and certainty are the most critical factors. The energy transition is no longer a future ambition – it is a present-day economic, environmental and security imperative. Parliamentarians can act decisively to reform outdated systems, align trade and investment frameworks with climate goals, and ensure that the transition delivers prosperity, equity and resilience for all.

A just transition to a low-carbon economy involves social as well as technological change. There are huge opportunities, and a wide range of social benefits, that can be delivered through sustained action to reduce demand for energy. To achieve net zero we need actors from across society to be engaged. Place-based organisations that work at the mid-level (e.g. local businesses, schools, community groups) and operate between scales and sectors are especially important. Engaging citizens in genuine and meaningful debate about change and generating positive visions of a net zero future will also be essential.

**Electric vehicle sales in major car markets**



# Food, forests and fisheries

**We produce enough food for 10 billion people – yet a third of all food is wasted, and 800 million people remain hungry.**

## Transforming food for people and planet

Since the 1970s, deaths from famine have declined dramatically – even as the global population doubled. But food access remains profoundly unequal. We produce enough food for 10 billion people – yet a third of all food is wasted, and 800 million people are hungry.

### Food for thought

1. Accelerate the shift to plant-based foods
2. Support organic farming & composting
3. Reduce food waste
4. Eliminate harmful subsidies for industrial agriculture and promote regenerative agriculture and healthy soils that store carbon dioxide

Almost half of habitable land is used for agriculture. 16% of this grows crops for human consumption – providing 83% of our calories. Meanwhile, 80% of agricultural land is used to raise livestock for meat and dairy – providing just 17% of the world's calories.

Agriculture is the largest driver of deforestation and biodiversity loss, and the food system contributes about a third of global greenhouse gas emissions. This includes emissions from farm production, land-use changes, production processes and food waste. The agriculture sector is the largest anthropogenic source of methane and nitrous dioxide, with global warming potential in the short term far greater than that of carbon dioxide.

These environmental and climate costs are driving increased floods, fires, droughts, desertification and soil depletion – reducing our capacity to produce food worldwide. Policymakers can enable a shift from industrial to sustainable agriculture, and a tipping point towards plant-based diets.

One opportunity is to repurpose agriculture subsidies – over 90% of which have damaging impacts. For example, the World Bank estimates that subsidies for soya beans, palm oil and beef are responsible for 14% of forest loss every year.



Reduced waste, localised consumption and farmworker rights could be prioritised – supporting planetary health, community cohesion and resilience. Fair and equitable working conditions are important too; while women make up 43% of agricultural workers, they represent only 15% of landowners. A better, fairer food system could feed the planet without costing the Earth.

## Protect forests to preserve climate and biodiversity

Forests cover more than four billion hectares globally – approximately 30% of the earth's land surface and provide us with timber, food and medicine. They also provide vital ecosystem services, playing a key role in global cycles of carbon and water. Globally, forests absorb an estimated 7.8 gigatonnes of CO2 per year, which is about 20% of global emissions, and intact tropical rain forests in particular have been a sink for carbon emissions over recent decades. However, in the face of climate change, the capacity of forests to sequester carbon may be diminishing, and forest conversion is responsible for substantial carbon emissions. Hotter, drier climates – with more frequent severe drought and fire events – are driving widespread forest mortality, also increasing carbon emissions.

To preserve our planet's rich biodiversity, we must protect all forests – not just rain forests. One key to minimise further biodiversity loss and thereby stabilise our climate will be through conserving as many species-rich ecosystems as we can – because more diverse ecosystems are more resilient to climate change. Indeed, preserving intact natural ecosystems of all kinds minimises carbon emissions and creates the greatest opportunity for nature to thrive.

## Well-managed oceans could supply us indefinitely

Fisheries are a vital source of animal protein and nutrients for at least 3.3 billion people worldwide. Artisanal and small-scale fisheries account for over 40% of the global catch and are critical to alleviating poverty, hunger and malnutrition in low-income countries. Fish and shellfish are renewable resources that – if well managed – could supply us indefinitely. But poor management, overfishing, and use of destructive fishing methods have historically depleted fisheries worldwide. Although management is improving in places, these problems persist over vast regions.

Greenhouse gas emissions are driving rapid changes in the global ocean. Warming is changing where fish live and altering fishing opportunities, with losses likely in tropical and polar regions and gains in between. Warming is reducing primary productivity through greater water stratification and nutrient depletion in shallow waters. Warming-induced deoxygenation will slow fish growth to smaller maximum body sizes, reducing fisheries productivity and impacting on reproduction and replenishment.

The addition of climate change pressures to perennial problems of fisheries management demands a new, precautionary approach to build resilience for the future. The approach combines reduced exploitation rates with elimination of destructive and unselective fishing methods, and establishment of highly or fully protected areas over at least 30% of the ocean, in line with international conservation commitments. The World Trade Organisation Agreement on Fisheries Subsidies and UN High Seas Treaty have both come into force this year and will make a material contribution to achieving these goals.

# COP – Do your constituents care?

**When the Paris Agreement was adopted in 2015, our planet was on track to warm by nearly 5°C. Today, it's on track to warm by nearly 3°C.**

The NDC Equity Tracker database highlights country pledges for climate action, especially on gender justice, intergenerational equity, and civil society inclusion, and provides proposed solutions and improvements.

**ndcequitytracker.org**

## Focus on COP: How is the international community addressing climate change?

The Conference of the Parties (COP) is the central decision-making body of the United Nations Framework Convention on Climate Change (UNFCCC), established in 1992 to coordinate international efforts to prevent "dangerous human interference with the climate system". In addition to Environmental Ministers and negotiators, civil society, youth, Indigenous Peoples, and private actors attend COP to advocate and share knowledge.

Climate science plays a central role. The Intergovernmental Panel on Climate Change (IPCC), formed in 1988, provides scientific assessments of climate change, its impacts, and response strategies. Early climate impacts and UNFCCC efforts led to the Kyoto Protocol, adopted at COP3 in 1997 as the first treaty requiring industrialised nations to cut emissions. Because it lacked enforcement mechanisms, the Kyoto Protocol had limited success.

## Increasing ambition

The Kyoto Protocol laid the foundation for future negotiations by establishing the principle of differentiated responsibilities and the concept of quantified emission targets. In 2015, the UNFCCC adopted the Paris Agreement at COP15, calling on all countries to set emissions targets and limit global temperature rise to well below 2°C, striving for 1.5°C. Nationally Determined Contributions (NDCs) are core to the Agreement, and are national climate action plans submitted by countries every five years, with increasing ambition.

Every five years, NDCs are reviewed under the Global Stocktake (GST), which offers an opportunity for course correction on climate action. The first GST, adopted at COP28 in 2023, marked the first time the UNFCCC formally recognised fossil fuels as the main driver of climate change and called for a transition away from them, signalling a major shift in global dialogue. Beyond mitigation, the UNFCCC also includes discussions on climate finance, adaptation, gender action, capacity-building, education and empowerment, loss and damage, and more.

## Working in tandem

When the Paris Agreement was adopted, our planet was on track to warm nearly 5°C. Today, it's on track to warm by nearly 3°C. Every fraction of a degree and every ounce of climate action matters. While the UNFCCC offers a framework for cooperation, progress is slow due to the need for consensus among all Parties and lack of enforcement. To meet the urgency of the climate crisis, action must also come from national governments, local communities, businesses, and financial systems working in tandem with UNFCCC processes. Initiatives like the Race to Resilience and Global Methane Pledge exemplify how non-state actors and international coalitions can complement formal negotiations, accelerating efforts to build climate resilience and reduce emissions.

## Do your constituents really care?

A study of nearly 130,000 people across 125 countries (covering 97% of global emissions) found that 89% want more political action to protect the climate. However, many underestimate the willingness of their fellow citizens to act. Therefore, policymakers have an opportunity to foster and raise awareness of this consensus – providing crucial leadership and driving action to deliver a sustainable future for people, nature and the planet.

## Climate mis- and dis-information

For decades, oil and gas companies have known in accurate detail the catastrophic risks to the global climate from the continued burning of fossil fuels. Instead of shifting business models, fossil fuel producers strategically undermined public understanding of climate science to delay action.

These companies continue to misrepresent the overwhelming scientific consensus, spread disinformation, and engage in false advertising campaigns. Parliamentarians can avoid participating in climate disinformation by understanding key facts and being vigilant about false claims. Many reliable sources of information are available – including Real Climate and Skeptical Science, which has painstakingly collected responses to over 200 arguments against climate action and have organised them by type of argument (it's not real, it's not humans, it's not bad, etc).

Parliamentarians can support systemic action through the UN- and UNESCO-backed Global Initiative for Information Integrity on Climate Change. This is a great opportunity to use your voice to advocate for the accurate information we need to plan for a safer, better future for us all.

## Climate education

The need for society-wide climate education has long been recognised as critical to achieving climate targets – from the UNFCCC (1994) to the Paris Agreement (2015), both of which include provisions on education, training, public awareness, and access to information. Over the past decade, education has become increasingly visible as a foundation for broad societal understanding and engagement on climate. National ministries of education have invested in this agenda globally and locally, supported by UN agencies including the UNFCCC Secretariat, UNEP, FAO, UNICEF, UNU, UNITAR and UNESCO.

UNESCO's Greening Education Partnership (GEP) is mobilising international organisations, governments, youth, civil society and the private sector around four priorities: green schools, curricula, teacher training, and communities. While focused on climate, this intersects with biodiversity, pollution, and health.

UNITAR hosts the One UN Climate Change Learning Partnership (UN CC:Learn), offering a single entry point to UN climate knowledge through free online courses. These resources help scale climate literacy, yet education systems worldwide still lag behind the level of action required. Countries in the Global South, in particular, request greater support. Parliamentarians have a key role in championing stronger climate education, leveraging initiatives like GEP and UN CC:Learn to build informed societies.

| Key fact | Misinformation: Watch for |
|---|---|
| Climate change is real and primarily driven by fossil fuels | Claims it is not real, not human-caused, or stems from natural variability |
| It is harming people and ecosystems right now in many places | Claims impacts are far off geographically, will happen in the future, will be minor, or are beneficial |
| Scientists agree on the causes and risks | Attacks on scientific credibility |
| We have effective, proven solutions | Claims solutions are harmful (including being too expensive) or are unnecessary |

# Carbon capture and carbon markets

**All options must be on the table, but technical solutions will be needed to cope with the formidable scale of necessary carbon removal.**

## Carbon capture and storage

Natural processes are moving about half the carbon dioxide (CO2) that the burning of fossil fuels adds to the atmosphere into terrestrial and marine ecosystems. Half is not good enough. It will take millennia for nature to remove the remaining half, and furthermore nature's ability to remove carbon appears to be faltering both on land and sea, raising the question how far natural sequestration processes can be pushed. While nature-based solutions remain important, tech-based carbon capture is likely to gain increasing importance.

### How to ensure carbon credits are bona fide & reliable

To avoid greenwashing and buy high-integrity carbon credits, here's what to look for:

- ☐ Verified Standards
- ☐ Additionality
- ☐ Permanence
- ☐ Transparency
- ☐ Avoid "Too Good to Be True" Prices

## Exploring tech-based carbon capture

Net zero carbon is a prerequisite for fixing climate. Either the world stops fossil fuel burning and cement production, or for every tonne of CO2 coming out of the ground, another will have to be removed. Since stopping extraction in time to avert severe climate damages is no longer realistic, CO2 removal technologies must augment the phaseout of fossil fuels.

Conceptually, CO2 removal involves its collection, often referred to as carbon capture, and its safe and permanent disposal, referred to as carbon storage. Sometimes the two steps merge. For example, trees extract carbon dioxide from the atmosphere and sequester it as woody biomass for decades. Direct air capture collects carbon dioxide from the atmosphere just like a tree but without photosynthesis and delivers a stream of CO2 ready for use (bubbles in drinks for example) and/or storage.

## Smaller footprint

Direct air capture is currently more expensive than biological capture but also more powerful, resulting in a thousand times smaller footprint. Compensating for the world's current emissions through photosynthesis would take more than the land that is currently used for agriculture.

Unfortunately, direct air capture is still nascent and expensive, but its cost will likely drop as it is phased in. Through learning by doing, solar and wind energy costs have dropped about one hundredfold over a few decades. Furthermore, not all carbon dioxide would have to be removed directly from air. Flue gas scrubbers for power, cement, steel and chemical plants might intercept about half of all the CO2 before it is emitted.

Once collected, CO2 must be kept out of the environment for climate-relevant time scales, which are measured in millennia. Here, too, technical solutions can excel. Storing CO2 deep underground in saline aquifers or converting it into solid carbonate (mineral rock) provides sequestration on geological timescales.

All options need to be on the table. Low-cost biological storage sequesters carbon for decades and some biochar for millennia, but technical solutions will have to follow to cope with the formidable scale of the necessary carbon removal.

## Carbon markets and Article 6 of the Paris Agreement

After COP29, headlines focused on the new global finance goal to raise $1.3 trillion annually by 2035. But one of the most significant outcomes was the finalisation of the Article 6 Rulebook. "Article 6" might sound technical, but it's a game-changer for how we tackle climate change. It sets the rules for international carbon markets. And at COP29, after years of negotiation, we finally got it sorted.

Governments run their own compliance markets and domestic emissions trading schemes, while the voluntary market is international with many schemes and projects in operation, each varying considerably in credibility. Article 6 is a big deal for both compliance and voluntary markets. Governments alone can't solve climate change. They require companies to reduce, offset, and embrace policy, and individuals to support those businesses and voluntarily offset. But it's important to ensure voluntary offsetting makes a difference, and wouldn't be double counted somewhere else.

## Unlocking finance

This is where Article 6 comes in. It deals with ITMOs (Internationally Transferable Mitigation Outcomes), which are essentially carbon credits that can be traded between countries. The rules around ITMOs allow for centralised accounting at international level, ensuring everyone plays by the same rules. This is a huge step forward. It provides much-needed certainty for investors backing climate projects, and gives countries confidence to use these projects to meet their own climate pledges (NDCs). This unlocks a flow of finance into developing nations that are well-placed to generate high-quality carbon credits.

## What this means for stakeholders

These changes have wide-ranging implications for governments, businesses, investors, NGOs, Civil Society and individuals. To accelerate progress, governments must balance carrots and sticks: incentives (subsidies, credits) for renewable adoption, reforestation, biogas, and nature-based solutions; penalties for pollution and destructive practices; and transparent auditing of emissions baselines.

There are still some potential pitfalls. Greenwashing is a major concern. Carbon credits are a valuable tool – but not a silver bullet. However, the future of carbon markets is bright. As climate policies evolve, we'll need to adapt and ensure we're meeting the highest standards.

## The bottom line

COP29 was an important step forward, especially with the finalisation of Article 6. But it's just the beginning. The real work starts now.

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