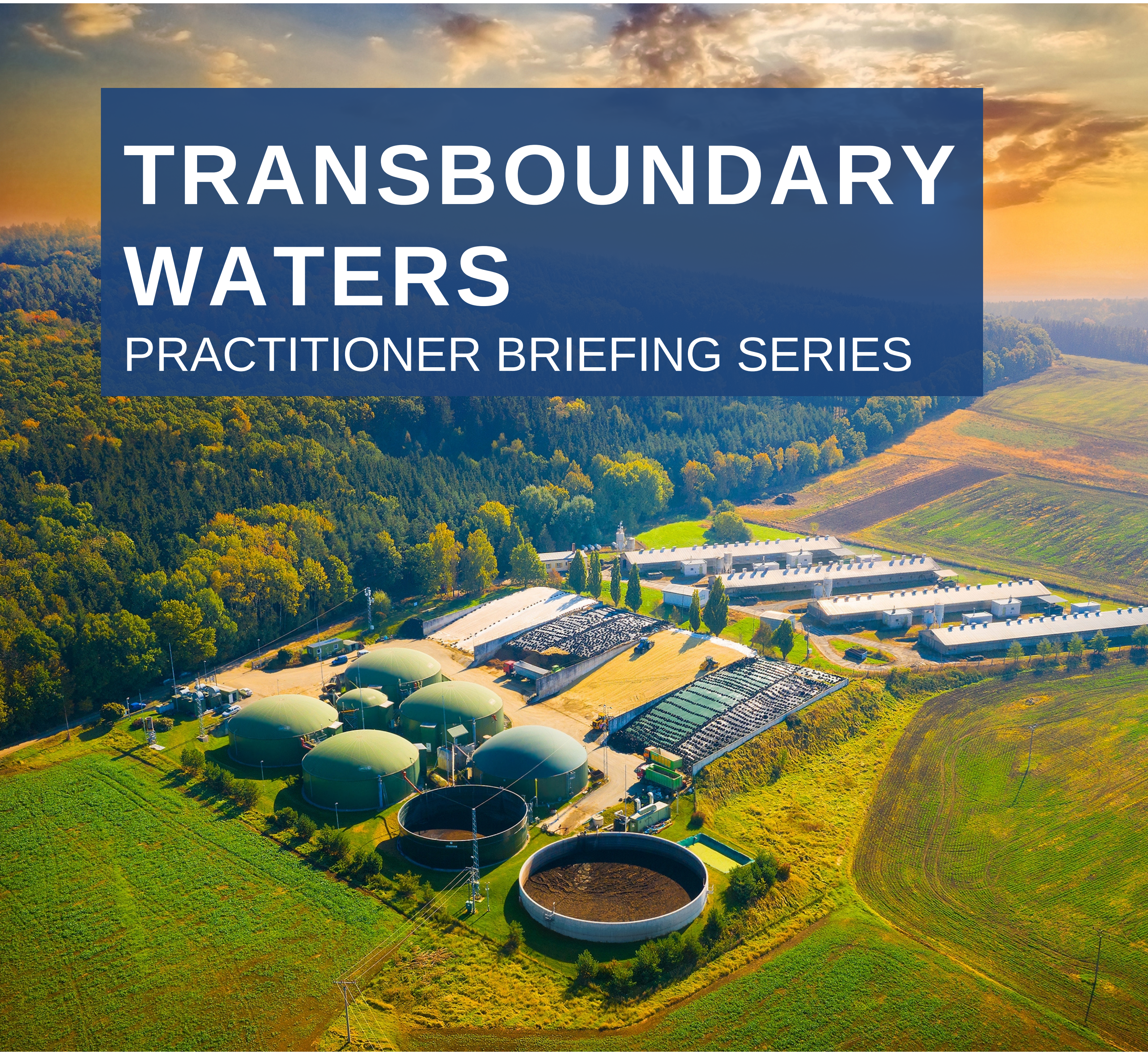
TRANSBOUNDARY WATERS

PRACTITIONER BRIEFING SERIES



Issue 15

Transboundary Carbon – Cooperation

Transboundary Carbon *Cooperation*

"It is up to the G20 countries responsible for 80% of global emissions that we are beholden to for our survival. Our survival is being held to ransom at the cost of profit and an unwillingness to act despite the ability to do so." *— Mark Brown, Prime Minister of the Cook Islands (COP 27)*

Shared Damage:

Carbon emissions everywhere cause climate change anywhere. 'Loss & Damage' from climate impacts now risks becoming unavoidable. Can transboundary carbon cooperation work fast enough?

Introduction

The UN IPCC Synthesis Report (AR6) released in March 2023 gave yet another stark warning of the current path and pace of climate change, the state of carbon emissions globally, and the severely lacking responses by governments around the world.

AR6 is notably a summary report, building onto the findings of prior reports and ongoing research and monitoring efforts that also give the same repeated warnings. Annual reports from the UNEP on the Emissions Gap and Adaptation Gap for 2022 were titled, "The Closing Window", and "'Too Little, Too Slow", which neatly sum up where we are today. Last year's carbon emissions hit new record highs for coal and gas as the world's 'carbon budget' was further depleted at an again increasing rate post-Covid19.

The report's release made some headlines, top stories, or features, then faded into the background with another news cycle. It seems with each year another dire report tells us what is coming and that we are running out of time to respond. The news makes the rounds, and then fades away for the next headline as the world collectively shrugs.

There is risk of climate fatigue to the repeated alarming headlines that do not seem to match the slow-moving oncoming train. Technology is in the pipeline; it will sort itself out. While climate change denialism and obfuscating about the weather show that the climate debate is still unsettled, although science may be.

On one hand tremendous progress has been made and there are reasons for hope, as we have the tools and means to respond to these challenges. On the other hand, complacency and overconfidence in technological solutions coming down the road allows political actions to stall or delay until the next summit or election. All these solutions require large investments and scale to become viable, and only international cooperation can set the appropriate stage.

The seemingly inexorable element weaving between the reports, media headlines, or high-level meetings, is transboundary carbon—the need to stop its release, to decouple it from economic growth or prosperity, and to undo the processes that have spent the planet's carbon budget and unbalanced the global carbon cycle. Politics and science cannot exist in a vacuum on this issue, and the inherent transboundary nature of carbon emissions requires delicate global maneuvering between stakeholders.

There is also a real question of whether the pace of global multilateral cooperation around climate and carbon emissions is up to the task at hand. Is global cooperation truly necessary or even desirable for the greatest collective action problem of today, or can more effective progress be made without grand green bargains? The end of this year will see the first Global Stocktake under the Paris Agreement, intended to be a gut-check moment where emission promises and plans must show their receipts. What comes after will define its impact versus being yet another report.

This issue will examine Transboundary Carbon Cooperation and the dynamics of climate change around global multilateral responses to this issue. Subsequent briefs will focus on Transboundary Carbon Technology such as novel methods of CDR (carbon dioxide removal), as well as the field of Carbon Valuation, making the economic case for carbon markets and offsets.

Practical Summary

- Climate change is the ultimate transboundary environmental issue as carbon dioxide and other GHGs cross all boundaries while accumulating in the atmosphere, and where climate impacts are felt most directly through changes in the water cycle.

- Addressing transboundary carbon is also the greatest collective action problem today, requiring international coordination around classic issues of market failure including the 'tragedy of the commons', 'free-rider' problems, and a 'prisoner's dilemma', where the business-as-usual case remains cheaper, with additional questions of climate justice across time and between countries.

- Landmark climate agreements from Kyoto to Cancun to Paris operationalize the multilateral UN Climate Framework of the UNFCCC but are falling well short of their stated goals. Regional approaches can be valuable to make progress in blocs.

- Carbon dioxide is the most consequential GHG although not the most powerful. Its release is most directly linked to human activity from the burning of fossil fuels, deforestation and land-use changes, agriculture, transport, and industrial processes.

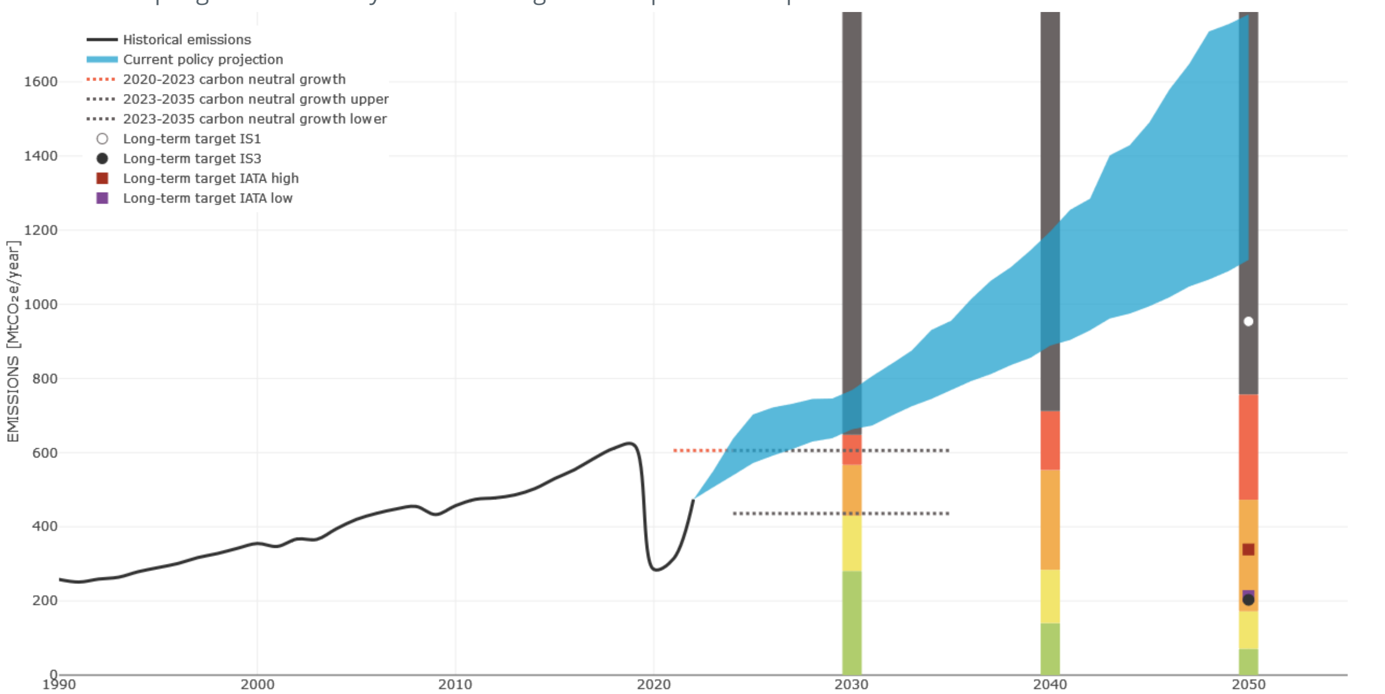
- Methane, Nitrous Oxide, and Sulfur Hexafluoride are also key GHG challenges that are even more powerful though smaller scale. Stopping and capturing methane leaks can have immediate impacts in the near term and have a clear economic value.

- Carbon mitigation seeks to limit and reduce carbon emissions, while climate adaptation seeks to better survive and live with climate changes happening today and into the future. Climate resilience seeks to adapt without significant disruption, and to create new options that did not previously exist.

- The 1st Global Stocktake of the Paris Agreement concludes with COP28 in the UAE. A potential global turning point for climate action, or just another set of recommendations absent of political will.

- An everything—everywhere—all-at-once approach is needed to address the greatest transboundary environmental issue of our time.

Aviation accounts for just 2% of global emissions but is on a path towards 1 - 1.8 GtCO2e per year by 2050. Decoupling transboundary carbon from growth requires a complete sector overhaul.



Source: Climate Action Tracker - International Aviation Sector

Global Climate Cooperation

Global cooperation on climate change as known today began with the 1992 'Earth Summit' in Rio de Janeiro, Brazil. Officially known as the UN Conference on Environment and Development (UNCED), the meeting of 178 countries created the mechanism, or *framework*, which serves to address climate change issues today, the UNFCCC—United Nations Framework Convention on Climate Change.

Several other principles, declarations, or conventions came out of this meeting like the Convention on Biodiversity, the Rio Declaration on Environment and Development, Agenda 21, or the Forest Principles. All of these were non-binding or statements of intent, but have led to real progress over time, such as the Sustainable Develop Goals (SDGs) from Agenda 21 to Agenda 30, or the Paris Agreement through the UNFCCC and its Conference of the Parties or COP meetings.

The 1990s were a period of peak multilateralism, with internationally negotiated agreements on topics ranging from tariffs and trade to landmines and chemical weapons, from peace processes in Madrid to Oslo and Dublin, or the first landmark agreement on the climate—the Kyoto Protocol of COP3 in 1997. Global carbon emissions that year were roughly 25 billion tons of CO2. This year will feature 'COP28' and the first Global Stocktake on emissions reductions under the subsequent Paris Agreement, with carbon emissions now at over 40 billion tons in 2022 and global emissions likely yet to peak.

The past decade has seen a swinging pendulum of multilateralism, as transboundary cooperation has achieved some great successes but also faced new and re-emerging challenges, while seeing some past triumphs erode. The Paris Agreement itself is an example of this. Decades in the making as an evolution of previous accords, it was ceremonially agreed to at the end of COP21 in Paris in 2015, to great applause and tears from conference participants. It was also about a decade behind schedule and lacked enforcement mechanisms.

Global Climate Timeline

1950 – World Meteorological Organization (WMO)
1972 – United Nations Environment Programme (UNEP) – UN Conference on the Human Environment
1979 – World Climate Conference
1986 – Advisory Group on Greenhouse Gases (AGGG)
1987 – Montreal Protocol on Substances that Deplete the Ozone Layer
1988 – Intergovernmental Panel on Climate Change (IPCC)
1991 – Global Environmental Facility (GEF)
1992 – United Nations Framework Convention on Climate Change (UNFCCC) – UN Conference on Environment & Development (UNCED) Earth Summit, *Rio de Janeiro*
1997 – *Kyoto Protocol* (COP 3)
2001 – Adaptation Fund, Least Developed Countries Fund, Special Climate Change Fund (COP 7) *Marrakech*
2005 – Kyoto takes effect, accounting for 55% of global emissions
2007 – Bali Action Plan (COP 13) 'Kyoto 2.0'
2009 – Copenhagen Accord (COP 15) – $100 Billion Promise by 2020
2010 – Green Climate Fund (COP 16) *Cancun*
2011 – Durban Platform on Enhanced Action (COP 17)
2012 – Kyoto Extension (COP 18) *Doha*
2013 – REDD+ (COP 19) *Warsaw*
2015 – *Paris Agreement* (COP 21)
2022 – Loss & Damage Fund (COP 27) *Egypt*
2023 – *First Global Stocktake* (COP 28) *UAE*

Just 2 years later in 2017, arguably the major party to the agreement as long the world's largest emitter withdrew from the agreement, vowing to negotiate a new and better deal that did not cause it economic harm. This was not China, the current world emissions leader, but the United States. This example and its process are key to understanding the issues of transboundary carbon and the multilateral efforts to respond to them. The state of climate change today is a direct function of the nature of the transboundary carbon problem and the often cumbersome global mechanism used to respond to it.

Another entity that informs these multilateral mechanisms, also predates it—the IPCC, or Intergovernmental Panel on Climate Change. The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the UN Environment Program (UNEP), as a scientific intergovernmental body that assesses, reviews, and summarizes the scientific literature around climate change, writing reports as experts in their fields, and then peer reviewed. It does not conduct original research but instead performs comprehensive assessments on the state of knowledge today. The IPCC is unique in that it is neither a strictly scientific nor strictly political body, but a uniquely independent and intergovernmental hybrid organization, made up of scientists representing their governments, issuing reports signed off by all participating governments. This may be seen as both a feature and an impediment.

The IPCC has published six assessment reports to date, the most recent of which was released at the end of March 2023 (AR6), and the first being issued in 1990, even before the formation of the UNFCCC two years later. The IPCC's reports have been instrumental in shaping the global response to climate change and setting the stage for discussions by giving a coherent set of facts to work from. Their reports have been used by policymakers, businesses, and the public to understand the science of climate change and its potential impacts. The IPCC's reports have also been used to inform and develop climate change mitigation and adaptation strategies as well.

It must be noted that the post-WWII institutions that make up the United Nations were not generally concerned with environmental issues at their inception. Peace and international development were paramount, and concerns about the environment primarily related to the finding and exploiting of natural resources for development. It thus took decades for environmental concerns or principles to be developed and considered within international law or multilateral frameworks.

In this context, the history of global cooperation on climate change can be traced back to the 1950s when scientists first began to recognize the potential impacts of greenhouse gases (GHGs) on the Earth's climate and sought to better understand atmospheric science, creating the World Meteorological Organization (WMO) in 1950, during the Atomic Age and an era of 'atoms for peace'. It would be still two decades later in the 1970s that the UN established the United Nations Environment Programme (UNEP) to coordinate international environmental efforts, including addressing climate change. A few study groups and workshops under the US National Academy of Sciences had examined the science of climate change, but no policies or emission standards were adopted from these meetings by governments as the discussion remained isolated.

The UNFCCC first established the policy goals of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system, another two decades later.

The creation of the UNFCCC was followed up with the adoption of the Kyoto Protocol in 1997 at COP3—the 3rd Conference of the Parties meeting under the Framework—which set binding emissions reduction targets for developed countries for the 1st commitment period of 2008-2012. Developing countries including China and India were not included in this commitment, and its targets were just 5% reductions from 1990 emissions levels. The United States, the world's largest emitter of greenhouse gases at the time, did not ratify the protocol.

Ultimately the legacy of the Kyoto Protocol is that it failed to bring in the most important parties, and only accounted for 18% of global emissions at best in 1997 and took until 2005 to come into effect, wherein a 5% reduction in 1990 emissions levels would mean very little to the global carbon budget over time, particularly as states like China and India continued to develop. By 2005, 55% of emissions were accounted for in the Protocol, with pledges to reduce around 5-8% compared to 1990, or to just keep from increasing above 1990 levels. Today, with specific temperature targets in mind, we are well behind schedule towards a path to 'Net-Zero', needing to bend a still rising curve all the way back down to zero.

The Copenhagen Climate Conference in 2009 was another key moment in global cooperation on climate change, but it ended without a legally binding agreement and thus frustration. However, countries set goals and agreed to work towards limiting global temperature rise to 2°C above pre-industrial levels and pledged $100 billion per year by 2020 to support developing countries' efforts to address climate change. To date, the $100 billion per year figure has not been reached, though new financial pledges exist, such as the most recent around 'Loss & Damage'. [1]

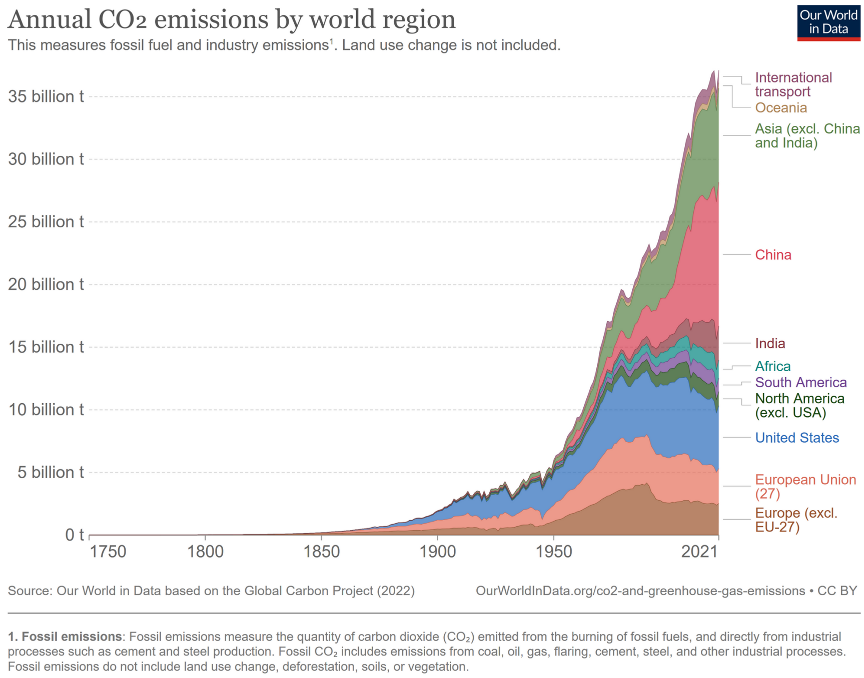
Origin of the climate issue

*While climatology has always been recognized as an important branch of the science and practice of meteorology (Landsberg, 1945) and the basic physics of greenhouse warming has been understood for more than a century (Houghton, 2009), the present global concern with climate issues really dates from the convergence of **five** important scientific, technological and geopolitical developments of the 1950s:*

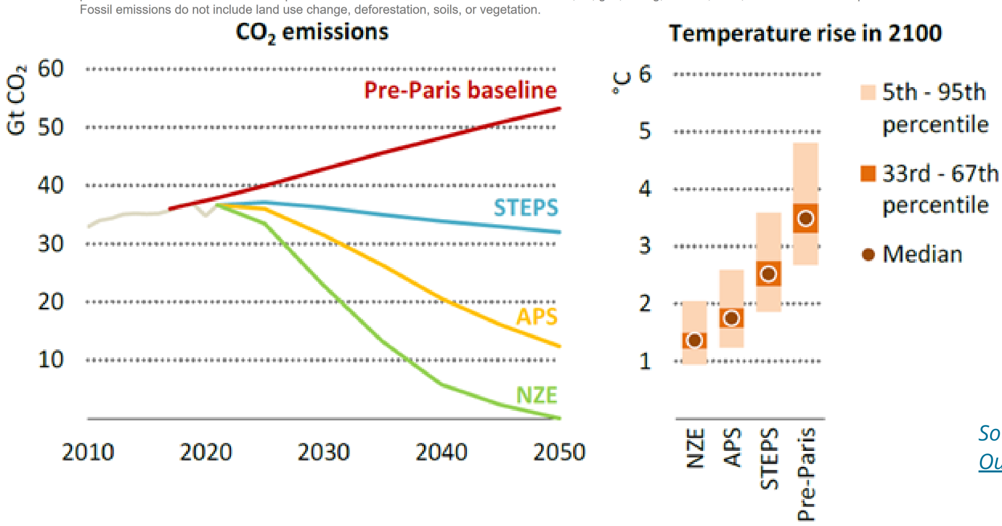
- *Post-World War II advances in basic atmospheric science that led to greatly increased understanding of the mechanisms of the large-scale circulation of the atmosphere;*
- *Initiation of a number of new geophysical observations (especially the Mauna Loa measurements of atmospheric carbon dioxide) during the 1957 International Geophysical Year;*
- *Recognition of the potential meteorological observing capabilities of Earth-orbiting satellites;*
- *The advent of digital computers; and*
- *The willingness of countries, even in the developing Cold War environment, to use the institutions of the United Nations System for cooperation in addressing important global problems;*

*which shaped the transition of climatology from a **descriptive** to a **physical** science (Flohn, 1970) and opened up the prospect of diagnostic and predictive modelling of the global climate system (Bolin, 2007).*

Source: World Meteorological Organization (WMO)



Source: Our World in Data - CO2 Emissions



Source: IEA World Energy Outlook 2022

The Paris Agreement

From Kyoto in 1997 to Copenhagen in 2009, global climate cooperation had not yet reached an impactful international agreement to address climate change. The following years would turn this around and set a course to Paris in 2015.

In December 2011 at Durban, COP17, 195 countries signed on to agree a new international agreement by 2015, to re-commit to the Kyoto Protocol, as well as launch the new Green Climate Fund. The 'Durban Platform on Enhanced Action' launched a new round of negotiations on global climate responses, aiming to develop a new protocol, another legal instrument, or an agreed outcome with legal force, for the post 2020 period. This would schedule a negotiations timeline from 2012-2015 and recommit the EU to the Kyoto Protocol for a 5–8-year period. Again, the sticking point for the US was a 'symmetrical' mandate that included developed as well as developing nations.

The Durban negotiations represented a fundamental change from the Kyoto period, whereby all parties to an agreement would be subject to it measures, with a focus on a legally binding nature. At this time, already a large 'ambition gap' had formed between the goals of mitigating climate change and the actual outcomes achieved thus far. Durban would set the most ambitious targets possible, and notably avoid any references of developed vs. developing negotiating tacks, or Annex I vs. non-Annex I parties, as the Kyoto Protocol or Bali Action Plan had done before. The prior structures were gone, to put a new set of goals onto the table—mitigation, adaptation, finance, technology, transparency, and capacity building, all within a legal framework. [2]

The Paris Agreement ('PA'), adopted through 'Decision 1/CP.21' in 2015 at COP21, represented a major milestone in global cooperation on climate change. It reached critical mass of ratification by at least 55 parties on November 4, 2016, thereby entering into force, and making its adoption much more rapid than Kyoto before it.

At its core, the Paris Agreement is an action plan for cooperation, with some specific goals and targets and a pathway for achieving them. The most important elements are the NDCs and the Global Stocktake, which are further discussed later.

The Agreement aims to limit overall global warming averages to well-below +2° Celsius from pre-industrial levels, with the goal of pursuing efforts to limit the increase to +1.5°C. These temperature targets set a new means to achieve emissions targets that were more relevant to the planet and more abstract for each country party. To meet this temperature goal, it also requires countries to regularly report on their emissions and progress towards meeting their own stated targets to achieve this, and updating these targets every five years—the Nationally Determined Contributions (NDCs). Between these five-year NDCs will be a Global Stocktake—the first set for 2023—to assess progress and efficacy of each country's NDC toward the overall climate targets, so they may adjust as necessary.

Articles of the Paris Agreement **[3]**

Art. 2 – **Long-term temperature goal**
Art. 4 – **Mitigation**, global peaking, 'climate neutrality'
Art. 5 – Sinks & reservoirs
Art. 6 – Voluntary Cooperation, market & non-market approaches
Art. 7 – **Adaptation**
Art. 8 – Loss & Damage
Art. 9-11 – **Finance, Technology, Capacity Building**
Art. 13 – Transparency
Art. 14 – **Global Stocktake**
Art. 15 – Implementation & Compliance

Each of the key negotiation points of the Durban Platform are included in the Articles of the PA, with its measures applying equally to all parties, while being flexible and nationally determined to create room for maneuverability. However, the key grounding of this flexibility is the temperature targets of 2°C and 1.5°C, which still constrains parties to a climate reality that must be met.

The PA has been ratified by 194 countries to date, including the United States, which briefly withdrew from the agreement under the Trump administration in 2017, but re-entered it in 2021 on the first day of the Biden administration. This absence was brief, in that the US withdrawal announced in 2017 only took effect on November 4, 2020, and was reversed by January 2021, due to the withdrawal structures placed into the Agreement—requiring a 1-year notice period, which could only be triggered after 4 years from coming into effect in 2016.

As previously noted, Kyoto failed to bring all parties on board, with the United States never ratifying, Canada withdrawing, and the two largest emitters today and likely going forwards (China & India) never being included in its targets. Kyoto's emission targets were

5% reductions on 1990 levels to be reached by 2012, without any link to climate metrics. In the 2012 Doha Amendment update, this target increased to 18% below 1990 levels by 2020. Per the UNFCCC, developed countries that ratified the Kyoto Protocol, as a group, reduced annual average emissions by 17 percent of 1990 levels, with the EU reducing by 25%. However, global emissions continued to peak throughout these time periods.

'Legally Binding'

A contentious aspect of the Paris Agreement that remains a topic of debate is its 'legally binding' nature under international law. For the Trump Administration in the US, this was a key stated reason for its withdrawal from the agreement, as it could relate to future liabilities for historic emissions, and in effect a punishment for historically earlier development prior to global climate cooperation.

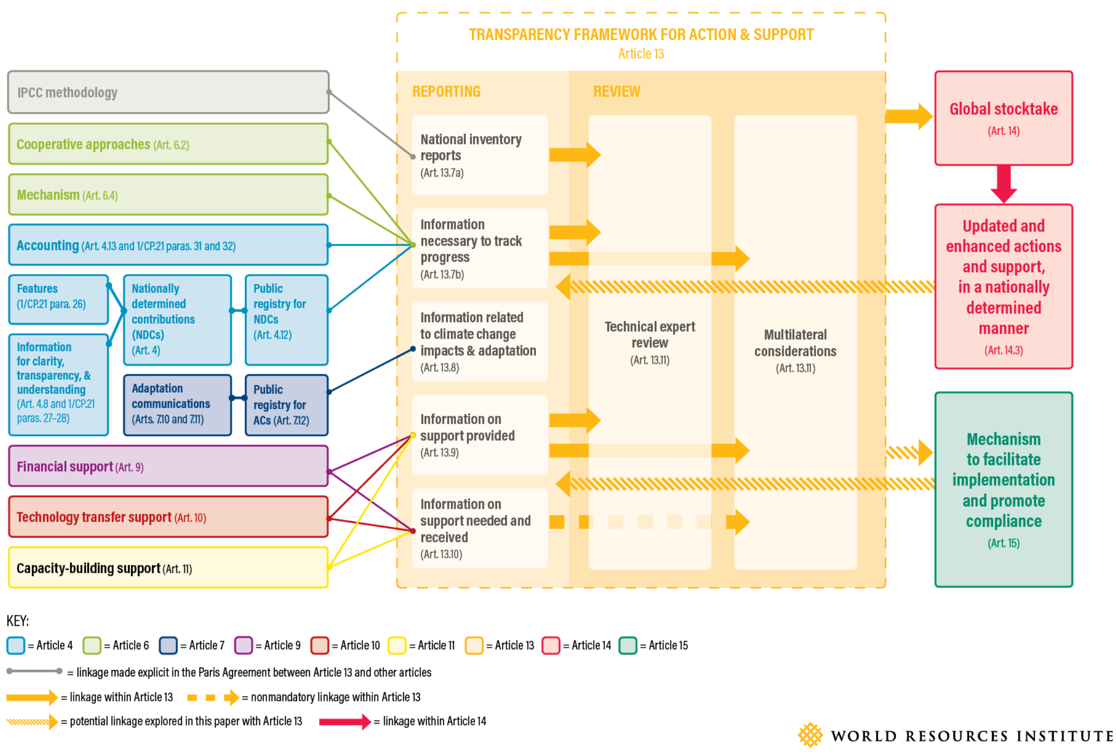
For some advocates of 'climate justice', providing funding for climate mitigation and adaptation going forwards is insufficient, and climate reparations should be paid by developed nations to developing nations (including China and India), as determined by a population-based share of the global carbon budget and what has been used to date since the industrial revolution—opening the potential for trillions of dollars in damages. Such concerns for precedence and potential future legal entanglements make progress on 'Loss & Damage' more difficult.

As has been seen with the GCF, pledges of $100 billion per year by 2020 have not yet been reached, with direct funding of less than $20 billion through two funding rounds in 2014 and 2019, against a stated goal that would be at minimum $300 billion by 2023. The newest climate fund on 'Loss & Damage' has been developed in theory, but how it is funded and to what level remains to be seen in practice.

At the time of the US announcement to withdraw from the PA, the substantive narrative was that this move was entirely unnecessary since the PA was not legally binding, and only amounted to voluntary commitments to reach climate targets via the NDCs. The international reputational damage of backing out of the agreement after agreeing, far outweighed the actual costs of remaining a party. The US could choose to revise its NDCs, or simply not meet them. Clearly there is some confusion and controversy on whether the PA is truly legally binding or not, and what either answer means in practice. Being legally binding but without enforcement, undermines the former.

The Durban Platform set out with the intent of creating a new protocol or legal agreement that met specific goals around common but differentiated responsibility. In the Paris Agreement, it appears to have achieved these aims, and it is explicitly referred to as a legally binding UN treaty by the UNFCCC and many others, including those who negotiated it.

Mapping the Linkages between the Transparency Framework and Other Provisions of the PA *Source: WRI*



Making progress on climate emissions and dealing with public good issues like free-rider problems on a global scale requires delicate coordinated action between states. Global climate cooperation to date has sought to meet this challenge with massive global multilateral agreements. Flexibility is a virtue in this space, to be able to coordinate the various interests and concerns of diverse parties while marching toward specific goals.

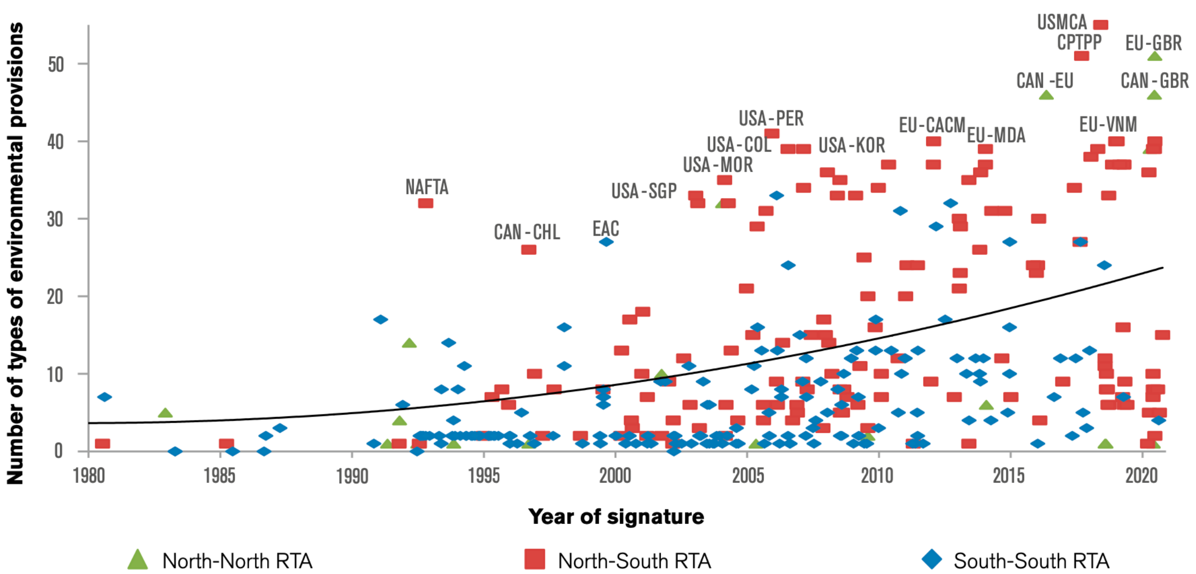
The Paris Agreement is not NATO or the WTO, and its legally binding connotations ultimately matter little unless coupled to domestic legal actions. In the US context, international agreements are either self-executing or not, with non-self-executing treaties requiring domestic legislation to make it enforceable. Without this, a ‘legally binding’ treaty may still bind, but the US would simply be in default of its international obligation. The question is if this default in obligations really matters in terms of enforcement and compliance.

For Kyoto, a 'Compliance Mechanism' worked to prevent non-compliance in advance, and applied penalties to countries that did not meet their agreed targets—by increasing their emissions reduction targets by 30% in the following period. Effectively, if you don’t pay today, you’ll be asked to pay more tomorrow. Rolling over emissions debts is questionable as an effective deterrent. For Paris, no enforcement mechanism exists, but a 'Compliance Committee' regulates transparency and reporting tied to the NDCs, while the Global Stocktake will serve as a public shaming exercise for inadequate NDCs.

Ultimately, states must consent to be enforced upon, and future negotiations can always allow for the opportunity to move the goal posts and incorporate or absorb past failures within new targets. Self-policing is often unreliable, and self-inflicted punishment is likely to be weak. In the example of the WTO, credible and tangible threats on trade enhance its rules enforcement capabilities, while clear benefits from trade increase buy-in and adoption. Climate enforcement has not yet been truly tested, as the focus has first been on achieving consensus and buy-in. Trade models of regional blocs moving towards international harmonization may prove useful in making climate agreements with acceptable enforcement mechanisms.

Overall, while progress on global cooperation on climate change has been slow and often contentious, the international community has made significant strides towards addressing this critical issue over the past few decades. The continued engagement and commitment of governments, businesses, civil society organizations, and individuals, will be essential in achieving the goals of the Paris Agreement and building a sustainable, low-carbon future.

Figure 1: The number of environmental provisions in RTAs continues to expand



Source: [WTO - Trade and Climate Change]

Carbon & Climate Change – Transboundary GHGs

Climate change can be considered the ultimate transboundary environmental challenge, and the ultimate 'collective action problem'. It requires global assessment and global responses, with great power rivalries and questions of historical equity or climate justice thrown into the mix.

As has already been addressed, Kyoto failed to go far enough or to include both key players and large developing nations. Paris can be seen as a triumph, but still relies on a relatively slow global process that has spent decades reaching agreements while peak emissions have not yet been reached.

The tragic reality of climate change is that those most responsible for the emissions that cause it will not be the most affected or are the most vulnerable to its impacts. Adaptation and resilience can be slogans for those with the means and resources to eventually respond, while for small island developing states ('SIDS') it is often an existential crisis, with their nation's fate out of their own hands.

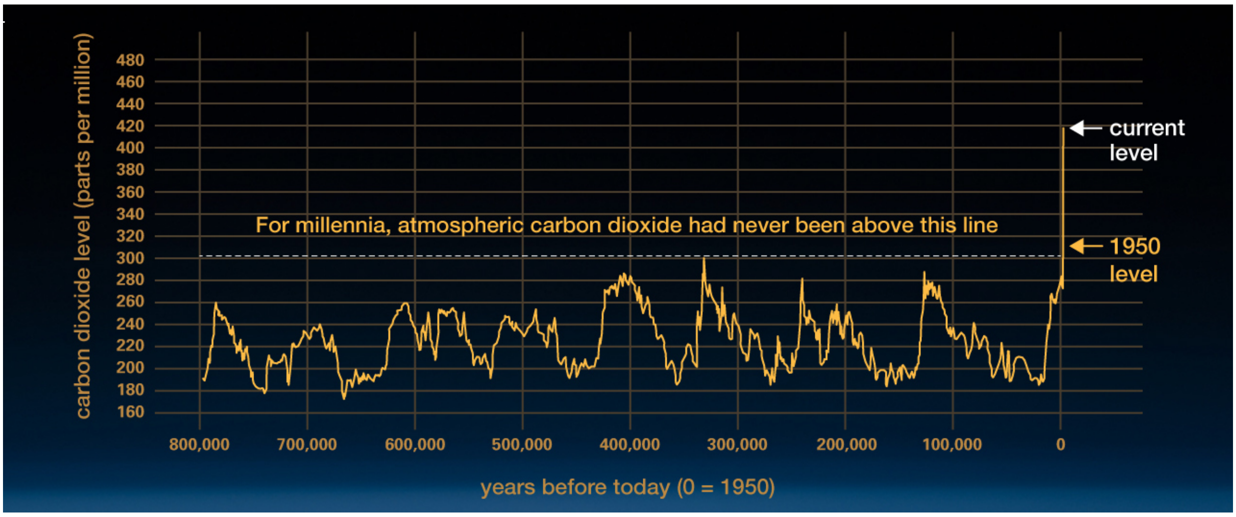
In a globalized market with globalized emissions, it can be difficult to convince nations to not take the path of least resistance or ask less developed countries to forego the development path that all other rich countries have previously traveled.

Climate cooperation suffers from the 'free-rider problem' whereby costs and benefits are not equally shared and the efforts of one can be exploited by another. Benefits are shared while costs are not. This is also tied to historical inequity however, as the most developed and richest nations today have produced the most historical emissions. If the earth has a relatively fixed carbon budget, then most of its spending limit has already been used by a few wealthier nations. Asking for equal actions and responses is complicated by this 'tragedy of the commons' scenario, and the atmosphere is the most common environment of all and our largest 'public good'.

This inequity in climate impacts is anchored in the very science of what drives human-induced climate change —accumulated carbon dioxide in the atmosphere that is evenly distributed. It is true that the Earth's climate has changed many times in the past with large variations in climate caused by various factors from solar influences, natural cycles, orbital changes, as well as its carbon dioxide (CO2) levels changing over time. The sun cannot be blamed for recent trends however, which can be seen in a warming Troposphere versus a cooling Stratosphere, which we can see later.

In the span of human history on Earth, CO2 levels have never been as high as they are today—roughly ***420 ppm***—and are well above the natural cycles of the past 800,000 years as measured in ice core data. Since the industrial revolution (circa 1800), CO2 levels have risen from 280 ppm in the pre-industrial period (1850-1900 average) to 420 ppm today, a 50% increase at a rising rate, coinciding with the large-scale use of fossil fuels and combustion engines, as well as massive economic growth and increased prosperity.

The fastest natural increase in CO2 levels that has been measured in older ice cores is around 15ppm (parts per million) over a period of about 200 years. For comparison, in the past 200 years atmospheric CO2 is now rising 15ppm ***every 6 years***.

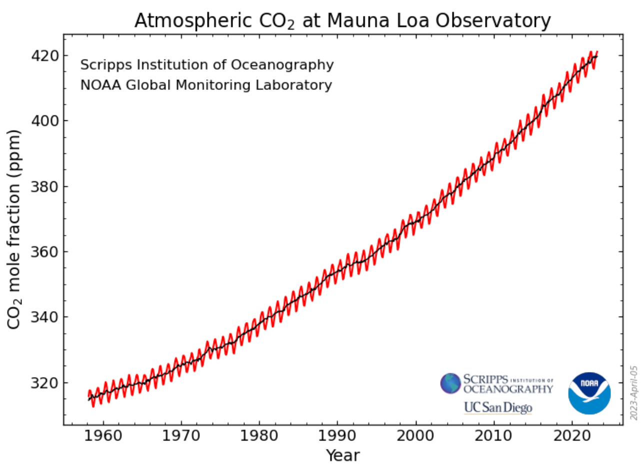


Source: NASA Climate

Carbon dioxide is just one of the Greenhouse Gases, or GHGs, which accumulates in the atmosphere and create the 'greenhouse effect'. Briefly, the greenhouse effect is the trapping of additional heat from sunlight in the Earth's atmosphere leading to an increase in surface temperatures, due to *radiative forcing* or heat from interacting with certain molecules. Rather than some sunlight being absorbed into the earth's surface and the rest being reflected out towards space, additional heat is reflected off accumulating gasses in the atmosphere and directed back towards the surface again, raising temperatures with accumulation.

This radiative energy effect is not caused by most gases in the atmosphere however and varies by molecules, with some absorbing longer wave lengths from the sun, and others like Ozone (O3) absorbing shorter wave lengths, like those reflected off the earth's surface. Most of our air is Nitrogen (78%) and Oxygen (21%), as N2 and O2, and have little to no radiative effect, while the remaining ~1% does. Without this radiative energy effect, Earth would in fact be extremely cold and uninhabitable.

Carbon dioxide is also well-mixed into the atmosphere, meaning it disperses evenly around the earth, such that CO2 concentrations are roughly the same everywhere on Earth—420 ppm, with a difference of +1-3 ppm being observable in areas of higher economic activity like cities—such that even though the source of that additional CO2 comes from specific nations and cities, it is disbursed evenly everywhere. Hence, industrialization and economic development in the 'global north' equally raises CO2 levels in the 'global south' that is far less industrially developed and makes the challenges of transboundary carbon rather unique.



Source: NOAA, UC San Diego

Land & Ocean Carbon Sinks

For most of the past 800,000, years longer than human civilization has existed, CO2 levels sat between 200 and 280 ppm, with 280 molecules of CO2 for every 1 million of air (N2 and O2). In just the past century, this has jumped to 420 ppm due to human activities adding more carbon than can be mitigated by natural processes. In fact, an estimated 30% of human carbon emissions have been absorbed by the oceans, greatly reducing the impacts of our emissions thus far.

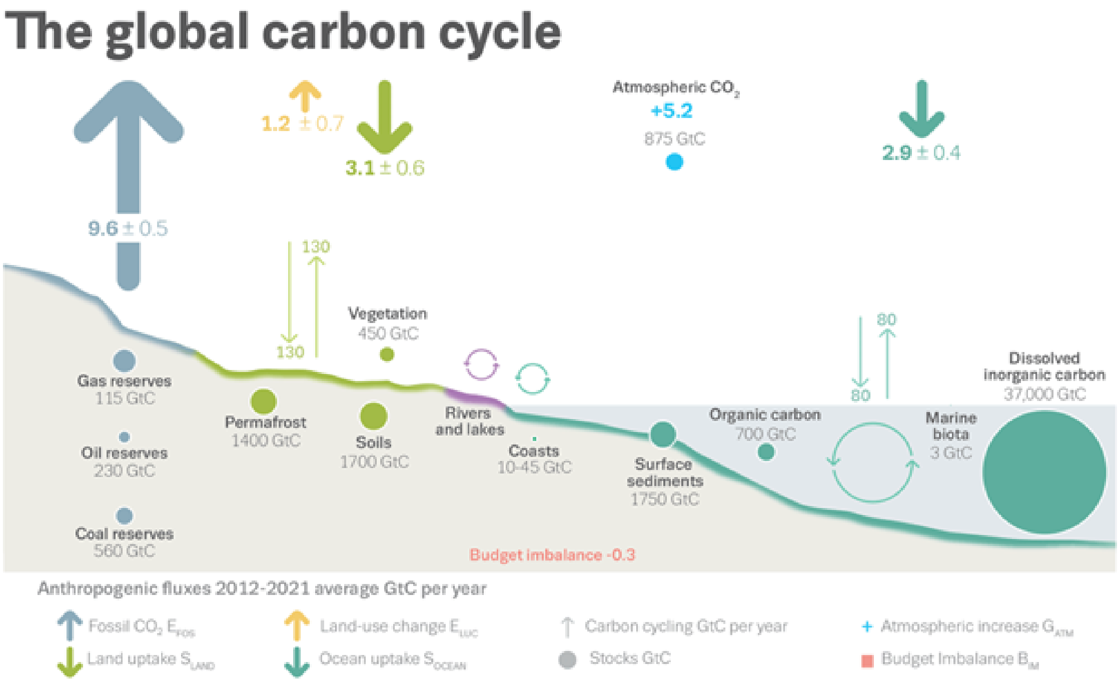
Both the land and the sea are the earth's natural carbon sinks, aborbing CO2 and releasing it again, or transforming it to oxygen.

In the oceans, carbon dioxide dissolves in water forming carbonic acid, or is aborbed by ocean plants like phytoplankton in photosynthesis. As CO2 in the atmosphere increases, ocean uptake of CO2 also increases, helping to keep balance. However, as temperatures increase, the ocean's ability to absorb CO2 decreases, whereby excess atmospheric carbon leads to a negative feedback on the ocean carbon sink process.

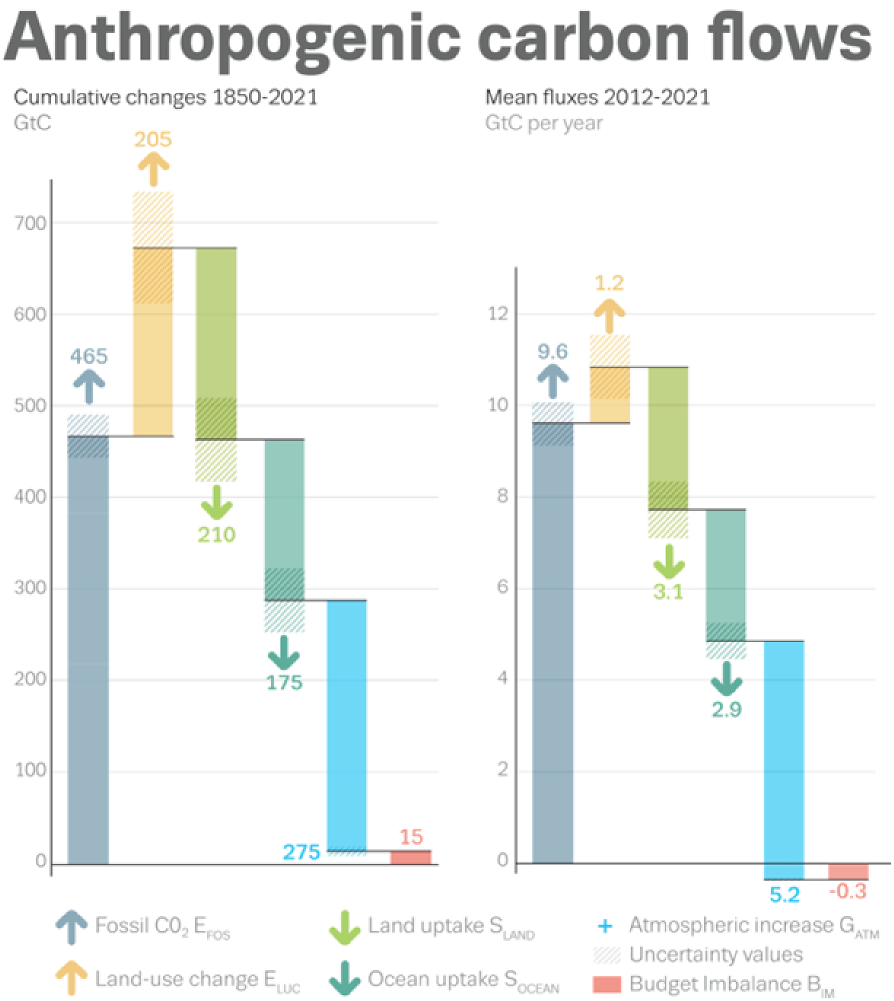
Ultimately, the ocean does not uniformly absorb carbon, but breathes, mixing with the atmosphere at its top layer, and cycling it through its currents. Most of the oceans' carbon sink occurs at its poles, where the temperatures are the coldest and cold salt water pulls CO2 or carbonic acid down to its depths.

The natural ocean carbon sink also offers unique potential for *Carbon Dioxide Removal* or CDR, as pulling CO2 from the ocean would stimulate the natural carbon sink process to pull more CO2 from the atmosphere.

Land sinks are another avenue to supercharge natural processes and permanently bury or 'store' carbon pulled from the atmosphere underground--such as bio-char or bio-oil, which will be discussed later.



Source: Earth System Science Data



The Spheres of Earth

The Earth is generally divided into five main inter-connected systems, or spheres, which all interact and make up both the planet and its environment in a dynamic system. The five spheres of Earth are:

1. ***Geosphere***: The solid Earth, including its rocks, minerals, and soil. This sphere includes the Earth's crust, mantle, and core, with the *Lithosphere* being the uppermost mantle and crust, such as where oil and gas extraction come from. The geosphere is responsible for the Earth's shape, its surface features, and tectonic activity, including earth-quakes, volcanic eruptions, and the movement of the continents.
2. ***Biosphere***: All living organisms on Earth, including plants, animals, and microorganisms. This sphere is the home of all life on Earth, and it interacts with the other spheres to shape the planet's ecosystems and biodiversity.
3. ***Hydrosphere***: Refers to all the liquid water on Earth, including oceans, rivers, lakes, groundwater, as well as atmospheric water vapor. This sphere plays a critical role in the Earth's climate and weather patterns, as well as providing a habitat for aquatic organisms.
4. ***Cryosphere***: All frozen water on Earth, such as glaciers, snow cover, ice caps, floating ice, and permafrost. This sphere plays a critical role in regulating the Earth's climate, as well as providing freshwater resources for human use as snow and glacial melt feed into rivers.
5. ***Atmosphere***: The layer of gases that surrounds the Earth, including primarily nitrogen, oxygen, carbon dioxide, and other gases, as well as water vapor. The atmosphere is responsible for regulating the Earth's temperature and weather patterns, protecting the planet from harmful solar radiation, and providing oxygen for living organisms.

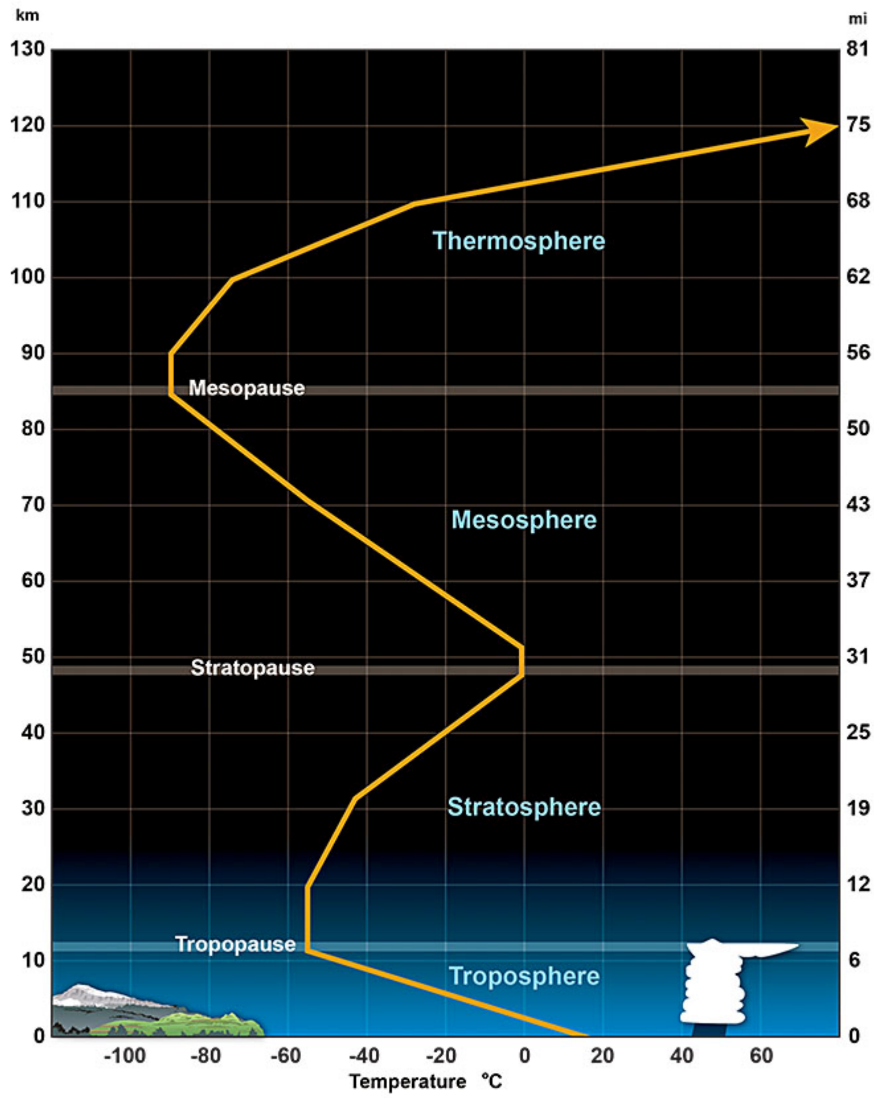
At a basic level, all organic and inorganic matter of the Earth fall into either the Geosphere or the Biosphere, and climate change is felt most directly through water changes, in the Hydrosphere, Cryosphere, and Atmosphere.

Together, these five spheres form a complex and interconnected system, which is slowly but constantly changing and evolving over time. Understanding the interactions between these spheres is critical for understanding the Earth's past, present, and future. Water plays a central role across these spheres, from the earth’s crust to the atmosphere and for all life on earth and is why climate change can be truly felt as water change. Water gives life in the biosphere, makes up all of the cryosphere and hydrosphere, and water vapor in the atmosphere is earth’s most abundant greenhouse gas that makes the planet livable.

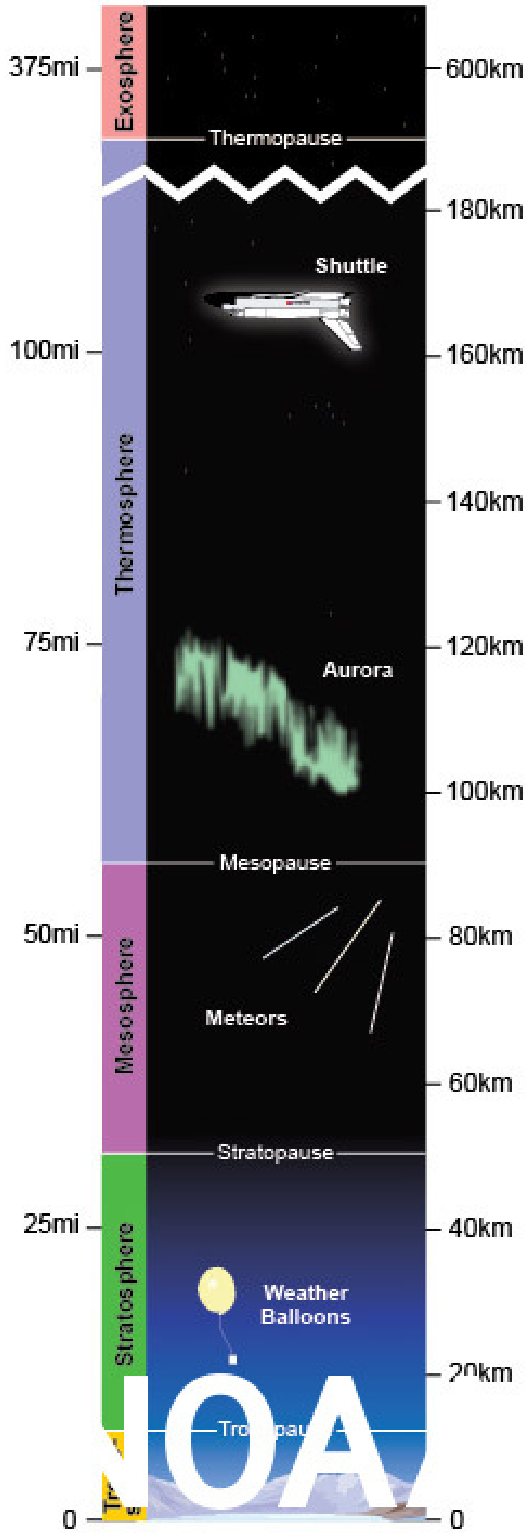
The driver of climate change however is found in the atmosphere. The Earth's atmosphere is also divided into five distinct layers based on their temperature gradients and physical properties, which swings between colder and hotter layers and pressure differences. From the surface to the outermost layer, these layers are:

1. ***Troposphere***: The lowest layer of the Earth's atmosphere, extending from the surface up to ~8-15 kilometers (5-9 miles) above sea level, and where life on Earth lives and breathes. The temperature in this layer decreases with increasing altitude, as the air becomes less dense. It contains most of the Earth's weather systems and is where most clouds and precipitation occur.
2. ***Stratosphere***: Extends from the top of the troposphere to ~50 km (31 miles) above sea level. This layer contains the ‘ozone layer’, which absorbs harmful ultraviolet radiation from the sun. The temperature in this layer begins to increase again with altitude due to the absorption of ultraviolet radiation by ozone.
3. ***Mesosphere***: Extends from the top of the stratosphere to ~85 km (53 miles) above sea level. This layer is the coldest layer of the atmosphere, with temperatures decreasing with altitude. It is also the layer where most meteoroids ‘burn up’ upon entering the Earth's atmosphere, due to their very high speed (20km/12mi per second) colliding with gas molecules, causing friction and heat.
4. ***Thermosphere***: Extends from the top of the mesosphere to ~600 kilometers (372 miles) above sea level. This layer is characterized by high temperatures as its name suggests, as it is exposed to the sun's radiation. It also contains the ionosphere, which is responsible for radio wave propagation.
5. ***Exosphere***: The outermost layer of the Earth's atmosphere, extending from the top of the thermosphere to the edge of space, or beyond Earth’s atmosphere. This layer is characterized by very low densities and is where low-earth orbit satellites orbit the Earth.

Source: National Geographic



Source: NOAA



Source: NOAA

Carbon & the GHGs –

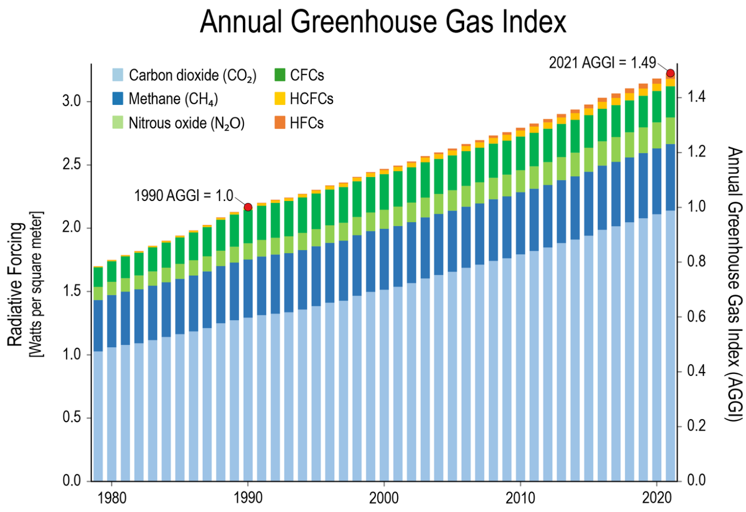
CO2, CH4, N2O, SF6, CFCs, O3, H2O

The ‘greenhouse effect’ is not quite the same as an actual greenhouse in your garden, but instead describes the warming that occurs from the radiative forcing of molecules that absorb and emit energy. Basic gases like O2 or N2, as generally pairs of molecules and which together make up 98-99% of the atmosphere, actually have almost no radiative effect. It is only the remaining 1% and its composition that makes all the difference to Earth’s climate.

It must be said that the greenhouse effect is firstly a natural phenomenon, which has helped to create warmth on the planet and to even develop life on earth. Without this effect, or the proper balance of this 1% of molecules, the Earth would be 33°C cooler—frozen in most places. However, human activity since the industrial era with the large-scale burning of fossil fuels has increased the concentration of GHGs in the atmosphere, causing increasing temperatures, at an increasing rate.

The change of this balance is what is referred to as 'global warming' (+net average to global temperatures) or ‘climate change’. Of course, the climate has always changed, but the speed and rate of change, and the forces that drive it, are the differences of anthropogenic influences vs. natural processes. The composition of GHGs in the atmosphere is part of a complex feedback loop of the water cycle, carbon sinks, and natural processes between the different spheres of Earth.

There are several gasses in the atmosphere which have this radiative effect: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), fluorocarbons (CFCs, HCFCs, HFCs, PFCs), and Sulfur Hexafluoride (SF6), as well as water vapor, which is the most abundant and part of this natural process. Water vapor levels can range from 1-4% of the atmosphere and account for ½ of the natural greenhouse effect. It can be the actual driver of the climate changes that are caused by excess CO2. At the molecular level, carbon is a key element of most of the GHGs from carbon dioxide and methane to the various fluorocarbons, but it is water vapor that is changing 7% for every 1°C.



Source: [US Global Change Research Program]

Carbon Dioxide – CO2

Carbon dioxide is the most significant GHG in terms of its contribution to climate change long-term, though it is not the most powerful GHG, nor the most abundant. Methane is considered 25x more powerful than CO2 as a GHG and accounts for ~20% of global emissions, while Sulfur Hexafluoride is 23,500x more powerful than CO2 and is the most powerful GHG known but is not emitted on nearly the same scale as CO2 by human activity. The aspects that make CO2 so important as a GHG are both its long-life alongside its vast scale, which is directly tied to human emissions from fossil fuels in the past two centuries. CO2 is considered as having a Global Warming Potential (GWP) of 1, as the reference GHG that all others are compared to. Other gases from methane to water vapor may be more powerful but are shorter lived or much less abundant.

Methane – CH4

Methane is a major component of ‘natural gas’ (~70-90%) and is associated with all hydrocarbon fuels, while also naturally occurring in the environment, such as in wetlands or animal digestion. It is very difficult to measure both in terms of leaks from fossil fuel industries that are inconsistent, or to accurately estimate from natural sources.

The current level of methane concentration in the atmosphere is nearly 1,900 ppb (parts per billion) as of 2021. This is a 162% increase from pre-industrial levels. The increase in methane concentration is primarily due to human activities producing more methane than which natural processes can absorb, such as in agriculture and the resulting land-use changes, or fossil fuel production, as well as from waste management such as landfills.

Agriculture: produced by livestock, such as cattle, as they digest their food (belching). It is also produced by rice cultivation and the decomposition of organic matter in manure and wetlands.

Fossil fuel production: released during the extraction, processing, and transportation of fossil fuels, such as natural gas and coal. Methane is the largest component of Natural Gas at 70-90% of its content.

Waste management: produced when organic matter like food scraps and yard waste decompose in landfills. Also produced by wastewater management in municipal treatment plants.

Methane is a powerful greenhouse gas—25x more powerful than CO2 over a 100-year time horizon—but doing the most damage in the near-term. In fact, it is about 80x more powerful in the near-term over 20 years. As it is the primary component of natural gas it is quite valuable if captured and stored or reused, making Methane emissions reductions a low-hanging fruit of climate change. Several things that can be done to reduce methane emissions:

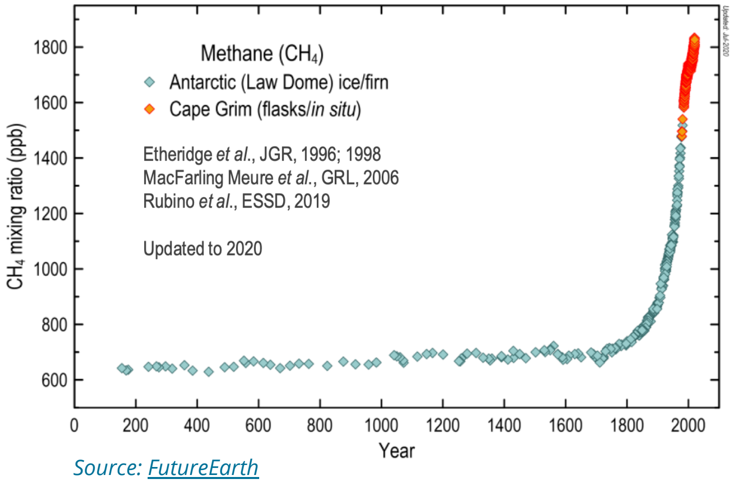
Improving livestock management: This can be done by reducing the overall number of livestock, by improving the diet of livestock, and by capturing methane from manure. (Belching is another matter)

Switching to renewable energy sources: This will reduce the need to extract and burn fossil fuels, which will reduce methane emissions created in the process of producing them.

Reducing food waste: This will reduce the amount of organic matter that decomposes in landfills and produces methane.

CCS—Carbon Capture & Storage: Methane leaks have been found to be much higher than anticipated and are highly valuable to many companies and industries. CCS technology can help to stop powerful emissions as well as improve their bottom lines.

It is also important to consider what happens to Methane in the atmosphere. After ~12 years, it is broken down through chemical interactions in the atmosphere, forming water as well as CO2.

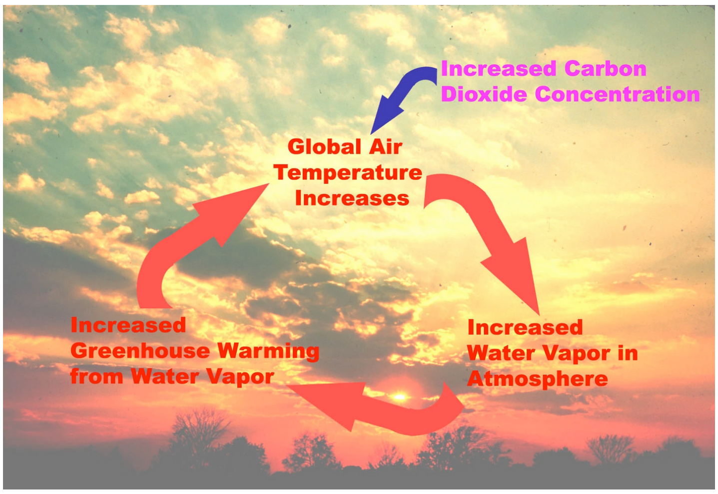


Source: FutureEarth

Water Vapor – H20

Water in its gaseous form as water vapor is also a GHG and the most abundant in the atmosphere ranging from 0-4%. It can and has been misattributed as the driver of the Earth's current warming, being a GHG that also forms a much larger portion of the atmosphere than CO2. However, it is not a cause but a consequence of Earth's warming, serving as a positive feedback loop to other GHGs like CO2 and CH4, amplifying their effects.

Increased water vapor in the atmosphere is the direct change in the water cycle caused by an off-balance carbon cycle, with warmer air holding more moisture, generating more heat, and more water vapor (+ feedback). Unlike the other GHGs mentioned thus far, water vapor is condensable and will change form from gas to liquid as rain or snow. While the other GHGs can last in the atmosphere for decades, or even thousands of years for CFCs and CO2, water vapor is recycled every 9 days on average. Carbon enhances the effect of water vapor and amplifies the global water cycle—causing bigger storms with more energy and more floods from more concentrated rains, even amid droughts.

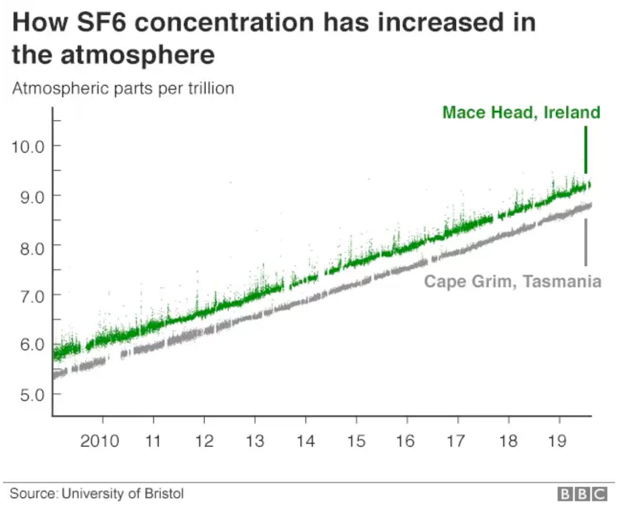


Source: NASA

Sulfer Hexafluoride – SF6

An often-unmentioned GHG is the most powerful currently known, at 23,500x more potent than CO2 at trapping infrared radiation. It is a synthetic gas that is typically used for electrical components and applications, as it is so dense that it will not allow for the conducting of electricity. However, it's use has been increasing rapidly alongside the need for increased electrification, ironically to limit GHGs emissions from fossil systems.

With increased usage comes increased leaks, and as we build out electrical grids with more and more input nodes and connections from renewable energy facilities, more and more SF6 will be used with the potential to leak over the electrical equipment's lifetime. With such a high GHG potency and a lifetime of over 3,000 years, proper management of this gas throughout its lifecycle is critical and will only continue to be as electrification increases.



Nitrous Oxide – N2O

Nitrous Oxide is a GHG 300x more powerful than CO2 and is formed by agriculture, fuel combustion, wastewater management, and industrial processes, with nearly 75% coming from agriculture soil management or fertilizers. It is considered the 3rd most important GHG and accounted for 6% of total U.S. emissions in 2021. While there is a natural nitrogen earth cycle, 40% of emissions arise from human activities. Growing more food for more people, or more cattle, increases N2O emissions. Natural sinks and chemical reactions remove this GHG in an average time span of 121 years.

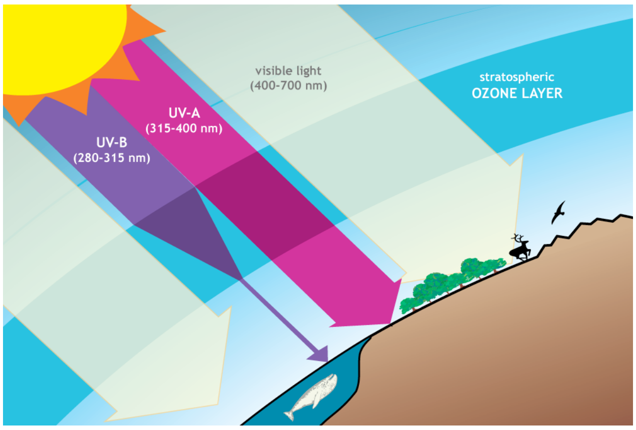
N2O is also not the same as NOx or NOX , which refers to the more reactive NO compounds of NO and NO2 that form 'smog', and are mostly found as a byproduct of combustion and naturally formed by lightning strikes. NO2 is also a contributing pollutant to another GHG, Ozone.

Ozone – O3

Ozone is triatomic form of Oxygen (O3 vs O2), a gaseous atmospheric constituent. It is created naturally in the troposphere and the stratosphere, as well as from photochemical reactions to smog caused by human activities (via NO2). In the troposphere Ozone acts as a GHG, while in the stratosphere it plays a role in radiative balance. Thus, the relationship between O3 and climate change is complicated, as it can be either beneficial or harmful depending on where it is in the atmosphere.

As previously mentioned, Ozone in the Stratosphere is what warms temperatures up again as it interacts with ultraviolet light from the sun. In does not react with the longer form wavelengths from the sun such as visible light, allowing them to pass through, but does interact with the shorter UV wavelengths, and those rebounding off the earth's surface as infrared radiation.

To also note, if increased solar activity or flaring were responsible for current warming trends on earth instead of CO2 emissions, we would also see increasing temperatures in the Stratosphere alongside increases in surface temperatures. Instead, we see decreasing stratosphere temperatures with increasing surface temperatures, as expected with increasing amounts of CO2 that radiate more energy back towards earth before reaching the Stratosphere.



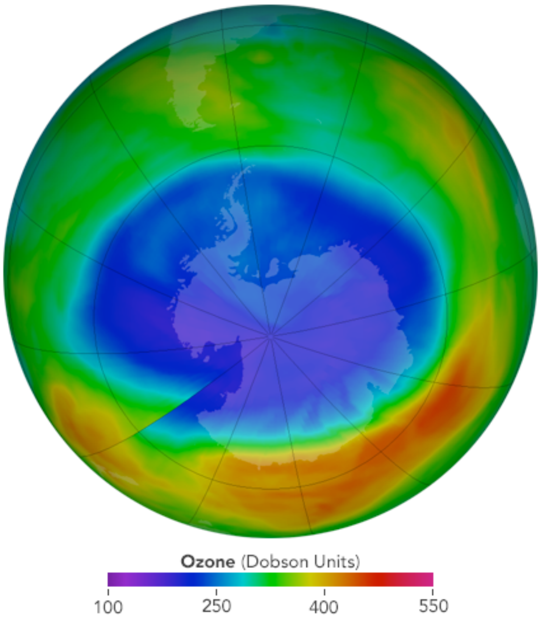
Source: [NOAA Climate]

Many may be familiar with the 'Ozone hole' and the need to close it—which is being done thanks to the ***Montreal Protocol.*** This is specific to the stratospheric Ozone layer's 'thin spot' that forms annually over Antarctica in the South Pole with consistently cold temperatures. This hole is in fact caused by chlorine, specifically from Chlorofluorocarbons, or CFCs.

Fluorocarbons – CFCs/HCFCs/HFCs

Aside from their role as Ozone destroyers, Fluorocarbons or CFCs are also a potent GHG unto themselves. Their relatively small quantity, measured on the order of trillions (vs. parts per billion for CH4 and million for CO2), makes them a very minor player directly in terms of greenhouse warming. This is thanks primarily to the success of the Montreal Protocol and their phase out from use since 1987.

Without this protocol, if CFCs were being used at the same rates today as prior to this agreement, they would now account for about 1/3rd of the total greenhouse effect compared to carbon dioxide. In addition, their role in depleting Ozone where it is beneficial in the stratosphere would be greatly compounding matters.



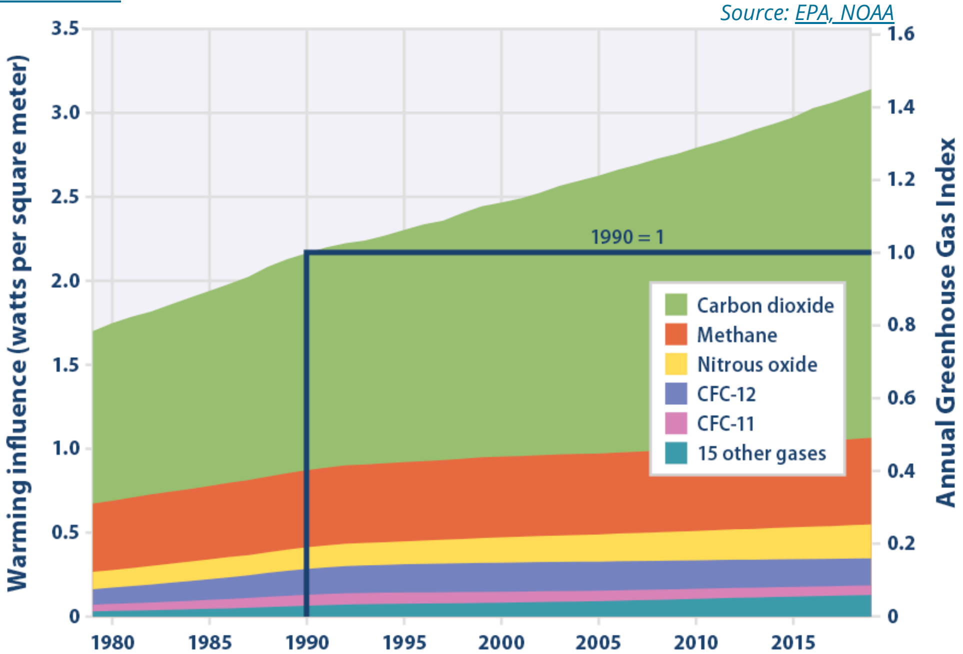
Source: NASA Ozone Watch

To recap, CO2 is the primary driver of climate change and the most important GHG, with a reference value of 1, and all other GHGs can be expressed in their CO2 equivalents, or CO2e, based on a timescale of over 100 years. The 100 year time scale came from limit warming by the end of the century, 2100. However, GHG timescales vary massively from just 9 days for water vapor, to thousands of years for SF6.

CO2 is highly abundant, linked to human activity, and lasts for 300-1,000 years. Methane is about 100x more powerful than CO2 in terms of its radiative forcing, but about 72x as powerful over its first 20 years, and just 25x as powerful over 100 years, due to its shorter-lived timescale of ~12 years. This has made Methane a lower level concern in global climate cooperation, despite its higher potency.

By comparing GHGs over a fixed time scale, we can undervalue emissions like Methane, which could have immediate impacts in the near term to halt temperatures rises by 2050, and can be address relatively easily via targeted requirements and leak monitoring, as it already has a clear economic value in the form of natural gas. Furthermore, after these 12 years, Methane breaks down with interactions to Ozone to form water and CO2, which will last longer and further increase temperatures.

Source: EPA, NOAA



State of Climate Change Today –

Emissions & Adaptation Gaps

Back in 2019 before the global Covid-19 pandemic, FutureEarth released a report on '10 *New* Insights in Climate Science'—the world is not on track, climate change is faster and stronger than expected, weather extremes were the new-normal, forests are under threat, biodiversity is under threat, and food security and health risks are increasing, while the poor and vulnerable will be the hardest hit. Four years later rebounding from the pandemic shutdowns, every insight remains an ongoing challenge that will continue to increase. [9]

***UNEP Emissions Gap Report 2022** – Falling Behind the Paris Agreement ahead of the Global Stocktake*

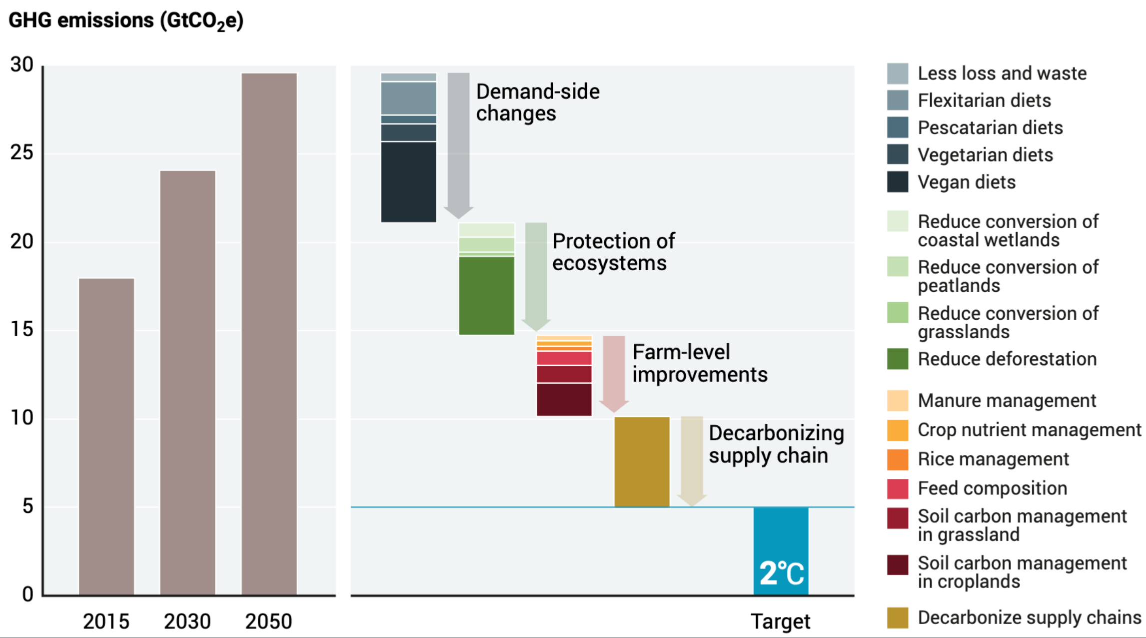
The 2022 UNEP Emissions Gap report adds to chorus of voices calling for more immediate action on climate mitigation. As has been touched on herein, emissions have likely still not yet peaked, amid the need to rapidly descend to '0' in the coming decades. Furthermore, most all Net-Zero scenarios as pledged rely heavily on Carbon Dioxide Removal (CDR) and the use of carbon offsets, which will need to scale up even more rapidly than emissions need to fall. As shown in the IEA's Net-Zero pathways chart, gigawatts of new energy sources must come online, and gigatons of CDR must be deployed, to move from 37 GtCO2e today to 0 Gt, and then further to negative emissions to crawl back the average temperature increases.

Since COP26 in Glasgow, Scotland in 2021, submitted NDCs have only removed 0.5 GtCO2e from projected global emissions in 2030—less than 1%. These are just the promised reductions in their nationally determined targets, which the G20 is expected to fall short of even this based on current trends. While decreasing, the conditionality of NDCs on factors like if international support is available, also remain a major problem. Most G20 members have only started to implement their NDCs. Simply put, there is no credible pathway to 1.5°C of warming at this time, and current pathways suggest a 2.8°C increase as being likely. Far beyond the Paris target of 2°C or aim of 1.5°C.

With each passing year of slow responses and inaction, the level of unprecedented change required ahead increases. Further moving the goal posts is the continued investment in fossil fuel plants from coal to natural gas, with additional future gigatons of CO2 to be released with these projects over their lifetime. In the U.S. alone, 22 projects have the potential to release 140 GtCO2e—4x the current levels of global annual emissions. The carbon budget cannot afford such projects while meeting the Paris temperature targets. [10]

The transition to renewable energy for electricity supply is well underway but must continue to accelerate to meet the future needs of electrification from decarbonization and growing demand. Net-Zero targets and pledges must be met along with unconditional NDCs to make 1.5°C targets viable and prevent a 2°C overrun.

Figure 6.2 Food systems emissions trajectory and mitigation potentials by transformation domain



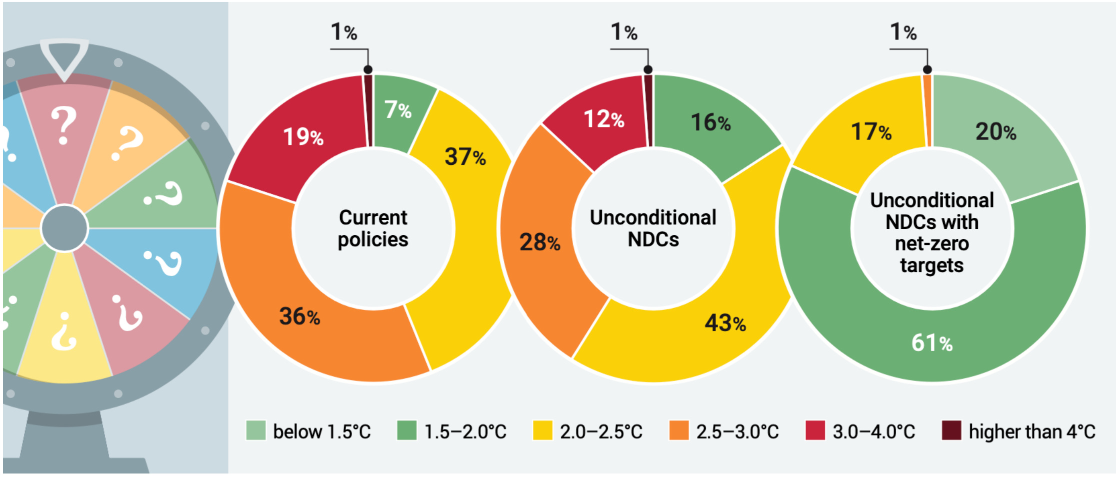
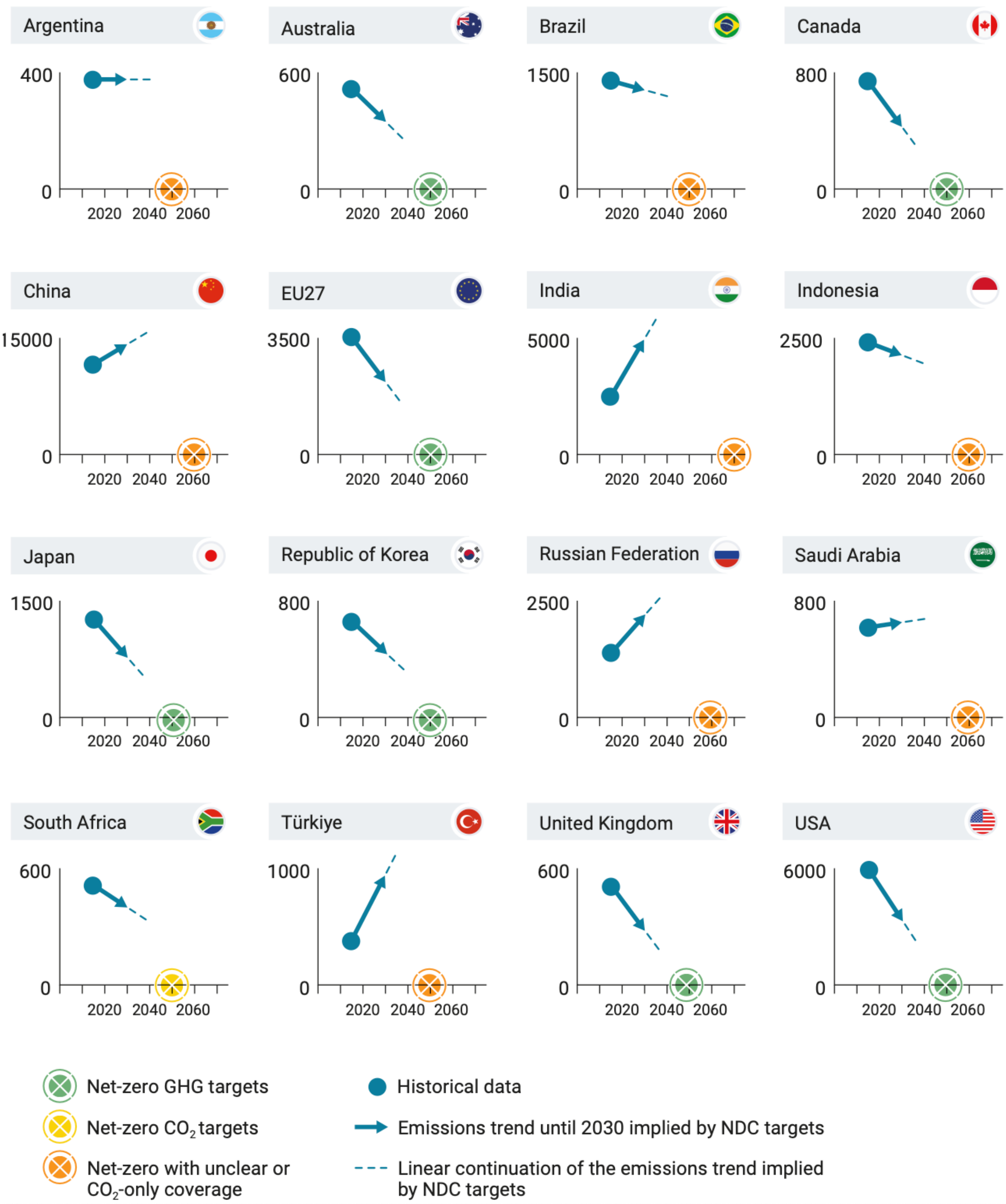


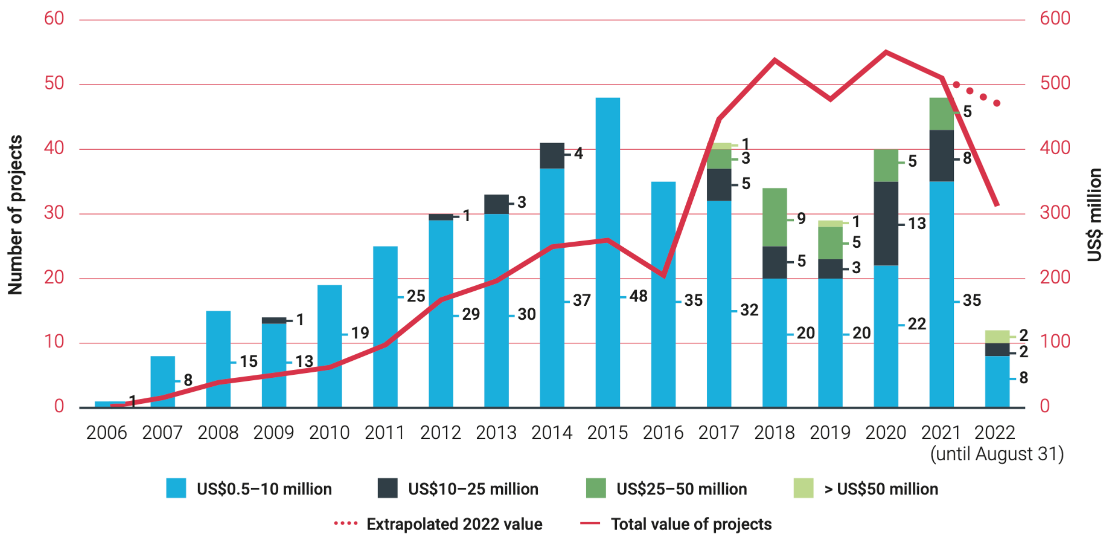
Figure ES.4 Emissions trajectories implied by NDC and net-zero targets of G20 members. National emissions in $MtCO_2e$/year over time.



***UNEP Adaptation Gap Report 2022** – Failing to prepare while speeding ahead*

The international failures around climate cooperation and mitigation to date thus far also increases the emphasis on the other side of climate responses—climate adaptation, and climate resilience. First we must define these terms. While climate mitigation is about reducing emissions to prevent climate change from occurring, climate adaptation seeks to lessen the impacts of climate change that we can likely expect to occur—mitigating the damage that climate impacts will have by preparing for them in advance. A further extension to this is climate resilience, in which resilience can be said to create new options where none previously existed.

Figure ES.4 Number of new adaptation projects per start year, size and combined annual funding value under the Adaptation Fund, Green Climate Fund and the Least Developed Countries Fund and Special Climate Change Fund of the Global Environment Facility, as at 31 August 2022



Resilience seeks to not only anticipate changes and reduce harm but find ways to recover and even thrive in the face of climate change. Mitigation is about preventing, Adaptation is about surviving, and Resilience is about thriving.

In practical terms, a climate adaptation project would seek to limit or manage climate risks, such as to weatherize renewable energy infrastructure to deal with cold temperatures. In the case of Texas, in 2021 a historic cold snap from a polar vortex froze much of its energy infrastructure (both windmills and natural gas plants) that had not been weatherized to deal with such temperatures, while similar infrastructure further north in equally cold weather in Idaho, continued to function as expected. The difference was a design choice. Both are climate mitigation infrastructure (renewable energy windmills), but one was built with adaptation (and resilience) in mind, while the other was not—as it is less costly, if deemed unnecessary.

To be further resilient, the example of a smart grid with greater integration through HVDC lines that can balance available power generation with needs across a wider area, would make an electric grid more resilient to disruptions from climate shocks. In the case of Texas, their grid was also not well integrated with the rest of the United States, causing more severe and prolonged power outages. [11]

Adaptation actions must also be careful to not interfere with or undermine mitigation efforts, by making an area more livable but increasing emissions in the process—air conditioning being a key example.

Unless run on 100% renewable energy, the increased power demands from AC will cause more emissions, creating more need for AC. In the GCC, 70-80% of total electricity demand is coming from air conditioning and water needs, and 80-85% of a building's energy consumption.

Synergistic examples of climate adaptation include urban greening, that combats the heat island effect while sequestering carbon in plants and trees, or the use of mangroves to protect coastlines while capturing carbon. In reverse, a mitigation project that can also reduce climate risks, such as hydropower for flood and drought protection, or reforestation to reduce landslide hazards.

Adaptation projects are well behind where they need to be for the most vulnerable states to climate change.

The quality of such projects must also be carefully considered to avoid maladaptation, which will prove redundant and a waste of resources over time. There is also a sunk-cost fallacy, that we must keep chasing this goal because resources have already been spent, coupled with the uncertainty of climate feedback loops and how they will unfold. What may seem to be a reasonable adaptation project under one scenario, may prove to be wholly inadequate and thus wasteful under a worse case scenario. With higher levels of warming, risks levels are complex and cascading.

The way forward

Ahead of COP28 in the UAE, the IEA are performing their own global energy transition stocktake, tracking progress towards the Paris Agreement targets from the investment and technology transition viewpoint.

Steep increases are required in clean energy investment in developing countries and emerging markets, from about $250 billion total today, to nearly $2 trillion by 2035. Without these investments, such states will be unable to reach their targets and the world will very likely overshoot the Paris temperature goals. Even for developed countries, closing the mitigation gap requires increasing investments in clean energy and new technologies rolled out at scale.

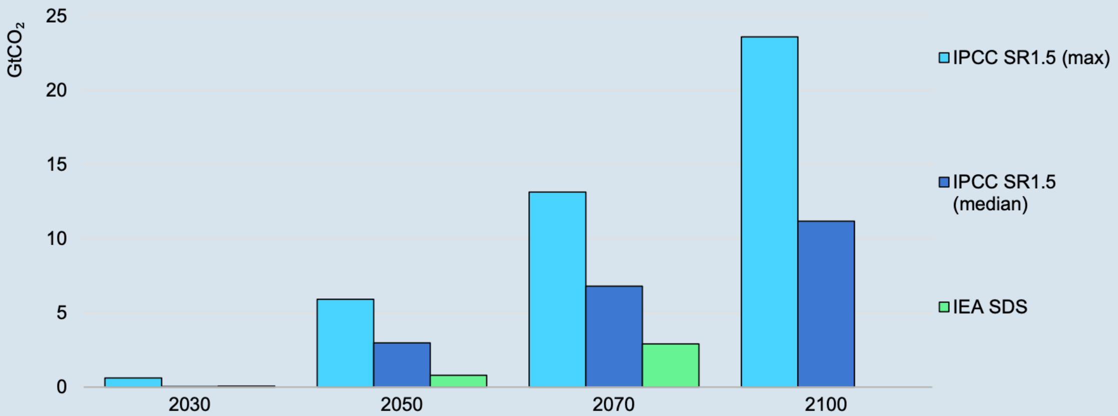
Reaching the Paris climate targets of 1.5°C - 2°C, and thus Net-Zero by mid-century, relies heavily on the rapid rollout of CDR technologies. The most common forms of CDR to date have been enhancing natural processes like bio-energy, referred to as BECCS.

Today, only about 0.2 GtCO2e, or 200 MtCO2e, of CDR is done annually, primarily through natural processes like reforestation, or BECCS, which have inherent limits of scalability, through enough space, material, or time. They are also often not permanent and risk being re-released, particularly in a changing climate with higher risls of extreme weather events.

Most Net-Zero strategies or pathways rely on at least 10 GtCO2e, and even up to 25 GtCO2e, of annual CDR--which today would account for 25-50% of annual emissions. Natural processess have natural limits, and technological solutions are currently limited in scale or are themselves high energy intensity.

The first Global Stocktake will show where the NDCs need to get more serious about their mitigation efforts and how much planned outlets like the CDR must be relied upon. In our next issue, we will explore this field of carbon technology further, as well as what it will need to succeed and scale sufficiently.

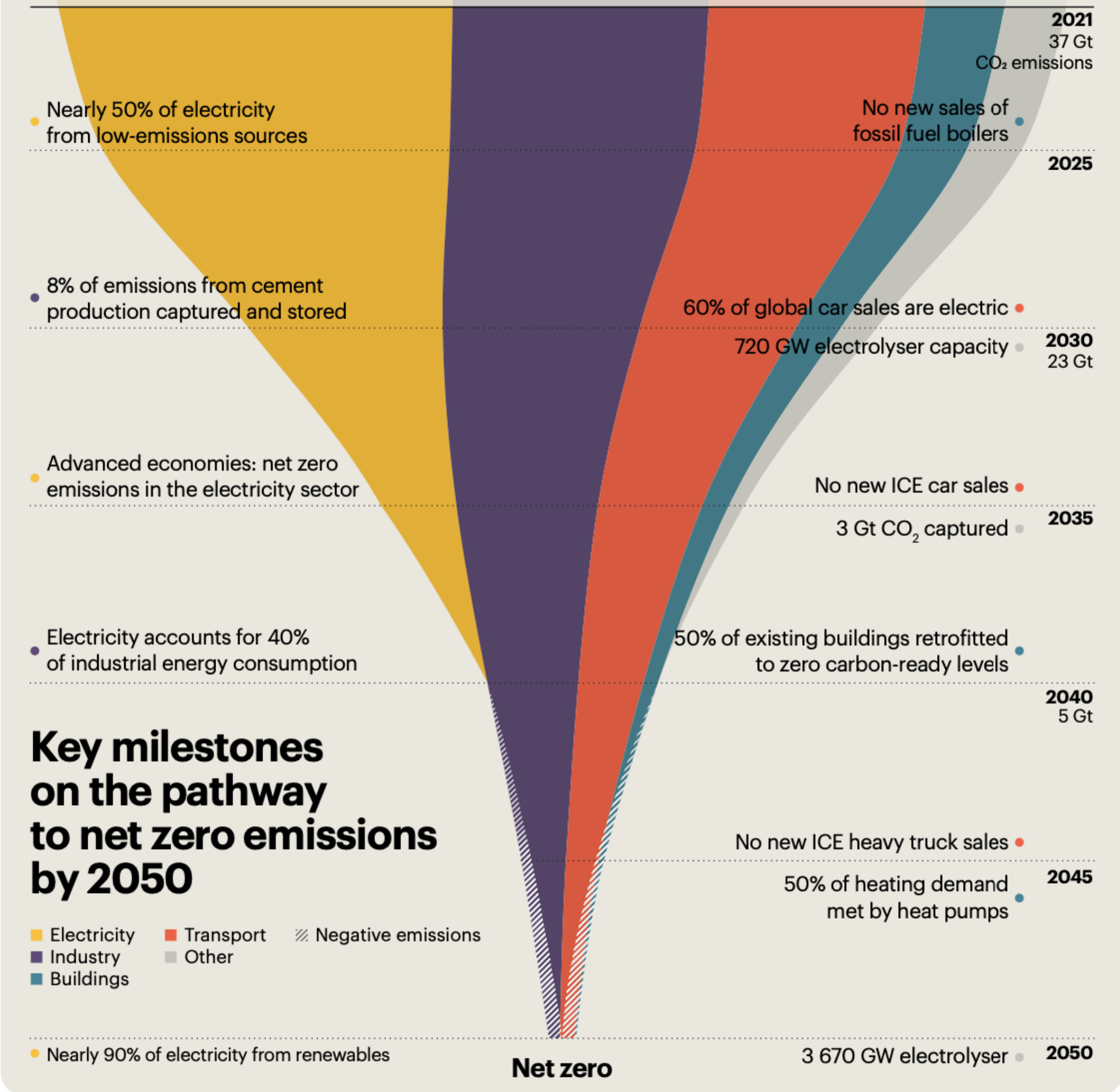
Carbon removal through BECCS and DACS in the Sustainable Development Scenario and IPCC SR1.5 scenarios

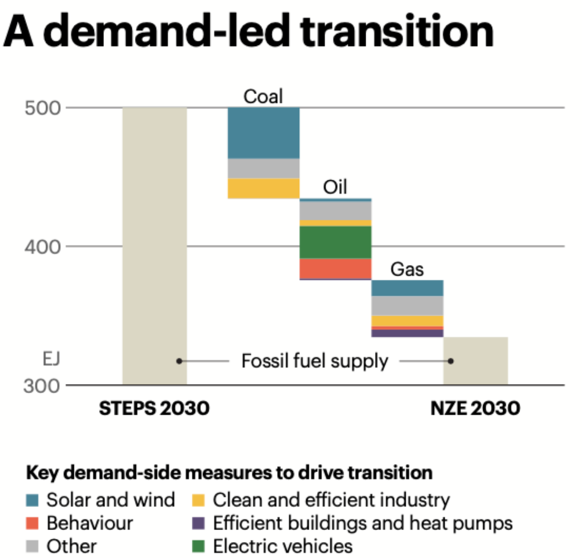


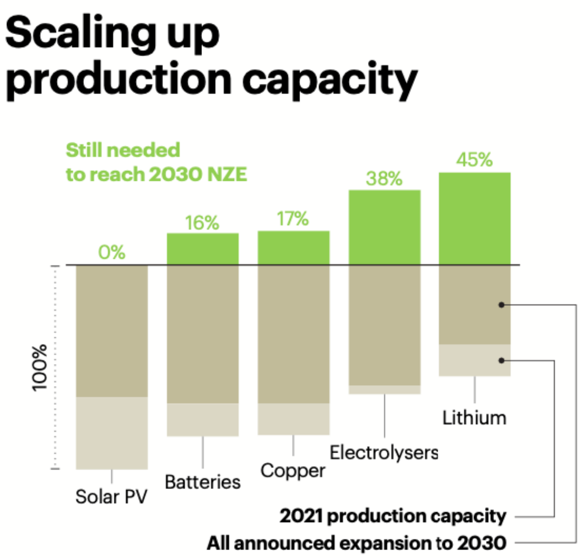
Notes: Values for the IPCC SR1.5 refer to either the maximum or median deployment of BECCS and DAC in all scenarios with a 66% likelihood of limit average future temperature increases to 1.7-1.8°C. SDS = Sustainable Development Scenario.

Source: Huppmann et al. (2018).

Source: IEA CCUS in Clean Energy Transitions 2020







Source: IEA World Energy Outlook 2022 - Net-Zero

Case Study: COP 27 to 28
The First Global Stocktake

The most recent Conference of the Parties (COP27) under the UNFCCC was held in Sharm El-Sheikh, Egypt in November 2022, and served to revisit and recommit to the previous outcomes of prior climate summits. In this way it was not a breakthrough meeting in the make of a Kyoto or Paris, but it did produce at least one outcome of note that was years in the making.

Its landmark output was the promise of a new Loss & Damage Fund, to directly deal with compensation for climate impacts. The concept of 'Loss & Damage' from climate impacts has been noted before, but there has not to date been a direct financial linkage to it. This progress was in fact remarkable, as it put forth momentum towards a potentially highly contentious issue around liability, specifically from rich and developed nations toward those most vulnerable to climate change impacts.

For some advocates, developing countries that are also now large emitters but have not yet used up their per capita share of the fixed global carbon budget, should be compensated financially. By one estimate, this would mean $170 trillion USD paid out at $6 trillion annually to 2050. [12]

The Loss & Damage fund itself may not yet exist, and could take years to operationalize, but the language and implications of loss and damage were moved towards action. As seen with the $100 billion per year climate finance promise viaf the Green Climate Fund (GCF), making good on these funding promises remains to be seen, and the very real need of support to deal with the impacts of climate change may be harmed by developed nations concerns around liability for past emissions. The language of liability could set concerning precedents that may be binding on the international stage in the future. Loss & Damage is inherently linked to climate justice and equity, both between nations and across generations.

For the developed countries, the pushback toward the Loss & Damage Fund has centered on the efficiency of creating yet another climate change fund versus mobilizing efforts through already existing mediums, such as the GCF, Adaptation Fund, Clean Technology Fund, Least Developed Countries Fund, etc. Their focus has been on addressing loss and damage from climate impacts as they come, as opposed to climate reparations.

There are beneficial tradeoffs to having specific missions tied to climate funds—which can still work across each other—that target specific goals or client segments. However, there is also the risk of overlap and lower scales of funding, when typically, larger scales are needed in climate-based project finance.

With no internationally agreed upon definition of Loss & Damage per se, we can consider it in its general sense, of the destructive impacts of climate change that could not be prevented by mitigation or adaptation, reflecting both economic loss and damage

Loss & Damage

Per Pricewaterhouse Coopers, up to November 2022, "damages from climate change so far are estimated to be over **$227bn**. With only ***$300m*** of new money being pledged for loss and damage at COP27, there are challenging discussions ahead on where finance will come from and who will be eligible to receive finance from the fund."
COP 27 The End Games

Paris Agreement – Article 14

1. The Conference of the Parties serving as the meeting of the Parties to this Agreement shall periodically take stock of the implementation of this Agreement to assess the collective progress towards achieving the purpose of this Agreement and its long-term goals (referred to as the "global stocktake"). It shall do so in a comprehensive and facilitative manner, considering mitigation, adaptation and the means of implementation and support, and in the light of equity and the best available science.

2. The Conference of the Parties serving as the meeting of the Parties to this Agreement shall undertake its first global stocktake in 2023 and every five years thereafter unless otherwise decided by the Conference of the Parties serving as the meeting of the Parties to this Agreement.

3. The outcome of the global stocktake shall inform Parties in updating and enhancing, in a nationally determined manner, their actions and support in accordance with the relevant provisions of this Agreement, as well as in enhancing international cooperation for climate action.

(livelihoods and property), and non-economic loss and damage (loss of life, biodiversity, and heritage). Ultimately, Loss & Damage encompasses extreme weather events that are becoming more common, and slower changes such as droughts and flooding from water cycle disruptions. [13]

In the current political climate, COP meetings are also a chance for country and institutional representatives to make headlines with bold statements, including some of those featured in this brief series. From calling out being on the 'highway to climate hell' with a foot on the accelerator, to the vulnerability of some nations due to the inaction of others, or the 'just rhetoric and marketing' of too many climate pledges, the meeting exemplified the often-precarious condition of much global multilateralism today.

The outcomes therefore of COP27 can be seen as a relative letdown and missed opportunity to pick up the pace on climate actions, instead of merely avoiding a backslide from COP26 in Glasgow the year before. The lack of moving backwards is not progress.

Looking ahead, the upcoming COP28 meeting will be highlighted by the first Global Stocktake ('GST') of the Paris Agreement, which is to be conducted every 5 years thereafter, falling in between the NDCs update timeline. The event should serve to enforce the NDCs in a meaningful way by giving an assessment of how serious each nation has been in their actual efforts and outcomes, compared to their promises. This is where the shame element of the Paris Agreement could come into play. If a country has set ambitious targets, not achieved them, and shows little progress or likelihood to achieve them, it can be noted in a very public way (though without enforcement).

As has been discussed, per the UNEP Emissions Gap Report, there is currently no credible pathway to keeping to 1.5°C of warming, too many NDCs are conditional, and actual progress to date is on track for +2.8°C of warming. The GST report should further clarify this in a comprehensive way via its technical dialogues. What comes after the report is the follow-up question.

Considering the progress to date, it is fair to wonder if the urgency of the 1.5°C temperature target is entirely misaligned with the 5-year timelines of NDCs. If the planet's carbon budget for a 1.5°C future is set to be exceeded by 2030, or earlier at the current rate, there is only time for 1 more adjustment before the next 5-year cycle, with stocktakes in 2023 and 2028. The resurgence of emissions post-Covid in 2022—during which China's economy was mostly slower than expected—does not bode well for 2019-2022 being the absolute peak in global emissions. The Paris Agreement is meant to account for this, by alternating updates of NDCs with the Global Stocktake to assess the current reality and progress of these goals and see if they are on target. All evidence thus far shows this system has not been up to that task.

Ahead of COP26 in Glasgow in 2021, the timeline for crossing the 1.5°C average was 11 years. Less than 2 years later in 2023, there is a 66% chance of passing +1.5°C by 2027, thanks to a shift to El Niño conditions. The hottest year on record from 2016 now has a 98% chance of being passed in the next 5 years, which was a +1.3°C year (+1.5°C has not yet been seen in any single year). From 2017 to 2021, the estimated probability of this occurring was only 10%. [14] Crossing +1.5°C in a single year would not yet mean crossing a +1.5°C average (+1.1°C avg. currently), but each new record year speeds up the timeline. The question becomes, are 5-year timelines sufficient, even with alternating stocktakes?

The GST has been touted as an opportunity to take a long hard look at the state of the planet, our responses to it, and to chart a better course forward. Through high level technical dialogues between UNFCCC member states, it is taking inventory, identifying gaps, and planning appropriate actions. Running between the 5-year time frames of the NDCs also allows for it to serve a monitoring and evaluation role of the NDCs themselves.

"The global stocktake is an ambition exercise. It's an accountability exercise. It's an acceleration exercise. It's an exercise that is intended to make sure every Party is holding up their end of the bargain, knows where they need to go next and how rapidly they need to move to fulfill the goals of the Paris Agreement." [15]
– UN Climate Change Executive Secretary Simon Stiell

Emphasis on the moment of the GST will still amount to nothing if the policy responses are not made once it is completed. Another roadmap and another set of 'solutions pathways' will be just another set of unachieved goals that put us further behind, no matter how detailed they are. This has been recognized by the Executive Secretary of UNFCCC—

"The global stocktake will end up being just another report unless governments and those that they represent can look at it and ultimately understand what it means for them and what they can and must do next. It's the same for businesses, communities and other key stakeholders." [15]

Between COP27 and 28 is the SB-58 (SBI and SBSTA) meeting held as part of the Bonn Climate Conference, recently concluded on June 15. The lesser advertised conference serves to set the groundwork in the lead up to COP28 in the UAE, conducting the GST process that will conclude in November. The GST's Technical Dialogue process began even before COP27, with the 1st TD Summary Report released in October 2022, and the 3rd Technical Dialogue completed at Bonn with SB58, with its report to be released ahead of COP28.

In Bonn, government delegates, observers and experts took part in a series of roundtables and events spread across six days. They discussed how to accelerate collective progress on mitigation, including response measures; adaptation; loss and damage; and means of implementation (climate finance, technology transfer, and capacity building).

In early September, the co-facilitators of the technical dialogue will publish a synthesis report, capturing the key findings of the three technical dialogue meetings. It will contain technical information, good practices and lessons learned to help Parties and non-Party stakeholders identify what to do to course-correct and achieve the Paris Agreement goals.

At the conclusion of Bonn, IRENA—International Renewable Energy Agency—based in the UAE, released the 2023 World Energy Transitions Outlook (WETO), and presented it to the COP28 president, calling for a tripling of renewable energy power by 2030, a 1,000 GW increase, to keep to the 1.5°C target.

By the end of 2023 when the GST is completed with COP28, it will be 6 years to meet the target of cutting global emissions in half by 2030. Instead of trending towards -50% fewer emissions by 2030, per the IPCC, countries have improved their scope from +13.7% to +10.6%, and are likely continuing to slowing their *increases* beyond 2030—a far cry short of their goals.

Since Kyoto in 1997, the initial climate goals were for developed countries only (37 + EU) to reduce their emissions by 5% from their 1990 levels by the period of 2008-2012—which were a total of 22.4 GtCO2e. A total 5% reduction from all countries would mean 21.3 GtCO2e in 2012. Actual 2008-2012 emissions were 32-35 GtCO2e. The goal posts have since moved to a 50% reduction from 2010 levels for the entire globe, putting the target at 16.7 GtCO2e from 33.36 GtCO2e, a then record high in 2010. In 2022, global emissions were 36.8 GtCO2e per the IEA.

"Pledges by Parties and their implementation are far from enough... So, the response to the stocktake will determine our success – the success of COP28, and far more importantly, success in stabilizing our climate." [17]

The goals of global climate cooperation have generally been set in the right direction, with GHG emissions expected to be 68% lower in 2050 than in 2019, if all long-term strategies and pledges are fully implemented, on time. However, no such targets have been met yet, to be either fully implemented, or on time. Planned reductions still would not achieve Net-Zero by 2050 and would rely heavily on technological and economic improvements in the areas of CDR. This sector will be critical to responding to climate change in the near to and long-term, but requires exponential market growth, on par with semiconductors.

The independent climate think tank E3G gives a proposed 10-point response plan ahead of the GST:

1. Set more ambitious & detailed targets for 2030-35
2. End fossil fuels for clean energy, triple wind & solar
3. Use climate finance to support clean energy, end fossil fuel public finance
4. Implement *transformational* adaptation plans
5. Double adaptation finance
6. Fund loss & damage
7. *Transform* food systems & end deforestation
8. *Transform* the international financial system for climate action
9. Strengthen climate reporting
10. Check progress again in 2025

Every one of these points has been discussed and negotiated at previous COP meetings, dialogues, and the like, and we are still seeking the same. If the Global Stocktake is not a catalyst to action and can only produce another rewriting of the same 'To Do' list, it will end up being another performative exercise.

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