CONSTRAIN

CONSTRAINING UNCERTAINTY OF MULTI-DECADAL CLIMATE PROJECTIONS

PRE-COP26 BRIEFING NOTE

WHAT EXACTLY IS A "1.5°C PATHWAY"?

Limiting global warming to 1.5°C requires immediate and decisive reductions in greenhouse gas emissions, but there are many different ways to achieve it.

The Paris Agreement commits countries to both limiting global warming and adapting to the impacts of climate change. The agreement's aim is to hold warming to well below 2°C above pre-industrial levels (1850-1900), and pursue efforts to limit it to 1.5°C, known as the Long-Term Temperature Goal (LTTG)[1]. This goal refers to warming from human activities, also known as anthropogenic warming, caused by emissions of greenhouse gases, above all carbon dioxide (CO_2).

Anthropogenic warming is different to observed warming. Although both follow similar decadal trends, observed warming might rise above 1.5°C in any given year due to natural variability[2,3].

By the end of 2020, the world had experienced approximately 1.2°C of anthropogenic warming[2]. As more frequent and intense extreme weather events show, this is already severely affecting people around the globe: every fraction of a degree matters, and brings additional climate risks and impacts, some of which may be irreversible. Therefore, the safest option is to not exceed 1.5°C, which will leave more opportunity for adapting to climate impacts, especially for the most vulnerable[4].

The window for limiting temperatures to 1.5°C is rapidly closing – but it can still be achieved[5] and there are many different paths to get us there: the Paris Agreement does not specify how we should go about limiting temperature rise[6].

As a result, the Intergovernmental Panel on Climate Change (IPCC) assesses a variety of "1.5°C pathways" that feature in the scientific literature. Each is about "as likely as not" to limit warming to 1.5°C. In other words, they come with about a 50% chance of limiting warming to 1.5°C. The IPCC has not identified pathways that will "likely" keep us below 1.5°C, which means with a greater than two out of three chance.

Likelihoods or probabilities of success have to be assigned to warming targets because there are uncertainties about how our climate system will respond, including possible feedback effects that can amplify or dampen the warming.

Temperatures may therefore temporarily exceed ("overshoot") 1.5°C before declining again: if a pathway has "no overshoot", it gives an at least 50% chance of staying below 1.5°C; "low overshoot" means that peak warming is limited to 1.6°C with a 50% chance and returns to 1.5°C by 2100[4]. These pathways also have an at least 90% chance of staying well below 2°C, and are therefore fully compatible with the Paris Agreement[7].

Among the five main new climate change scenarios assessed by the IPCC, the one with the lowest 21st century warming (SSP1-1.9) reflects most closely a 1.5°C target[8], but SSP1-1.9 is just one of many pathways that we could follow in reality. For example, the COVID-19 pandemic, which briefly reduced emissions, has presented the opportunity for post-pandemic economic investments that can set us on a low-emissions pathway in the form of a "green recovery"[9].

Regardless of the exact pathway we follow, limiting warming to 1.5°C requires global CO_2 emissions to peak in the immediate future (see figure), then rapidly decline until they reach net zero around mid-century. "Net zero" indicates that human-caused emissions sources (especially fossil fuels) are strongly reduced and any remaining emissions are balanced with the human-caused removal of CO_2 by sinks, for example, through forest management or carbon dioxide removal (CDR) technologies. Deep emissions reductions are always part of meeting net zero globally[10].

[1] https://www.un.org/en/climatechange/paris-agreement

[2] https://www.globalwarmingindex.org

[3] CONSTRAIN 2020 https://doi.org/10.5281/zenodo.4282461

[4] https://www.ipcc.ch/sr15

[5] https://theconversation.com/the-1-5-global-warming-limit-is-not-impossible-but-without-political-action-it-soon-will-be-159297

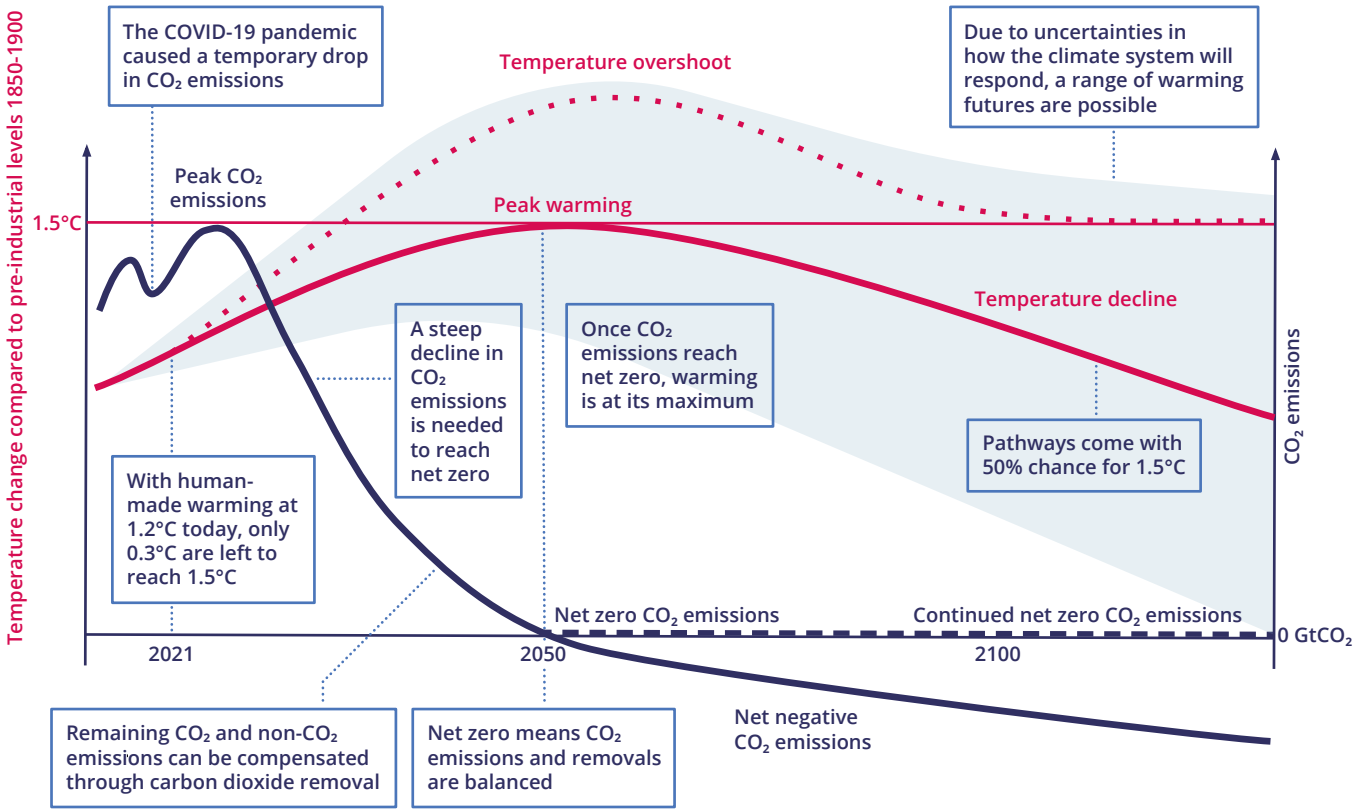
[6] Rogelj et al. 2019 https://doi.org/10.1038/s41586-019-1541-4

[7] Schleussner 2021 https://www.essoar.org/doi/abs/10.1002/essoar.10506712.1

[8] Meinshausen et al. 2020 https://gmd.copernicus.org/articles/13/3571/2020

[9] https://constrain-eu.org/wp-content/uploads/2021/06/CONSTRAIN_1.5_Briefing-Paper_final.pdf

[10] Rogelj et al. 2020 https://doi.org/10.1038/d41586-021-00662-3



Illustrative pathways of CO_2 emissions and temperature change relative to pre-industrial levels 1850-1900 over the course of the 21st century and beyond.

Because it will be hard to reduce emissions to zero in some activities and sectors in the near future, limiting warming to 1.5°C will also require some form of removal of CO_2 from the atmosphere[3]. But CDR comes with risks and sustainability concerns, and the sooner CO_2 emissions peak and then decline, and the more CO_2-producing infrastructure and activities are avoided, the less we will need to depend on CDR.

Limiting warming to 1.5°C also means reducing emissions of other greenhouse gases – mainly methane (CH_4) and nitrous oxide (N_2O) – so that the balance across all greenhouse gases reaches net zero in the second half of the century.

Once we reach net zero and temperatures peak, climate impacts will continue, including extreme weather events as well as those on longer timescales, such as sea level rise. For temperatures to decline and impacts to reduce significantly, we would need to achieve net negative CO_2 emissions.

Ultimately, there is no single "right" pathway that will limit peak warming to 1.5°C; instead there remain several pathways that stand a chance of leading us to the same destination, and some are more beneficial to broader sustainable development goals than others.

But we are still only talking about a 50% chance. So the important thing is that we act now, before the window of opportunity closes.

The race to net zero is on.

THE CONSTRAIN PROJECT

The EU-funded CONSTRAIN project is a consortium of 14 European partners tasked with developing a better understanding of global and regional climate projections for the next 20-50 years. CONSTRAIN launches its ZERO IN reports each year at the UNFCCC Conference of the Parties (COP), providing a platform to discuss new developments in climate science.

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