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The 1.5°C goal of the Paris Agreement

Position of the German Environment Agency

The feasibility of meeting the 1.5°C goal of the Paris Agreement is a central debate among climate scientists and policymakers, as it threatens to fall out of reach due to insufficient global climate action. Still, the politically set 1.5°C goal remains the most important benchmark for ambitious global climate policy and action. Limiting the global temperature increase to 1.5°C is essential for survival in the most vulnerable countries.

What's clear: Any further increase in temperature will cause irreparable damage, many deaths, greater loss of species and increasing efforts and costs to cope with the unavoidable impacts of climate change. Nevertheless, a temporary overshoot has been discussed in climate science for some time, i.e. the extent to which the global mean temperature exceeds the target value before it is brought back down to it.

The 1.5°C goal is formally included in current international resolutions (see e.g. COP28 resolutions) and in national strategies (see e.g. Germany's Strategy on Climate Foreign Policy). This underlines the continued importance of the goal and its relevance in environmental policy, as confirmed by the decision of the Federal Constitutional Court on 24 March 2021 (BVG, 2021). The 1.5°C goal is also of great relevance and importance to the Nationally Determined contributions (NDCs) of the Parties to the Paris Agreement. The member states (the so called "Parties") are called to align their new NDCs, which are due by COP30 in Brazil in 2025, with the 1.5°C goal.

However, countries' current NDCs and climate action are inadequate and would result in a warming of 2.8°C by the end of the century compared to pre-industrial levels. If the current global warming trend and its dramatic impacts continue, various challenges must be considered with regards to the 1.5°C goal:

- Implementation problems if the goal falls increasingly out of reach
- Credibility problems if politicians continue pursuing a goal that is barely achievable
- Communication problems with the public if meeting the goal, even after a temporary overshoot, becomes increasingly complex and difficult to explain in a way that is comprehensible

In this factsheet, the German Environment Agency seeks to shed light on the understanding of, the relevance and tensions surrounding the 1.5°C goal of the Paris Agreement, as well as the prospect of a temporary overshoot.

1 The aim is to keep the goal of limiting global warming to 1.5°C within reach.

1.1 Emergence of the 1.5°C goal of the Paris Agreement

With the adoption of the Paris Agreement in 2015, the global community set itself the overarching goal to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." (Paris Agreement, 2016). Over time, the 1.5°C goal has become the benchmark in global climate policy and action. The special report on global warming of 1.5°C by the Intergovernmental Panel on Climate Change's (IPCC), published in 2018, underlined the importance of this temperature limit for the protection of people and the environment (IPCC, 2018).

Limiting the increase of the global mean temperature to 1.5°C is a politically determined global goal. It is the result of a process in which the limits of political, technical and social feasibility have been explored. In view of the impacts of climate change that have already occurred and those that are still to be expected, limiting global warming to below 1.5°C is worth striving for. The term "1.5°C goal" therefore derives its meaning from the context of the scientific, technical, economic and social dimensions of climate action and climate change, and can only be meaningfully used within this context (alternative terms are "1.5°C limit", "threshold" or "benchmark").

1.2 Meeting the 1.5°C goal of the Paris Agreement

The Paris Agreement compares the increase in global mean temperature with the pre-industrial average temperature level as a reference. The IPCC uses the average from 1850 to 1900 as the pre-industrial reference period, which is the earliest period with reliable, almost global temperature data and is also used by UBA.

Exceeding the 1.5°C benchmark over relatively short periods of time (e.g. monthly, annual or even multi-year averages) does not mean that the Parties have failed to meet the goal of the Paris Agreement. Shorter time periods can be dominated by natural variation, so that longer observation periods are required to make climatologically relevant assumptions. The goal of the Paris Agreement refers to the averaged mean temperatures over a longer period of time, generally 20 to 30-year averages, cf. paragraph 5 of Decision 21/CP.27 of the Parties at COP27 (UNFCCC, 2023a).

Whether the 1.5°C goal of the Paris Agreement has been exceeded or met will therefore only be determined beyond doubt in retrospect. In science, politics and communication, a careful distinction must be made between a short-term overshoot of the 1.5°C benchmark and an overshoot averaged over several years.

2 An overshoot of the 1.5°C benchmark must be kept to a minimum in terms of extent and duration.

2.1 Current temperature trends

2.1.1 Global annual average temperature

2024 was the hottest year since temperature observation has been recorded (WMO, 2025) and therefore most likely the hottest in the last 120,000 years (Berkeley Earth, 2025). The temperature data from the World Meteorological Organisation (WMO) is calculated using data from six independent, leading international institutions: The temperature increase compared to the common reference period of 1850-1900 averaged over the last year was +1.55°C. In 2023, the WMO reported +1.48°C, the hottest year up to that date. One of the six calculations is carried out by the European climate service Copernicus, based at the ECMWF (European Centre for Medium-Range Weather Forecasts). The Copernicus data for the temperature increase in 2024 is actually +1.60°C (Copernicus, 2025) and is therefore very similar to that of the independent US institute Berkeley Earth (+1.62°C), which uses the most comprehensive methodology and the largest collection of historical data sets.

The data from the two US agencies NASA and NOAA are always slightly lower, which is primarily due to methodological differences in the calculation of global average temperatures from 1850 to 1900 (and here again primarily due to deviating methods in the calculation of ocean temperatures) (Berkeley Earth, 2025).

In addition to the general warming trend of climate change, the periodically occurring climate phenomenon "El Niño - Southern Oscillation" (ENSO) also contributed to the record temperatures in 2023 and 2024. Due to the changeover of El Niño to its opposite phenomenon (La Niña), the global average temperature for 2025 is expected to remain below those of 2023 and 2024. However, following those two years, 2025 will very likely be the third hottest year since (at least) 1850.

2.1.2 Long-term global average temperatures

Current studies using the methodology of the Sixth IPCC Assessment Report show the decadal mean of the observed warming from **2014 to 2023** at +1.19°C, with a 95% confidence interval of +1.06°C to +1.30°C (Forster et al., 2024). According to these calculations, the change in global mean surface temperature between the pre-industrial period 1850-1900 and the 20-year period from **2004 to 2023** was 1.05°C [0.90-1.16 °C] (Forster et al., 2024) and therefore 0.07°C higher than the value stated three years earlier in the Sixth IPCC Assessment Report (IPCC, 2021). These changes are broadly in line with the typical warming rates of recent decades, which were estimated at 0.76°C (using linear trends according to the least squares method) or 0.019°C per year for the period from **1980 to 2020** in the sixth IPCC Assessment Report (IPCC, 2021).

2.2 Exceeding 1.5°C benchmark expected in coming years

Based on the annual temperature increases of recent years, we can see a current warming trend of around 0.25°C per decade. The average for the years 2025 to 2034 would therefore be approx. +1.58°C. The average for the 20-year period from 2015 to 2034 would be approx. +1.46 °C. Therefore, exceeding the 1.5°C goal of the Paris Agreement could only be determined beyond doubt after 2035, even if the temperature rise is already above the 1.5°C benchmark for

individual years. The general warming trend would thus have to be halted at an early stage, well before the 10- or 20-year average reaches 1.5°C.

Excursus: The relevance of the inertia of the climate system for the 1.5°C goal

Due to its long atmospheric lifetime, the anthropogenic CO_2 that has been emitted not only causes an additional greenhouse effect right now, and thus a higher temperature of the earth's surface than before industrialisation, but also in the long-term (IPCC, 2021). Considering global greenhouse gas emissions are currently still rising, it seems impossible to reduce emissions to zero within a few years, and it is probably already inevitable that average annual temperatures will continue to rise until at least 2040. Due to human activities (especially the burning of fossil carbon), the concentration of carbon dioxide in the atmosphere today is 50 percent higher than before the industrialisation.

2.3 Clearly limiting the extent and duration of overshooting 1.5°C

Even though it is considered to be in line with the Paris Agreement to exceed the 1.5°C benchmark to then reduce the warming again and stabilise it at 1.5°C, this overshoot must be limited in its extent and duration (temporary overshoot). It needs to only be a matter of a clearly limited overshoot of the critical temperature threshold, because on the one hand a subsequent reduction of the global mean temperature back to 1.5°C is not guaranteed, and on the other hand it will result in the loss of human lives and biodiversity which cannot be recovered – e.g. thinking of the low-lying island states threatened by rising sea levels. Climate change mitigation must thus be pursued consistently and ambitiously (see Chapter 3) in order to minimise the risk of exceeding the 1.5°C benchmark.

Excursus: Temporary Overshoot

The concept of "overshoot" has been analysed as part of the scientific debate on the feasibility of meeting global temperature goals. This concept describes a development in which the global mean temperature rises above the target value before it is brought back down to the target level. Although the general physical correlations and prerequisites for this have been known for decades, the first IPCC report highlighting temporary temperature overshoots was only published in 2014 (IPCC, 2014; Reisinger & Geden, 2023). One reason for the "temporary overshoot" may be insufficient efforts to reduce greenhouse gases, which are to be offset later on through increased climate action and the expansion of carbon sinks. Since the pressure on ecosystems and societies increases enormously in the overshoot scenario, the extent to which the 1.5°C benchmark is exceeded must be minimised and the duration kept as short as possible. Any overshoot can result in serious and possibly irreversible changes in the climate system, with unforeseeable effects on people and the environment. Therefore, the goal remains to act early and consistently in order to avoid such scenarios.

3 Global climate action needs to be consistently aligned with the 1.5°C goal.

3.1 Requirements for achievieng the goal

In order to meet the internationally agreed 1.5°C goal, a comprehensive strategy is required that includes both reducing greenhouse gas emissions and preserving as well as expanding natural carbon sinks, and additional technical sinks. All of these actions are necessary to achieve a

stabilisation of the global mean temperature. In order to meet the 1.5°C goal of the Paris Agreement, the balance of CO_2 emissions and removals from the atmosphere through sinks must be equalised by the early 2050s at the latest – i.e. global CO_2 neutrality must be achieved (IPCC, 2023).

3.1.1 Drastic reduction of greenhouse gases required immediately

Technically, to meet the 1.5°C goal, global greenhouse gas emissions must peak before 2025 and then be rapidly and drastically reduced (IPCC, 2022b). In order to achieve the temperature target at the lowest possible cost over time, greenhouse gas emissions must fall by 43 percent by 2030 compared to 2019, and by 60 percent by 2035 (IPCC, 2022b). The gap widens with every year in which global greenhouse gas emissions are not recognisably on a declining path. As of 2024, emissions must be reduced by 7.5 percent annually by 2035 to meet the 1.5°C goal (UNEP, 2024).

Achieving CO_2 neutrality requires a rapid change in the economy and the way we live, that much is clear. Climate-friendly technologies and knowledge of sustainable practices are available. Economic paradigms need to be reviewed and new institutional rules negotiated. These affect the economic interests of many stakeholder groups (Section 3.1.4).

3.1.2 Preserving and strengthening natural carbon sinks

Natural carbon sinks, such as forests, oceans and soils, absorb CO_2 from the atmosphere. The preservation and protection of the world's natural sinks is therefore essential for climate action. They also play a key role in achieving global CO_2 neutrality, as unavoidable emissions can be offset by strengthening and expanding natural sinks.

However, the mitigation potential of natural carbon sinks is limited and is being increasingly reduced worldwide due to the intensifying climate change. In order to utilise natural carbon sinks in a more environmentally friendly way and not beyond a sustainable level, it is necessary to reduce greenhouse gas emissions as quickly and as far as possible, i.e. to keep unavoidable residual emissions as low as possible.

The natural carbon sinks, which are also the habitat of diverse flora and fauna, must be protected and strengthened – both for the mitigation of climate change and for biodiversity conservation.

3.1.3 Additional technical sinks for unavoidable residual emissions

The key to achieving global CO_2 neutrality is to completely move away from fossil fuels, in particular by expanding renewable energies, increasing energy efficiency and electrification. Some processes based on fossil resources, which cannot be dispensed with for the time being, will continue to generate CO_2 emissions. These must be further reduced to a minimal residual level through technological development and changes in behaviour.

For unavoidable residual emissions, technical measures for carbon sinks are being discussed. These are intended to remove the emitted CO_2 from the atmosphere directly or via photosynthesis and subsequent processes (Carbon Dioxide Removal, CDR). These technical sinks cannot replace the necessary reduction in emissions. Their use must be targeted and planned, as their availability is scarce and provision is very costly, and they compete with e.g. other uses of natural resources such as land and carbon storage options (UBA, 2023).

3.1.4 Necessary decisions and potential pitfalls

Ambitious climate action, to which the Federal Constitutional Court has committed the German Government (BVG, 2021) and which is also needed to meet the 1.5°C goal, requires a

comprehensive transformation at all levels and therefore a networked solution to the problem. Policymakers must actively lead the way and create the basic conditions for all stakeholders so that they can become active in their fields of expertise and anticipate the necessary conditions for ambitious climate action (Lünenbürger et al., 2023).

- Many steps towards ambitious climate action have already been taken internationally, e.g. through Nationally Determined Contributions (NDCs) and long-term strategies (see Chapter 2.2), but implementation is still insufficient.
- Climate action can fail. Possible pitfalls in climate action must be identified in time so that countermeasures can be rapidly applied.
- Climate action requires a wide range of negotiation processes between numerous interest groups and sectors (e.g. environment, health, agriculture or energy). The central area of negotiation is politics, which must directly or indirectly enable and strengthen new forms of climate-friendly activity – individually, within (civil) society and economically. Negotiation processes are put to the test where implementing climate action is fraught with conflict – especially when changes can produce both winners and losers. Progress in climate action can therefore also require a readjustment of the tight institutional network in which the various interest groups act.
- At an individual level, the aim is to satisfy human needs and requirements in the most climate-friendly way possible. In addition to suitable frameworks and management methods, understanding one's own needs is also crucial. Approaches that increase transformation skills, which should be widely promoted, are helpful and effective in the longer term. A convincing sufficiency approach can provide support in this context.
- At a societal level, a lack of social compatibility of current climate action instruments stands in the way of ambitious climate change mitigation, as does a low level of acceptance and a lack of discourse on its normative aspects. This may exacerbate tendencies towards social polarisation. Climate policy must take these problems seriously and develop integrated policy mix concepts for the socio-ecological transformation.
- The renegotiation of governance structures and the core issues to be negotiated must also take place globally. CO_2 neutrality and conservation of resources require both changed and new forms of global economic activity and trade partnerships.

3.2 Alignment of national climate action

The 1.5°C goal also serves as a guideline for the design of the Nationally Determined Contributions (NDCs) of the Parties to the Paris Agreement. In a resolution of the UN Climate Change Conference in 2023 (COP28), states are called upon to align the next NDCs “with limiting global warming to 1.5°C”; see (UNFCCC, 2023b). New ambitious NDCs must be submitted by the Parties before COP30 in Brazil in 2025.

At present, neither the NDCs and long-term strategies nor the policies and measures implemented are even remotely sufficient to meet the 1.5°C goal. Implementing the current NDCs would lead to a 2.8°C warmer world by the end of the century (UNEP, 2024). Even if the “peak" – i.e. the maximum global level of emissions – had been reached before 2025, this would not mean that the ambitious reduction rates required thereafter would also be achieved and emissions would fall quickly enough. In particular, a lack of global cooperation, failure to manage the necessary energy and land use transformation and the increase in resource-intensive consumption stand in the way of achieving a 1.5°C pathway (see IPCC, 2023).

4 Every temperature increase that is avoided, however small, counts.

4.1 Any deviation from the 1.5°C benchmark is relevant

It is important to emphasise that every additional greenhouse gas emission or temperature increase, however small, should be avoided, regardless of its apparent insignificance. Whether we are talking about "(warming) increments", "tenths of a degree", "hundredths of a degree" or "grams of CO_2" is irrelevant. Every contribution to climate change, however small it may seem, can have a significant cumulative impact. Overshooting the 1.5°C benchmark must be avoided and minimised as much as possible.

4.2 Any further warming considerably increases climate change-related risks and adaptation requirements, limits mitigation options and causes more damage and losses

Thousands of scientific studies show that any further warming significantly increases the risks of climate change, be it extreme weather events, intensifying feedback processes in the climate system or the growing danger of exceeding tipping points (Kornhuber et al., 2024). Only if greenhouse gas emissions are reduced quickly, profoundly and sustainably, can dynamically increasing catastrophic climate impacts for humanity be averted (IPCC, 2023).

The global community must therefore take immediate and ambitious action in line with the precautionary principle. Any further increase in temperature is associated with irreparable damage, e.g. loss of biodiversity and negative effects on human health. It is also associated with increased efforts and costs for coping with the unavoidable consequences of climate change, e.g. due to extreme weather events.

Excursus: Climate justice

Climate justice means viewing climate change through the lens of social justice and of justice between generations. Measures to combat climate change should be distributed fairly and equitably, as both the responsibility for climate change and the impacts and damage caused by climate change are unequally distributed. Decisions made in the present have a direct impact on future generations, such as whether they will have the opportunity to live in a clean, healthy and safe environment. Countries, social groups and different generations have contributed to anthropogenic climate change to varying degrees, are affected differently by the impacts of climate change and have different capacities to adapt and contribute to mitigation action.

For example, extreme weather events and natural disasters, which have increased significantly due to climate change, have led to far more deaths in developing countries in recent decades (1970-2021) than in industrialised countries (WMO, 2023). In general, it is the poorest people who are most affected by climate change and the associated environmental changes (IPCC, 2022a; Lankes et al., 2022). At the same time, a direct link between higher incomes and higher greenhouse gas emissions still exists globally and within most societies (Stockholm Environment Institute, 2024). Climate justice therefore means that countries with high greenhouse gas emissions in the past and also in the present, as well as high-income groups, take responsibility and support developing countries and disadvantaged communities. Overall, climate justice aims to address social, economic and environmental inequalities and ensures that all groups in society and future generations have the opportunity to adapt to the consequences of climate change and benefit from the solutions.

In the climate negotiations, the international community agreed on the principle of “common but differentiated responsibilities and respective capabilities in light of different national circumstances” (Paris Agreement, 2016; United Nations, 1992). This means that all countries contribute to combating climate change, but have different obligations and capabilities. This principle is applied in various contexts, e.g. in individual contributions to reducing greenhouse gas emissions, climate finance and financial support for loss and damage.

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Section V 1.1 – International Climate Action

A Literature

Berkeley Earth. (2025, Januar 10). *Global Temperature Report for 2024*. Berkeley Earth. https://berkeleyearth.org/global-temperature-report-for-2024/

BVG. (2021, März 24). *Beschluss vom 24. März 2021*. https://www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/DE/2021/03/rs20210324_1bvr265618.html

Copernicus. (2025, Januar 10). *Copernicus: 2024 is the first year to exceed 1.5°C above pre-industrial level | Copernicus*. https://climate.copernicus.eu/copernicus-2024-first-year-exceed-15degc-above-pre-industrial-level

Forster, P. M., Smith, C., Walsh, T., Lamb, W. F., Lamboll, R., Hall, B., Hauser, M., Ribes, A., Rosen, D., Gillett, N. P., Palmer, M. D., Rogelj, J., Von Schuckmann, K., Trewin, B., Allen, M., Andrew, R., Betts, R. A., Borger, A., Boyer, T., … Zhai, P. (2024). Indicators of Global Climate Change 2023: Annual update of key indicators of the state of the climate system and human influence. *Earth System Science Data*, *16*(6), 2625–2658. https://doi.org/10.5194/essd-16-2625-2024

IPCC. (2014). *Climate Change 2014—Mitigation of Climate Change*. Cambridge University Press.

IPCC. (2018). *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* [IPCC Special Report]. Cambridge University Press. https://doi.org/10.1017/9781009157940

IPCC. (2021). *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1. Aufl.). Cambridge University Press. https://doi.org/10.1017/9781009157896

IPCC. (2022a). *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (1. Aufl.). Cambridge University Press. https://doi.org/10.1017/9781009325844

IPCC. (2022b). *Climate Change 2022—Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate*

Change. IPCC. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

IPCC. (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Kornhuber, K., Klönne, U., Kellou, D., & Schleussner, C.-F. (2024). *Kipppunkte und kaskadische Kippdynamiken im Klimasystem* (Climate Change). Umweltbundesamt. https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/08_2024_cc_kipppunkte_und_kaskadische_kippdynamiken.pdf

Lankes, H. P., Soubeyran, E., & Stern, N. (2022). *Acting on climate and poverty: If we fail on one, we fail on the other* [Policy Insight]. Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science. https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2022/04/Acting-on-climate-and-poverty_if-we-fail-on-one-we-fail-on-the-other-2.pdf

Lünenbürger, B., Purr, K., & Schultz, K. (2023). *Ambitionierter Klimaschutz: Fallstricke und Bedingungen des Gelingens* (No. 04/2023; Climate Change). Umweltbundesamt. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2023-02-03_climate-change_04-2023_ambitionierter_klimaschutz_bedingungen_des_gelingens_bf.pdf

Reisinger, A., & Geden, O. (2023). Temporary overshoot: Origins, prospects, and a long path ahead. *One Earth*, *6*(12), 1631–1637. https://doi.org/10.1016/j.oneear.2023.11.008

Stockholm Environment Institute. (2024, Dezember 16). *Emissions Inequality Indicator*. Global Dashboard. https://emissions-inequality.org/

UBA. (2023). *Carbon Capture and Storage: Diskussionsbeitrag zur Integration in die nationalen Klimaschutzstrategien* [Positionspapier]. Umweltbundesamt.

https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/230919_uba_pos_ccs_bf.pdf

Übereinkommen von Paris (2016). https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:22016A1019(01)

UNEP. (2024). *Emissions Gap Report 2024: No more hot air … please! With a massive gap between rhetoric and reality, countries draft new climate commitments*. United Nations Environment Programme. https://doi.org/10.59117/20.500.11822/46404

UNFCCC. (2023a, März 17). *FCCC/CP/2022/10/Add.2*. https://unfccc.int/sites/default/files/resource/cp2022_10a02E.pdf

UNFCCC. (2023b, Dezember 13). *Matters relating to the global stocktake under the Paris Agreement*. UN Climate Change Conference - United Arab Emirates Nov/Dec 2023.

United Nations. (1992). *United Nations Framework Convention on Climate Change*. https://unfccc.int/resource/docs/convkp/conveng.pdf

WMO. (2023, Mai 22). *Atlas of Mortality and Economic Losses from Weather, Climate and Water-related Hazards (1970-2021)*. WMO. https://wmo.int/publication-series/atlas-of-mortality-and-economic-losses-from-weather-climate-and-water-related-hazards-1970-2021

WMO. (2025, Januar 10). *WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level* [News]. https://wmo.int/media/news/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level