What does the IPCC say about the remaining CO_2 budgets?

The goal of the Paris Agreement is 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".

The UN Intergovernmental Panel on Climate Change (IPCC) published the following figures in its Sixth Assessment Report Working Group I 20021 (IPCC, 2021, cf. Tables SPM.2 and 5.8):[1]

Warming	**Estimated remaining carbon budgets**			Scenario variation	Geophysical uncertainties			
				Non-CO_2 scenario variation	Non-CO_2 forcing and response uncertainty	Historical temperature uncertainty	ZEC uncer-tainty	Recent emissions uncertainty
Probabilities:	*50%*	*67%*	***83%***					
[°C]	[$GtCO_2$ from 2020 on]			[$GtCO_2$]				
1.5	500	400	**300**	**±220**	±220	±550	**±420**	±20
1.6	650	550	**400**					
1.7	850	700	**550**					
1.8	1000	850	**650**					
1.9	1200	1000	800					
2.0	1350	1150	900					

A remaining CO_2 budget is currently being used up with **annual emissions** of around **41 Gt**.[2]

Here is a web app for calculating linear global emission paths that comply with a given CO_2 budget (temporary overshooting can be taken into account): http://global-paths.climate-calculator.info.

The IPCC writes about the CO_2 budget (IPCC, 2021, p. 28 f., emphasis and [...] not in the original):

«***D.1.1*** *[…] there is* ***a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause****. Each 1000 $GtCO_2$ of cumulative CO_2 emissions is assessed to likely cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C. […] This quantity is referred to as the transient climate response to cumulative CO_2 emissions (TCRE). This relationship implies that reaching net zero anthropogenic CO_2 emissions is a requirement to stabilize human-induced global temperature increase at any level, but that* ***limiting global temperature increase to a specific level would imply limiting cumulative CO_2 emissions to within a carbon budget***.»

«***D.1.2*** *[…]* ***Remaining carbon budgets have been estimated for several global temperature limits and various levels of probability****, based on the estimated value of* ***TCRE*** *and its uncertainty, estimates of historical warming [±550 $GtCO_2$], variations in projected warming from non-CO_2 emissions [±220 $GtCO_2$], climate system feedbacks such as emissions from thawing permafrost [±220 $GtCO_2$], and the global surface temperature change after global anthropogenic CO_2 emissions reach net zero [ZEC]*.»

Regarding probabilities, the IPCC notes (IPCC, 2021, p. 29, emphasis not in the original):

«*This likelihood is based on the uncertainty in transient climate response to cumulative CO_2 emissions (TCRE) and additional Earth system feedbacks and provides the probability that global warming will not exceed the temperature levels […]. Uncertainties related to historical warming (±550 $GtCO_2$) and non-CO_2 forcing and response (±220 $GtCO_2$) are* ***partially addressed*** *by the* ***assessed uncertainty in TCRE****, but uncertainties in recent emissions since 2015 (±20 $GtCO_2$) and the climate response after net zero CO_2 emissions are reached (±420 $GtCO_2$)* ***are separate***.»

[1] See also recent publications on the remaining CO_2 budget, for example (Forster, et al., 2023) and (Lamboll, et al., 2023). For (Forster, et al., 2023) application, see (SRU, 2024) and (Wolfsteiner & Wittmann, 2024).
[2] Actual CO_2 emissions in 2019 were estimated at 40.9 Gt (GCP, 2023). 36.3 Gt result from the use of fossil fuels and cement production and 4.6 Gt from land use change (LUC).

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