

Counting the Numbers: EU's carbon budget not compatible with the 1.5°C target

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Since the IPCC's first publication of global carbon budget estimates, a lot of scientific progress has been made to tackle the uncertainties in this concept. The latest numbers as contained in the WG I contribution to the IPCC's Sixth Assessment Report are now much more robust and the carbon budget concept has even made its way into the Glasgow Climate Pact. The briefing below calculates the EU's carbon budget under currently agreed targets and compares this to the remaining global carbon budget. The conclusion is that the EU will emit at least double the amount of what could be considered its per capita share of the remaining global 1.5°C carbon budget. It is thus fair to conclude that the EU's current targets and policies are not compatible with a 1.5°C pathway and it would be good if EU decision-makers could acknowledge that.

1. THE GLOBAL CARBON BUDGET

There is robust scientific understanding that global temperature rise is near-linear proportional to the total amount of CO₂ that the world emits¹. This knowledge has led to the development of the global carbon budget concept, the cumulative amount of total CO₂ that can be emitted (between pre-industrial times and the moment net zero CO₂ emissions are achieved) to stay within a certain temperature limit. When subtracting the CO₂ emissions from the past, we can estimate the remaining carbon budget. The level of certainty with which this remaining budget can be defined has improved substantially over the last decade², and is now taken up in the Glasgow Climate Pact³ (COP26, November 2021): "3. Expresses alarm and utmost concern that human activities have caused around 1.1 °C of warming to date, that impacts are already being felt in every region, and that carbon budgets consistent with achieving the Paris Agreement temperature goal are now small and being rapidly depleted".

The Intergovernmental Panel on Climate Change (IPCC) Working Group I (WG I) contribution to the Sixth Assessment Report⁴ (AR6) in particular tackled five key elements of the carbon budget that substantially improved the science around this concept, both compared to its 2014 Fifth Assessment Report and its 2018 Special Report on Global Warming of 1.5°C (SR1.5). These are:

- Warming to date: this relates to the question how much the earth has actually warmed on average since pre-industrial times. The AR6, based on a full reassessment of all available data, has set average global surface temperature increase for the period 1850-2015 to be at 0.94°C;
- Warming per tonne of CO₂: AR6 assessed that for every 1.000 GtC (or 3.664 GtCO₂) we would see a temperature increase of 1.0°C to 2.3°C, up from 0.8°C-2.5°C in SR1.5 (this is also known as the TCRE - Transient Climate Response to Cumulative CO₂ Emissions). This means that for a 50% likelihood, the numbers are the same, but for higher or lower likelihoods, AR6 budgets are larger than previously estimated;

1 Note that this link is only established between CO₂ and temperature levels and this is not the case for the other greenhouse gases, hence the carbon budget only applies to CO₂ emissions

2 see: Joeri Rogelj (2021). A Deep Dive Into The IPCC's Updated Carbon Budget Numbers. In: www.realclimate.org/index.php/archives/2021/08/a-deep-dive-into-the-ipccs-updated-carbon-budget-numbers/

3 see Chapter 1 para 3 in: UNFCCC. Decision -/CMA.3. Glasgow Climate Pact. 13 November 2021. <https://unfccc.int/documents/310497>

4 see in particular Chapter 5.5 in: Canadell e.a. (2021). Chapter 5: Global Carbon and other Biogeochemical Cycles and Feedbacks. IPCC AR6 WGI report. www.ipcc.ch/report/ar6/wg1/#FullReport

- Warming to occur once net zero CO₂ is reached: this question relates to how much warming can still be expected once global CO₂ emissions reach (and remain at) zero (also called ZEC -Zero Emissions Commitment). AR6 confirms previous estimates that no further CO₂-induced warming is to be expected once CO₂ emissions reach zero;
- Non-CO₂ warming: the next piece of the puzzle relates to projected warming from non-CO₂ emissions. AR6 uses deep mitigation pathways with updated climate projections for tens of different gases that have substantially reduced the uncertainties around non-CO₂ gases;
- Earth system feedback otherwise not covered: the global carbon budget also needs to take account of earth system feedbacks that would otherwise not be covered. Since SR1.5 substantial progress has been made on this issue, allowing for estimations on these issues to be entirely included in the budget calculations.

The WG I contribution to AR6 from August 2021 thus provides updated numbers for the remaining global carbon budget for a range of temperature limits, based on more accurate methods that ensure that model uncertainties over the historical period are not accumulated in the future. The IPCC now considers that to have a 67% to 83% likelihood of limiting temperature rise to 1.5°C, global CO₂ emissions between 2020 and the moment global emissions reach net zero (likely in this case 2050) should be limited to 300 to 400 GtCO₂ (see table SPM.2 from WG I/AR6 below). With a certain level of uncertainty remaining over the impact of non- CO₂ emissions on the carbon budget. Though there is general agreement that any substantial emission reduction scenario that really envisages to achieve the Paris Agreement's objectives will be stringent for both CO₂ and non-CO₂ emissions, which reduces this uncertainty substantially.

Table SPM.2 | Estimates of historical carbon dioxide (CO₂) emissions and remaining carbon budgets. Estimated remaining carbon budgets are calculated from the beginning of 2020 and extend until global net zero CO₂ emissions are reached. They refer to CO₂ emissions, while accounting for the global warming effect of non-CO₂ emissions. Global warming in this table refers to human-induced global surface temperature increase, which excludes the impact of natural variability on global temperatures in individual years.
{Table 3.1, 5.5.1, 5.5.2, Box 5.2, Table 5.1, Table 5.7, Table 5.8, Table TS.3}

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO ₂ Emissions from 1850 to 2019 (GtCO ₂)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C) ^a	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 (GtCO ₂)					Variations in reductions in non-CO ₂ emissions ^c
		Likelihood of limiting global warming to temperature limit ^b					
		17%	33%	50%	67%	83%	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO ₂ emissions can increase or decrease the values on the left by 220 GtCO ₂ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

^a Values at each 0.1°C increment of warming are available in Tables TS.3 and 5.8.

^b This likelihood is based on the uncertainty in transient climate response to cumulative CO₂ emissions (TCRE) and additional Earth system feedbacks and provides the probability that global warming will not exceed the temperature levels provided in the two left columns. Uncertainties related to historical warming (±550 GtCO₂) and non-CO₂ forcing and response (±220 GtCO₂) are partially addressed by the assessed uncertainty in TCRE, but uncertainties in recent emissions since 2015 (±20 GtCO₂) and the climate response after net zero CO₂ emissions are reached (±420 GtCO₂) are separate.

^c Remaining carbon budget estimates consider the warming from non-CO₂ drivers as implied by the scenarios assessed in SR1.5. The Working Group III Contribution to AR6 will assess mitigation of non-CO₂ emissions.

2. SHARING THE REMAINING GLOBAL CARBON BUDGET

On the basis of the estimations of the remaining global carbon budget, an effort can be made to assess whether national, or regional as in the case of the EU, policies and targets are in line with the challenging limitations to the amount of CO₂ the world can still emit. This has proven to be a controversial exercise as

the methodology to share the effort to avoid dangerous climate change is a moral/political question and not a scientific one. The central issue lies with the concept of fairness, one of the core principles of international climate cooperation, as reflected in the 1992 Framework Convention on Climate Change, which states that countries "*should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities.*"⁵

Many proposals have been developed on how the efforts to limit climate change can be shared among countries (both related to how the budget can be divided as to the kind of targets countries should set for emission reductions and limitations within a given time frame, eg. by 2020/2030/2050, ...). These proposals can roughly be divided into three categories:

- **Per capita** approaches whereby countries are assigned a slice of the budget on the basis of their share of the global population;
- **Equity** approaches whereby countries are assigned a slice of the budget taking into account not only their size of the population but also their historical responsibility and/or capacity to act. The most explicit proposal here is the Greenhouse Development Rights/Climate Equity Reference Project⁶ that assigns each country a certain responsibility for global (not just domestic) emission reductions;
- Best **potential** approaches whereby countries are assigned a slice of the budget taking into account a country's potential for emission reductions and potentially also the costs of such reductions.

Equity approaches are most in line with the UNFCCC principles, though as indicated above such approaches often translate into a country's responsibility for reducing global greenhouse gas emissions thereby combining domestic emission reduction efforts with support to emission reductions abroad. This paper does not aim to dive deep into this concept and hence takes a very simplistic approach in using a per capita comparison while acknowledging that for the EU domestic emission reduction efforts need to be complemented by the provision of substantial climate finance support for poorer countries, not only for reducing emissions, but also to support and loss and damage. Such financial support, to respect the principles of equity and fairness would likely need to be beyond 100 bn euro/year, for the EU alone.

The EU currently represents 5.78% of the world's population⁷. This is expected to drop to 4.36% in 2050.⁸ The average for the 2020-2050 period is thus 5.07%. This would mean that the EU's per capita share of the 2020 to 2050 CO₂ budget limiting temperature rise to 1.5°C, would be 20.28 GtCO₂ for a likelihood of 67% and 15.21 GtCO₂ for an 83% likelihood.

3. THE EU'S CURRENT CARBON BUDGET: DOUBLE ITS PER CAPITA SHARE

While the European Commission has not supported the concept of developing an EU-wide carbon budget, current EU climate policies do have a budget approach as they go beyond end year targets and allow for the impact of the EU's overall emissions to be calculated. Both for the Emissions Trading (ETS) as well as for the Effort Sharing (ESR) legislation, emission pathways are developed that foresee annual emissions budgets, which when all taken together, inform the EU emissions budget for, in this case, the period 2021 to 2030.

Based on the changes to the three key pieces of climate legislation as proposed by the Commission in June 2021, we can calculate the amount of total emissions and removals that can be assumed under the ETS Directive, the Effort Sharing Regulation and the Land Use Land Use Change and Forestry Regulation (see table 1).

5 UN (1992). United Nations Framework Convention on Climate Change. unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change

6 see: climateequityreference.org

7 see: World Bank: data: Total Population: data.worldbank.org/indicator/SP.POP.TOTL

8 see: World Bank: databank.worldbank.org/source/population-estimates-and-projections

Table 1: Total allowable greenhouse gas emissions (in MtCO₂-e) for the EU for the period 2021 to 2030 under the European Commission's legislative proposals on Emissions Trading, Effort Sharing and LULUCF of June 2021

	Emissions Trading Sectors (ETS) (1)	Non-ETS Sectors (ESR) (2)	Land Use Land Use Change and Forestry (3)
2021	1.572	2.226	-225
2022	1.529	2.142	-225
2023	1.486	2.063	-225
2024	1.361	1.985	-225
2025	1.275	1.906	-225
2026	1.189	1.933	-267
2027	1.103	1.828	-278
2028	1.018	1.723	-289
2029	932	1.618	-299
2030	846	1.513	-310
Total	12.311	18.937	-2.568
Total ETS+ESR	31.248		
Total ETS+ESR-LULUCF			28.680

(1) Numbers from Commission presentation on "Cap and Linear reduction factor" to European Council Working Party on Environment of 5 November 2021; (2) Numbers calculated based on the June 2021 proposal and assuming emissions in 2021-2023, which form the basis for calculating emission allowances for the period 2026-2030, are equal to the allowances foreseen under the Regulation⁹; (3) Numbers calculated based on the June 2021 LULUCF proposal and assuming the annual removal budget for the period 2021 to 2025 equals 225 MtCO₂ which also informs the starting point for linear reductions applied from 2026¹⁰.

On top of this, emissions after 2030 are calculated assuming a linear greenhouse gas emission reduction between 2030 and 2050 (when greenhouse gas emissions reach net zero), while also assuming the total removal capacity set for 2030 in the LULUCF Regulation will remain the same for the period 2031-2050. Total emissions then amount to 17.955 MtCO₂-e for the period 2031 to 2040, and 7.710 MtCO₂-e for the period 2041-2050.

As the carbon budget only relates to CO₂ while the above policies (all together) cover all greenhouse gas emissions, a calculation is made of the likely amount of CO₂ emissions under the assumption that the share of CO₂ in total greenhouse gas emissions would remain fairly stable (as has been the case in the last decade). The total amount of CO₂ emissions is set based on the EU's average percentage of CO₂ emissions from the last decade which is 81.49%¹¹.

As indicated in Table 2 below, the EU's carbon budget for the period from 2020 until the moment it reaches net zero emissions is approximately 40 GtCO₂. This is (more than) double the per capita share of the global remaining budget to stay within the 1.5°C limit and represents 10% of the remaining budget for a 67% likelihood to stay within the 1.5°C limit and 13% of the remaining budget for a 83% likelihood, as opposed to the EU's population representing only 5.78% of the global population in 2020 and even only 4.36% in 2050. One can thus safely conclude that the EU's currently proposed and/or agreed targets and policies are not in line with a 1.5°C pathway.

⁹ see article 1(3) in: European Commission (2021). Proposal for a regulation on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030. eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:555:FIN

¹⁰ see article 4 in: European Commission (2021). proposal for a regulation on LULUCF. eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021PC0554&from=EN

¹¹ see EEA greenhouse gases data viewer: www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer

Table 2: Total amount of greenhouse gas/CO₂ emissions and removals under current EU targets and policies for the period 2020 to 2050, in MtCO₂-e

	Greenhouse gas emissions	CO ₂ emissions (81.49%)	CO ₂ removals	total CO ₂ budget
2020 ¹²	3.377	2.752	-270	2.482
2021-2030	31.248	25.464	-2.568	22.896
2031-2040	17.956	14.632	-3.100	11.532
2041-2050	7.710	6.283	-3.100	3.183
Total	60.275	49.131	-9.038	40.093

In fact, if the global carbon budget was divided across countries on an equal per capita basis, the currently proposed EU budget would need a global carbon budget of approx. 800 GtCO₂, which would correspond to a global carbon budget of 1.8°C (with a 67% likelihood) and of 1.9°C (with an 83% likelihood) according to the IPCC's AR6¹³.

4. THE EU'S CARBON BUDGET UNDER THE TARGETS PROPOSED BY CAN EUROPE

Climate Action Network (CAN) Europe, the European federation of climate NGOs, believes the EU needs to do more than currently planned if it is to make a fair contribution to efforts to limit temperature rise to 1.5°C. It therefore calls for:

- Greenhouse gas emissions to be reduced by at least 65% by 2030;
- Carbon removals through LULUCF to be increased to at least 600 Mt CO₂ by 2030;
- Climate neutrality to be achieved by 2040;
- Total greenhouse emissions to be reduced by at least 90% by mid century.

On the basis of the above, an alternative carbon budget for the EU can be calculated. The total carbon budget for the EU for the period 2020 to 2050, when fully implementing CAN Europe's proposals, would be 19 GtCO₂ (see table 3 below).

Table 3: Total amounts of greenhouse gas/CO₂ emissions and removals under CAN Europe's policy proposals for the period 2020 to 2050, in MtCO₂-e

	Greenhouse gas emissions	CO ₂ emissions (4)	CO ₂ removals (5)	Total carbon budget
2020	3.377	2.752	-270	2.482
2021-2030 (1)	24.679	20.111	-4.515	15.596
2031-2040 (2)	11.058	9.011	-6.000	3.011
2041-2050 (3)	5.065	4.127	-6.000	-1.873
Total	44.179	36.001	-16.785	19.216

(1) calculation made on the basis of a linear reduction from the EU's 2020 emissions of 3.377 MtCO₂-e to a -65% reduction in 2030; (2) calculation made on the basis of a linear reduction of a -65% reduction in 2030 to a total maximum amount of emissions of 600 MtCO₂-e (equals to the foreseen total removals through LULUCF in 2040); (3) calculation made on the basis of a linear reduction from a total amount of 600 MtCO₂-e in 2040 to a -90% reduction in 2050; (4) calculated on the basis of a stable share of CO₂ in total greenhouse gas emissions of 81.49%; (5) calculated assuming that from 2030 onwards total removals from LULUCF would remain stable at 600 MtCO₂/year

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12 see: European Commission (2021). EU Climate Action Report. November 2021.

13 see: Chapter 5.5 in: Canadell e.a. (2021). Chapter 5: Global Carbon and other Biogeochemical Cycles and Feedbacks. IPCC AR6 WGI report. www.ipcc.ch/report/ar6/wg1/#FullReport