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Climate Change Research

Quantifying a 1.5°C compatible emissions budget for Czechia

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NB: *All views contained within this report are attributable solely to the authors and do not necessarily reflect those of researchers within the wider Tyndall Centre.*

In preparing this report we expressly have not addressed the practical feasibility of respecting the emissions budgets represented, nor have we addressed the implications of the budgets for the Paris Agreement commitment to reduce emissions in line with the principle of equity. We make no comment on the appropriateness or otherwise of the temperature–probability targets, the associated emissions budgets and apportionment regime presented in this report.

This is an addendum to our 2021 report 'Quantifying the Implications of the Paris Agreement for the Czech Republic' (Anderson & Calverley, 2021).

1. Taking the remaining global carbon budget for a 50% chance of 1.5C as a starting point, what would Czechia's national carbon budget be from the start of 2024?

In our 2021 report the Paris Agreement's commitment to *"[holding] the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels*" was interpreted in light of the then most up to date emissions budgets, taken from the IPCC's Special Report on Global Warming of 1.5°C (SR1.5) (IPCC, 2018). Since then, the IPCC has published its Sixth Assessment Report (AR6) (IPCC, 2021), with revised budgets for a wider range of temperature probabilities. Our 2021 analysis used a single budget from SR1.5 associated with a 67% chance of 2°C (the highest headline probability interval published at the time), a 50% chance of 1.7°C and a 33% chance of 1.5°C.

The European Commission has recently adopted an emissions reduction target for the European Union of at least 90% by 2040. This followed advice from the European Scientific Advisory Board (ESAB), which argued that such a target is consistent with a 50% chance of not exceeding 1.5°C with no or limited overshoot (ESAB, 2023). The Commission acknowledges that "*this scenario … relies on a fully developed carbon management industry by 2040, with carbon capture covering all industrial process emissions and delivering sizable carbon removals*" (European Commission 2024, p.29).

It is important to be aware that the ESAB is careful to emphasise that under some ethical principles, even an EU 90–95% reduction by 2040 may not meet 'fairness' criteria, as *"the EU has already exhausted its fair share of the global emissions budget"* (ESAB, 2023, p.10). Moreover, even the 90–95% reduction in the EU's domestic emissions *"need*[s] *to be complemented by measures outside the EU*" if the EU is *"to achieve a fair contribution to climate change mitigation"* (ibid.).

The analysis in this addendum is in relation to a global budget associated with a 50% probability of not exceeding 1.5°C, for consistency with the ESAB's focus on that temperature and probability combination.

Global annual CO_2 emissions are around 36 $GtCO_2$ from energy and 4 $GtCO_2$ from land use (primarily deforestation) (Table 1).

	Fossil fuels $GtCO_2$	**LUCF $GtCO_2$**	**Total historical global $GtCO_2$**
2020	35.0	4.3	39.3
2021	36.8	4.3	41.1
2022	37.1	4.3	41.5
2023	*37.1*	*4.3*	*41.5*
2024	*37.1*	*4.3*	*41.5*
Total CO_2 2020–2024			205

Table 1. Historical global emissions since our last report and remaining carbon budgets. Italics denote assumed values in years for which official data have not yet been released. LUCF = Land Use Change and Forestry (Emissions data: Global Carbon Project).

The IPCC's headline remaining carbon budget from the start of 2020 for 50% chance of 1.5°C is 500 $GtCO_2$. Once emissions in the intervening years (2020–2024 inclusive) are removed, the IPCC's remaining global carbon budget for 50% of 1.5°C from the start of 2025 is therefore set to be around 295 $GtCO_2$ (Table 2).

However, recent scientific evidence since the publication of AR6 strongly suggests that the IPCC budgets are optimistic. In the case of Lamboll et al. (2023), adjustments to the way that remaining carbon budgets are calculated to take better account of factors such as aerosol masking, result in a 43% reduction in the remaining budget for 50% chance of 1.5°C. Lamboll et al's remaining carbon budget (from the start of 2025) for a 50% chance of 1.5°C is 167 $GtCO_2$, falling to 126 $GtCO_2$ after international bunkers are removed[1].

[1] Emissions from international bunkers for aviation and shipping were removed from the global budget before the per capita allocation to individual nations. This was done to permit comparison with the Czech Climate Protection Policy, which does not include international aviation and shipping. Emissions from aviation are taken from ICAO's Long Term Aspirational Goal Integrated Scenario 2 (IS2, their central scenario in terms of technology optimism and traffic demand growth) (ICAO, 2022). However, since ICAO IS2 has residual emissions from aviation continuing indefinitely, we have assumed they will be brought to zero in a linear fashion by 2100. This yields cumulative emissions of 33.5 GtCO2 from aviation from the start of 2025 to the end of the century. Emissions from shipping are taken from the IMO's most ambitious decarbonisation scenario ('Strive'), which results in 7.7 GtCO2 from the start of 2025 until reaching zero emissions in 2050 (Bullock et al., 2023). International bunkers therefore consume 41.2 $GtCO_2$ of the global budget for 50% chance of 1.5°C from the start of 2025, leaving 254 $GtCO_2$ remaining for allocation to individual countries.

	Total global $GtCO_2$ remaining from the start of 2025
IPPC 50% 1.5°C budget	295
IPCC 50% 1.5°C excl. international bunkers (see fn.1)	254
Lamboll et al 50% 1.5°C excl. intnl bunkers (see fn.1)	126

Table 2. remaining carbon budgets for 50% probability of not exceeding 1.5°C from the start of 2025. In the case of the IPPC budget, this is the AR6 headline budget (from the start of 2020) minus emissions in the intervening years. The Lamboll et al budget has been updated from their 2023 estimate by removing emissions in 2023 and 2024.

In this addendum we have been asked to calculate a national carbon budget for Czechia that would provide a higher probability (50%) of not exceeding 1.5°C than we used in our 2021 report. This invokes a considerably smaller global carbon budget than in our previous report. Furthermore, four years of emissions since our 2021 report have further depleted the budget. The remaining IPCC budget for 50% chance of 1.5°C of 295 $GtCO_2$ represents a little over six years of current global emissions.

Our 2021 report gave a Paris-compliant budget for Czech CO_2 emissions from energy only, that is to say excluding CO_2 from land use change and forestry (LUCF) and cement production[2]. The underlying assumption was that CO_2 emissions from LUCF, primarily from deforestation, would 'break even' over the course of the century through (i) "*increased emphasis on rapidly reducing and ultimately eliminating LULUCF emissions*"; and (ii) "*a programme of ambitious net carbon sequestration is pursued across global forests, such that between 2020 and 2100, emissions from deforestation and degradation are balanced by the carbon uptake in managed LULUCF sequestration*" (Anderson et al, 2020, pp.4-5, §3.1.2.). We once again assume that LUCF emissions break even over the century and do not affect the budget for energy.

[2] Whereas in our 2021 report, a 'global overhead' for cement process emissions was removed from the global budget (for a 67% chance of 2°C) prior to apportionment to the groups of developing and developed nations, it does not make sense to do so for the considerably smaller budget remaining for a 50% chance of 1.5°C. The previous cement global overhead shared the burden of cement process emissions from construction of infrastructure in poor countries, since wealthy countries already have extensive built infrastructure in place. However, given how small the remaining global budget is for 50% of 1.5°C, as noted at the start of this report we have not considered feasibility, therefore a global overhead for cement is redundant.

As noted in our 2021 report, there are numerous methods of apportioning a global budget to nations, each with their own advantages and disadvantages. However, under the theoretical constraint of a budget as small as that for 50% chance of 1.5°C, there is little to recommend one method over another. No matter which apportionment methodology is selected, (i) real-world equity and development priorities must be disregarded; and (ii) all countries receive untenably small national budgets because the global budget itself is so small.

Therefore, to calculate Czechia's share of the global budget for 50% chance of 1.5°C, we apply a simple equal per capita allocation. In August 2024 Czechia's population represents 0.13% of world population (Worldometer), which gives a remaining budget for Czechia of 333 $MtCO_2$ from the start of 2025, excluding LUCF and international bunkers. For context, this represents around three years of Czechia's current emissions (Table 3).

	Czechia emissions $MtCO_2$ exc. LUCF & intnl bunkers
Remaining IPCC-based budget for 50% chance of 1.5°C	**333**
Remaining Lamboll et al-based budget for 50% chance of 1.5°C	165
2020	91.70
2021	96.67
2022	97.97
2023	*97.97*
2024	*97.97*
Total emissions since our 2021 report (2021–24)	391

Table 3. Czechia's equal per capita share of the remaining global carbon budget for a 50% chance of not exceeding 1.5°C, from the start of 2025 (top part of table), compared with historical Czech CO_2 emissions since our 2021 report (bottom part of table). Italics denote assumed values in years for which official data have not yet been released. (Emissions data: UNFCCC & Global Carbon Project).

2. Provide an illustrative pathway under which Czech emissions would stay within the global carbon budget for a 50% chance of staying below 1.5°C of warming.

For the purposes of illustrating what such a trajectory looks like on paper, Table 4 and Figure 1 show Czechia's remaining budget and a theoretical mitigation pathway to zero CO_2 emissions. With equal annual reductions from the start of 2025 (i.e. a straight line reduction), Czechia would have to reach zero CO_2 emissions by around 2032. The rate of year-on-year reductions necessary to keep within this budget would be 23%. Under an equal per capita apportionment principle this rate is the same for all nations, from Czechia and the USA to Rwanda and Bangladesh.

	$MtCO_2$	**Annual reduction rate**	**Absolute reduction vs. 2024**
2024	98	-	-
2025	85	13%	13%
2026	73	15%	26%
2027	60	17%	38%
2028	48	21%	51%
2029	35	26%	64%
2030	23	36%	77%
2031	10	55%	90%
2032	0	100%	100%

Table 4. Czech CO_2 emissions pathway compatible with an IPCC-based global budget with a 50% probability of not exceeding 1.5°C. Note: using more recent global carbon budget analysis (Lamboll et al) would see Czechia's zero emissions date brought forward to the end of 2027.

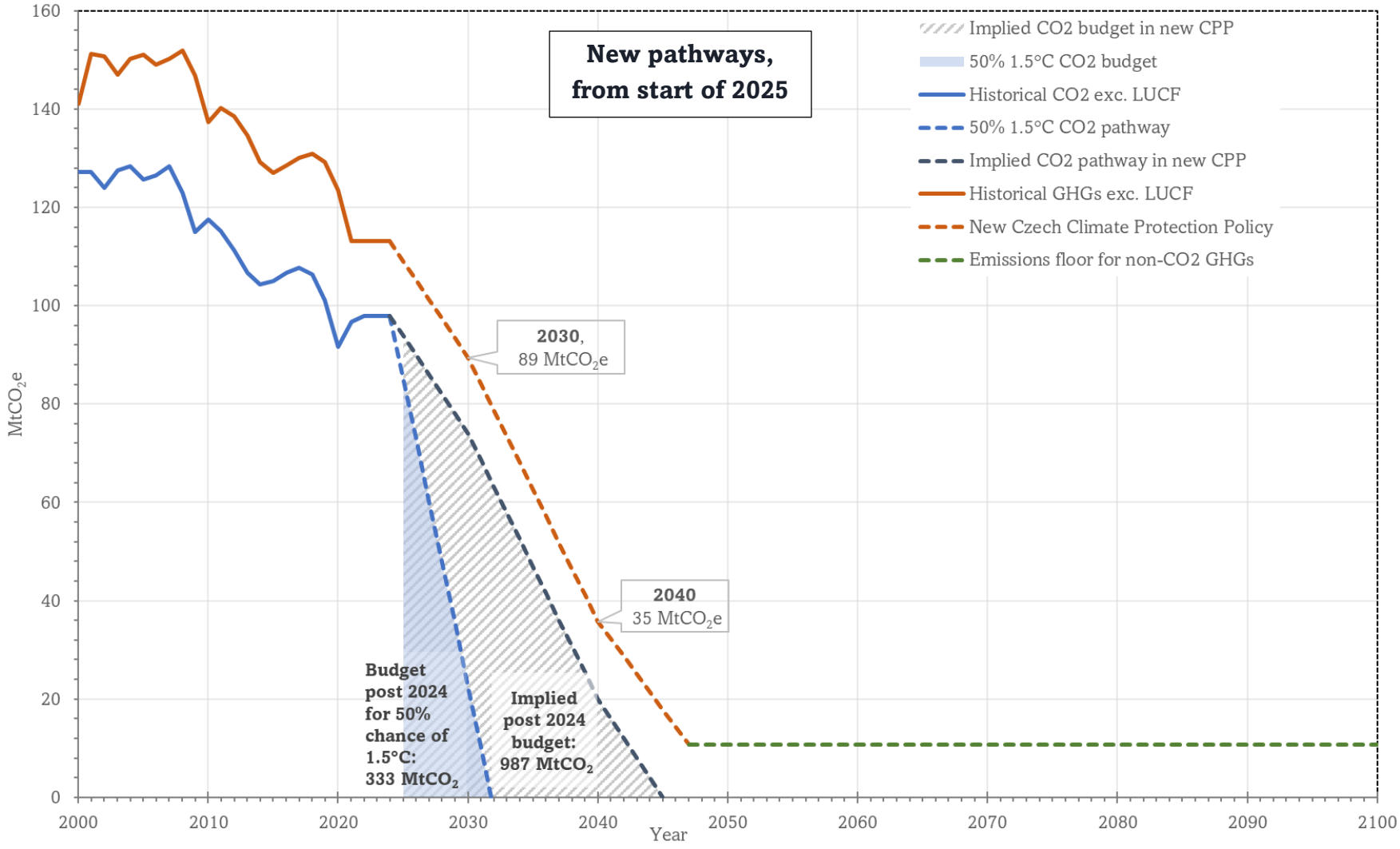

Figure 1. Emissions pathways and budgets for Czechia compatible with an IPCC global budget with a 50% probability of not exceeding 1.5°C. Note: as in our 2021 report, both CO_2 and GHG values exclude emissions from both land use change and forestry (LUCF) and international bunkers. (Data source: UNFCCC; Global Carbon Project; Czech CPP).

3. Compare the illustrative 1.5C pathway set out in question 2 with the new Czech Climate Protection Policy, which establishes revised climate targets for 2030 (-55%), 2040 (-86%, both compared with 1990), and climate neutrality in 2050.

Figure 1 shows the CO_2 pathway for Czechia based on an equal per capita allocation of the remaining IPCC global budget for a 50% probability of not exceeding 1.5°C, compared with the CO_2 emissions that would result from following the new Czech Climate Protection Policy (CPP),[3] assuming a straight line rate of reduction between the milestone years. As in our 2021 report, in the absence of specific information, CO_2 emissions are assumed to track the GHG reduction pathway in the CPP.

	$MtCO_2$
Czech CO_2 budget for 50% chance of 1.5°C from the start of 2025	333
Cumulative CO_2 under the new Czech CPP from the start of 2025	927
New Czech CPP as proportion of IPCC derived 50% of 1.5°C budget	278%
New Czech CPP as proportion of Lamboll et al derived 50%–1.5°C budget*	561%

Table 5. Comparison of Czech CO_2 emissions budgets for 50% chance of 1.5°C and CO_2 emissions from the new Czech CPP, all from the start of 2025. (*Lamboll et al derived budget not shown on Fig.1).

4. Compared with the results in your original analysis, what global carbon budget has been utilized and remains, based on actual data? Compare CO_2 from the new Czech Climate Protection Policy with the national CO_2 budget in your original 2021 report.

In our 2021 report, we calculated an emissions budget for Czechia based on an interpretation of the Paris Agreement's temperature *and equity* goals. We did this by taking the remaining portion of the IPCC's SR1.5 global budget for a 33% chance of not exceeding 1.5°C (at the start of 2021) and apportioning it first between two groups, in keeping with the Paris Agreement distinction between 'developed' and 'developing country parties'. This initial allocation between developed and developing countries was based on the peer-reviewed methodology in Anderson et al 2020, whereby the then most ambitious feasible peak emissions date (2025) and mitigation rates (ramping up to 10% per year) were assumed for developing countries. The remainder of the global carbon

[3] The new Climate Protection Policy (CPP) has not been adopted yet, but its latest version (as of 21.8.2024) includes the following emission reduction targets: for 2030 a reduction by 55% CO2e compared with 1990; for 2040 no specific target is set, while a reduction of 86% of CO2e compared with 1990 is indicated. For 2050, there is an aim to "steer towards climate neutrality".

budget was then assigned to the group of developed countries and grandfathered between them.

While the implied CO_2 pathway in the new (2024) Czech Climate Protection policy results in a smaller quantity of cumulative emissions than the CO_2 pathway implied by the previous CPP, emissions under the new CPP pathway still substantially exceed the Czech emissions budget that we outlined in our 2021 report (derived from IPCC SR1.5 global budget with a 33% chance of not exceeding 1.5°C, along with a 50% chance of not exceeding 1.7°C and 67% probability for 2°C).

To put it another way, 2021–2023 emissions have significantly exceeded the 2021 report's reduction pathway.

	$MtCO_2$
Original Czech CO_2 budget for 33% chance of 1.5°C from the start of 2021	800
Czech CO_2 emissions since start of 2021 (Table 3)	391
Remaining portion of the post-2021 budget	409
Cumulative CO_2 under new Czech CPP from the start of 2025 (Table 4)	927
Cumulative CO_2 on new Czech CPP, inc. emissions from start of 2021	1,318
New Czech CPP + emissions since 2021 as proportion of original post-2021 budget	165%

Table 6. Comparison of CO_2 emissions under the new Czech Climate Protection Policy with the Czech CO_2 budget presented in our original 2021 report.

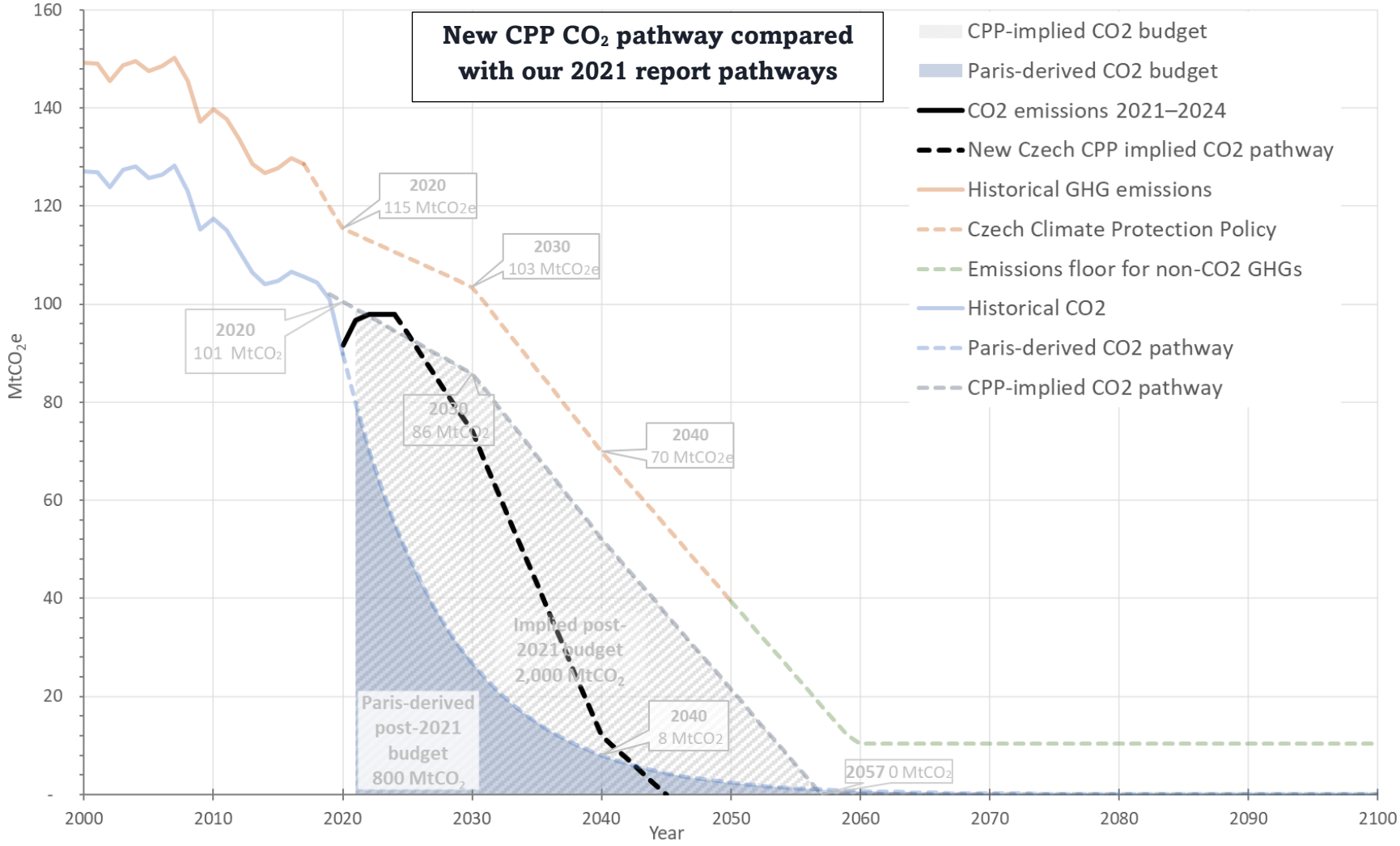

Figure 2. The implied CO_2 emissions pathway from the new Czech Climate Protection Policy overlaid on the emissions pathways and budgets for Czechia as presented in our 2021 report (Figure 1 in Anderson & Calverley, 2021). As in this update, both GHGs and CO_2 values exclude land use, land use change and forestry and international bunkers.

5. Update estimates to Section 6b of the 2021 report – how much global warming would result if all countries behaved like the Czech Republic?

Cumulative CO_2 emissions generated by the pathway implied in the new Czech CPP are approximately three times greater than the remaining national budget for 50% chance of 1.5°C (Table 6). If all countries exceeded their budget by the same factor, it would result in emissions three times greater than the remaining global carbon budget for 50% chance of 1.5°C. This would yield global emissions from the start of 2020 of around 1021 $GtCO_2$, which carries a slightly better than 67% probability of not exceeding 2°C (Table 5.8, chapter 5 of WG1 report in IPCC AR6).

It is fair to say that if all countries were to follow a pathway similar to the new Czech Climate Protection Policy, it will place any non-negligible chance of staying below 1.5°C off the table. Furthermore it would seriously jeopardise the Paris Agreement goal of holding average global temperature rise to well below 2°C. This is even clearer when taking into account the refinements to remaining carbon budgets since AR6 by Lamboll et al.

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