

Carbon Budget Briefing Note 2 (CBBN2)

Paris Compliant CO₂-Budgets for Sweden and its Regions

Isak Stoddard¹ & Kevin Anderson^{1,2,3}

¹Natural Resources & Sustainable Development, Department of Earth Sciences, Uppsala University, Uppsala, Sweden.

²Centre for Environment and Development Studies (CEMUS), Uppsala University, Uppsala, Sweden.

³Tyndall Centre for Climate Change Research, School of Engineering, University of Manchester, Manchester, UK.

Email: isak.stoddard@geo.uu.se; kevin.anderson@manchester.ac.uk

1. Introduction and key message

This briefing note summarizes key findings from a recently published report on Paris-compliant carbon budgets for Sweden's counties. For details on the assumptions and methods underpinning the findings, see the full report [1].

The publication of the IPCC's Sixth Assessment Report (AR6) in August 2021 [2], presented a new and updated suite of global carbon budgets. With these as a basis, a set of Paris-compliant carbon budgets for Sweden have been developed, subsequently downscaled to estimate the remaining emission space for Sweden's 21 counties as of January 1, 2024. The key message of this analysis is that for Sweden to deliver on its Paris-commitments [3], it would now need to decrease its CO₂ emissions by a minimum of 13,5% per annum for a good chance of a "well below" 2°C future (taken here as a 83% chance of not exceeding 2°C). Following current plans and official projections instead result in greatly overshooting such a Paris-compliant budget for Sweden, possibly by as much as a factor three or more. The estimates of Sweden's territorial carbon budget within this briefing note (CBBN2) are for energy-related CO₂ emissions, including international bunkers (i.e. shipping and aviation).

2. Headline carbon budgets and mitigation rates for Sweden

(these values remain provisional and subject to refinement)

Starting January 2020 → updated values for January 2024	50% chance of not exceeding 1.5°C	83% chance of not exceeding 2°C
1. Carbon budget for Sweden in MtCO ₂	~ 260 → 80	~ 465 → 285
2. Years of current CO ₂ emissions in remaining budget	5.2 → 1.8	9.4 → 6.4
3. Exponential decline pathway: national % annual reduction rate	16.0 → 35.7	9.6 → 13.5
4. Linear / straight line reductions pathway: real zero year	~ 2030 → 2027	~ 2038 → 2036
5. % budget being used per month	1.4 → 4.7	0.8 → 1.3



Table 1: Sweden's Paris-compliant carbon budgets starting January 1st, 2020 and what remains at the start of 2024. These estimates are for energy-related territorial CO₂ emissions, including international bunkers (aviation & shipping) and excluding cement process emissions. Values based on IPCC's AR6 [2], Anderson *et al.* [4] and Swedish national emissions statistics [5,6]. See full report [1] for details. The budget for a 50% chance of $\leq 1.5^{\circ}\text{C}$ remains in line with what we have previously [estimated for Sweden](#). The value for an 83% chance of $\leq 2^{\circ}\text{C}$ is slightly higher than the earlier value provided for a 50% chance of $\leq 1.7^{\circ}\text{C}$. The main reason for this is that the IPCC's carbon budget for the former (2°C) is ~6% larger than for the latter (1.7°C). The estimated size of the remaining carbon budgets from January 2024 rests on the assumption that the estimated annual CO₂ emissions in 2022 (~45 MtCO₂) remained the same during 2023.

3. Regional carbon budgets for Sweden's 21 counties

Having downscaled the global carbon budget to Sweden, the question arises, should the budget be further downscaled to a local or regional level of governance? The decisions of whether or not to do so, if so how, and for what purposes, is more nuanced than downscaling from the global to the national scale. For indicative purposes, we here provide a set of provisional headline regional carbon budgets for Sweden's 21 counties. Using the largest of the Paris-compliant national carbon budgets in Table 1 (465MtCO₂ in January 2020) as a starting point, all territorial emissions were subsequently allocated to the regional level based on their respective values in 2019 (i.e. grandfathering principle) whilst international bunker fuel emissions were kept as a national overhead. Removing emissions between 2020-2021 and estimated emissions between 2022-2023, results in regional carbon budgets for Sweden's 21 counties requiring 11-17% annual reduction rates (exponential decline pathways) or reaching zero emissions 2033 to 2040 (linear reduction pathways). Under this scenario, international bunker fuel emissions are assumed to decline by close to 15% per annum, or reaching zero emissions by 2035. For further details on the post-2023 regional carbon budgets, see full report [1].

4. Comparison with current plans and projections

Whatever the choice made in terms of which emissions to downscale to the subnational level and how this is to be done, the fundamental challenge to stay within the national Paris-compliant carbon budget of 285MtCO₂ remains. To highlight the gap of ambition, this budget can be compared to estimates of the total cumulative CO₂ emissions that would result should current targets, plans and projections instead be followed. Three different estimates are presented here, based on the climate targets of the current climate policy framework [7], projections of CO₂ emissions up until 2050 (with existing measures) by the Swedish Environment Protection Agency [8] and targets and estimates on future global CO₂ emissions from international transport by the International Maritime Organisation (IMO) [9] and the International Civil Aviation Organisation (ICAO) [10]. The total cumulative CO₂ emissions across the century from three estimated pathways range from a highly optimistic 455MtCO₂, up to as much as 1055MtCO₂ when only existing measures are considered, i.e. a factor 1.6 - 3.7 larger than what we argue is in line with the commitments made in the Paris Agreement. See Figure 1.



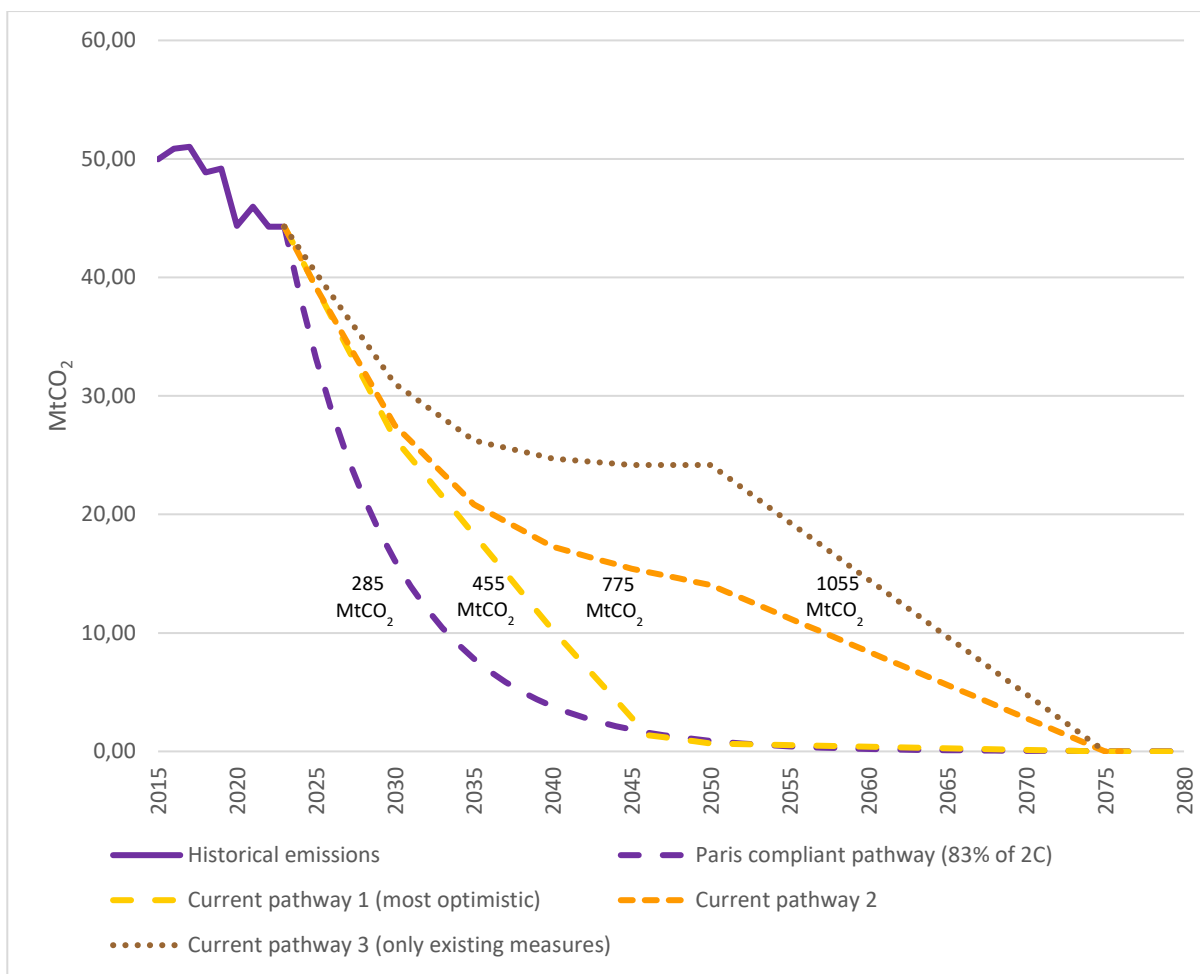


Figure 1: A Paris-compliant mitigation pathway for Sweden's emissions of fossil CO₂ compared to three different projected pathways following current plans and existing measures. Emissions in all pathways are territorial, excluding cement process emissions but including bunker fuels for international shipping and aviation. The associated cumulative emissions for each pathway indicated under each curve shows the large difference in their respective contribution to further climate forcing. Projected territorial CO₂ emissions calculated using targets in Sweden's climate policy framework (Current pathway 1) and estimates by the Swedish Environment Protection Agency [8] (Current pathway 2 and 3). Projected emissions from international transport based on most optimistic targets and estimates by the International Maritime Organisation [9] and the International Civil Aviation Organisation [10] (Current pathway 1 and 2) and estimates by the Swedish Environment Protection Agency [8] (Current pathway 3).

5. How confident are we in our findings?

These new carbon budgets for Sweden are estimated using the method detailed in Anderson *et al.* [4]. It is certainly possible to 'fine tune' some of the assumptions that underpin our analysis. However, starting from the assumption that whatever allocation principles are chosen, the associated national pathways need to collectively be able to deliver mitigation within the rapidly diminishing global IPCC carbon budgets for 1.5–2°C, and with attention paid to the UNFCCC framing of equity [11], the budgets outlined here are sufficiently robust to provide a strong guide to Sweden's mitigation policy. The 1.5 to 2°C carbon budgets are now so depleted that equity between nations cannot be delivered through differential mitigation alone. In this regard, and with practicality still guided by principles of equity, the best that can be achieved is the 'least unfair distribution' of the remaining global carbon budget.



A potential exception to this is whether it is considered appropriate or not to expand the IPCC's carbon budgets through future 'Carbon Dioxide Removal' (CDR), deployed at planetary scale and principally in the second half of the century. Specifically, in relation to emissions of carbon dioxide from the energy sector, the inclusion of highly-speculative-at-scale CDR is judged inappropriate, as it works against the tenets of precaution. Moreover, whilst CDR is now ubiquitous in mitigation analyses, the IPCC's estimates of additional feedbacks, potentially reducing carbon budgets, are seldom if ever included. For this analysis, a conservative approach is adopted, neither easing the mitigation burden through CDR nor increasing it through additional feedbacks.

We caution any reader of the report to recognise that the adopted Swedish national carbon budget and all subsequent budgets downscaled to regions, are premised on: 1) the least ambitious framing of the Paris Agreement; 2) a highly optimistic estimate of the remaining global carbon budget; and 3) a relatively weak interpretation of equity and the principle of CBDR-RC. Ultimately, and regardless of any spurious level of precision, the key message is clear. The scale of change now required by Sweden (and all other wealthy, industrialised nations) demands a fundamental departure from earlier commitments (net-zero by 2045), the current government's climate plans, and, more profoundly, many of the core economic-growth tenets of contemporary society. In so many respects, this deeply uncomfortable conclusion is a product of the long-term failure of global and national leadership to deliver on the UNFCCC's original obligations to which nations committed in 1992 [12].

6. Acknowledgements and further information

The research and analysis behind this briefing note were made possible through funding from the Swedish Energy Agency for the project *Regional carbon budgets and rapid transition to a fossil-free energy system* (project number 46532-1).

For more information on the development of national and regional carbon budgets for Sweden, see [the project website](#) where a full list of publications can be found, including the full report [1] on which this briefing note is based as well as the paper by Anderson *et al.* [2] which outline the method in more detail. If questions remain, contact the authors of this briefing note.

Over the past seven years, some fifty municipalities, counties and regions in Sweden have had regional carbon budgets developed, building on principles and method as outlined in this briefing note. For direct inquiries about establishing a regional carbon budget (for Kommun, Region or Län) contact the not-for-profit Klimatsekretariatet (www.klimatsekretariatet.se); they are experts in developing, digitalising, visualising and updating regional carbon budgets within Sweden.

7. References

- [1] Anderson K & Stoddard I (2023) Paris-compliant carbon budgets for Sweden's counties. Report for the project 'Regional carbon budgets and rapid transition to a fossil free energy system' funded by the Swedish Energy Agency. Uppsala university.
- [2] IPCC (2021) [AR6 Climate Change 2021: The Physical Science Basis](#).
- [3] United Nations Framework Convention on Climate Change (2015) Decision 1/CP.21, Paris Agreement, document FCCC/CP/2015/10/ Add.1. Paris: United Nations.
- [4] Anderson K, Broderick JF & Stoddard I (2020) [A factor of two: how the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways](#), *Climate Policy*, 20:10, 1290- 1304, doi:



10.1080/14693062.2020.1728209. NB: for this briefing note, we adopt the DD2, rather the DD1 budgets from the paper.

[5] Statistics Sweden (2023) [Totala utsläpp av växthusgaser efter växthusgas och sektor. År 1990-2021.](#)

[Database].

[6] Naturvårdsverket (2023) [Sveriges utsläpp och upptag av växthusgaser.](#) [Database].

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[9] IMO (2023) [2023 IMO strategy on reduction of GHG emissions from ships.](#) Annex 1. Resolution MEPC.377(80) in MEPC 80/WP.12.

[10] ICCT (2023) [ICAO's 2050 net-zero CO₂ goal for international aviation.](#) ICCT Policy update.

[11] United Nations (1992) United Nations Framework Convention on Climate Change. doi: [10.35935/edr/31.2513.](#)

[12] Stoddard I, Anderson K, Capstick S, Carton W, Depledge J, Facer K, Gough C, Hache F, Hoolohan C, Hultman M, Hällström N, Kartha S, Klinsky S, Kuchler M, Lövbrand E, Nasiritousi N, Newell P, Peters G, Sokona Y, Stirling A, Stilwell M, Spash C & Williams M (2021) [Three decades of climate mitigation: why haven't we bent the emission curves?](#) *Annual Review of Environment and Resources*, 46:1, 653-689. Doi: 10.1146/annurev-environ-012220-011104.

