Climate Resource

Updated assessment of Australia's emission reduction targets and 1.5°C pathways

Briefing

About the authors

A/Prof. Malte Meinshausen is a Lead Author of the Working Group 1 (the physical science) of the IPCC's Sixth Assessment Report (AR6), an author of the IPCC AR6 Assessment Report Synthesis Report (due to be released in September 2022) and has long-standing international expertise on carbon budgets, the Paris Agreement and national and subnational emission targets.

Dr. Zebedee Nicholls was a Contributing Author to 5 chapters in Working Group 1 of AR6 and was closely involved in the preparation of the carbon budget numbers. Dr. Zebedee Nicholls also provided temperature assessments of thousands of emission scenarios to Working Group III (mitigation of climate change) of the IPCC, providing a link to the latest science on emissions reductions pathways and their warming implications.

Image: M. Meinshausen

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Disclaimer

Summary

- **Despite being strengthened in the last 12 months, Australia's current 2030 target is still inconsistent with limiting warming to 1.5°C:** The strengthening from a 26-28% to a 43% reduction compared to 2005 levels is a step in the right direction. It reduces Australia's projected cumulative emissions by around 2.0 $GtCO_2$-eq. Further strengthening is needed to be on a pathway consistent with limiting warming to 1.5°C.

- **A 1.5°C consistent pathway for Australia requires at least a 67% reduction relative to 2005 levels by 2030 and net zero by 2038:** Such a pathway is consistent with limiting warming to 1.5°C with a 50% chance. Assuming Australia's share of the global emissions budget is a generous 0.97%, a net zero date before 2038 would be in line with a greater than 50% chance of staying below 1.5°C.

- **An equal allocation of emissions to each person on Earth would imply that Australia has already spent its full emissions budget:** The results above are calculated based on Australia's fair share of global emissions being 0.97%. However, Australia's share of the global population is only around 0.33%. If this share is given to Australia, as of the start of 2021 Australia would have exhausted its emissions budget. Some other jurisdictions have adopted equal per capita shares in recent years to determine a country's fair share of the global emissions budget[1].

[1] For example Germany, following a German Federal Constitutional Court ruling in 2021 that the Federal Climate Change Act was partially unconstitutional because the annual emissions allowed until 2030 gave insufficient regard to what is required in subsequent decades to limit warming to well below 2°C or 1.5°C. See https://www.umweltrat.de/SharedDocs/Downloads/EN/01_Environmental_Reports/2020_08_environmental_report_chapter_02.html

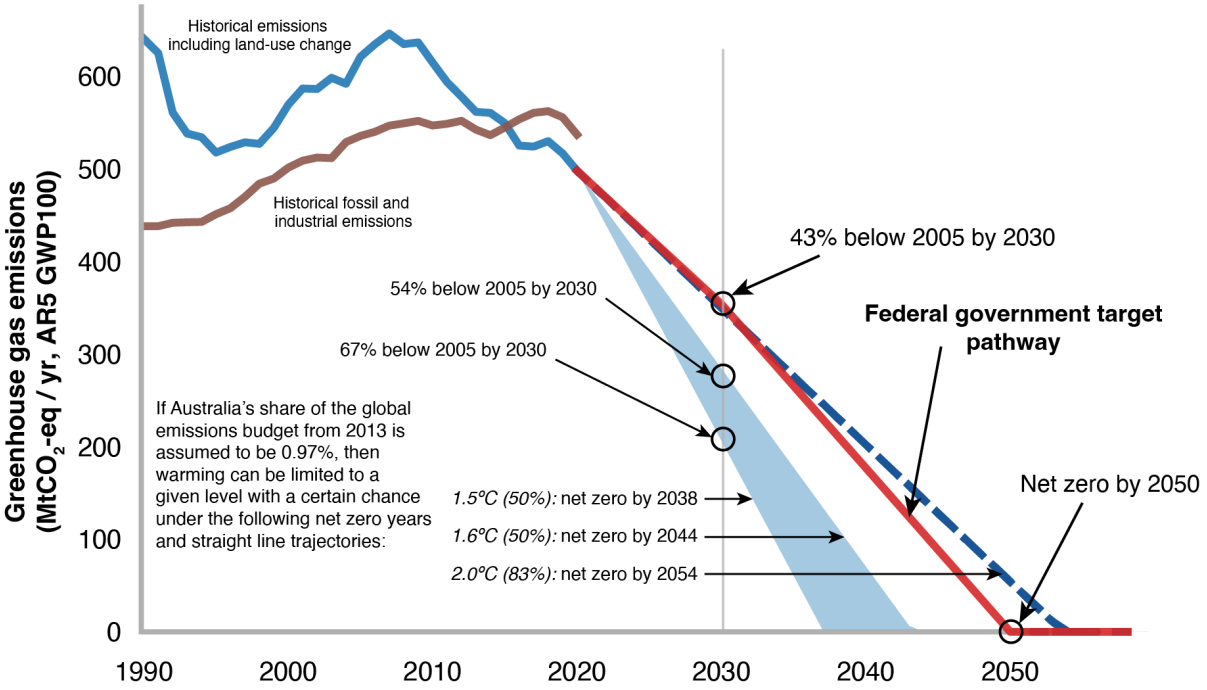

Figure 1 Historical emissions and pathways in line with different emissions budgets.

Table 1 Cumulative emissions (i.e. emissions budgets) and emissions reduction milestones for different pathways. Note that the below pathways are calculated assuming that Australia's fair share of the remaining emissions budget from 2013 is 0.97%, consistent with CCA (2014), with the exception of the row "Federal Government", which is based on the current Australian government targets. Under an equal allocation of emissions per person on Earth from 2013 onwards, Australia has exhausted its budget as at the start of 2021.

Pathway	Cumulative emissions	Net zero year	2030	2035	2040	2050
	$GtCO_2$-eq		*Percentage reduction relative to 2005*			
Federal Government	7.6	2050	43	57*	71*	100
1.5°C @ 50%	4.0	2038	67	90	100	100
1.6°C @ 50%	5.6	2044	54	71	89	100
2.0°C @ 83%	8.1	2054	44	56	67	91

* These values are not official government milestones, but are instead interpolated based on the assumption of a straight line path between the federal government's milestones[2]

[2] https://unfccc.int/sites/default/files/NDC/2022-06/Australias%20NDC%20June%202022%20Update%20%283%29.pdf

Our rapidly closing window

As the recent IPCC Sixth Assessment report confirmed, achieving the Paris Agreement goal of limiting warming to 1.5°C requires "rapid and deep and, in most cases, immediate greenhouse gas emissions reductions in all sectors this decade".[3] Cumulative emissions between now and the time we reach global net-zero emissions are the key determinant of how high global-mean temperature rises before, depending on our actions and the response of the climate system thereafter, it might start to gradually decrease. Strong reductions are required this decade. Cost-efficient pathways indicate that a 43% reduction in global greenhouse gas emissions by 2030 (relative to 2019) is in line with limiting warming to 1.5°C with no or limited overshoot. For 2035, global reductions in line with a 1.5°C limit are 60%.[4] Developed countries, with higher capacity and higher historical emissions, and Australia in particular, with the highest per-capita emissions in the developed world, need to make much stronger reductions by 2030 than the global 43% benchmark. Australia's current target of 43% below 2005 levels is only a 31% reduction below 2019 levels.

Overview

- **This briefing note provides an update to Climate Resource's assessment of Australia's greenhouse gas emissions budget:** Since the previous note, the federal government has announced a new target of 43% by 2030 below 2005. This note also updates the science in line with the release of the latest IPCC reports.
- **Despite being strengthened in the last 12 months, Australia's current 2030 target is still inconsistent with limiting warming to 1.5°C:** The strengthening from a 26-28% to a 43% reduction compared to 2005 levels is a step in the right direction. It reduces Australia's projected cumulative emissions by around 2.0 $GtCO_2$-eq. Further strengthening is needed to be on a pathway consistent with limiting warming to 1.5°C.
- **A 1.5°C consistent pathway for Australia is at least a 67% reduction relative to 2005 levels by 2030 and net zero by 2038:** Such a pathway is consistent with limiting warming to 1.5°C with a 50% chance. Assuming Australia's share of the global emissions budget is a generous 0.97%, a net zero date before 2038 would be in line with a greater than 50% chance of staying below 1.5°C.
- **The federal government's emissions reduction targets exceed Australia's emissions budget:** The federal government's plan leads to cumulative emissions of 7.6 $GtCO_2$-eq between January 2021 and net zero in 2050, roughly double Australia's emissions budget of 4.0 $GtCO_2$-eq for a 50% chance of staying below 1.5°C.
- **An equal allocation of emissions to each person on Earth would imply that Australia has already spent its full emissions budget:** The results above are calculated based on Australia's fair share of global emissions being 0.97%. However, Australia's share of the global population is only around 0.33%. If this share is given to Australia, as of the start of 2021 Australia would have exhausted its emissions budget. Some other jurisdictions have adopted

[3] https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf, page 21
[4] https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf, page 22

equal per capita shares in recent years to determine a country's fair share of the global emissions budget[5].

- **The 2030 target must be strengthened for Australia to meet its obligations under the Paris Agreement, given the science.** Under the current targets, 4.2 $GtCO_2$-eq will be emitted between the start of 2021 and the end of 2030. This means that, before the end of 2030 under the current targets, Australia will exceed its budget of 4.0 $GtCO_2$-eq for a 50% chance of staying below 1.5°C.
- **Calls to increase Australia's contribution to global mitigation efforts may grow if Australia exceeds its fair share of the global emissions budget in the coming years.** These contributions could come in many ways, such as climate finance to support other countries to reduce emissions or zero emissions exports.
- **Updated science since the previous report for WWF-Australia.** Updates to methodology to better reflect the difference in temperature between pre-industrial and 1850-1900 and to better account for emissions from international shipping and aviation slightly increase the available budget. The release of the IPCC WG3 report also allows us to update the relationship between CO_2 and GHG emissions, also slightly increasing the available budget. The results of this report remain consistent with those presented in the 2022 report commissioned by WWF-Australia[6], although the budgets are slightly larger (around 5%) and net zero dates are slightly later (2-3 years).

[5] For example Germany, following German Federal Constitutional Court ruling in 2021 that the Federal Climate Change Act was partially unconstitutional because the annual emissions allowed until 2030 gave insufficient regard to what is required in subsequent decades to limit warming to well below 2°C or 1.5°C. See https://www.umweltrat.de/SharedDocs/Downloads/EN/01_Environmental_Reports/2020_08_environmental_report_chapter_02.html

[6] https://www.climate-resource.com/reports/wwf/WWF_March2022_a.pdf

Further details

Australia's total emissions have dropped since 2005, but largely because reported net land-use emissions have dropped (and have become negative in the last few reported years, see Figure 1). Electricity emissions have fallen markedly but, even with the COVID pandemic, total fossil and industrial emissions in 2020 were at roughly the same level as in 2005. Total fossil and industrial emissions have only fallen for two short periods: when a carbon price applied during the 2013 and 2014 financial years and then again in 2019 and 2020 (the last two reported years, see Figure 1). However, the most recent 2020 reduction should be treated with some caution due to the effects of the COVID-19 pandemic. For an interactive examination of Australia's sectoral emissions, see https://opennem.org.au/emissions/au/.

The results given here regarding Australia's remaining emissions budget consistent with a 1.5°C pathway are subject to a number of assumptions and caveats. We follow the methodology of the previous report[7], with the addition of a step to account for emissions from international aviation and shipping. We briefly describe the assumptions and caveats here, for full details refer to Chapter 2 in *The Superpower Transformation*[8]:

- There is uncertainty in the remaining global carbon budget.
- While the concept of a carbon budget strictly applies to CO_2 only, here we use a correlation between CO_2 and greenhouse gas emissions found in cost-optimal scenarios to convert IPCC carbon budgets into all greenhouse gas emissions budgets. As discussed in Meinshausen et al.[9], the correlation is appropriate for assessing peak warming, transparent, simple to apply and is built on the wide range of emission reduction options explored in the cost-optimal scenarios considered by the IPCC. The correlation comes with an uncertainty of +/- 100 $GtCO_2$-eq (compared to a total, global greenhouse gas budget of approximately 900 $GtCO_2$-eq for a 50% chance of 1.5°C). This uncertainty does not affect the broad conclusions of the analysis presented above.
- We also account for a difference in land-use emissions accounting methodologies between country-reported emissions and international modelling exercises based on Grassi et al.[10], ensuring that the targets presented are compatible with emissions as reported by the governments, including the Australian government, in their submissions to the UNFCCC.
- We remove an estimate of emissions from international aviation and shipping, because this source is not considered when deriving countries' fair shares (hence must be removed before allocating shares to countries).
- We further assume that Australia's 0.97% share of the global carbon budget for 2013 to 2050 equally applies to carbon budgets from 2013 to net zero, as most cost-optimal 1.5°C scenarios reach net zero around 2050. Under other views of equity, such as equal shares per

[7] https://www.climate-resource.com/reports/wwf/WWF_March2022_a.pdf
[8] Garnaut, Ross, ed. *The Superpower Transformation: Making Australia's Zero-carbon Future*. La Trobe University Press, 2022.
[9] https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0016/421702/Greenhouse-Gas-Emissions-Budgets-for-Victoria.pdf
[10] https://doi.org/10.1038/s41558-021-01033-6

person, Australia's share would be much smaller (0.33% for a per capita share)[11]. Given that the remainder emission budget for Australia is very tight or already exhausted, questions of how Australia can contribute beyond domestic emissions reductions become more pertinent. That includes Australia's opportunities to contribute to decarbonisation in other countries as a supplier of renewable energy exports, to use its land and geological resources for carbon dioxide removal and to acknowledge and act upon its capacity to provide climate finance. For a further discussion of these issues and potential options, see Chapter 2 of *The Superpower Transformation*[12].

- For global historical emissions we use Nicholls et al.[13](based on Gidden et al.[14]), assuming that emissions from 2015 - 2020 follow the SSP2-4.5 scenario. For Australian emissions we use emissions as reported to the UNFCCC by the Australian Government[15].

Even with an optimistic reading of the uncertainty range in the remaining carbon budget, and different reasonable assumptions on these points, the federal government target is short of what is required for Australia to be regarded as pursuing efforts to limit warming to 1.5°C. As stated in the main body of the report, assuming a fair share based on an equal per capita approach would significantly reduce Australia's emissions budget, to the point that it has already been exhausted as at the start of 2021. Approaches based on historical responsibility or capability would allocate yet smaller shares to Australia, further increasing the wide gap between Australia's targets and its emissions budget.

[11] The budget sharing question has often been viewed as 'sharing a pie'. One other way to think of it is as 'sharing a bin with your neighbours'. The fair share is how much of the bin you should be allowed to use. If one household takes more than their fair share on the first day of the week, then there is less space for everyone else over the rest of the week. If everyone else also still takes their fair share, then the bin will overflow. To avoid the bin overflowing, everyone else must compensate for the first party's overuse by using less than their fair share (e.g. by producing less rubbish or keeping the rubbish in their house).

[12] Garnaut, Ross, ed. *The Superpower Transformation: Making Australia's Zero-carbon Future*. La Trobe University Press, 2022. Page 142-143 are most relevant for this point.

[13] https://doi.org/10.5194/gmd-13-5175-2020

[14] https://doi.org/10.5194/gmd-12-1443-2019

[15] https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-accounts-2020/state-and-territory-greenhouse-gas-inventories-data-tables-and-methodology, last accessed 19 April 2023

Appendix A: calculations

This appendix outlines the steps involved in the calculation of the budgets above to calculate Australia emissions budget from 2021 onwards (the last year for which Australia had reported data to the UNFCCC at the time of writing). For full details of the rationale behind each step, see Chapter 2 in *The Superpower Transformation*[16].

Note that, throughout the tables below, results are rounded as appropriate. As a result, small differences in sums and products may occur. Greater precision than shown is carried in the actual calculations so where there is a conflict, the final numbers (right-hand columns) take precedence.

1. Global remaining carbon budget

Temperature level and likelihood of staying below	**Global remaining carbon budget from 2020 ($GtCO_2$)**	**Enlarging budget to account for global emissions between 2013 and 2020 ($GtCO_2$)**	**Reducing the carbon budget to make it relative to true pre-industrial (1750) , rather than early pre-industrial (1850-1900, $GtCO_2$)**	**Global remaining carbon budget from 2013 relative to pre-industrial ($GtCO_2$)**
<1.5°C @ 50%	500	277	-150	627
<1.6°C @ 50%	650	277	-150	777
<2.0°C @ 83%	900	277	-150	1027

2. Global emissions budget

Temperature level and likelihood of staying below	**Global remaining carbon budget from 2013 relative to pre-industrial ($GtCO_2$)**	**Additional non-CO_2 greenhouse gas emissions until peak warming ($GtCO_2$-eq)**	**Global remaining emissions budget from 2013 relative to pre-industrial ($GtCO_2$-eq)**
<1.5°C @ 50%	627	370	997
<1.6°C @ 50%	777	402	1179
<2.0°C @ 83%	1027	456	1483

[16] Garnaut, Ross, ed. *The Superpower Transformation: Making Australia's Zero-carbon Future*. La Trobe University Press, 2022.

3. Adjust to reconcile LULUCF accounting differences

Temperature level and likelihood of staying below	Global remaining emissions budget from 2013 relative to pre-industrial ($GtCO_2$-eq)	Adjustment to CO_2 part of emissions budget to account for different CO_2 sink accounting in IPCC methodology for national inventories and IPCC methodology for remaining carbon budget (see Grassi et al.) ($GtCO_2$)	Global remaining emissions budget from 2013 relative to pre-industrial after LULUCF adjustment ($GtCO_2$-eq)
<1.5°C @ 50%	997	-94	903
<1.6°C @ 50%	1179	-117	1063
<2.0°C @ 83%	1483	-154	1329

4. Account for international shipping and aviation emissions

Temperature level and likelihood of staying below	Global remaining emissions budget from 2013 relative to pre-industrial after LULUCF adjustment ($GtCO_2$-eq)	Removal of emissions from International shipping and aviation ($GtCO_2$)	Global remaining emissions budget from 2013 relative to pre-industrial after LULUCF adjustment and international shipping and aviation are removed ($GtCO_2$-eq)
<1.5°C @ 50%	903	-50	853
<1.6°C @ 50%	1063	-50	1013
<2.0°C @ 83%	1329	-50	1279

5. Downscaling the global budget

Temperature level and likelihood of staying below	Global remaining emissions budget from 2013 relative to pre-industrial after LULUCF adjustment and international shipping and aviation are removed ($GtCO_2$-eq)	Australia's share of remaining emissions budget (%)	Australia's remaining emissions budget from 2013 ($GtCO_2$-eq)
<1.5°C @ 50%	853	0.97	8.27

<1.6°C @ 50%	1013	0.97	9.82
<2.0°C @ 83%	1279	0.97	12.40

6. Australia's budget from 2021

Temperature level and likelihood of staying below	**Australia's remaining emissions budget from 2013 ($GtCO_2$-eq)**	**Australia's emissions from 2013 to 2020 ($GtCO_2$-eq)**	**Australia's remaining emissions budget from Jan 2021 ($GtCO_2$-eq)**
<1.5°C @ 50%	8.27	-4.26	4.01
<1.6°C @ 50%	9.82	-4.26	5.56
<2.0°C @ 83%	12.40	-4.26	8.12

Appendix B: changes from 2022 WWF-Australia report

There are three noteworthy changes from the methods used in the Climate Resource 2022 report commissioned by WWF-Australia[17]. The first is the use of scenarios from the IPCC's latest assessment report, AR6, for deriving the relationship between CO_2 and GHG emissions. In the previous report, the latest available set was the SR1.5 report. Changing to the newer dataset slightly changes the relationship and increases the global budgets by around 40 $GtCO_2$-eq (although the number varies slightly with the specific warming limit of interest).

The second is an update to how we account for the difference between pre-industrial temperatures and temperatures relative to 1850-1900 (which is what is used by the IPCC). In the 2022 report , we used an adjustment of 222 $GtCO_2$. This number is derived by assuming that all of the adjustment should apply to CO_2. However, non-CO_2 is also part of this adjustment, so 222 $GtCO_2$ is an overestimate. The results presented in IPCC AR6 WG1 provide an adjustment that includes the effect of non-CO_2. For each 0.1°C change in warming limit, the budgets in AR6 WG1 change by about 150 $GtCO_2$. The AR6 WG1 budgets consider non-CO_2 effects too, hence 150 $GtCO_2$ is the more appropriate number to use and what we adopt here. The result of this change is an increase in the global budget of 72 $GtCO_2$.

The third change is the consideration of emissions from international shipping and aviation. In previous work, we omitted this step. However, emissions from international shipping and aviation contribute to climate change and must be considered. Here we include the effect of emissions from international shipping and aviation based on emissions projected in the mitigation scenarios considered by IPCC AR6 WG1 (namely SSP1-1.9 and SSP1-2.6). In these scenarios, emissions from international shipping and aviation until net zero are around 50 $GtCO_2$. The result of this change is a decrease in the global budget of 50 $GtCO_2$.

[17] https://www.climate-resource.com/reports/wwf/WWF_March2022_a.pdf