

**AUSTRALIA'S PARIS AGREEMENT PATHWAYS:
UPDATING THE CLIMATE CHANGE AUTHORITY'S
2014 EMISSIONS REDUCTION TARGETS**



A REPORT OF THE CLIMATE TARGETS PANEL, JANUARY 2021

CLIMATE TARGETS PANEL: ABOUT THIS REPORT AND ITS AUTHORS

The Secretary General of the United Nations has made it clear that the world's current greenhouse reduction pledges are not enough to limit global warming to well below 2°C, the goal of the Paris Agreement, and has beseeched the parties to the Paris Agreement to more rapidly cut pollution. United States President Joe Biden has signalled that he will hold a global summit in the first 100 days of his presidency, at which he will ask countries to do more. Later in 2021, countries of the world will meet at the next global climate summit, the Conference of the Parties, where they will be asked to lift their emissions-reduction ambitions.

To do its fair share and to be compliant with the goals of the Paris Agreement, Australia must increase its emissions reduction targets. Australia's own Climate Change Authority (CCA) produced a key review in 2014, which set out the targets Australia needed to follow to help limit global warming to less than 2°C. Since then, the CCA has not updated this research. The authors of the current paper, the Climate Targets Panel, have prepared this report to ensure that debate about the targets Australia takes to these upcoming summits to meet the Paris Agreement 2°C goal are informed by sound science and policy.

The Climate Targets Panel is an independent group of Australia's most senior climate scientists and policymakers who have come together for the purpose of ensuring that debate about Australia's emissions reductions targets are informed by sound science and policy. Concerned that the federal CCA has not published any comprehensive analysis of Australia's climate targets since 2014, but given that Australia's climate targets will be a focus in 2021, this ad hoc group has come together to update the CCA's 2014 analysis to help inform the Australian debate.



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Professor Lesley Hughes

Lesley Hughes is a Distinguished Professor of Biology and Pro Vice-Chancellor (Research Integrity & Development) at Macquarie University. She is an ecologist whose main research interest has been the impacts of climate change on species and ecosystems, and the implications of climate change for conservation. She is a former Lead Author in the Intergovernmental Panel on Climate Change's 4th and 5th Assessment Report, a former federal Climate Commissioner and currently a member of the Wentworth Group of Concerned Scientists and a Councillor with the Climate Council of Australia.



Associate Professor Malte Meinshausen

Malte Meinshausen is founding Director of the Climate & Energy College at the University of Melbourne and Co-Director of the Energy Transition Hub. Before coming to The University of Melbourne, he was a senior researcher at the Potsdam Institute for Climate Impact Research (PIK) from 2006 to 2011 and continues close collaborations with the Potsdam Institute. He has been contributing author to the Fourth and Fifth Assessment Report of the Intergovernmental Panel on Climate Change, the Special Report on 1.5°C and is a lead author for the forthcoming Sixth IPCC Assessment Report.

CONTENTS

1.0 INTRODUCTION AND KEY FINDINGS	5
2.0 AUSTRALIA'S EMISSIONS BUDGET AND THE CCA	7
3.0 BUDGETS AND TARGETS FOR 2°C	8
4.0 BUDGETS AND TARGETS FOR 1.5°C	9
5.0 BUDGETS AND TARGETS FOR 'NET-ZERO BY 2050'	10
APPENDIX: HIGHER 2030 TARGETS WITH A 2050 NET-ZERO GOAL	12

1.0 INTRODUCTION AND KEY FINDINGS

As the Secretary General of the United Nations has repeatedly warned, we are in a climate emergency. The window for action is closing, with recent research suggesting climate tipping points may be breached very soon. Australia's Bureau of Meteorology recently gave evidence to the Australian Parliament that the country is on track for 4.4°C of warming this century. This would be catastrophic for our society, health, economy and environment.

Australia must do its fair share to tackle the climate crisis. That means rapidly reducing greenhouse gas emissions. Sound independent scientific and policy advice is essential for determining how much Australia should reduce its emissions and by when.

As part of the 'Clean Energy Future' package legislated in the 2010 Parliament, the Climate Change Authority was established pursuant to the Climate Change Authority Act 2011. The CCA is composed of the Chief Scientist plus further members appointed by the relevant Minister, each of whom have experience in areas such as climate science, industry, economics and social policy. The CCA was empowered to conduct research about matters relating to climate change and to conduct certain climate-related reviews, including reviewing the greenhouse gas emission reduction targets that Australia should adopt to tackle global warming.

In February 2014, as required by the Clean Energy Act 2011, the CCA released the seminal 'Reducing Australia's Greenhouse Gas Emissions— Targets and Progress Review Final Report', an analysis of both Australia's emissions budget and the emissions reductions targets necessary to stay within that budget.¹

Since 2014, greenhouse gas emissions have continued to rise, both in Australia and worldwide. Significant research published since 2014 has also updated the global 'emissions budget' and set out trajectories for the world to limit global warming to 1.5°C.² The Paris Agreement was also signed and ratified after the CCA published its 2014 review, an agreement which has implications for the global carbon budget.

However, despite these significant developments, and although it still has wide-ranging powers under its enabling legislation, since 2014 the CCA has not conducted any further research about targets or progress, nor has any Minister requested it to conduct such research.

As a party to the Paris Agreement, Australia and all other parties have been requested to submit more ambitious 2030 targets to the next Conference of the Parties in 2021.

In the absence of further work by the CCA, this report adopts the CCA's methodology from 2014 and updates it to take account of both the current global emissions budget and Australia's domestic emissions since the CCA report.

This analysis has derived both short and long-term targets for Australia consistent with the temperature goals contained within Article 2 of the Paris Agreement. They are:

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, recognizing that this would significantly reduce the risks and impacts of climate change.³

¹ Climate Change Authority (2014) *Reducing Australia's Greenhouse Gas Emissions— Targets and Progress Review Final Report* <<https://www.climatechangeauthority.gov.au/reviews/targets-and-progress-review-3>> Under another piece of legislation in the Clean Energy Future package, the Clean Energy Act 2011, the CCA was required to review and report on the level of Australia's carbon pollution caps and any indicative national emissions trajectory and national carbon budget. The CCA was also required to review and report on progress in achieving Australia's medium-term and long-term targets for the reduction of net greenhouse gas emissions and progress in achieving any national carbon budget.

² IPCC (2018) *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.*

³ United Nations Framework Convention on Climate Change (2015) *Adoption of the Paris Agreement* <https://unfccc.int/sites/default/files/english_paris_agreement.pdf>

Given recent commitments from trading partners to 'net-zero by 2050' targets (or in China's case, 'net-zero by 2060'), the analysis also considers what 'net-zero by 2050' would mean for Australia's emissions budget and what interim targets would be necessary if net-zero were to be achieved in 2050 (and not earlier).

In this year 2021 when Australia and the world's climate targets will be under scrutiny, the conclusions from this current analysis also underscore a crucial point. Although 'net-zero by 2050' has entered the mainstream discussion in Australia, with some urging the government to adopt this target over and above its '26-28% by 2030' target, this current analysis concludes that this is not consistent with Australia's 2°C emissions budget. In other words, this analysis concludes that Australia would not be acting consistently with the Paris Agreement goal of limiting global to well below 2°C if it simply adopts a 'net-zero by 2050' goal, a point sometimes lost in current debate.

In effect, a key finding of the Climate Target Panel's current analysis is that so much of Australia's emissions budget has been spent and current emissions levels are so high that drawing a 'straight line' out to 2050 with linear emissions reductions trajectories is no longer enough for Australia. It is beyond the scope of the Panel's work to considering the adequacy of other countries' 2050 or 2060 'net-zero' targets, as this would require an analysis of each of those countries' 'fair share' and their respective remaining emissions budgets. The point is that although 'net-zero by 2050' may be gaining traction internationally, in Australia it would blow our remaining emissions budget.

This is consistent with our general finding that significant reductions are required over the next decade if we are to act consistently with meeting our Paris Agreement goals. The discussion about 2050 can serve to distract from the clear need for urgent action over the next decade. In this respect, 2030 targets are crucial. Without stronger action in the short term, it becomes impossible for Australia to act consistently with the Paris Agreement goals. Indeed, our analysis has found that a 'straight line' trajectory from 2020 to net-zero in 2050 would consume the entire 2°C budget by 2038 and would consume the entire 1.5°C budget by 2029.

Relatedly, in the current discussion about targets, it is worth recalling that the Climate Change Authority recommended 2030 targets of at least 45% reduction on 2005 levels if Australia were to do its fair share of limiting global warming to well below 2°C. The current government's target of 26-28% does not have its basis in any CCA or other science-based recommendation. It is a target that is not consistent with limiting global warming to well below 2°C.

FINDINGS OF THE REPORT

The Climate Targets Panel has concluded:

1. To be consistent with the Paris Agreement goal of limiting global warming to well below 2°C, Australia's 2030 emissions reduction target must be 50% below 2005 levels. A 2035 target would need to be 67% below 2005 levels. Net-zero emissions would need to be reached by 2045.
2. To be consistent with the Paris Agreement goal of limiting global warming to 1.5°C, Australia's 2030 emissions reduction target must be 74% below 2005 levels, with net-zero emissions reached by 2035.
3. A simple 'net-zero emissions by 2050' target for Australia is not sufficient for the Paris Agreement goal of limiting global warming to well below 2°C (nor 1.5°C).

2.0 AUSTRALIA'S EMISSIONS BUDGET AND THE CCA

In 2014, the Climate Change Authority concluded it was appropriate to first consider the global emissions budget available if the world was to limit global warming to 2°C and to then derive Australia's appropriate share of that budget. It concluded first:

C.3 A global emissions budget that provides at least a likely (67 per cent probability) chance of limiting warming to less than 2 degrees above pre-industrial levels is used as a reference for the Review. This equates to a global budget of no more than 1,700 Gt CO₂e emissions of Kyoto gases from 2000 to 2050.⁴

To determine Australia's 'fair share', the Authority resolved to adopt a 'modified contraction and convergence' model and then derive a domestic emissions budget:

Appendix C2 [...]

C2.2 Australia's 2013–2050 national emissions budget

Australia's long-term national emissions budget of 10,100 Mt CO₂e is calculated as follows:

1. The 2000–2050 global emissions budget based on Meinshausen et al. (2009; see Chapter 3) is adjusted to remove global emissions from 2000–2012. Global emissions from 2000–2012 are estimated to be 608 Gt CO₂e, based on International Energy Agency (IEA 2013a), using linear interpolation between 2000, 2005 and 2010 data points and the annualised growth rate for 2005–2010 to estimate 2011 and 2012 global emissions.
2. Australia's share of the resulting 2013–2050 global emissions budget is calculated based on its share (0.97 per cent) of global emissions under a modified contraction and convergence approach. This is an Authority calculation based on the spreadsheet tool used for the Garnaut Climate Change Review 2008 with updates for emissions, population and GDP from the Treasury and DIICCS RTE modelling report. All emissions in the long-term national emissions budget calculation use GWPs from the IPCC's Second Assessment Report for consistency with the original Meinshausen et al. (2009) global emissions budget. This will tend to underestimate the global and national budget by a small amount; budgets calculated using AR4 GWPs are likely to be slightly larger in CO₂e terms.⁵

From this domestic emissions budget, domestic targets were derived, including 2030 targets:

To 2030, the Authority recommends a trajectory range of 40 to 60 per cent below 2000 levels [which translates to approximately 45 to 65 per cent below 2005 levels]. This range allows Australia to step up efforts if stronger global action emerges or to moderate them if weaker global action makes more than 2 degrees of warming likely. It also maintains flexibility to respond to new information about climate science and economic developments.⁶

These targets were derived by drawing a 'straight line' from the start of the budget period (2020) to the end. In other words, the analysis neither front-ended nor back-ended the emissions reduction task.

This analysis adopts the same approach, updating the global budget using the Meinshausen et al approach adopted by the CCA, determining Australia's fair share of that budget and then deriving domestic targets for the 2021–2050 period.

⁴ Climate Change Authority (2014) *Reducing Australia's Greenhouse Gas Emissions— Targets and Progress Review Final Report* <<https://climatechangeauthority.gov.au/reviews/targets-and-progress-review-3>>

⁵ *ibid.*

⁶ *ibid.*

3.0 BUDGETS AND TARGETS FOR 2°C

As noted above, the 2014 CCA report proceeded by determining the remaining global carbon budget and then allocating Australia its 'fair share' of that budget (0.97%). As also noted above, the 2014 CCA report relied on analysis from Meinshausen et al to determine the global emissions budget.⁷

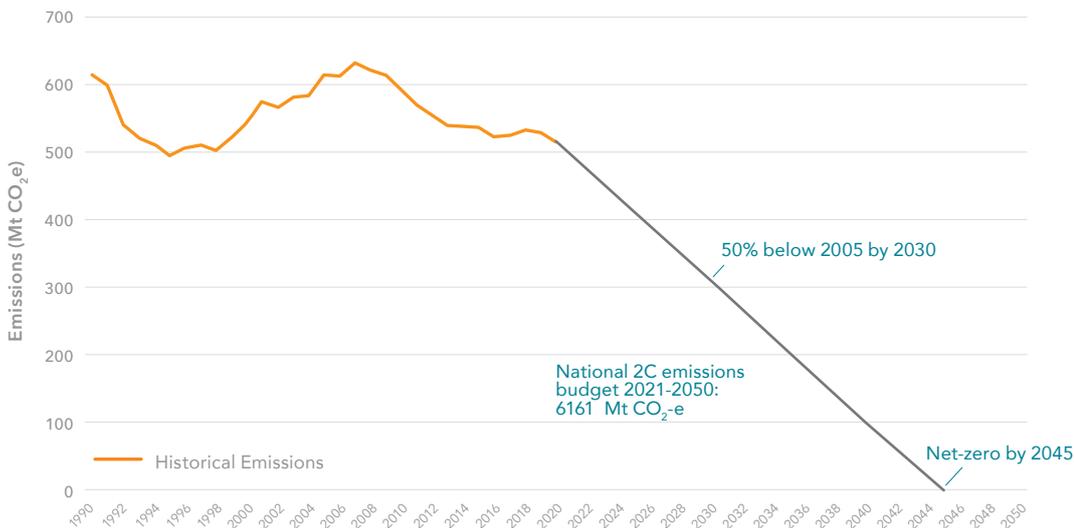
Meinshausen et al have since updated the global emissions budget. In their June 2018 paper *Greenhouse Gas Emissions Budgets For Victoria*, Associate Professor Malte Meinshausen, Yann Robiou Du Pont and Anita Talberg of the University of Melbourne, assessed whether the CCA 2014 budget "continues to be valid in the context of scientific and methodological developments".⁸ Their findings took into account both the increased pollution since 2014 as well as other global developments.

The June 2018 paper from Meinshausen et al considered the most recent global emissions data available up to that point as well as the most current projections regarding remaining global carbon budgets. It determined that the remaining global budget from 2000 to 2050 was 1750 Gt CO₂e, a figure slightly higher than that relied on by the CCA.

The paper also concluded that although the 'fair' share of Australia of a remaining global emissions budget can be derived in many different ways based on various value judgements and methodologies, resulting in a broad range from 0.52% to 1.27% (see Table 3 in Meinshausen et al. (2018) footnote 4), the CCA determination that Australia's fair share of the global carbon budget is 0.97% remained valid. Likewise, this current analysis follows the 2014 CCA approach and an allocation of Australia's 'fair share' at 0.97% is assumed.

The CCA determined that Australia's 2013-2050 carbon budget was 10,100 Mt CO₂e. By applying the 0.97% share to the updated 2013-2050 global budget, one obtains an updated Australian 2013-2050 budget of 10,400 Mt CO₂e. However, in the period between 2013-2020, Australia has emitted 4,239 Mt CO₂e.⁹ As such, adopting the same approach as the CCA, Australia's remaining carbon budget from 2021 onwards is now 6,161 Mt CO₂e.

Figure 1: Paris-compliant emissions trajectory for 2°C



⁷ We note that Australia's 'fair share' of 0.97% of the remaining global carbon budget is well above Australia's share of the world's population (0.33% according to the United Nations Population Division), leading some to argue that Australia's fair share is in fact lower than this. However, for the purposes of this analysis, the Panel has continued with the approach of the Climate Change Authority.

⁸ Meinshausen, M., Robiou du Pont, Y. and Talberg, A. (2018) *Greenhouse Gas Emissions Budgets for Victoria* <<https://engage.vic.gov.au/climate-change-targets-2021-2030>>

⁹ Department of Industry, Science, Energy and Resources (2020) *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2020* <<https://www.industry.gov.au/sites/default/files/2020-11/nggi-quarterly-update-june-2020.pdf>>

Therefore, if Australia is to stay within a 2°C budget, using the same 'straight line' projection methodology as the CCA, it would require a 2030 target of a 50% reduction on 2005 emission levels, a 2035 target of 67% reduction on 2005 emissions levels, and net-zero emissions by 2045.

Table 1: Paris-compliant targets for Australia for 2°C

YEAR	REDUCTION ON 2005 LEVELS
2030	50%
2035	67%
2040	84%
	Net-zero emissions by 2045

4.0 BUDGETS AND TARGETS FOR 1.5°C

The 2014 CCA report pre-dated the Paris Agreement. In that agreement, in addition to the goal of well below 2°C of temperature rise, the Paris Agreement committed to action to work towards limiting warming to 1.5°C. A similar emissions budget analysis can be performed to determine targets consistent with a 1.5°C emissions budget.

It is important to note that there is significant debate within the climate science community on the achievability of keeping global average temperature rise below 1.5°C without substantial overshoot. This report continues the analysis and assumptions of the recent IPCC Special Report on Global Warming of 1.5°C, noting that further work is likely to be released in 2021 regarding the prospects of limiting warming to below 1.5°C. This report does not pre-empt any of that research but simply updates the CCA analysis on the basis of existing published research.

Consistent with the 2014 CCA approach, the report models a 67% chance of limiting global warming to below 2°C. The report relies on published carbon budget analysis to model only a 50% chance of remaining below 1.5°C, and does not consider what if any budget is left to achieve a 67% chance of remaining below 1.5°C.

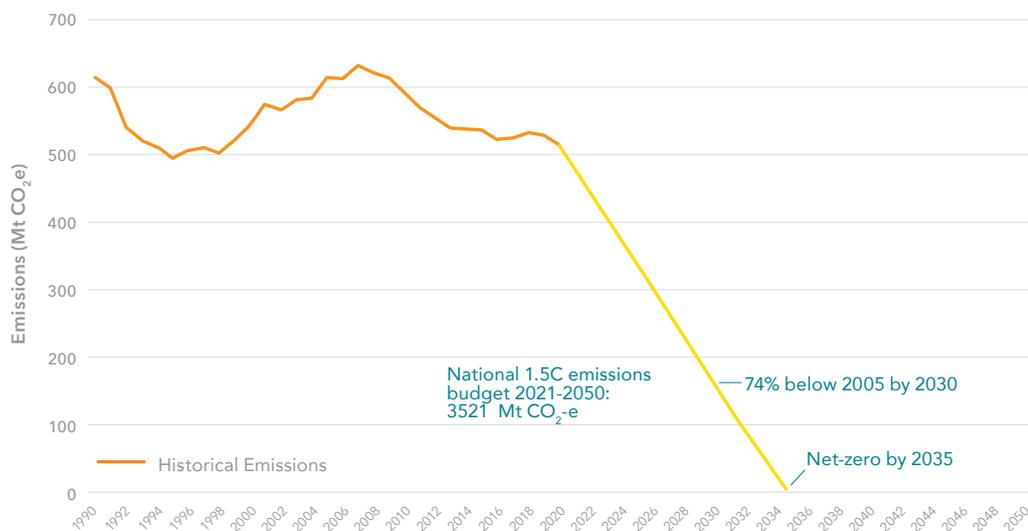
In March 2019, Associate Professor Malte Meinshausen's paper *Deriving a global 2013-2050 emission budget to stay below 1.5°C based on the IPCC Special Report on 1.5°C*¹⁰ calculated a global 2013-2050 emissions budget of 800 Gt CO₂e for the world to have a 50% chance of limiting global warming to 1.5°C. Using the same methodology for allocating Australia's share of the global budget as the CCA (0.97%), this provided for a 7,760 Mt CO₂e budget for Australia from 2013-2050.

This analysis adopts this Meinshausen approach to a 1.5°C budget. Taking into account emissions for 2013-2020¹¹, which together total 4,239 Mt CO₂e, the remaining 1.5°C budget for Australia is 3,521 Mt CO₂e.

¹⁰ Meinshausen, M. (2019) *Deriving a global 2013-2050 emission budget to stay below 1.5°C based on the IPCC Special Report on 1.5°C* <<https://engage.vic.gov.au/climate-change-targets-2021-2030>>

¹¹ Department of Industry, Science, Energy and Resources (2020) *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2020* <<https://www.industry.gov.au/sites/default/files/2020-11/nggi-quarterly-update-june-2020.pdf>>

Figure 2: Paris-compliant emissions trajectory for 1.5°C



Therefore, if Australia is to stay within a 1.5°C budget, using the same ‘straight line’ projection methodology as the CCA, it would require a 2030 target of a 74% reduction on 2005 greenhouse gas levels, with net-zero by 2035.

Table 2: Paris-compliant targets for Australia for 1.5°C

YEAR	REDUCTION ON 2005 LEVELS
2030	74%
2035	Net-zero emissions

5.0 BUDGETS AND TARGETS FOR ‘NET-ZERO BY 2050’

Recently, key trading partners Japan and South Korea have committed to ‘net-zero by 2050’ targets and there has been discussion about whether Australia should do the same. China, Australia’s largest trading partner, has committed to a net-zero by 2060 target.¹²

Based on the straight line emission trajectory assumption employed above, we found that Paris Agreement-compliant 1.5°C and 2°C targets require net-zero by 2035 or 2045 respectively. Therefore a ‘straight line’ approach to net-zero by 2050 is not compatible with either the 1.5°C or 2°C emissions budget.

If Australia was to rely solely on a 2050 net-zero target starting from 2020, a ‘straight line’ projection out to 2050 would result in total emissions between 2021 and 2050 of 7,496 Mt CO₂e. This would exceed the remaining 2°C budget by 1,335 Mt CO₂e and exceed the 1.5°C budget by 3,975 Mt CO₂e.

The emissions budget is further exceeded if there is a 26-28% reduction on 2005 emissions by 2030 (Australia’s current targets), followed by a linear reduction to 2050. This would miss Australia’s emissions budget by an even larger margin, exceeding the remaining 2°C budget by 2,813-2,998 Mt CO₂e and the 1.5°C budget by 5,453-5,638 Mt CO₂e. This means that if Australia were to persist with its current 2030 target, then a subsequent ‘net-zero by 2050’ commitment is not compatible with limiting warming to 2°C.

¹² Many other countries now also have net-zero by 2050 targets, including but not limited to New Zealand, the United Kingdom, the European Union and Canada.

In summary, in the absence of stronger early targets, simply adopting a 'net-zero by 2050' target is incompatible with the Paris goal of 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. The emissions budget is exceeded even further if the 'net-zero by 2050' target is paired with a 2030 target of 26-28% reduction.

NOTES ON TERMINOLOGY AND PROBABILITIES

The Paris agreement commits parties to keeping global temperatures well below 2°C. The 'global carbon budget' approach adopted by the CCA is based on projected global warming of 2°C. Other approaches to calculating a well below 2°C budget (such as a budget based on limiting global warming to 1.8°C) would yield even more ambitious targets, but to maintain consistency with the original 2014 CCA approach, these have not been explored here.

The approach of the CCA and of this analysis has been to prepare '2°C carbon budgets' on the basis of a 67% likelihood of remaining below 2°C. The 67% probability (of remaining below 2°C) has been chosen because it is the figure used by the Climate Change Authority and also because that probability makes it likely that the desired outcome will be achieved. However it remains for many an unacceptably high risk, given that it effectively means a 1 in 3 chance of not achieving the outcome. Higher probabilities would result in more ambitious emissions reduction targets.

The CCA has not considered a 1.5°C budget and therefore has not considered what probability to apply to a 1.5°C budget. Given already-measured severe warming of 1.1°C, drastic urgent action is required to remain below 1.5°C. Recognising the challenge, the published 1.5°C carbon budgets relied upon in this analysis have presumed only a 50% (not 67%) probability of limiting global warming to below 1.5°C.

Budgets are expressed in terms of probabilities of remaining below a given temperature for a number of reasons, one of which is the possibility of carbon cycle feedbacks. This refers to self-reinforcing changes in nature that contribute to global warming. An example is the thawing of Arctic permafrost as the planet heats, which releases carbon dioxide and methane to the atmosphere which in turn contribute to global warming. The main concern of scientists is that some of these feedback reactions may become unstoppable, severely affecting the ability to limit global warming to the specified temperature, regardless of future emissions.

All references to tonnes of emissions are to tonnes of CO₂e (carbon dioxide equivalent) gases. The reference to 'GWP' in the Climate Change Authority 2014 report is to the 'global warming potential' of various gases, which measures how potent they each are as greenhouse gases in comparison with CO₂. Although CO₂ is the main source of climate pollution, other gases - such as methane - also contribute to global warming. As such, most standard measurements of greenhouse gas emissions (including the Australian government's) cover not just carbon dioxide, but also other greenhouse gases. These other emissions are measured in terms of the equivalent CO₂ emissions.

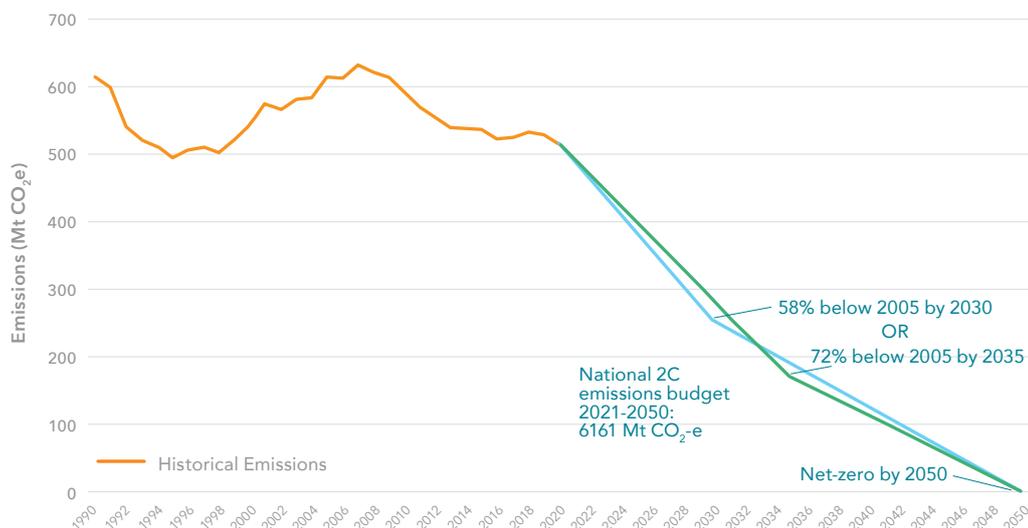
When considering Australian emissions, figures are in megatonnes (Mt). One megatonne is one million tonnes. When considering global emissions, figures are in gigatonnes (Gt). One gigatonne is one thousand megatonnes.

All historical emissions data for Australia is sourced from The Department of Industry, Science, Energy and Resources' *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2020*.

APPENDIX: HIGHER 2030 TARGETS WITH A 2050 NET-ZERO GOAL

If emissions cuts are 'front-ended' and stronger 2030 or 2035 targets are adopted, then a 'net-zero by 2050' target can be made consistent with the Paris Agreement, where total emissions between 2021 and 2050 are made to remain within the emissions budget. This is achieved by identifying 2030 or 2035 targets that, when combined with straight line trajectories both from 2021 to the target year, and then from the target year to 2050, stay within a given emissions budget. This is illustrated in the figure below:

Figure 3: Paris-compliant emissions trajectory for 2°C with net-zero 2050



For a 67% chance of keeping global average temperature rise below 2°C, as modelled by the CCA, sharper front-ended cuts by either 2030 or 2035 would be necessary if the net-zero tail were extended out to 2050. The following trajectories are compatible with this scenario:

Table 3: 'Net-zero by 2050' Paris-compliant targets for 2°C

YEAR	REDUCTION ON 2005 LEVELS (2030 TARGET, THEN STRAIGHT TO 2050)	REDUCTION ON 2005 LEVELS (2035 TARGET, THEN STRAIGHT TO 2050)
2030	58%	
2035		72%
2040	[79%]	[82%]
2050	Net-zero	Net-zero

For keeping global average temperature rise below 1.5°C, if the goal is to reach net-zero in 2050 (and not earlier), then an 87% target is required for 2030. If no 2030 target is adopted and instead only a 2035 target is set, net-zero emissions has to be reached in 2035: in other words, there is simply not enough remaining in Australia's 1.5°C carbon budget to reach net-zero in 2050 without strong action over the next decade.

Figure 4: Paris-compliant emissions trajectory for 1.5°C with net-zero 2050

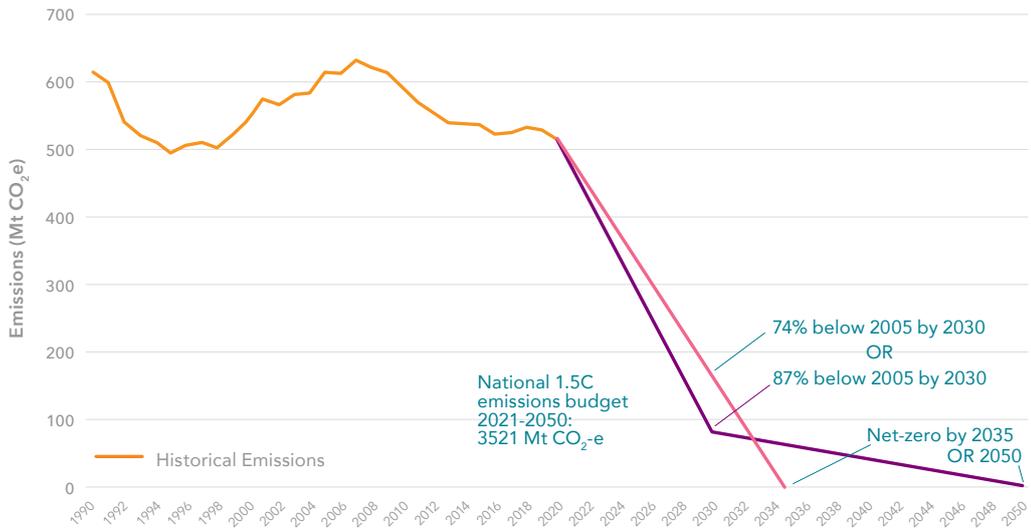


Table 4: 'Net-zero by 2050' Paris-compliant targets for 1.5°C

YEAR	REDUCTION ON 2005 LEVELS (2030 TARGET, THEN STRAIGHT TO 2050)	REDUCTION ON 2005 LEVELS (2035 TARGET, THEN STRAIGHT TO 2050)
2030	87%	
2035		Net-zero
2040	[94%]	Net-zero
2050	Net-zero	Net-zero

In summary, without a very ambitious 2030 target (beyond 74%) and without assuming net negative emissions later on, the 1.5°C target requires a phasing out of net emissions by 2035.