



Australian Government
Climate Change Authority

SPECIAL REVIEW DRAFT REPORT

Australia's future
emissions reduction targets

APRIL 2015



Published by the Climate Change Authority

www.climatechangeauthority.gov.au

This work is licensed under the Creative Commons Attribution 3.0 Australia Licence. To view a copy of this license, visit <http://creativecommons.org/licenses/by/3.0/au>

The Climate Change Authority asserts the right to be recognised as author of the original material in the following manner:



© Commonwealth of Australia (Climate Change Authority) 2015.

IMPORTANT NOTICE – PLEASE READ

This document is produced for general information only and does not represent a statement of the policy of the Commonwealth of Australia. The Commonwealth of Australia and all persons acting for the Commonwealth preparing this report accept no liability for the accuracy of or inferences from the material contained in this publication, or for any action as a result of any person's or group's interpretations, deductions, conclusions or actions in relying on this material.

DRAFT REPORT

This draft report presents the Climate Change Authority's recommendations on Australia's future emissions reduction targets, and constitutes the first part of the Authority's response to the Special Review requested by the Minister for the Environment in December 2014. The Authority will consult further with stakeholders on this report, and is inviting further submissions from interested parties; it will, if deemed appropriate, review its recommendations in the light of those consultations and submissions.

Key dates

Minister requests a special review on emissions trading and related matters

December 2014



Draft report on Australia's future emissions reduction targets

April 2015



Draft report on emissions trading and other policies to reduce emissions

November 2015



Final report recommending Australia's climate action

June 2016

How to make a submission

Details on how to lodge your submission can be found at:
www.climatechangeauthority.gov.au/submissions.

Submissions can be lodged:

via email

submissions@climatechangeauthority.gov.au

via post

Submissions
Climate Change Authority
GPO Box 1944
Melbourne VIC 3001

Contacts

For further information about the Review or making a submission, contact the Climate Change Authority on freecall 1800 475 869 or via email at enquiries@climatechangeauthority.gov.au.

Web site

www.climatechangeauthority.gov.au

CONTENTS

Introduction	1
Background	2
Preliminary recommendations.....	3
Supporting arguments.....	4
1. Climate science confirms the problem	4
2. The problem is long term.....	7
3. The problem is global.....	8
4. International action and Australia's fair contribution.....	9
5. How Australia's and global efforts contribute to climate goals.....	19
6. Why the recommended targets are in Australia's best interests	23
7. Are the recommended targets achievable?.....	25
Appendix A Terms of Reference	27
Appendix B Public consultation	28
Glossary	29
Abbreviations and Acronyms	32
References	Error! Bookmark not defined.

FIGURES

Figure 1 Country performance in first commitment period of the Kyoto Protocol.....	12
Figure 2 Comparing countries' capacity.....	14
Figure 3 Comparing countries' targets, 2005 to 2025.....	15
Figure 4 Recommended 2025 target for Australia: alternative base years	16
Figure 5 EU and Australia emissions pathways, 1990 and 2005 base years	16
Figure 6 Emissions reductions: 1990 to 2012, and to 2025 targets	17
Figure 7 Countries' emissions trajectories to the 2 degree goal.....	19
Figure 8 Relationship between targets, trajectories and national emissions budget	21
Figure 9 UNEP Emissions Gap Report: outlook to 2030.....	22

TABLES

Table 1 Advances in scientific understanding of climate change	5
Table 2 Projected climate change impacts on Australia under different global warming scenarios	6
Table 3 Top 15 greenhouse gas emitters, 2011	9
Table 4 Announced post-2020 targets.....	11
Table 5 Rate of emissions reduction and budget use for 2020 and 2025 targets.....	22
Table 6 Submissions to the call for comment on targets.....	28

INTRODUCTION

The Minister for the Environment has requested the Authority to conduct a Special Review under section 59 of the *Climate Change Authority Act 2011* (Cth). The Authority received the Terms of Reference for this three-part review on 15 December 2014; a copy is at Appendix A.

The first part of this Special Review requires the Authority to provide advice on Australia's future emissions reduction targets, particularly for the period beyond 2020. The Minister has asked that this part of the Authority's report be available for public consultation by 30 June 2015.

The Government has also established a taskforce in the Department of the Prime Minister and Cabinet. The taskforce will propose possible post-2020 targets for Australia to take to the Paris Conference of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015, when all countries will be expected to sign off on their post-2020 contributions. The taskforce has released an issues paper and called for public comments by 24 April 2015.

Preparations for the Paris Conference are well underway. Although no firm deadline has been set, countries have been invited to announce their post-2020 targets well in advance of the Paris meeting. Some have done so already and several more, including Australia, are working towards mid-year announcements.

This report is intended primarily as an input into the Government's deliberations and to the Parliament more broadly. Given the Government's intention to announce Australia's targets by mid-2015, the Authority is releasing its draft recommendations now to provide time for public consultations with interested parties before the Government makes its decision.

The second and third parts of the Special Review will analyse possible policy instruments (including an emissions trading scheme) to help meet whatever targets might be determined for Australia in the context of the Paris negotiations. These policy options will be the subject of subsequent reports and consultations.

BACKGROUND

This report builds on the work in the Authority's recent report, *Reducing Australia's Greenhouse Gas Emissions—Targets and Progress Review*, which was provided to the Minister (and released publicly) on 27 February 2014. That report, which reflected extensive public consultation, presented the Authority's comprehensive assessment of the evidence coming from climate scientists, the efforts being made by other countries to reduce their emissions, and the targets judged to be in Australia's best interests. The Authority recommended a target for 2020 and a trajectory range for emissions out to 2030. It also recommended a long-term emissions budget to guide Australia's planning over the period to 2050.

Weighing up all the relevant factors, the Authority recommended a 2020 target for Australia of 19 per cent below 2000 levels. By way of guidance for the period beyond 2020, the Authority recommended a trajectory range to 2030 of emissions reductions of between 40 and 60 per cent below 2000 levels. Under the *Clean Energy Act 2011* (Cth) the Government was obliged to respond to these recommendations by the end of August 2014 but, with the repeal of that Act, this obligation lapsed.

In preparing this current report, the Authority has revisited the material underpinning its February 2014 report and updated its analysis in the light of new information that has emerged since that time, particularly in regard to the science of climate change and the recent efforts of many countries to reduce their greenhouse gas emissions.

The Authority believes this new information supports its previous assessment that Australia's conditions for moving some way beyond its unconditional target have been met (CCA 2014d, p. 67). These conditions included increased clarity around the level and credibility of international action and agreement on emissions accounting and reporting. Australia's commitment under the UNFCCC includes an unconditional emissions reduction target of 5 per cent below 2000 levels by 2020, and conditional targets of up to 15 or 25 per cent (UNFCCC 2013).

The present Government has shown no inclination to move beyond the unconditional 2020 target. The consequences of limiting Australia's emissions reductions to this minimum 5 per cent target have been factored into the Authority's consideration of appropriate post-2020 targets.

For reasons elaborated below, the Authority considers that:

- Australia's targets should be expressed in 'net' terms. That is, they should include both domestic emissions reductions and purchases of international emissions reduction units, net of any sales of domestic units overseas.
- The Government should set a single 2025 target and adopt a trajectory range to 2030. While no specific time horizon for post-2020 targets has been prescribed internationally, with some countries choosing 2025 and others 2030, the recommended approach would retain a degree of flexibility to respond to changing circumstances.

PRELIMINARY RECOMMENDATIONS

2020 TARGETS

The Authority remains of the view that Australia should go beyond the minimum 2020 target of a 5 per cent reduction in emissions compared with 2000 levels.

The Authority has previously recommended a 2020 target of 19 per cent below 2000 levels (a minimum reduction of 15 per cent, plus 4 percentage points from Australia's carryover under the Kyoto Protocol). It also recommended Australia use international emissions reductions to complement domestic measures in meeting this target (CCA 2014d).

The Authority believes these recommendations remain appropriate if Australia is to make a fair contribution to global action in the period to 2020 and help to limit warming to less than 2 degrees. In the absence of more concerted efforts to reduce emissions over the years immediately ahead, the task of achieving credible 2020 and subsequent targets will become progressively more challenging.

POST-2020 TARGETS

In considering targets for the post-2020 period, the Authority has taken account of the uncertainty regarding Australia's action to 2020, and how quickly Australia might reasonably 'catch up' with global efforts. It has also continued to attach most weight to the science of climate change, the efforts of comparable countries to reduce their emissions, and Australia's own long term interests.

If Australia does not better the minimum target of a 5 per cent reduction in emissions by 2020, but is prepared to match what comparable countries are planning to do by 2025—a reasonable and achievable objective in the Authority's judgment—the Authority recommends a 2025 target of 30 per cent below 2000 levels.

In the event that Australia is able to reduce emissions by more than 5 per cent by 2020, this would allow a more gradual acceleration of the effort required beyond 2020, but would not change the Authority's recommended target for 2025.

The Authority also recommends the Government set a limit on total emissions for the period 2021-25, in line with current practice under the Kyoto Protocol.

Looking beyond 2025, the Authority recommends a range of 40 to 60 per cent reductions from 2000 levels by 2030. Such a range is consistent with Australia playing its fair part in global action, while providing flexibility to adjust policy in the light of new information.

In the Authority's view, these targets are consistent with climate science, with what comparable countries are doing, and with Australia's best interests. The evidence to support this view is set out in the remainder of this paper; the Authority will discuss its recommendations—and the reasoning behind them—with stakeholders.

SUPPORTING ARGUMENTS

1. CLIMATE SCIENCE CONFIRMS THE PROBLEM

The Authority's recommendations in this report, as in its earlier reports, are founded on the comprehensive scientific evidence that human activities are the major contributor to global warming. Burning fossil fuels, many industrial processes, and land clearing activities (among others) produce greenhouse gases that trap heat radiated from the earth within the atmosphere, like a greenhouse. As concentrations of greenhouse gases increase, more heat is retained and the climate warms. We are already experiencing the early impacts of the problem: globally, extreme weather events have become more frequent and sea levels have risen; in Australia, there are already more days of extreme heat, more frequent and intense heatwaves, and increased coral bleaching on the Great Barrier Reef (CSIRO & BOM 2014; Australian Academy of Science 2015).

Since the beginning of the Industrial Revolution (about 1750), the concentration of carbon dioxide in the atmosphere has grown by 40 per cent, methane by 150 per cent and nitrous oxide by 20 per cent. Ice core records, which show the atmosphere's historical composition, suggest that the current concentrations of these three gases substantially exceed those at any other time over the past 800,000 years (IPCC 2013b). The Earth has warmed in response to the rapid increase in greenhouse gas concentrations; between 1880 and 2012, average global surface temperatures over land and the ocean warmed by 0.85 degrees. Each of the last three decades was successively warmer, and each was warmer than any preceding decade since 1850 when instrumental records began. The world's oceans are also warming. Since the 1970s, oceans have absorbed about 90 per cent of the additional heat within the Earth's system (IPCC 2013b).

While the climate is clearly warming, uncertainties exist regarding the extent of future climate changes. Future levels of greenhouse gas concentrations in the atmosphere will depend largely on the effectiveness of policies to reduce emissions, and on changes in population and technology. The precise temperature response to future greenhouse gas concentrations is also uncertain; climate models project future temperature changes associated with different concentration scenarios, but can only do so within ranges of probability.

These uncertainties, however, have been diminishing over time, as understanding of the climate system improves and climate models become more sophisticated. Since the first comprehensive assessment of climate change science by the IPCC in 1990, these improvements have resulted in greater confidence in the connection between human activities and climate change, and in the projected climate impacts (Table 1).

The impacts of climate change over the 21st century will depend upon the limits the global community places on global greenhouse gas emissions. The global community has agreed to limit greenhouse gas emissions so that the increase in warming is limited to less than 2 degrees above pre-industrial levels (UNFCCC 2010). This is a level that is expected to avoid the worst of the projected impacts of climate change; achieving this level will require deep, urgent and sustained emissions reductions.

Table 1 Advances in scientific understanding of climate change

IPCC report	First Assessment Report (1990)	Fourth Assessment Report (2007)	Fifth Assessment Report (2013)
Temperature levels	Warming over the last 100 years is estimated at 0.3-0.6 degrees	Between 1906 and 2005, global average temperatures warmed 0.74 degrees 11 of the 12 years between 1995 and 2006 were the warmest since instrumental records began in 1850	Between 1880 and 2012, average global surface temperatures increased 0.85 degrees The last three decades in the Northern Hemisphere were 'likely' (over 66 per cent certainty) the warmest in 1,400 years
Human involvement in the climate system	It is certain that greenhouse gases have a natural warming effect and emissions from human activities are substantially increasing the atmospheric concentrations of some greenhouse gases	'Very likely' (over 90 per cent certainty) that humans have caused most of the warming observed since the mid-20th century	'Extremely likely' (95-100 per cent certainty) that humans are the dominant cause of warming since the mid-20th century
Extreme events	No firm evidence of increased weather variability to date 'Most likely' that with an increase in mean temperature, episodes of high temperatures will become more frequent, and cold episodes less frequent	'Very likely' that cold days became less frequent and warm days became more frequent in the late 20th century (from about 1960) 'Very likely' that warm spells, heatwaves and heavy rainfall events will continue to become more frequent over the 21st century 'Likely' that the area affected by drought will increase over the 21st century 'Likely' increased incidence of extreme high sea level events over the 21st century	'Very likely' that cold days became less frequent and warm days became more frequent since 1950 'Very likely' that frequency and duration of heatwaves and high rainfall events will increase by the late 21st century 'Likely' that drought intensity or duration will increase on a regional to global scale by the late 21st century 'Very likely' that incidence and magnitude of extreme high sea level events will increase by the late 21st century

Source: IPCC 1990; IPCC 2007c; IPCC 2014b.

Even if the world made the required emissions reductions, significant risks to the environment and quality of life would remain. By the end of this century, dry regions of the globe are projected to experience more frequent droughts, while wet regions are projected to experience higher rainfall. Risks from extreme weather events, including heatwaves, floods and storm surges, are projected to become more frequent and more intense for some locations. Human health would be affected, including by increased likelihood of injury, disease and deaths from more intense heat waves and fires, diminished food production and water scarcity (IPCC 2014b).

Sea levels are projected to continue to rise. Global average sea levels rose 0.19 metres between 1901 and 2010, driven by a combination of thermal expansion (water expanding as it warms), glaciers melting, and Greenland and Antarctic ice sheets melting. Greenhouse gases emitted during this century will continue to affect the atmosphere and have an additional long-term impact on sea levels (see Table 2). Rising sea levels increase the risks of flooding, coastal erosion and salt contamination of fresh water, with significant damage to human settlements, infrastructure and coastal ecosystems.

As a comparatively hot and dry country, Australia is highly exposed to the adverse impacts of climate change. Australia's climate has already warmed by 0.9 degrees since 1910, with every decade in Australia warmer than the previous one since the 1940s; 2013 was Australia's hottest year on record (CSIRO & BOM 2014). The frequency and intensity of fires, droughts, floods and storm surges are all

projected to increase, particularly for current high-risk areas. Snow depth and area are projected to decline. The Great Barrier Reef is expected to experience more frequent and severe episodes of coral bleaching, disease and mortality as a result of ocean warming and acidification (IPCC 2014a).

Temperature increases beyond 2 degrees would see progressively more serious climate impacts, with more extreme weather events and associated human deaths, species extinction and risks to global and regional food security. Higher temperatures and humidity would compromise growing food or working outdoors in some regions of the globe for parts of the year (IPCC 2014b). The combination of rising sea levels and more frequent extreme weather could contribute to large scale migration of populations in affected regions, and increased risk of insecurity and conflict in fragile states (Department of Defence 2013, p. 18).

Table 2 Projected climate change impacts on Australia under different global warming scenarios

	2 degrees	3 degrees	4 degrees
Hot days -Number of days over 40 degrees each year by 2090 in Perth (1995 = 4 days) ¹ ; median	7 days	10 days	20 days
Less rain -Percentage change in median spring rainfall in southern Australia by 2090 ² ; median	-5%	-10%	-18%
Sea level rise -by 2090; median	0.4m	0.5m	0.6m
Commitment by 2100 to sea level rise in 2300, even with no further anthropogenic emissions; spread of model scenarios	0.2 to 0.7m	0.3 to 1.5m	0.9 to 3.6m
Virus spread -Additional Australians exposed to dengue fever in 2100 compared with 2000 (scenario medians quoted)	0.7 million	NR	5 to 8 million
Coral reefs including Great Barrier Reef by 2050-2100	Density and diversity of corals on reefs likely to decline; vastly reduced habitat complexity and loss of biodiversity.	Few reef-building corals remaining.	
Snow depth in 2040-59 Reference (1980-99)			
Falls Creek 1.5m	NR	0.5 to 1.1m	0.2 to 0.8m
Mt Hotham 1.3m		0.4 to 0.9m	0.2 to 0.7m
Mt Buller 1.0m		0.2 to 0.6m	0.1 to 0.5m
Mt Buffalo 0.6m		0.1 to 0.3m	0.0 to 0.2m

Notes: In the text, and for 'Hot days,' 'Less rain' and 'Sea rise', the 2, 3 and 4 degree impacts are respectively based on IPCC Representative Concentration Pathway (RCP) 2.6, RCP 4.5 and RCP 8.5. For 'Virus spread,' 'Coral reefs including Great Barrier Reef' and 'Snow depth in 2040-59,' 2, 3 and 4 degree impacts are based on analogous scenarios described in the source texts. NR: not reported.

¹ Impacts on the number of hot days vary across Australia; Perth illustrates the effect.

² Rainfall is projected to be most affected in southern Australia in spring.

Sources: 'Hot days,' 'Less rain' and 'Snow depth in 2040-59' are adapted from (CSIRO & BOM 2014); 'Sea level rise' is adapted from IPCC (2013a); 'Virus spread' is adapted from Bambrick *et al.* (2008); 'Coral reefs including Great Barrier Reef' is adapted from Hoegh-Guldberg *et al.* (2007).

Warming of more than 2 degrees also increases the risks of triggering permanent changes in some physical systems. These changes could take a very long time to be fully realised, but once the 'tipping point' is crossed, they would be irreversible. The Greenland Ice Sheet is one such example: warming above a certain threshold—estimated to be somewhere between one and four degrees—could trigger a near-complete melting of the Sheet, raising global sea levels irreversibly by several metres over a millennium or more (IPCC 2013b).

Scenarios of greater than 2 degrees warming would make adaptation increasingly challenging for all countries: with warming of 4 degrees or more, Australia (along with other countries) would be hard pressed to manage its exposure to many severe impacts (Table 1) (CSIRO 2010, p. 60).

On a more positive note, many countries are now moving towards stronger climate policy actions, and setting goals to continue reducing emissions beyond 2020. These actions, discussed further in Section 4, are indicative not only of a widespread re-awakening of the need to avoid dangerous climate change but also of an appreciation that effective policy measures are available and can be implemented without undermining economic prosperity.

2. THE PROBLEM IS LONG TERM

Climate change is a long-term problem, and avoiding dangerous climate change requires a long-term response, including sustained reductions of emissions over very long time periods.

Unlike some pollutants, carbon dioxide emissions have impacts that unfold over hundreds, even thousands, of years. There are three main reasons for this:

- Emissions can cause atmospheric concentrations to be elevated for a long time. About one-third of the carbon dioxide increase due to emissions this year will remain in the atmosphere in 100 years and about 20 per cent will still be present in 1,000 years (IPCC 2007b).
- It takes several decades for the effects of any given concentration of greenhouse gases to have its full influence on atmospheric temperatures. If, for example, greenhouse gas concentrations and other human influences on the climate stayed constant at 2000 levels, further warming of about 0.6 degrees would occur by 2100 (in addition to the 0.8 degrees of warming observed to 2000) (IPCC 2013b).
- Elevated temperatures can cause impacts to gradually become more severe over centuries or millennia—even when temperatures stabilise, ice sheets would continue to melt over many centuries, adding to rises in sea levels.

The long term nature of the problem means that countries cannot wait to see how bad the impacts of climate change are before deciding whether to take decisive action—by then it could be too late. It also means that the cumulative emissions from human activity over many decades matter much more than the quantity of emissions in any one year. For this reason, the Authority attaches considerable significance to long term emissions budgets in the process of determining appropriate emissions reduction targets, as explained in Section 5.

The long term nature and likely severity of climate change highlights the desirability of substantial and sustained action. Many studies show that this approach can be expected to have lower costs than delaying substantial action now, and then ramping up emissions reductions later to compensate (IPCC 2014d; Treasury 2008).

The greatest effects of climate change will be experienced by today's children and those that come after, even if they do not themselves contribute additional emissions. Climate change, therefore, tests the willingness of the present generation to act in the interests of future generations—to have proper

regard, for example, to the health and other hazards associated with climate change, and the higher costs of reducing emissions that would accrue the longer effective action is delayed.

These problems are skipped over in the recently released *Intergenerational Report*, which focuses primarily on the consequences of projected demographic changes out to 2055 for future Commonwealth spending and debt. Spending on the environment and climate change is passed over because it ‘...is not directly linked with demographic factors’ (Australian Government 2015, p. 40). How debt burdens are shared among different generations does raise important issues for policymakers, but the wellbeing of present and future generations of Australians will be affected by many other factors besides demographic changes. In a number of respects, climate change poses even more challenging—and more intractable—policy issues, in part because of its global dimension.

3. THE PROBLEM IS GLOBAL

No country can solve the problem of climate change alone. No matter where greenhouse gases are emitted, in rich countries or poor, they contribute to warming the global climate system. Strong international cooperation is essential to reduce the risks of climate change, with all countries playing their part.

International negotiations have often involved substantial debate about who is responsible for the problem and who should take the strongest actions to reduce their emissions. Countries have sometimes sought to promote their own short-term national interest by negotiating special or favourable conditions for themselves. Once one country receives recognition for its special circumstances, however, other countries inevitably seek similar treatment and put effective cooperation at risk.

In Australia, it is often argued that there is no point taking action on climate change because its emissions constitute such a small proportion of global emissions. Australia is a small emitter in global terms (1.3 per cent) but it is still the 13th largest emitter in the world (Table 3). Australia also has only 0.3 per cent of the world’s population; on a per capita basis, the latest data show Australia’s emissions are the highest of all developed countries. On these numbers alone, Australia’s emissions reduction efforts should be comparable with those of other wealthy developed countries and free of any special pleading.

Moreover, while Australia may be responsible for ‘only’ 1.3 per cent of global emissions, it is significantly exposed to climate change resulting from the impacts of the other 98.7 per cent. From this perspective, it is in Australia’s interest to play its part in encouraging all major emitters to reduce their emissions.

As discussed in Section 4, more and more countries are stepping up to the challenge. Under the Kyoto Protocol, emissions reduction targets applied only to a select list of ‘developed’ countries, but by 2010 almost 100 developed and developing countries had pledged action to reduce their emissions. As the Paris meeting approaches, all countries have been invited to put forward their Intended Nationally Determined Contributions (INDCs), and many are expected to set absolute emissions reduction targets.

Some developing countries will still need help (and time) to reduce their emissions and grow their economies in less emissions-intensive ways. Climate finance, technology cooperation and capacity

building programs exist to help poorer countries on to a cleaner development path so that they too can contribute to the global emissions reduction task.

Table 3 Top 15 greenhouse gas emitters, 2011

Rank	Country	Emissions (MtCO ₂ e)	Per cent of global emissions	Emissions per capita (tCO ₂ e)
1	China	10,260	22.3	7.6
2	United States	6,135	13.4	19.7
3	India	2,358	5.1	1.9
4	Russian Federation	2,217	4.8	15.5
5	Indonesia	2,053	4.5	8.4
6	Brazil	1,419	3.1	7.2
7	Japan	1,170	2.5	9.2
8	Canada	847	1.8	24.7
9	Germany	806	1.8	9.9
10	Mexico	723	1.6	6.1
11	Iran	712	1.6	9.4
12	Republic of Korea	656	1.4	13.2
13	Australia	595	1.3	26.6
14	United Kingdom	541	1.2	8.5
15	Saudi Arabia	533	1.2	19.2

Note: WRI 2011 data is the most recent consistent set of emissions data available for these countries. Different sources of data for Annex I countries have been used elsewhere in this report for methodological reasons; for example, WRI data for Australia differs significantly from official Department of the Environment data.

Source: WRI (2014); emissions include those from land use, land use changes and forestry.

4. INTERNATIONAL ACTION AND AUSTRALIA'S FAIR CONTRIBUTION

International action

Australia's future emissions reduction targets should be set against the background of the science of climate change (discussed in Section 1) and have regard to the efforts of other countries (elaborated in this section). As indicated earlier, the Authority is recommending that Australia's 2025 target should be comparable with that of other relevant countries.

The negotiations now underway on a new international climate agreement will build on the existing UN Framework Convention on Climate Change (UNFCCC) and lay the foundations for global action beyond 2020. In December 2014, at the annual UNFCCC conference in Lima, countries agreed the key elements of the new international agreement. Negotiations will continue through 2015, with the aim of concluding the agreement in December 2015 in Paris.

All countries have been invited to announce their emissions reduction goals well before the Paris conference. These 'Intended Nationally Determined Contributions' (INDCs) will be lodged with the

UNFCCC and scrutinised by other countries in the course of the negotiations. Countries have agreed INDCs will be a “progression” beyond (that is, an improvement on) current pledges, and have been invited to explain how their individual pledges are fair, ambitious and contribute toward the overarching goal of avoiding dangerous climate change (UNFCCC 2014c).

Since the Authority last assessed global efforts in its Targets and Progress Review (CCA 2014d), global attention and action in relation to climate change have gained momentum amongst political and business leaders, and within community groups generally.

One manifestation of this is the Climate Change Summit hosted by the UN Secretary General in September 2014 in New York. The Summit was attended by the largest ever delegation of country leaders to a climate conference, and also attracted strong support from business leaders. Participants announced a range of new initiatives to improve energy efficiency, reduce deforestation, support carbon markets and mobilise climate finance (Ban Ki-moon 2015).

The Green Climate Fund is also making progress. The Fund was established in 2010 under the UNFCCC to provide large-scale financial assistance to developing countries; pledges to the Fund totalled US\$10.2 billion by the end of 2014 (UNFCCC 2015a). Australia announced in December 2014 it would contribute A\$200 million over a four year period. Other major contributors include the United States, Japan, the UK, Germany, France and Canada.

The major emitting countries are stepping up their collaboration on climate change. On the eve of the G20 Leaders’ meeting in November 2014, China’s President Xi and the United States’ President Obama announced several joint initiatives focused on research, development, commercialisation and trade in low-carbon technologies, energy efficiency and green infrastructure (The White House 2014). More recently, the United States and India strengthened their cooperation on climate change and clean energy, including through a five-year memorandum of understanding on energy security, clean energy and climate change (The White House 2015).

Global attention and action is starting to have a material impact on emissions. The International Energy Agency reported that, in 2014, for the first time in 40 years of data collection there was no increase in global energy emissions (outside periods of global recession) (IEA 2015). IEA analysts attributed this largely to a reduction in coal use by China, and shifts to cleaner energy by OECD countries.

Post-2020 pledges and policies

Some countries have already announced post-2020 targets (Table 4). Seven of these—the United States, the EU, Russia, Switzerland, Norway, Mexico and Gabon—have formalised their announcements by lodging an INDC. More INDCs from both developed and developing countries are expected to be announced ahead of the Paris conference. Some projections suggest that the post-2020 pledges made in 2014 by the EU, United States and China could, if fulfilled, reduce warming by around 0.3 degrees by 2100 (ECOFYS *et al.* 2014).

Table 4 Announced post-2020 targets

Country	Announced Target	Longer-Term Target
China	peak CO ₂ emissions around 2030	not specified
US	26 to 28 per cent below 2005 levels by 2025	80 per cent below 2005 levels by 2050
EU	at least 40 per cent below 1990 levels by 2030	80 to 95 per cent below 1990 levels by 2050
Russia	25 to 30 per cent below 1990 levels by 2030	not specified
Switzerland	50 per cent below 1990 levels by 2030	80 to 95 per cent below 1990 levels by 2050
Norway	at least 40 per cent below 1990 levels by 2030	carbon neutral by 2050
Germany	55 per cent below 1990 levels by 2030	80 to 95 per cent below 1990 levels by 2050
UK	50 per cent below 1990 levels over the period 2023-27	80 to 95 per cent below 1990 levels by 2050
Mexico	25 per cent reduction in greenhouse gases and short lived climate pollutants from BAU in 2030	50 per cent below 2000 levels by 2050
South Africa	42 per cent below BAU by 2025	not specified
Gabon	50 per cent below BAU in 2025	not specified

Note: BAU: business-as-usual.

Source: US, EU, Russia, Norway, Switzerland, Mexico and Gabon: UNFCCC INDC submissions (2015b). China: Joint US-China announcement (The White House 2014). Germany: Energy Concept 2010 (Germany 2010). UK: (Committee on Climate Change 2015). South Africa: (Department of Environmental Affairs 2010).

The announced INDCs represent a progression on previous pledges—that is, each country's INDC is more ambitious than its 2020 target—and countries are implementing new policies to meet these stronger targets.

The United States 2025 target, for example, requires roughly double the rate of emissions reductions underlying its 2020 target of 17 per cent below 2005 levels (Podesta, J & Holdren, J 2014). The INDC identifies some of the main policies the US proposes to use to meet its targets, including regulations and standards issued under the national Clean Air Act 1970. A wide range of state-based schemes, including emissions trading and renewable energy mandates, are planned to run in parallel with the national measures.

China's commitments to halt growth in its carbon dioxide emissions around 2030 (or earlier if possible), and to increase its share of non-fossil fuels in primary energy consumption to around 20 per cent by 2030, are crucial undertakings from the world's biggest emitter. To meet these commitments, China plans to install 800 to 1,000 GW of new zero emissions capacity by 2030—more than ten times Australia's current total electricity-generating capacity (Podesta, J & Holdren, J 2014). China has seven pilot emissions trading schemes (ETS) in operation; it is set to launch a national ETS in 2016 which will cover around 3 to 4 billion tonnes of emissions—around twice the size of the EU ETS (Reuters 2015). China has set a cap on total energy consumption for 2015, and a cap on coal use for 2017. It is also continuing to close small inefficient coal plants; by 2011 it had closed 85 GW of capacity (IEA 2013, p. 48).

India has indicated it is preparing an INDC that will be based on its National Action Plan on Climate Change, with some new initiatives. India has ambitious plans to increase renewable energy capacity to 175 GW by 2022 (BNEF 2015; MNRE 2015). Current installed renewable capacity in India is 27 GW, the sixth highest in the world (REN21 2014). India also has an energy efficiency target supported by a

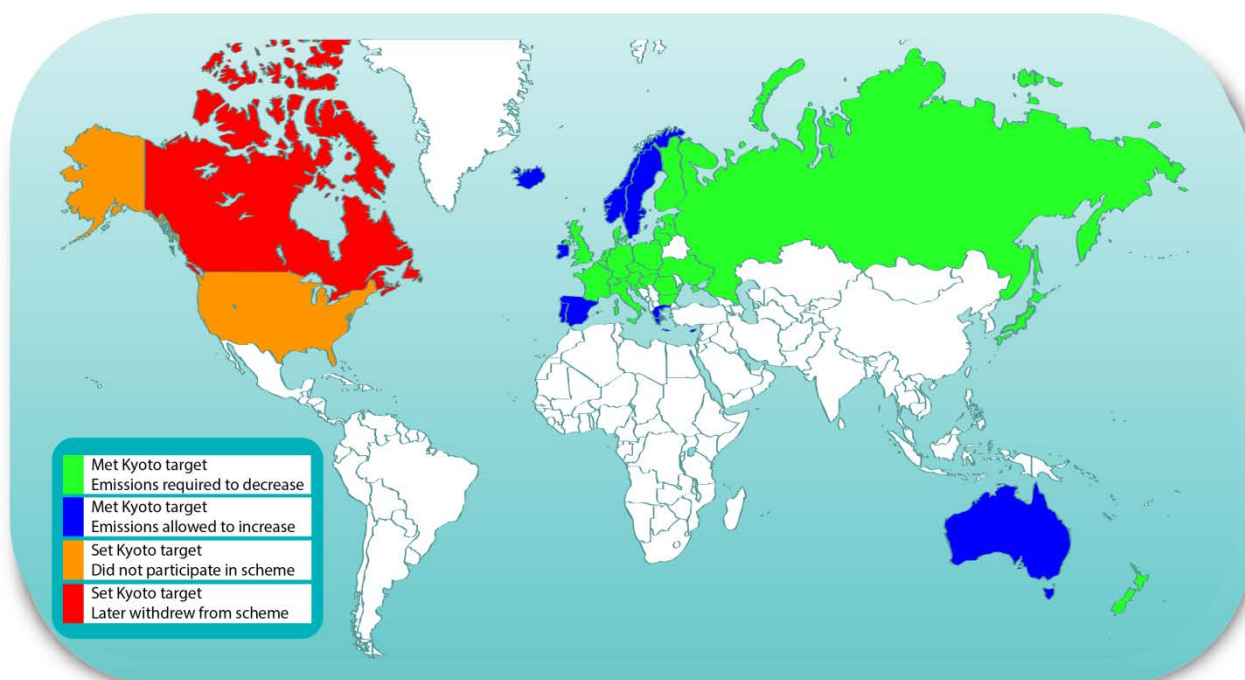
trading scheme, which covers companies representing around 25 per cent of GDP and about 45 per cent of India's primary energy consumption (Bureau of Energy Efficiency 2012; Indian Energy Exchange 2015).

Country pledges are credible

Experience indicates countries overwhelmingly take their emissions reduction targets seriously. Most developed and developing countries have implemented a range of policies and measures to reduce their emissions and most have met (or surpassed) their previous targets. It is therefore reasonable to expect that most countries will also meet the future targets they commit to.

The Kyoto Protocol, agreed in 1997, was the first international agreement with binding national emissions targets. The Protocol set out targets for 38 countries (developed economies and economies-in-transition) for the first commitment period of 2008-12. Of those 38 countries, the United States did not participate, while Canada initially participated but later withdrew. All of the remaining 36 countries—which together accounted for 20 per cent of global emissions in 2010—reduced their emissions to 24 per cent below 1990 levels on average over the five year commitment period, far surpassing the aggregate target of a 4 per cent reduction (Morel & Shishlov 2014). While compliance processes are not yet finalised, initial evaluations suggest all participating countries have met their individual targets (Figure 1).

Figure 1 Country performance in first commitment period of the Kyoto Protocol



Source: Climate Change Authority, using data from (Morel & Shishlov 2014) (EEA 2014).

Many countries, including Australia, surpassed their first commitment period targets. The Kyoto Protocol rules allow these countries to 'carryover' the unused emissions allowances to the second commitment period. The UK has voluntarily cancelled its carryover (Department of Energy & Climate Change 2009), while the EU is yet to formalise its position. The Australian Government intends to use Australia's carryover, estimated at 129 Mt CO₂-e, to help meet its unconditional 5 per cent target for 2020 (DoE 2015).

Almost 100 developed and developing countries have made emissions reduction pledges for 2020. Most have made non-binding pledges under the UNFCCC (2014b); a few have committed to binding targets under the second commitment period of the Kyoto Protocol (UNFCCC 2012).

Nearly all developed countries and some major developing countries have set quantifiable emissions reduction targets as part of their pledge. The UN Environment Programme (UNEP) has undertaken an independent, comprehensive assessment of how countries are progressing; it found that the majority of countries are expected to meet their 2020 targets. Four countries—Australia, the United States, Canada and Mexico—are assessed as not currently on track. To meet their targets, UNEP considers that they will need to either strengthen policies to reduce domestic emissions or buy emissions reductions from other countries. Four countries could not be assessed, either because the country had made major policy revisions (for example, Japan) or because emissions data are uncertain (for example, Indonesia) (UNEP 2014).

The legal status of the pledge (that is, whether it is legally binding or not) does not appear to have affected countries' performance, suggesting that the precise legal status of Paris pledges is unlikely to bear heavily on the extent to which they are met.

How Australia compares

In assessing Australia's fair contribution to global efforts, the Authority has considered how its recommended 2025 target compares with those of other countries. It has considered evidence across four key criteria—capacity to reduce emissions, adequacy relative to global climate goals, responsibility for climate change, and effort required to meet the target—to help make its comparisons robust and relevant (CCA 2015). Adequacy is discussed in Section 5.

As to Australia's 2020 targets, the Authority concluded in its earlier review that the conditions for doing somewhat better than the minimum 5 per cent target had been met and that its recommended target of a 19 per cent reduction would be more in line with the 2020 targets of many other countries (CCA 2014d). The present Government, as noted earlier, has not been persuaded by this advice.

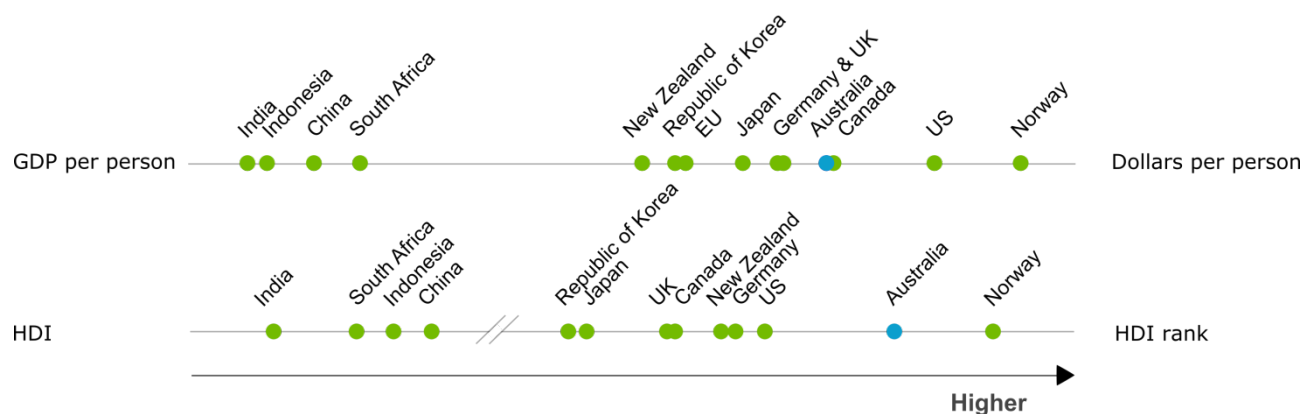
Projections of Australia's emissions have been revised downwards over the years and the latest projections show that the emissions reduction effort required to meet the 5 per cent unconditional target is now much less than previously thought; for the period 2013-20 the task has been revised down from 1,335 Mt CO₂-e in 2008 to 236 Mt CO₂-e in 2014-15 (DoE 2015). This reflects a range of factors that are mostly unrelated to climate change policy, including the aftermath of the global financial crisis, industrial closures and declining electricity demand.

Comparability of the recommended 2025 target

The Authority believes the recommended 2025 target of 30 per cent below 2000 levels is comparable with the targets announced by other countries, taking account of Australia's relative capacity and responsibility to reduce emissions, and the effort required to meet the announced targets.

In broad terms, as a wealthy, developed country Australia has more capacity to act on climate change than developing countries (including South Africa, China and India) and similar capacity to other developed countries (including the United States, Norway, United Kingdom and Germany). Figure 2 illustrates Australia's relatively high capacity as measured by Gross Domestic Product (GDP) per person and the UN Development Program's Human Development Index (HDI).

Figure 2 Comparing countries' capacity



Note: Data are for 2010. EU estimate represents EU28.

Source: GDP: measured in terms of Purchasing Power Parity, 2005 US dollars (OECD 2013); EU28 estimated by CCA based on OECD EU21 data with scaling factor from IMF (IMF 2014). HDI: UNDP (2014). Population: Australia: (Australian Government 2015); other countries: (United Nations 2013).

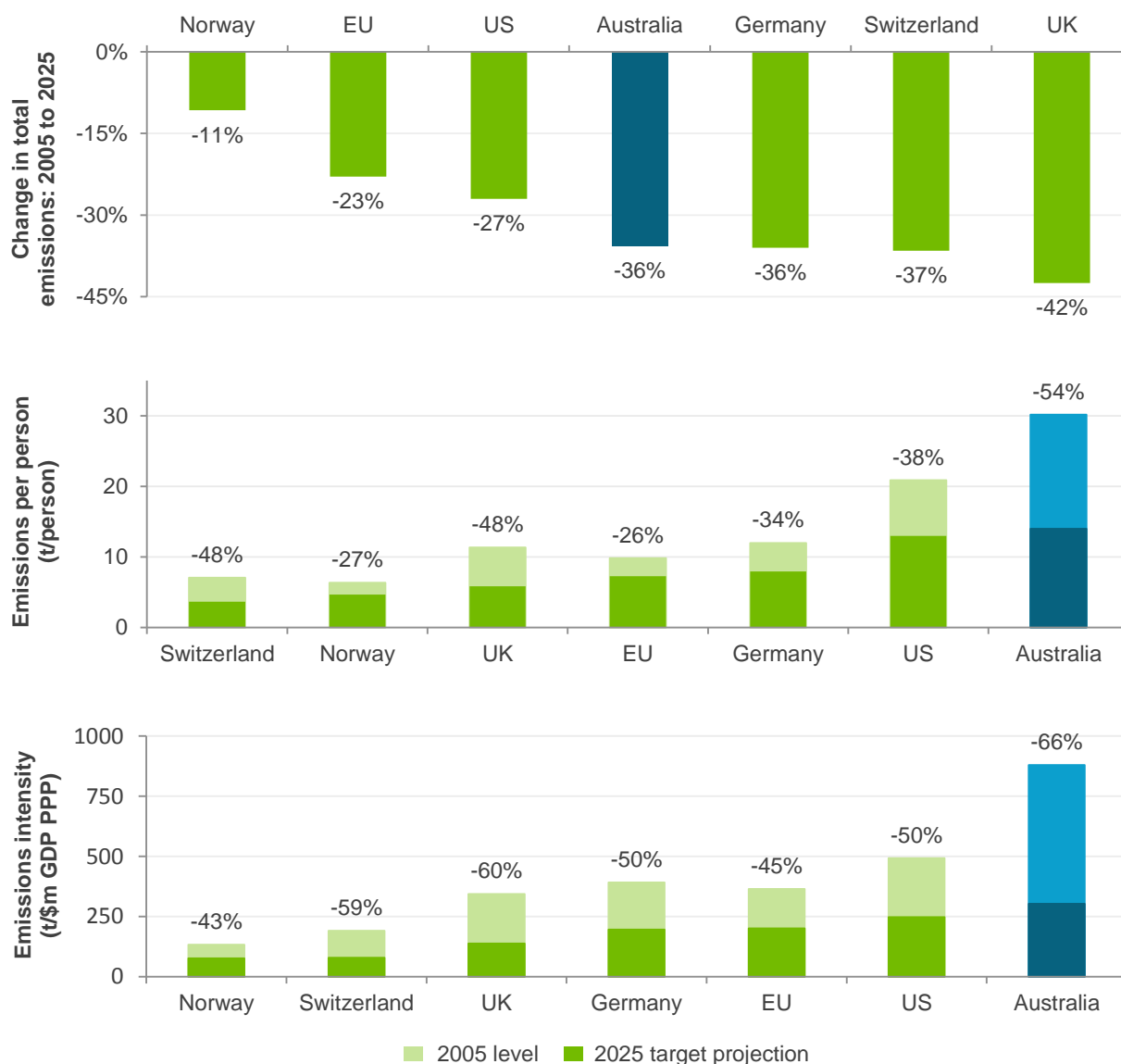
Australia also has extensive lower-emissions natural resource endowments, including large natural gas and uranium reserves and extensive renewable energy resources (IRENA 2012; OECD & IAEA 2014). These endowments reinforce Australia's capacity, as they provide opportunities to reduce Australia's emissions by switching to zero and lower emissions energy sources.

As noted earlier, in 2011 Australia was the 13th largest greenhouse gas emitter in the world, with the highest per person emissions of all developed countries. Australia also has a relatively emissions-intensive economy. Figure 3 shows Australia's emissions per person and emissions intensity in 2010. On these metrics alone, it could be argued that Australia has a moral responsibility to at least match the targets of comparable developed countries.

Given the present structure of Australia's economy, its energy intensity and its starting level of emissions, Australia would have to make greater efforts than many other countries to meet a given target. Based on various projections and assumptions, Figure 3 shows, for several measures of effort, that the recommended 30 per cent target would require relatively strong reductions in total emissions, emissions per person and emissions intensity; it also suggests that meeting this target would still leave Australia with measures of emissions per person and emissions intensity among the highest of developed countries.

Targets are often compared in terms of reductions of emissions relative to business-as-usual (BAU) levels but results based on this measure need to be interpreted carefully. BAU projections generally include the effects of existing policies (so can make countries that have already taken substantial action look less ambitious), and countries apply different economic and other assumptions in their projections (CCA 2015). For these reasons, more robust measures of effort—change in emissions intensity of GDP and in emissions per person—are presented here.

Figure 3 Comparing countries' targets, 2005 to 2025



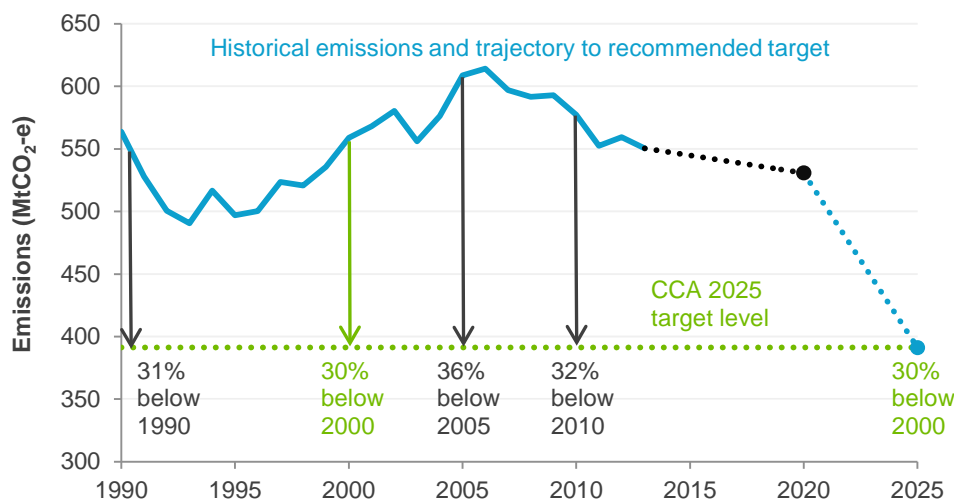
Note: Top panel: reductions are based on announced targets. The numbers below the bars are the percentage reductions from 2005 levels. Middle and lower panels: these show levels in 2005 and 2025; the numbers above the bars show the percentage change from 2005 levels. US figure is midpoint of its 2025 target range. EU, Norway, Switzerland and Germany figures are midpoints between their 2020 and 2030 targets. This figure uses UNFCCC emissions data (including land sector). This may not match countries' Kyoto Protocol emissions accounts (particularly for Norway). **Source:** Historical Emissions—Australia: 2014-15 Projections (DoE 2015); Remaining countries: (UNFCCC 2014a). Emissions targets—See Table 4. GDP and Population—See Figure 2.

Costs are obviously relevant to assessing relative effort. Australia's current economic structure and dependence on fossil fuels (particularly coal) for energy mean it must make a relatively greater effort than many other developed countries. The costs (and benefits) of the Authority's recommended target are considered further in Sections 6 and 7. The main point to note here is that costs depend heavily on the policies adopted to pursue targets, not just the strength of the targets themselves. A weak target could impose high costs if inefficient policies are used; conversely a strong target could be achieved at relatively modest cost if efficient policies are adopted.

Reference years and time frames are also relevant when comparing effort. The Government has sought views on what base year should be used for Australia's post-2020 target (PM&C 2015). Figure 4 shows how the recommended 2025 target of 30 per cent below 2000 levels compares with other possible

reference or ‘base’ years. Using a different reference year for a target does not change the effort required to meet it, but can make the target appear stronger or weaker depending on the particular circumstances surrounding the chosen base year.

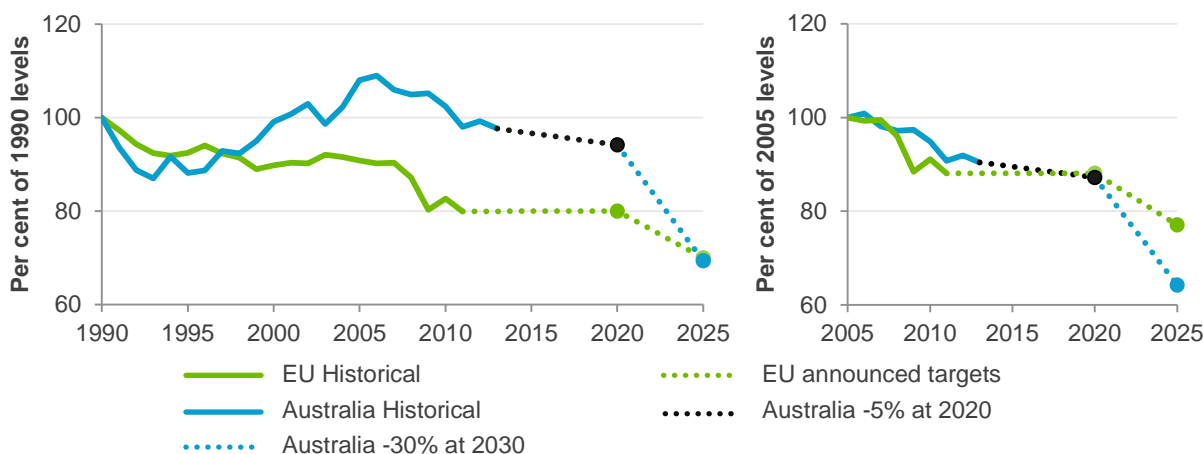
Figure 4 Recommended 2025 target for Australia: alternative base years



Source: Historical greenhouse gas emissions: (DoE 2015).

Australia’s targets are usually presented against a 2000 base year. When considered against a 1990 base year the recommended 2025 target for Australia appears essentially the same as the EU; a 2005 base year makes Australia’s targets appear much more ambitious (Figure 5). The earlier base year highlights the reductions the EU has already achieved, while the later base year highlights the reductions still to come.

Figure 5 EU and Australia emissions pathways, 1990 and 2005 base years



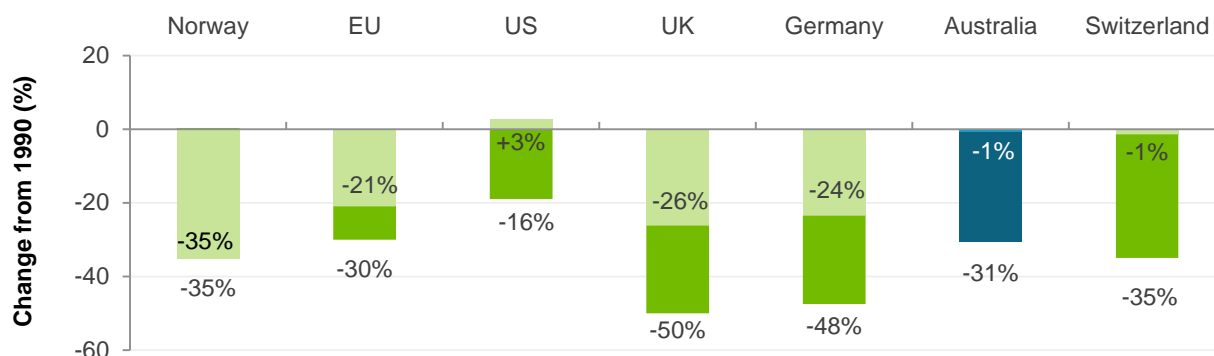
Note: To illustrate the effect of using different base years, the two panels index emissions at 1990 and 2005 levels. Australia’s emissions trajectory is to 5 per cent in 2020, then to the Authority’s recommended 30 per cent target in 2025. The EU trajectory is to 20 per cent in 2020, and 30 per cent in 2025 (the mid-point to the EU’s 2030 target of at least 40 per cent).

Source: As per Figure 3.

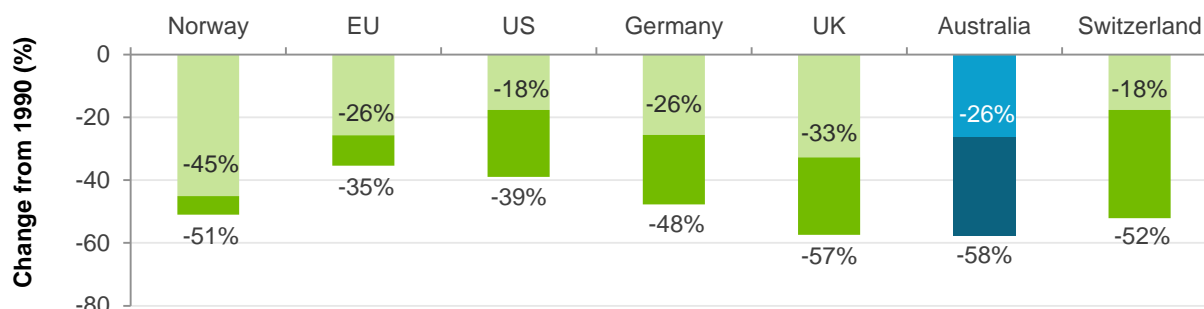
Figure 6 illustrates trends over time for a wider set of countries that have indicated targets for 2025, using three measures: changes in total national emissions, emissions per person and the emissions intensity of the economy. It distinguishes the reductions that have already occurred (1990-2012) from the reductions yet to come (2012-2025). Countries are ordered according to the reductions required to 2025 to meet announced targets: countries requiring the smallest future reductions are on the left; countries requiring the largest future reductions on the right.

Figure 6 Emissions reductions: 1990 to 2012, and to 2025 targets

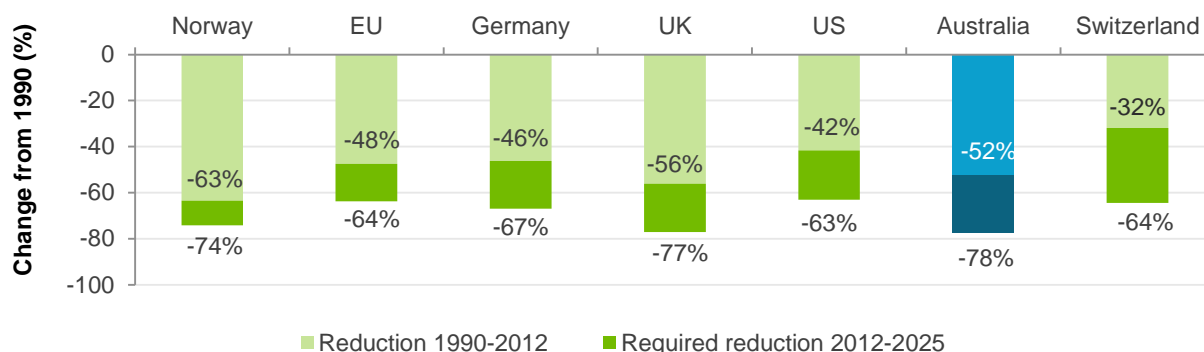
Total emissions



Emissions per person



Emissions intensity



■ Reduction 1990-2012 ■ Required reduction 2012-2025

Note: Numbers in light green bars show change 1990-2012 and numbers below bars show total change 1990-2025. This figure uses UNFCCC emissions data (including land sector). This may not match countries' Kyoto Protocol emissions accounts (particularly for Norway).

Source: See Figure 3.

Most of these countries have reduced their total emissions, and all have reduced their emissions per person and emissions intensity since 1990. All countries' targets imply further improvements. In general, the countries that have achieved the least reductions to date are proposing to lift their efforts in the post-2020 period. The Authority's recommended 30 per cent target for Australia would require relatively large reductions, but this should be seen against comparatively small reductions—particularly

in total emissions—over the past two decades. Larger reductions are inevitable if Australia is to ‘catch-up’ and match the efforts of other comparable countries.

In the Authority’s judgment, based on the preceding discussion, an Australian emissions reduction target of 30 per cent below 2000 levels by 2025 would be broadly comparable to the targets announced by other relevant countries. It would mean that, by 2025, Australia would have narrowed (but not closed) the gap between its per person emissions and emissions intensity levels and those of other similar, comparable developed countries.

A trajectory range to 2030

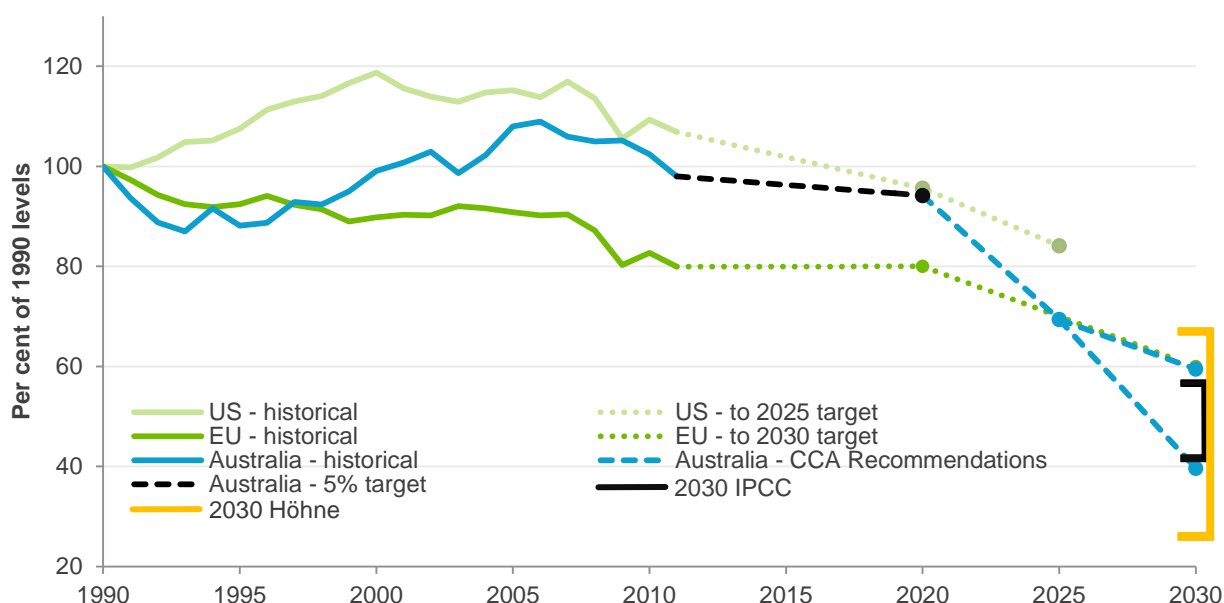
As noted earlier, while there is no prescribed time horizon for post-2020 targets the Authority recommends the Government set a single target for 2025, and a trajectory range to 2030. This provides reasonable flexibility to adjust and respond to new information, including on climate science and international action, rather than being locked into a single target more than a decade into the future.

A 30 per cent target by 2025 is consistent with the medium-term emissions reduction goals recommended in the Authority’s Targets and Progress Review (CCA 2014d). That Review recommended that Australia reduce emissions by between 40 and 60 per cent below 2000 levels by 2030. A 30 per cent target by 2025 lies at the lower (weaker) edge of that trajectory range. Beyond 2025, the Authority considers its previously recommended trajectory range remains appropriate.

The recommended 2030 range appears consistent with international benchmarks of the action required to limit warming to 2 degrees. Höhne et al. (Höhne *et al.* 2014), for example, reviewed over 40 studies of global emissions reduction pathways. They found that OECD nations in aggregate would need to contribute about a 50 per cent reduction in emissions from 2010 levels by 2030 (within a range of 37 to 75 per cent) for the world to have a roughly even chance of staying below 2 degrees. Non-OECD countries would also have to take significant action.

Figure 7 compares the recommended 30 per cent target by 2025 and 40 to 60 per cent trajectory to 2030 for Australia with the EU and United States targets. These targets are also compared with the OECD range from Höhne et al. The weaker bound of the Authority’s recommended 2030 trajectory range for Australia and the EU’s 2030 target compare well on this measure. The United States would need to accelerate its emissions reductions beyond 2025 to fall within the identified range. The stronger bound of the recommended 2030 trajectory range provides scope for Australia to remain in line with others if global action continues to strengthen.

Figure 7 Countries' emissions trajectories to the 2 degree goal



Note: Australia: trajectory shows historical emissions, a 5 per cent 2020 target, a 30 per cent 2025 target, and the trajectory range to 2030. Höhne: Illustrated range at 2030 of 33-74 per cent reductions from 1990 levels corresponds to published estimate of 37-75 per cent reductions from 2010 levels. IPCC: Illustrated range at 2030 is a straight line interpolation between IPCC estimates of required reductions of 25-40 per cent from 1990 levels by 2020, and 80-95 per cent by 2050, for Annex I (developed) countries, as part of global action to give an even chance of stabilising temperatures at two degrees.

Source: See Figure 3. Höhne range: (Höhne *et al.* 2014). IPCC range: (IPCC 2007a).

5. HOW AUSTRALIA'S AND GLOBAL EFFORTS CONTRIBUTE TO CLIMATE GOALS

In setting its targets, Australia needs to look not only at other countries' current pledges to reduce emissions in the decade or so ahead but also at the overall goal of limiting global warming to less than 2 degrees. Science can determine, for different probabilities, the maximum level of global emissions that can be emitted before warming exceeds 2 degrees (that is, the global budget). What constitutes Australia's fair share of that budget, however, is a matter of judgment.

A global budget for 2 degrees

Emissions budgets serve to define overall limits for global and national emissions. As discussed in Section 1, global warming results from an increased concentration of greenhouse gases in the atmosphere, rather than emissions in any one year. These concentrations are determined by cumulative emissions over an extended period, given greenhouse gases stay in the atmosphere for a long time. Emissions budgets link cumulative emissions of greenhouse gases to prospective temperature increases and thereby help to communicate the ongoing scale of the challenge to limit global warming, as explained by climate science.

Box 1 Selecting a global emissions budget

Budgets are expressed as cumulative greenhouse gas emissions over a period of time and defined in terms of their probability of restricting global warming to a specified level. In its Targets and Progress Review, the Authority used a global emissions budget that provides a likely chance (67 per cent probability) of limiting warming to 2 degrees or less to help determine a long term emissions budget for Australia. This budget corresponds to around a 90 per cent chance of staying below 3 degrees and more than 95 per cent chance of staying below 4 degrees.

Tighter global budgets (that is, lower total emissions) provide a higher probability of keeping global warming below 2 degrees and help minimise the chance of greater warming.

The Authority used a multi-gas budget covering gases regulated by the Kyoto Protocol, rather than only carbon dioxide, to better recognise the range of activities and gases contributing to global warming. The global emissions budget used by the Authority is approximately 1,700 gigatonnes of carbon dioxide equivalent (Gt CO₂-e) over 2000-2050 (Meinshausen *et al.* 2009, p. 1161; CCA 2014d, p. 47; IPCC 2007b). About 36 per cent of this global budget had already been used up between 2000 and 2012 (CCA 2014d, p. 117).

From global to national budgets

Another way of assessing whether Australia is making its fair contribution to global action to keep warming below 2 degrees (separate from the comparability approach discussed in Section 4), is to consider Australia's utilisation of its 'fair share' of the global emissions budget. Through the UN Framework Convention, countries have agreed to make equitable contributions to avoiding dangerous climate change, taking account of differences in national capacity and responsibility. Determining how to balance these different aspects involves value judgments; these judgments lie at the heart of different approaches to determining what constitutes 'fair' shares.

In its Targets and Progress Review, the Authority concluded that, in the long term, it is fair that all countries have equal rights per person to emit. It went on to calculate a fair share of the global emissions budget for Australia, according to a 'modified contraction and convergence' approach, in which countries contract from their current emissions per person and converge to equal rights by 2050 (CCA 2014d, p. 117). The approach used was developed by Professor Garnaut (2008, pp. 206–208) and allows fast-growing developing countries a transitional period of additional growth before they decline to the global average level. Many submissions to the Targets and Progress Review supported this approach. The Authority considers this approach to be conceptually fair and consistent with the equity principles embodied in the UNFCCC and the Authority's statutory guidance. While some approaches would result in a larger share for Australia, many others would result in a smaller share—for example, approaches based on immediate convergence to equal emissions per person and approaches that take account of historical emissions.

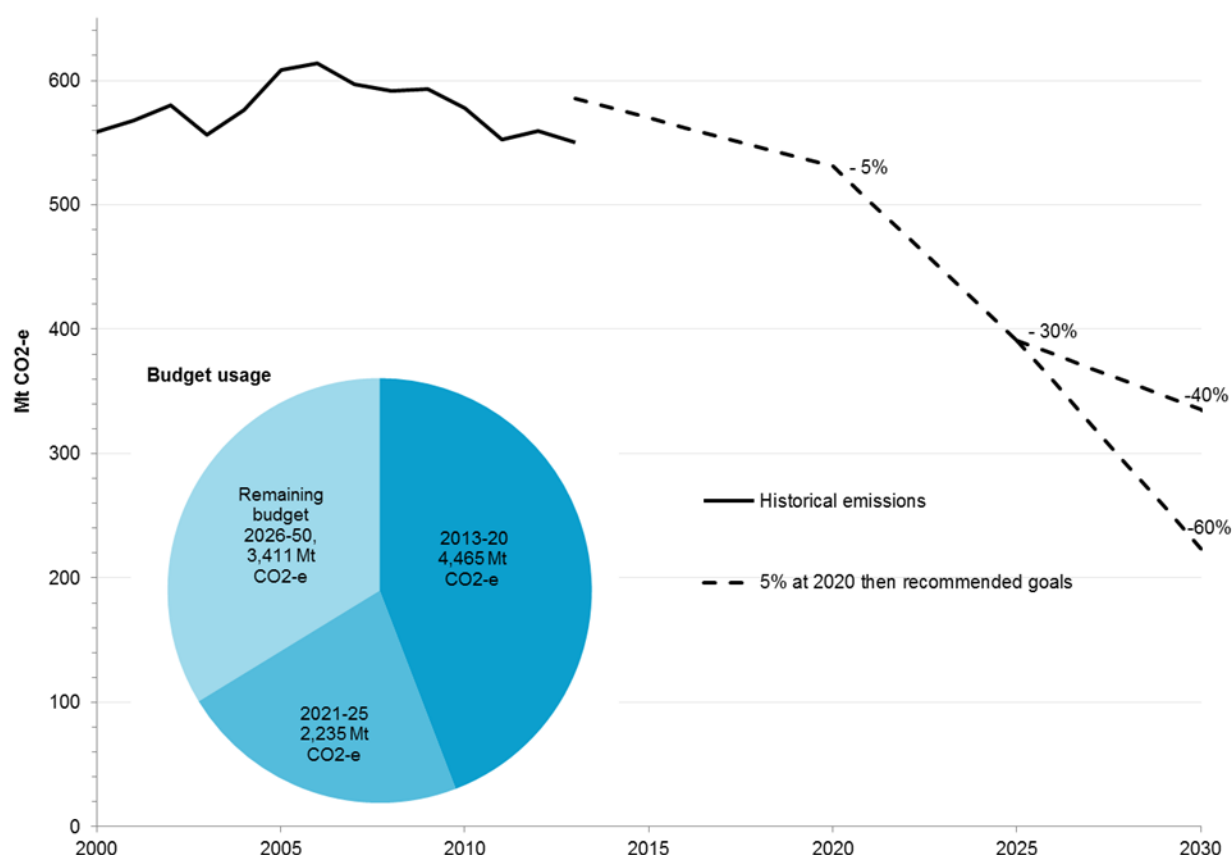
Applying the modified contraction and convergence approach, the Authority calculated a long term national emissions budget for Australia of 10.1 Gt CO₂-e for the period 2013 to 2050. This represents Australia's fair share of global action that is estimated to provide a likely chance (67 per cent probability) of achieving the 2 degree goal and provides a relevant long-term backdrop to setting short- and medium-term targets.

From national budgets to targets

Long-term budgets do not tightly prescribe the timing or pace of emissions reductions; a number of different pathways for national emissions could limit Australia's cumulative emissions to its 'fair share' long-term national budget. Budgets do, however, make clear the trade-off between actions taken earlier and those made necessary later. Weaker targets use up more of the budget now and leave more of the required mitigation effort to Australians in the future. Stronger near term targets preserve options for Australia to scale up (or down) its future action to respond to changes in the science or level of global action.

Figure 8 illustrates the implications of a 5 per cent 2020 target and the recommended 30 per cent 2025 target for the distribution of effort over time. Table 5 shows the corresponding rates of reduction for each time period and how quickly Australia's derived long-term budget is exhausted.

Figure 8 Relationship between targets, trajectories and national emissions budget



Note: The trajectory is calculated from Australia's first Kyoto target (108 per cent of 1990 levels) in 2010, the mid-point of the first Kyoto commitment period. Levels are based on emissions figures and projections updated in 2015. The recommended trajectory range to 2030 reflects the 30 per cent target in 2025.

Source: Historical greenhouse gas emissions: (DoE 2015). All other data: Climate Change Authority.

Table 5 illustrates the general point that modest efforts by Australia to reduce its emissions over the years immediately ahead will necessitate much more intensive efforts in the years beyond 2020 just to match the efforts of comparable countries by 2025—and will need to be sustained long thereafter if Australia is to make its fair contribution to achieving the global 2 degree goal.

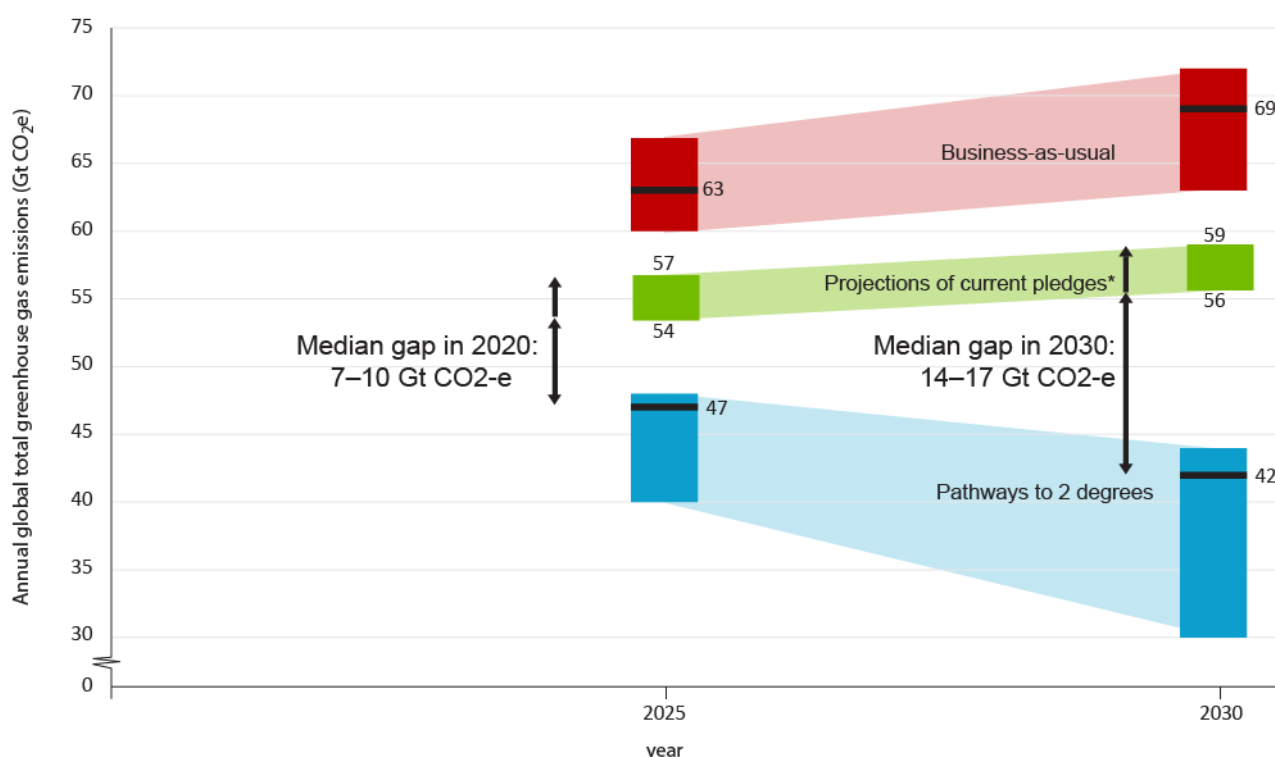
Table 5 Rate of emissions reduction and budget use for 2020 and 2025 targets

Target points (2020/2025)	Average percentage change			Budget	
	2010-20	2020-25	Post 2025	Share of long-term budget remaining after 2025, year exhausted	2021-25 budget (Mt CO ₂ -e)
5/30	-1.3	-4.6	-3.6	34 per cent, 2044	2,235

Note: The year the budget is exhausted is based on a straight line trajectory post-2025 that runs until the long-term budget is exhausted.

The global budget approach highlights the need for all countries—not just Australia—to intensify their efforts to reduce emissions. Despite global agreement to limit warming to less than 2 degrees, and despite signs of growing momentum, the UN Environment Programme (UNEP) projects aggregate global reductions still fall short of what is required to put the world on a clear pathway to the 2 degree goal. Looking out to 2030, UNEP estimates the difference between projections based on current emissions reduction pledges and pathways to 2 degrees is equivalent to about one third of current annual global emissions (Figure 9). UNEP believes, however, that it is still feasible to limit warming to less than 2 degrees.

Figure 9 UNEP Emissions Gap Report: outlook to 2030



Note: This chart is adapted from UNEP Gap report. Business-as-usual scenarios exclude country pledges and action after about 2008—the median and 20-80th percentile range are shown. These scenarios are consistent with 4 degrees of warming. The blue band shows pathways consistent with a likely chance of limiting global warming by 2100 to 2 degrees—the median and 20-80th percentile range are shown. These projections are based on the large range of scenarios in the IPCC database, sourced from multiple models.

Source: UNEP (2014) with scenarios from IPCC (2014c).

6. WHY THE RECOMMENDED TARGETS ARE IN AUSTRALIA'S BEST INTERESTS

The Authority believes it is unarguably in Australia's interests that an effective international agreement to reduce greenhouse gases be reached in Paris. As noted earlier, as the driest inhabited continent, Australia is particularly exposed to the adverse impacts of climate change. Sustained global cooperation and action are essential to properly manage these risks, and Australia needs to demonstrate it is up to carrying its share of the load.

In setting targets that are in Australia's best interests, all relevant costs, benefits and risks should be assessed. This is not an easy task. The main benefits, for example, come from effective global action to reduce the adverse effects of climate change, which depends among other things on the emissions reduction targets to be adopted by Australia and other countries in Paris. On the other side of the equation, the costs to Australia will depend heavily on the particular suite of measures implemented to pursue Australia's target—another area of some uncertainty at this time.

A better assessment of the net benefits (or costs) to Australia will become possible as these current uncertainties are resolved. The Authority's judgment, however, is that its recommended targets—backed by appropriate policy measures—are very much in Australia's best interests.

Costs of recommended targets

Some opportunities to reduce emissions, especially those that improve energy efficiency, can provide net benefits, even without factoring in the climate-related benefits. The Authority has argued, for example, that introducing light vehicle emissions standards would reduce emissions while also reducing costs to consumers. While such actions can deliver useful emissions reductions, further measures required to achieve substantial additional reductions would come at some cost.

Costs can impact in a variety of ways, depending on the policies used. Consumers may have to pay more for goods and services that are emissions intensive to produce. Some firms may experience declining sales (and profits) as their customers switch to less emissions-intensive products. Other firms may lose market share to competitors in countries that are not affected (or less affected) by emissions reduction policies. More generally, the transformation to a lower emissions economy is likely to affect industry sectors and regions unevenly, which can lead to transition costs.

Some means of reducing emissions produce benefits that are not related to climate change. These co-benefits can, to some extent, offset the costs of reducing emissions; for example:

- shifting to renewable energy can reduce local air pollution, which can have significant health benefits (Doctors for the Environment Australia 2015, *Submission*)
- planting forests to sequester carbon (that is, remove carbon dioxide from the atmosphere) can also provide biodiversity and other benefits (CCA 2014a).

It is the sum of all relevant costs (net of co-benefits) that is most relevant in assessing the costs of possible targets, rather than any one particular type of cost or impact on any particular sector or group. Concerns are often raised, for example, about the potential for emissions reduction efforts to harm the international competitiveness of Australian firms (Minerals Council of Australia 2015, *Submission*; Australian Industry Greenhouse Network 2015, *Submission*); this issue is also raised specifically in the

terms of reference for the Special Review. Such concerns are understandable, but are best addressed through the design of policies so as to (for example) assist particular activities—such as those of trade-exposed industries—to better withstand competition from industries in countries that are not taking comparable action. Compensation might also be appropriate to protect low-income households and other disadvantaged groups. These issues will be considered in Reports 2 and 3 of the Special Review.

As noted earlier, the Authority is not in a position to prepare meaningful estimates of the costs of meeting its recommended target, primarily because many of these costs will depend on the policies adopted. (For this and other reasons, it is also not possible to make meaningful comparisons of the costs Australia and other countries might incur in pursuing their respective targets.) Using inefficient policies to achieve a weak target could well have higher costs than pursuing a strong target through efficient policies. The Authority will examine Australia's policy options and their associated costs in the later stages of the Special Review.

In its 2014 report on targets, the Authority calculated—based on modelling by the Treasury, and assuming a set of efficient policies—that the overall cost of strengthening Australia's 2020 target (from minus 5 per cent to minus 19 per cent) would be quite modest, equivalent to slowing average annual growth in income per person by 0.02 percentage points over the period to 2020 (CCA 2014d). Assuming similarly efficient policies were used, the Authority believes it would be reasonable to anticipate that the costs of meeting its recommended 2025 target would also be modest (relative to the outcome under a weaker target).

Benefits of recommended targets

The introduction to the 2015 Intergenerational Report mentioned earlier noted that 'It is difficult for individual governments to control or affect the collective and cumulative impact of human activity globally' (Australian Government 2015, p. xii). This view probably downplays the influence that some countries, through strong leadership, can have on the actions of some other countries but it does underline the need for all countries to do their fair share of the work required to combat global problems like climate change.

By making its fair contribution to reducing greenhouse gas emissions, Australia will demonstrate that it is behaving as a good global citizen and has a legitimate right to expect other countries to behave similarly. For the reasons detailed in this report, the Authority believes the Government's adoption of the recommended 2025 target of a 30 per cent reduction in emissions from 2000 levels would deliver this recognition and right.

The targets recommended in this report would also assist Australia's transition to a low-emission economy. This transition will take time and require sustained endeavours in a number of areas. Perhaps most of all it will require the Australian Government to clearly articulate to the whole community that this transition is necessary and will be supported. A credible 2025 target that matched those of comparable countries would be a significant step in that direction.

It would, moreover, send clear signals to investors, encouraging increased attention to new areas and discouraging further investments in long-lived assets that lock-in high emissions (which might later need to be prematurely retired, at considerable expense). These same signals would also encourage Australians to develop expertise and a comparative advantage in using low-emission technologies and practices.

This latter benefit is not inconsistent with the Authority's earlier advocacy of the benefits of purchasing international emissions reductions to complement policies to reduce domestic emissions. Rather, it points to the need for a balance between achieving emissions reductions in Australia and purchasing them from overseas. Using international purchases to complement domestic action potentially lowers the cost of achieving particular targets and assists Australia to continue to exploit its comparative advantage in some emissions-intensive activities, without compromising its contribution to international action. The 'right' balance of domestic and international reductions is likely to change over time; again it can best be achieved through careful policy design, rather than through targets which prescribe the source of reductions. These issues will be taken up in the subsequent stages of the Special Review.

7. ARE THE RECOMMENDED TARGETS ACHIEVABLE?

The Authority has consistently argued that Australia should build a comprehensive suite (or 'toolbox') of market and non-market policies to deliver necessary emissions reductions at least cost. Such a toolbox does not exist at present. While the Emissions Reduction Fund (ERF), the central plank of the government's Direct Action Plan, does operate across all sectors, there are low-cost emissions reduction opportunities that it is not able to access (CCA 2014a). The planned ERF Safeguard Mechanism, which will impose penalties for major emitters who exceed a baseline level, could also assist, but this will depend crucially on the baselines that are set.

The Authority's analysis, and experience from overseas, suggests that it is feasible to implement policies to meet the recommended 2025 target while still maintaining strong economic growth (CCA 2014d). A range of possible measures is available. The European Union has introduced a region wide emissions trading scheme (ETS), while the Republic of Korea, China, the United States, Japan and some other countries have ETSS, either at the national or sub-national level. China, for example, has pilot ETSS in seven regions and cities; the coverage of these schemes is approaching one quarter of China's total emissions. Several other countries, including Chile and Mexico, have opted for an emissions tax. Targets and other incentives for renewable energy, and regulated energy efficiency standards for appliances, buildings and vehicles, have been adopted in many countries.

The second and third parts of this Special Review will examine and recommend policies to achieve post-2020 targets. The Review's terms of reference require the Authority to consider the case for an ETS specifically, but provides scope to consider other policies, either to complement an ETS or as alternatives.

In previous reports, the Authority has examined a number of policy options.

- The Authority's most recent review of the Renewable Energy Target found that it was effective in reducing emissions at reasonable cost in the centrally important electricity sector (CCA 2014b). The review made the case for urgent action to end the policy uncertainty that has hampered the scheme's recent operation. The Authority recommended the existing Large-scale Renewable Energy Target not be scaled back but, given the sharp decline in investor confidence and the need for incumbent generators to adjust to falls in projected electricity demand, that it be deferred by up

to three years. The review also proposed that consideration be given to whether targets should be increased and extended and whether coverage should be expanded to a wider set of technologies, after 2020.

- The Authority also reported that introducing light vehicle emissions standards could significantly reduce Australia's greenhouse gas emissions. This policy could increase the average cost of a new car, but any additional costs would be offset several times over by fuel savings, leaving motorists (and the community more generally) better off. Customer choice could be preserved by setting the standard as an average across the fleet, rather than applying it to individual vehicles. Many other countries, including the United States, Canada, Korea, China, India and the European Union already have light vehicle emissions (or fuel economy) standards. As the fuel efficiency of light vehicles in Australia lags behind that in many other countries, the introduction of emissions standards appeals as a relatively straight-forward and cost effective opportunity to help reduce the carbon intensity of the economy.
- The Authority considered the role that international emissions reductions could play in helping to meet Australia's emissions reduction targets in its Targets and Progress Review (CCA 2014d). It has also examined the practicalities of accessing international emissions markets (CCA 2014c). This work shows that international purchases can be an environmentally sound and cost-effective complement to domestic measures to reduce emissions. The purchase of international units remains a particularly attractive option at present because prices are low.

The Authority will be reporting on possible policies to reduce emissions, including those mentioned briefly above, in the subsequent stages of this Special Review.

APPENDIX A TERMS OF REFERENCE



15 DEC 2014

COMMONWEALTH OF AUSTRALIA

SPECIAL REVIEW BY THE CLIMATE CHANGE AUTHORITY

By this written instrument I, Greg Hunt, Minister for the Environment, request that the Climate Change Authority conduct a review under section 59 of the *Climate Change Authority Act 2011*, as below:

- Assess whether Australia should have an Emission Trading Scheme in the future and what conditions should trigger the introduction of such a scheme.
- This review must consider:
 - whether the USA, China, Japan, Republic of Korea and the EU have established ETSS or equivalent schemes that have similar effect;
 - Australia's international commitments and undertakings under the United Nation's Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to which Australia is a party;
 - whether Australia should introduce an ETS that does not harm Australian businesses international competitiveness; and
 - what future emissions reduction targets Australia should commit to as part of an effective and equitable global effort to achieve the objective of the UNFCCC (Article 2) or subsequent agreement to which Australia is a party.

Timing

- The Authority should issue a draft report on what future emissions reduction targets Australia should agree to for public consultation by 30 June 2015.
- The Authority should issue a draft report on an Emissions Trading scheme for public consultation by 30 November 2015.
- The Authority should issue a final report by 30 June 2016 recommending what action Australia should take to implement outcomes flowing from the Paris conference.

Dated 10 December 2014

Greg Hunt

Minister for the Environment

APPENDIX B PUBLIC CONSULTATION

The Authority is required to conduct public consultation for all of its reviews. On 9 February 2015, the Authority called for submissions on Australia's post-2020 targets. The Authority received 24 submissions from a wide range of interested parties, including the public, business, and environment and community groups (Table 6). These submissions are available on the Authority's website: <http://www.climatechangeauthority.gov.au/submissions/submissions-received>.

The Authority also reviewed submissions to its 2014 Targets and Progress Review that were relevant to the Special Review.

There will be further opportunities through the Special Review for stakeholders to provide their thoughts on other matters, including the relative merits of different emissions reduction policies and the right policy mix for Australia.

Table 6 Submissions to the call for comment on targets

Acciona Energy	Gillian Pechey
Australian Academy of Science	Green Building Council of Australia
Australian Industry Greenhouse Network	Hydro Tasmania
Australian Medical Students Association	Joint submission - Climate and Health Alliance and Public Health Association of Australia
Australian Petroleum Producers & Exploration Association	Minerals Council of Australia
Barbara Fraser	National Farmers Federation
Business Council of Australia	Origin Energy
Chris Nunn JLL	Sustainable Business Australia
Doctors for the Environment Australia	The Climate Institute
Energy Supply Association of Australia	Tim Kelly
Enhar Sustainable Energy Solutions	U3A Climate Conversation Group
Eva Nilsson	WWF Australia

GLOSSARY

2 degree goal	The global goal to limit global average warming to less than 2 degrees above pre-industrial levels. This goal has been agreed by the 196 signatories to the United Nations Framework Convention on Climate Change (UNFCCC).
Annex I countries/Parties	Industrialised countries and economies in transition listed in Annex I to the UNFCCC.
Assessment Report	Comprehensive assessment of the state of climate change science published by the Intergovernmental Panel on Climate Change.
business-as-usual emissions trend	Emissions that would occur without any policy intervention (or without additional policy intervention).
carbon dioxide equivalent	A measure that quantifies different greenhouse gases in terms of the amount of carbon dioxide that would deliver the same global warming.
carryover	An emissions allowance that can be 'carried over' to the next commitment period of the Kyoto Protocol. This allowance arises when a country has performed better than its Kyoto target.
climate change	A long-term change in global or regional climate patterns. In this report, 'climate change' refers to changes resulting from human activity.
climate system	A highly complex global system consisting of five major components—the atmosphere, the land surface, the biosphere, frozen and liquid water, and the interactions between them.
commitment period	A timeframe of binding national goals under the Kyoto Protocol. The first commitment period was five years from 2008–2012. The second commitment period is eight years from 2013–2020.
Direct Action Plan	The Commonwealth Government's policy to reduce greenhouse gas emissions and establish a clean-up and environment conservation program. A central element of the plan is the Emissions Reduction Fund.
electricity emissions	Emissions released when fuels, such as coal and natural gas, are combusted to generate electricity.
emissions budget	A cumulative emissions allowance over a period of time.
emissions intensity	A measure of the amount of emissions associated with a unit of output; for example, emissions per unit of gross domestic product.
emissions reduction	The act or process of limiting or restricting greenhouse gas emissions.
Emissions Reduction Fund	A \$2.55 billion fund to allocate money through a reverse auction to eligible projects and activities that reduce emissions.

emissions reduction goal	Any emissions reduction objective, such as an emissions reduction target or target range, an emissions budget or an emissions trajectory. Includes a pledge to reduce or limit emissions made under the UNFCCC.
emissions reduction target	A goal for national emissions in a specific year.
emissions rights	The rights of individuals or countries to emit greenhouse gases.
emissions trading scheme	A market-based approach to reducing emissions that places a limit on emissions allowed from all sources covered by the scheme. Emissions trading allows entities to trade emissions units with other entities.
emissions unit	One metric tonne of carbon dioxide equivalent that is emitted, reduced or removed from the atmosphere.
global emissions budget	The total amount of emissions projected to result in a given rise in global temperature. Budgets are expressed in terms of probabilities to reflect uncertainties about the exact temperature effect of a given amount of emissions. The Authority has used a budget giving a 67 per cent chance of causing warming of less than 2 degrees as a reference for Australia's goals.
global warming	A warming of the Earth's average temperature caused by increased atmospheric concentrations of greenhouse gases. This warming results in changes to the climate system.
greenhouse gas	Any gas (natural or produced by human activities) that absorbs infrared radiation in the atmosphere. Key greenhouse gases include carbon dioxide, water vapour, nitrous oxide, methane and ozone.
gross domestic product	A measure of the value of economic production in the economy.
gross national income	An economic measure that reflects gross domestic product, the terms of trade and international income transfers.
Industrial period	The period after 1750.
Intergovernmental Panel on Climate Change	An international scientific body operating under the auspices of the United Nations. Its role is to review, assess and synthesise the latest information on climate change.
international emissions reduction units	An emissions unit from an international source that is accepted for compliance with a target set nationally, under the Kyoto Protocol, or as part of the new international agreement.
land use, land use change and forestry (emissions)	Changes in emissions associated with human-induced changes in land use, such as deforestation, afforestation and forest management.
Kyoto Protocol	An international agreement adopted under the UNFCCC in 1997. It includes binding national targets for developed countries and flexible mechanisms including the Clean Development Mechanism (CDM).
national emissions budget	A country's cumulative emissions allowance over a period of time.

net targets	The recommended emissions reduction goals are net of trade. This means Australia could buy international emissions reductions units to help meet its target and that any emissions reductions generated in Australia and sold overseas would not be counted. Emissions in Australia could be higher than the target if offset by sufficient purchases of international emissions reductions.
parts per million	A measure of the concentration of greenhouse gases in the atmosphere. One part per million is equivalent to one cubic centimetre of gas per cubic metre of air.
pre-industrial period	The period before 1750.
Renewable Energy Target	A Commonwealth Government scheme that places a legal obligation on electricity retailers and large electricity users to buy a certain proportion of their electricity from eligible renewables-based generation.
trajectory	An indicative year-by-year emissions pathway to an emissions goal.
trajectory range	A range within which future targets and trajectories may be set.
unconditional target	A target that stands irrespective of the actions of other countries. The Commonwealth Government has specified a set of conditions for strengthening Australia's 2020 emissions reduction target from an unconditional 5 per cent up to 15 per cent or 25 per cent reductions.
United Nations Framework Convention on Climate Change	An international treaty that commits signatory countries (Parties) to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous, human-induced interference with the climate system.

ABBREVIATIONS AND ACRONYMS

AR4	Fourth Assessment Report of the Intergovernmental Panel on Climate Change
AR5	Fifth Assessment Report of the Intergovernmental Panel on Climate Change
BAU	business-as-usual
CO₂	carbon dioxide, a greenhouse gas
CO₂-e	carbon dioxide equivalent
CFI	Carbon Farming Initiative
CH₄	methane, a greenhouse gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIICCSRTE	(former) Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
DoE	Department of the Environment
ERF	Emissions Reduction Fund
ETS	Emissions Trading Scheme
EU	European Union
EU ETS	European Union Emissions Trading System
GCF	Green Climate Fund
GDP	gross domestic product
GNI	gross national income
GJ	gigajoule (energy, one billion (10 ⁹) Joules)
Gt	gigatonne (mass, one billion (10 ⁹) metric tonnes)
GW	gigawatt (power, one billion (10 ⁹) watts)
HDI	Human Development Index
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
Mt	megatonne (mass, one million metric tonnes)
OECD	Organisation for Economic Co-operation and Development
ppm	parts per million
PPP	purchasing power parity

t	tonne (mass, one metric tonne)
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America

8. REFERENCES

- Australian Academy of Science 2015**, *The science of climate change: Questions and answers*, viewed 17 Apr. 2015, <https://www.science.org.au/climatechange>.
- Australian Government 2015**, *2015 Intergenerational Report: Australia in 2055*.
- Bambrick H, Dear K, Woodruff R, Hanigan I, McMichael A 2008**, *The impacts of climate change on three health outcomes: temperature-related mortality and hospitalisations, salmonellosis and other bacterial gastroenteritis, and population at risk from dengue*, prepared for the Garnaut Climate Change Review, viewed 17 Apr. 2015, Canberra, [http://garnautreview.org.au/CA25734E0016A131/WebObj/03-AThreehealthoutcomes/\\$File/03-A%20Three%20health%20outcomes.pdf](http://garnautreview.org.au/CA25734E0016A131/WebObj/03-AThreehealthoutcomes/$File/03-A%20Three%20health%20outcomes.pdf).
- Ban Ki-moon 2015**, *2014 Climate Change Summary – Chair’s Summary*, viewed 19 Mar. 2015, New York, <http://www.un.org/climatechange/summit/2014/09/2014-climate-change-summary-chairs-summary/>.
- Bloomberg New Energy Finance (BNEF) 2015**, *Commentary: India*, viewed 20 Apr. 2015, <https://www.bnef.com/core/country-profiles/IND/commentary>.
- Bureau of Energy Efficiency 2012**, *PAT: Perform, Achieve and Trade*, Ministry of Power, Government of India, India.
- Climate Change Authority (CCA) 2014a**, *Carbon Farming Initiative Review*, Melbourne.
- CCA 2014b**, *Renewable Energy Target Review*, Melbourne.
- CCA 2014c**, *Using International Units to Help Meet Australia's Emissions Reduction Targets*, Melbourne.
- CCA 2014d**, *Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review*, Melbourne, <http://www.climatechangeauthority.gov.au/reviews/targets-and-progress-review-3>.
- CCA 2015**, *Comparing Countries Emissions Targets: A Practical Guide*, Melbourne.
- Committee on Climate Change 2015**, *Carbon budgets and targets*, viewed 08 Apr. 2015, <http://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/>.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2010**, *Climate change - science and solutions for Australia*, CSIRO Publishing, Melbourne.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) Bureau of Meteorology (BOM) 2014**, *State of the Climate*, viewed 17 Apr. 2015, <http://www.bom.gov.au/state-of-the-climate/>.
- Department of Defence 2013**, *Defence White Paper*, viewed 17 Apr. 2015, <http://www.defence.gov.au/whitepaper/2013/>.
- Department of Energy & Climate Change 2009**, *Carbon Accounting Regulations 2009*, No. 1257, viewed 01 Apr. 2015, http://www.legislation.gov.uk/ukxi/2009/1257/pdfs/ukxi_20091257_en.pdf.
- Department of Environmental Affairs 2010**, *South Africa Communication to Executive Secretary of the UNFCCC*, viewed 02 Apr. 2015, Republic of South Africa, https://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/southafricacphaccord_app2.pdf.
- Department of the Environment (DoE) 2015**, *Australia's emissions projections 2014-15*, Canberra.
- Department of the Prime Minister and Cabinet (PM&C) 2015**, *Setting Australia's post-2020 target for greenhouse gas emissions: Issues paper*, viewed 09 Apr. 2015,

<http://www.dpmc.gov.au/pmc/publication/setting-australias-post-2020-target-greenhouse-gas-emissions-issues-paper>.

ECOFYS Climate Analytics PIK New Climate Institute 2014, *China, US and EU post-2020 plans reduce projected warming*, viewed 05 Jan. 2015, <http://climateactiontracker.org/news/178/China-US-and-EU-post-2020-plans-reduce-projected-warming.html>.

European Environment Agency (EEA) 2014, *Trends and projections in Europe 2014 — Tracking progress towards Europe's climate and energy targets for 2020*, viewed 30 Mar. 2015, Luxembourg.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Germany) 2010. Energy Concept: for an Environmentally Sound, Reliable and Affordable Energy Supply.

Garnaut R 2008, *The Garnaut Climate Change Review: Final Report*, Cambridge University Press, Melbourne.

Hoegh-Guldberg O, Mumby PJ, Hooten AJ et al. 2007. Coral reefs under rapid climate change and ocean acidification, *Science* 318, pp.1737–42.

Höhne N, den Elzen M, Escalante D 2014. Regional GHG reduction targets based on effort sharing: a comparison of studies, *Climate Policy* 14, pp.122–47.

Indian Energy Exchange 2015, *Energy Saving Certificates*, viewed 09 Apr. 2015, <http://www.iexindia.com/pdf/products/PAT.pdf>.

Intergovernmental Panel on Climate Change (IPCC) 1990, *Climate Change: The IPCC Scientific Assessment: Report prepared for IPCC by Working Group 1*, Houghton, J. T., Jenkins, G. J., Ephraums, J. J. (eds.), Cambridge University Press, Cambridge and New York.

IPCC 2007a, *Climate Change 2007: Mitigation of Climate Change: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Metz, B., Davidson, O. R., Bosch, P. R., Dave, R., Meyer, L. A. (eds.), Cambridge University Press, Cambridge, United Kingdom, New York, NY, USA.

IPCC 2007b, *Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K., Tignor M, Miller H.L. (eds.), Cambridge and New York.

IPCC 2007c, *Summary for Policymakers in Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden P.J., Hanson, C. (eds.), Cambridge and New York.

IPCC 2013a, *Climate Change 2013: The Physical Science Basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P. M. (eds.), Cambridge University Press, Cambridge and New York.

IPCC 2013b, *Summary for Policy Makers. In Climate Change 2013: The Physical Science Basis: Working Group I Contribution to the IPCC Fifth Assessment Report*, Stocker, T., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P. M. (eds.), Cambridge and New York.

IPCC 2014a, *Climate Science 2014: Impacts, Adaptation and Vulnerability: Working Group II contribution to the Fifth Assessment Report*, Part B: Regional Aspects, Barros, V. R., Field, C. B., Dokken, D. J., Mastrandrea, M. D., Mach, K. J., Bilir, T., Chatterjee, M., Ebi, K. L., Estrada, Y., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N., MacCracken, S., Mastrandrea, P. R., White, L. L. (eds.), Cambridge University Press, Cambridge and New York.

- IPCC 2014b**, *Climate Science 2014: Impacts, Adaptation and Vulnerability: Working Group II contribution to the Fifth Assessment Report*, Part A Global and Sectoral Aspects, Field, C.B., Barros, V.R., Dokken, D. J., Mach, K. J., Mastrandrea, M. D., Bilir, T., Chatterjee, M., Ebi, K. L., Estrada, Y., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N. (eds.), Cambridge University Press, Cambridge and New York.
- IPCC 2014c**, *Scenarios database for the Fifth Assessment Report*, viewed 17 Apr. 2015, <https://secure.iiasa.ac.at/web-apps/ene/AR5DB/>.
- IPCC 2014d**, *Summary for Policy Makers. In Climate Change 2014: Synthesis Report: Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Pachauri R.K., L.A. Meyer (eds.), IPCC, Geneva, Switzerland.
- International Energy Agency (IEA) 2013**, *Tracking Clean Energy Progress 2013: IEA Input to the Clean Energy Ministerial*, viewed 20 Apr. 2015, Paris, http://www.iea.org/publications/tcep_web.pdf.
- IEA 2015**, *Global energy-related emissions of carbon dioxide stalled in 2014*, viewed 07 Apr. 2015, <http://www.iea.org/newsroomandevents/news/2015/march/global-energy-related-emissions-of-carbon-dioxide-stalled-in-2014.html>.
- International Monetary Fund (IMF) 2014**, *World economic outlook database*, viewed 31 Dec. 2014, Washington D.C., <http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx>.
- International Renewable Energy Agency (IRENA) 2012**, *Renewable Energy Country Profiles: Pacific: September 2012 Edition*, viewed 17 Apr. 2015, United Arab Emirates, http://www.irena.org/documentdownloads/publications/_pacificcomplete.pdf.
- Meinshausen M, Meinshausen N, Hare W et al. 2009**. Greenhouse-gas emission targets for limiting global warming to 2C, *Nature* 458, pp.1158–63.
- Ministry of New and Renewable Energy (MNRE) 2015**, *Renewable Energy Manufacturing Sector*, viewed 08 Apr. 2015, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=117383>.
- Morel R, Shishlov I 2014**. Ex-post evaluation of the Kyoto Protocol: Four key lessons for the 2015 Paris Agreement, *Climate Report* 44.
- Organisation for Economic Cooperation and Development (OECD) 2013**, *Economic outlook database*, viewed 31 Dec. 2014, <http://stats.oecd.org>.
- Organisation for Economic Cooperation and Development (OECD) International Atomic Energy Agency (IAEA) 2014**, *Uranium 2014: Resources, Production and Demand*, viewed 17 Apr. 2015, <http://www.oecd-nea.org/ndd/pubs/2014/7209-uranium-2014.pdf>.
- Podesta, J & Holdren, J 2014**, *The U.S. and China just announced important new actions to reduce carbon pollution*, viewed 14 Apr. 2015, https://www.whitehouse.gov/blog/2014/11/12/us-and-china-just-announced-important-new-actions-reduce-carbon-pollution?utm_source=email&utm_medium=email&utm_content=email390-graphic&utm_campaign=climate.
- Renewable Energy Policy Network for the 21st Century (REN21) 2014**, *Renewables 2014 Global Status Report*, Paris.
- Reuters 2015**, *China plans CO2 caps for 6 industrial sectors initially under national scheme: NDRC*, viewed 08 Apr. 2015, <http://economictimes.indiatimes.com/news/international/world-news/china-plans-co2-caps-for-6-industrial-sectors-initially-under-national-scheme-ndrc/articleshow/46117462.cms>.
- The White House 2014**, *U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation: Press Release*, <https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change>.

- The White House 2015**, *Fact Sheet: U.S. and India Climate and Clean Energy Cooperation*, January 25, 2015, viewed 18 Mar. 2015, <https://www.whitehouse.gov/the-press-office/2015/01/25/fact-sheet-us-and-india-climate-and-clean-energy-cooperation>.
- Treasury 2008**, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, Treasury, Canberra.
- United Nations 2013**, *World Population Prospects—the 2012 revision*, viewed December 2014, New York, <http://esa.un.org/wpp/Excel-Data/population.htm>.
- United Nations Development Programme (UNDP) 2014**, *Human Development Index: 2013 rankings*, viewed 23 Jan. 2015, <http://hdr.undp.org/en/data>.
- United Nations Environment Programme (UNEP) 2014**, *The Emissions Gap Report 2014: A UNEP Synthesis Report*, United Nations Environment Programme (UNEP), Nairobi, Kenya.
- United Nations Framework Convention on Climate Change Secretariat (UNFCCC) 2013**, *Quantified economy-wide emission reduction targets by developed country Parties to the Convention: assumptions, conditions, commonalities and differences in approaches and comparison of the level of emission reduction efforts: Technical paper FCCC/TP/2013/7*.
- UNFCCC 2014a**, *Greenhouse Gas Inventory Data*, viewed 08 Dec. 2014, http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php.
- UNFCCC 2014b**, *Compilation of economy wide emissions reduction targets to be implemented by Parties included in Annex I to the Convention: FCCC/SBSTA/2014/INF.6*.
- UNFCCC 2015a**, *Green Climate Fund*, viewed 08 Apr. 2015, http://unfccc.int/cooperation_and_support/financial_mechanism/green_climate_fund/items/5869.php.
- United Nations Framework Convention on Climate Change (UNFCCC) 2010**, *Copenhagen Accord: FCCC/CP/2009/11/Add.1*.
- UNFCCC 2012**, *Doha amendment to the Kyoto Protocol: Decision 1/CMP.8*.
- UNFCCC 2014c**, *Lima call for climate action: Decision -/CP .20*, Lima.
- UNFCCC 2015b**, *Intended Nationally Determined Contributions (INDCs)*, viewed 07 Apr. 2015, http://unfccc.int/focus/indc_portal/items/8766.php.
- United States 1970**, *Clean Air Act*, viewed 17 Apr. 2015, <https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change>.
- World Resources Institute (WRI) 2014**, *CAIT 2.0: Climate Analysis Indicators Tool*, WRI's Climate Data Explorer, viewed 10 Apr. 2015, <http://cait.wri.org>.