Australian Government
Climate Change Authority

COMPARING COUNTRIES' EMISSIONS TARGETS
A PRACTICAL GUIDE

MARCH
2015

Published by the Climate Change Authority

www.climatechangeauthority.gov.au

ISBN: 978-0-9925422-4-5

HOW TO COMPARE TARGETS FOR DIFFERENT COUNTRIES

TAKE C-A-R-E TO CONSIDER THE BIGGER PICTURE

No single number or simple formula tells you how good one country's target is relative to another's. You need to consider a mix of relevant criteria, metrics and timeframes, and use judgement to assess whether the target is 'comparable' based on the full picture.

KNOW THE LIMITATIONS OF THE METRIC AND THE DATA BEHIND IT

- Understand the difference between data sources and the way it is collected. Useful—that is, genuinely consistent—information is not always available for all countries.
- Estimating some metrics—for example the cost of reducing emissions and changes in emissions relative to business-as-usual—involve detailed analysis and many assumptions. Different assumptions, all of which may be reasonable, will produce divergent estimates. As a result, these metrics should be used with caution.

C	A	R	E
CAPACITY	**ADEQUACY**	**RESPONSIBILITY**	**EFFORT**
The ***country's*** capability to reduce emissions	The environmental effectiveness of the ***target***; its consistency with global climate goals	The ***country's*** emissions; its contribution to climate change	The scale of change implied by the ***target***; the emissions reduced and the cost of doing so

COMPARE LIKE WITH LIKE

- **Understand the countries before comparing their targets.** If comparing targets of developing and developed countries, take into account their different *capacity* and *responsibility*.
- **Take account of different types of goal.** Not all countries will put forward targets expressed as a percentage change in emissions over time. Some targets are expressed as a change in emissions intensity, others a change relative to 'business-as-usual'. Targets may be for a different year, and expressed relative to a different base year. Targets may need to be converted to the same form to allow comparison.
- **Reference years and timeframes are important.** Changing the reference year can change how strong or weak a target looks. Longer timeframes can take account of action over time, not just at a single point in time.

IMPLICATIONS FOR AUSTRALIA

This guide provides a framework to compare countries' targets, rather than a formula for where Australia's targets should sit compared with those of other countries. However, using the criteria outlined in this paper, some broad conclusions can be drawn. Australia is a high income, technologically advanced country with strong governance institutions. Compared with many other countries, it therefore has a high capacity to reduce emissions. It also has a relatively high level of responsibility due to its very high emissions per person. On the other hand, the effort required to reduce emissions in Australia might be higher than that in many other countries: reducing our current high reliance on fossil fuels will require significant structural adjustment. Finally, from the perspective of adequacy, stronger targets over time would be more consistent with the global goal of avoiding dangerous climate change.

WHAT'S THE PURPOSE OF THIS GUIDE?

In the lead up to the Paris Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015, countries are beginning to set emissions reduction targets for the period beyond 2020 ('post-2020 targets'). The Australian Government has said it will put forward its target in mid-2015. The Climate Change Authority is currently conducting a Special Review of Australia's climate action, and will recommend post-2020 targets for Australia. As part of its analysis, the Authority will consider the action other countries are taking. Countries' action on climate change involves many elements, including emissions reductions, adaptation to climate change, technology development and finance and support to developing countries. This guide focuses only on emissions reduction targets.

WHY COMPARE EMISSIONS REDUCTION TARGETS?

An emissions reduction target is a key component of national action and provides information about the country's contribution to global efforts to avoid dangerous climate change. Within the UNFCCC talks, post-2020 targets are known as Intended Nationally Determined Contributions (INDCs), and will be announced over the course of 2015. All countries are likely to compare their targets with others', both in deciding what their targets should be, and in the course of negotiating the new global climate agreement.

Targets are the most common type of emissions reduction goal, and typically state an intended level of emissions (or emissions intensity) in a certain year. Emission budgets, on the other hand, specify a total limit on emissions over a period of time. Some countries (especially high-income countries like Australia) may include budgets in their INDCs (for example, covering the period 2020 to 2025). Some countries might also consider longer term budgets, and frame their short-term commitments against these longer term constraints. Because climate change is caused by cumulative global emissions over very long periods of time, budgets can ensure more consistency of action with climate science over time, and demonstrate the trade-offs between early and later action. The Authority therefore recommended both targets and budgets for Australia in its 2014 Targets and Progress Review. While this guide focuses on targets, the principles outlined could also be used to compare budgets.

Comparing emissions targets can help promote transparency and improve the community's understanding of national climate change actions. It can improve the quality of discussion within international climate change negotiations and help countries develop and understand their own and others' targets. Countries have agreed as part of international negotiations that post-2020 targets 'will represent a progression beyond current undertakings' and be fair and ambitious (UNFCCC 2014, p1 paras 10 and 14). Well designed assessments of national targets can help countries meet this undertaking and strengthen global emissions reduction efforts over time.

HOW TO USE THIS GUIDE

This guide provides a framework for comparing countries' targets to limit or reduce emissions. It does not provide a formula for deciding whether a target is 'fair' or 'comparable'. Such decisions involve judgement; people will weigh the relevant considerations differently, reflecting their own objectives and values. The Authority set out its views regarding Australia's comparable 2020 target in its Targets and Progress Review, and will set out its views on Australia's post-2020 target in its forthcoming Special Review draft report on targets.

This guide helps readers to conduct their own analyses and to critique others' comparisons. It shows how measures (metrics) can best be used to compare countries, and compare their targets.

No single measure provides the full story of how one country's emissions reduction targets compares with another's. The guide identifies four criteria—capacity, adequacy, responsibility and effort—and their corresponding metrics. If considered together, these provide a balanced view of countries' targets, and can support a robust comparison.

This guide first discusses how to ensure comparisons are fair, explaining the four central criteria (Capacity, Adequacy, Responsibility and Effort) and how to compare like with like. The guide then reviews specific metrics for each of the four criteria, noting the limitations of metrics and data, and illustrating metrics by comparing Australia with other key countries.

HOW CAN WE ENSURE THAT COMPARISONS ARE FAIR AND NOT MISLEADING?

1

TAKE C-A-R-E TO CONSIDER THE BIGGER PICTURE

All four criteria should be considered in a balanced comparison of targets. Capacity and responsibility relate to the country proposing the target, while adequacy and effort relate to the target itself.

- **Capacity** (or capability)—most commonly this refers to a country's economic capacity to act, but other types of capacity are also important, such as its opportunities to reduce emissions, which in turn depend upon the country's economic structure, access to technology, resource endowment and existing energy system.
- **Adequacy** (or environmental effectiveness)—takes account of the extent to which a target is consistent with the emissions reductions necessary to meet the global goal of limiting warming to no more than two degrees above pre-industrial levels.
- **Responsibility**—identifies the country's contribution to climate change, and thus its responsibility to take climate action. It is commonly associated with current and historical emissions levels (given that climate change is caused by cumulative emissions over long timeframes). It can be assessed at the national and per person level.
- **Effort** (or ambition)—identifies the scale of emissions reductions required to meet a target. Effort can be assessed by change of total emissions over time, change relative to economic output or change relative to population, or by taking account of how emission targets diverge from what emissions might otherwise have been (also called 'business-as-usual' (BAU) emissions). Effort can also be measured in terms of the investments made to reduce emissions.

The United Nations Framework Convention on Climate Change (UNFCCC) incorporates these criteria. Article 3(1) of the convention calls on countries to protect the climate system on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Article 4(1) recognises that action should take account of specific national circumstances. In other words, each country should contribute an equitable level of *effort* that will provide an *adequate* response to the problem, in light of its respective *capacity* and *responsibility*.

Different criteria can be emphasised depending on the purpose for comparing targets. For example, if targets are seen solely as a means to meet the global climate goal then the focus is likely to be on adequacy. If the priority is to minimise the economic impacts of emissions reduction action, the focus may be on effort. The nature of the emissions targets being compared is also important. If a target is for domestic emissions reductions only, an important measure of capacity will be its emissions reduction opportunities; if a target allows for the use of international emissions reductions, income level is relatively more important measure of capacity.

The metrics discussed in this guide are useful tools; each provides a different way of looking at targets, and is a proxy for the four assessment criteria—that is, each provides information about one or more of the criteria, but is not a comprehensive measure.

To provide a balanced comparison of targets, several metrics spanning all four criteria are needed. Focusing on only one or two gives only a partial picture, and is likely to be misleading.

BOX 1: CONSIDER A RANGE OF METRICS

The following example shows how focusing on only two metrics can tell a different story than a fuller analysis.

Two metrics: Australia's unconditional emissions target of 5 per cent reduction by 2020 from 2000 levels implies a 32 per cent reduction in emissions per person from 2005 levels. This suggests Australia is making more effort than many other developed countries (for example reductions of: Japan 3 per cent; EU 15 per cent; Norway 18 per cent; US 27 per cent). Australia's unconditional target also requires a 45 per cent reduction in emissions intensity from 2005 levels; again relatively more effort compared to 30 per cent for the EU and 36 per cent for the US.

On the basis of these two metrics, Australia's 2020 target appears strong.

More metrics: Taking into account measures of responsibility changes this picture. Australia's emissions per person in 2005 were 30.2 tonnes of carbon dioxide equivalent; EU had 9.8 tonnes and the US 20.9 tonnes. Australia's is the second highest of developed countries, after Luxembourg which suggests it has a high responsibility to reduce emissions. In the same year Australia's emissions intensity was 880 tonnes per unit of GDP; the EU had 365 tonnes and the US 493 tonnes. In 2020, Australia is still expected to have among the highest per person emissions and emissions intensity—even if its unconditional target is met.

To reach a comparable level of emissions as other countries on these measures, its target would have to be stronger than at present.

In its Targets and Progress review, the Authority considered a range of metrics across all four criteria, concluding that Australia's unconditional target is weaker than that of many comparable countries.

COMPARE LIKE WITH LIKE

COMPARING DIFFERENT TYPES OF GOALS

Targets can be expressed in different ways and not all countries will put forward targets in the same form. In order to compare the targets it is best to convert them to absolute emissions in a common year and calculate changes relative to a common base year (or consider multiple base years). For example, emissions intensity can be converted to an emissions level by combining it with projected economic output.

Australia's 2020 emissions reductions target range is specified as a percentage reduction in absolute emissions compared to a base year: 5–15 or 25 per cent below 2000 levels. Countries can also set emissions budgets for a period: for example, the United Kingdom has set four carbon budgets to 2027; each budget limits their total emissions for a five year period.

Rapidly industrialising developing countries typically project continued growth in emissions, in line with their increasing GDP. Consequently, they may pledge to limit their increases in emissions rather than commit to absolute reductions (this is analogous to Australia's first target under the Kyoto Protocol: Australia committed to limit emissions to an average of 8 per cent above 1990 levels over the period 2008–2012). The Republic of Korea has set a 2020 target of 30 per cent below expected levels in a business-as-usual scenario. This target is equivalent to an estimated 10 per cent above 2000 levels. Post-2020, China has proposed another kind of point-in-time target: to ensure that its absolute emissions peak by 2030 and then fall. It has not yet indicated an emissions level for this peak. Countries may also set targets to reduce the emissions intensity of their economies—the number of tonnes of emissions for each dollar of gross domestic product. For instance, India has pledged to reduce its emissions intensity by 20–25 per cent below 2005 levels by 2020.

All the metrics in this guide refer to production-based emissions, i.e. those produced from activities in a country, including from the production of goods and services it exports (but not the goods and services it imports). This method of measurement is the internationally-agreed standard and has a well established methodology. An alternative approach is to determine a country's 'carbon footprint' by counting all emissions created from consumption within a country, including those arising from the production of imports (to explore this further see http://carbonfootprintofnations.com/). Many of the metrics discussed in this guide could—if the required data was available—be adapted to consumption-based emissions if desired.

REFERENCE YEARS AND TIMEFRAMES ARE IMPORTANT

In assessing countries' emissions targets, two timing considerations are important. The first is when (in which year) to start the assessment, and the second is at which time point(s) to assess countries' circumstances and emissions performance. These choices can change the story told by the metrics.

Different start and end years are common, and complicate the process of comparing targets. Within the international negotiations countries are permitted to choose the form of their target including the base year. For example, the US target is a 17 per cent reduction by 2020 compared with 2005 levels. Australia's target range is a 5–15 or 25 per cent reduction by 2020 below 2000 levels. For the US, a 17 per cent reduction from 2005 is equivalent to a 19 per cent reduction from its 2000 levels—which appears much more ambitious than Australia's minimum 5 per cent target. On the other hand, for Australia, a 5 per cent reduction from 2000 is equivalent to a 13 per cent reduction from its 2005 levels. This appears less ambitious than the US's 17 per cent target, but not dramatically so. This highlights how sensitive target comparisons can be to simple assumptions.

When assessing countries' action to reduce greenhouse gas emissions, 1990 is a reasonable point to start in most circumstances. Distant past emissions occurred when their impact was not well understood or foreseen. From 1990, however, there was widespread global recognition of the risks of climate change and the need to reduce greenhouse gas emissions. The UNFCCC was agreed in 1992 and the Kyoto Protocol adopted in 1997. Both used 1990 as a baseline for targets.

A 1990 base year recognises early action by countries to reduce emissions; recent years such as 2010 indicate the further action required relative to a country's current position. Looking out to 2020 and 2030 targets shows intended future effort.

BOX 2: CONSIDER MORE REFERENCE YEARS

Countries use different base years for their 2020 targets: Australia's minimum is 5 per cent below 2000 levels; the US is 17 per cent below 2005 levels; and the EU is 20 per cent below 1990 levels.

Figure 1 compares these three targets against different reference years. Relative to 1990, Australia's 6 per cent reduction, and the US' 4 per cent, compare poorly to the EU's 20 per cent reduction. In contrast, relative to 2010, the US reduction of 13 per cent appears most ambitious.

These charts show the EU target involves the deepest cuts over time while the US target requires the deepest cuts over the current decade.

FIGURE 1: COMPARING TARGETS TO DIFFERENT REFERENCE YEARS, 1990 TO 2020

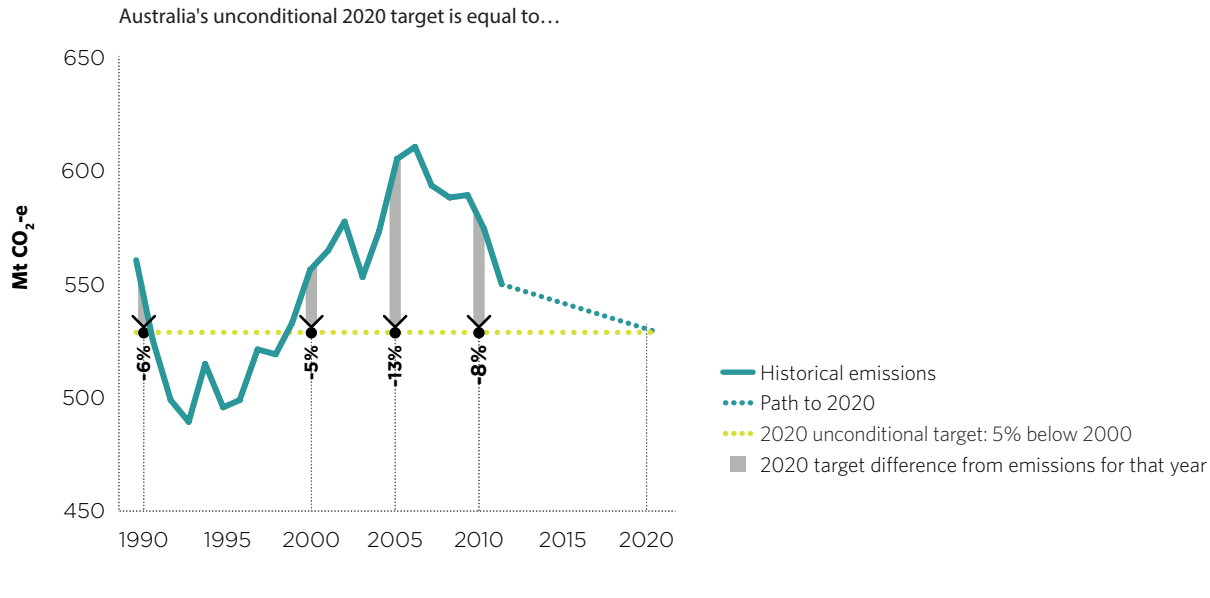
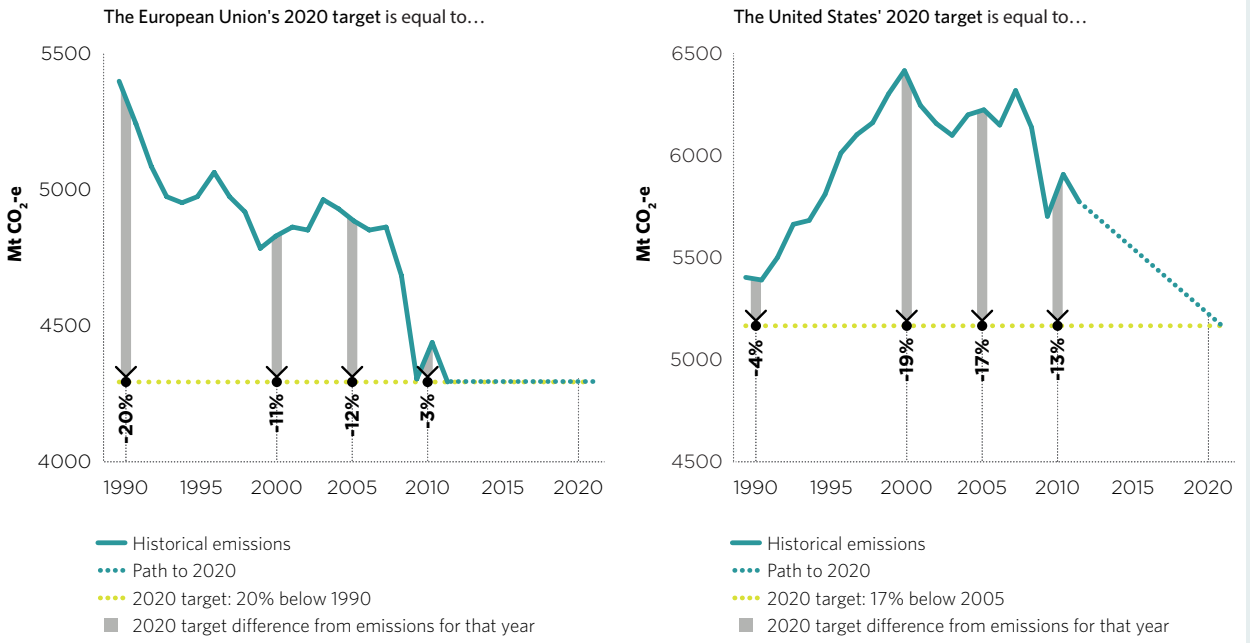


FIGURE 1: COMPARING TARGETS TO DIFFERENT REFERENCE YEARS, 1990 TO 2020



Note: Australia's 2020 target used throughout the Guide is its unconditional target of 5 per cent below 2000 levels, except where otherwise specified. EU's 2020 target is its unconditional 20 per cent below 1990 levels.
Source: Historical greenhouse gas emissions: Australia—Department of the Environment (2015); US and EU—UNFCCC (2014b). Emissions targets: UNFCCC (2014a).

2

TAKING C-A-R-E WITH THE METRICS

KNOW THE LIMITATIONS OF YOUR DATA

Metrics are most useful when based on good data which is consistent across different countries. Ideally, metrics and data should be:

- measureable—the metric clearly connects to robust data
- verifiable—others can replicate the data, relevant high quality data is readily available and it is clear how figures are obtained
- universal or comparable across countries—data is available for the metric and each country measures it in the same way (Aldy & Pizer 2014).

Metrics which require modelling or other complex calculations which are based on sets of assumptions have particular limitations. Different assumptions, all of which may be reasonable, will produce divergent estimates. Detailed quantitative studies are often carried out only for specific countries or regions, so multiple sources (using different methodologies) may be needed to compare across countries, giving less robust results. This particularly affects metrics related to business-as-usual (BAU) emissions, emissions reduction opportunities, and costs. These metrics are discussed further in the 'effort' section below.

C

CAPACITY

A country's capacity or capability to act on climate change can be understood in at least three ways:

- A country with high levels of wealth, development, governance, infrastructure or other resources has more capacity to act to reduce greenhouse gas emissions.
- A country with very high emissions intensity may have more capacity to reduce emissions, as it is likely to have more reduction opportunities.
- A country with extensive natural resource endowments to support renewable energy generation may have more capacity to reduce emissions than a country without such endowments.

WEALTH AND LEVEL OF DEVELOPMENT

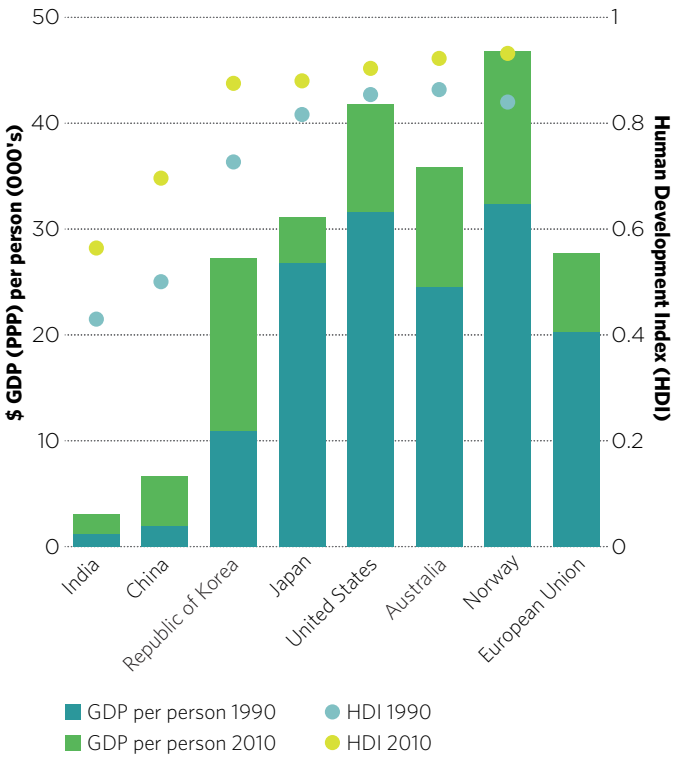
Wealthier countries can better afford the costs of reducing emissions than poorer countries. Gross Domestic Product (GDP) per person indicates a country's economic resources; countries with higher GDP per person have greater capacity to meet strong targets.

The Human Development Index (HDI) is a composite measure of average achievement in key dimensions of human development, covering life expectancy, education, and income. HDI ranges between 0–1 with countries ranked into four groupings. Countries that score highly on the HDI are generally wealthier, with greater access to technology, and have more sophisticated governance arrangements. These all indicate a greater capacity to implement strong and effective policies to reduce emissions.

Figure 2 shows countries with very different levels of development, as indicated by HDI score and GDP per person. Australia is ranked 2nd globally (2010) and scores 0.93 on the HDI, while India is ranked 135th and with a score of 0.57 is classified as having medium human development. Figure 2 also shows that a country's capacity to act can change over time. For instance, the Republic of Korea's economic development has accelerated rapidly since 1990, and its HDI score has increased from 0.73 to 0.88 in 2010.

This comparison demonstrates that the US, EU, Norway and Japan have similar economic capacity to Australia, so they provide reasonable benchmarks for evaluating Australia's targets. In contrast, Australia's economic capacity is very different to that of China and India; this needs to be considered when comparing targets.

FIGURE 2: GDP PER PERSON AND HDI SCORE FOR SELECTED COUNTRIES, 1990 AND 2010



Note: HDI is not calculated for the EU. 1990 GDP is not available for China in 1990, GDP in 1995 is used.
Source: GDP: OECD (2013), data in constant US$2005 Purchasing Power Parity (PPP); EU(28) GDP estimated by CCA based on OECD (2013) and IMF (2014). Population: Australia—Department of the Environment (2015); all others—UN (2013). HDI: UNDP (2014).

EMISSIONS INTENSITY

The level of emissions intensity (emissions per unit of economic output) of a country's economy provides some indication of the potential for further emissions reductions. Emissions intensity reflects the structure of a country's economy, productivity and resource endowment. It can be strongly linked to effort (discussed below) and can reflect the results of previous climate action and other policies. Countries with higher emissions intensities are likely to have more emissions reduction opportunities. Transitioning to a low carbon world means that countries need to shift from highly emissions-intensive fuels, technologies and activities to less emissions-intensive ones (that is, they need to reduce their emissions intensity).

Figure 3 shows the emissions intensity of Australia, the US and the EU in 1990 and 2010 alongside projected intensities consistent with announced targets for 2020 and 2030. The mid-point of the 2030 target range recommended by the Authority in its Targets and Progress Review is also shown for comparison. Australia has already achieved significant reductions in emissions intensity, but its economy remains more emissions intensive than the US and EU. In fact, if Australia meets its minimum 5 per cent target, its emissions intensity in 2020 would still be higher than the US and EU in 2010. This suggests that Australia may have relatively more opportunities to reduce emissions in the future.

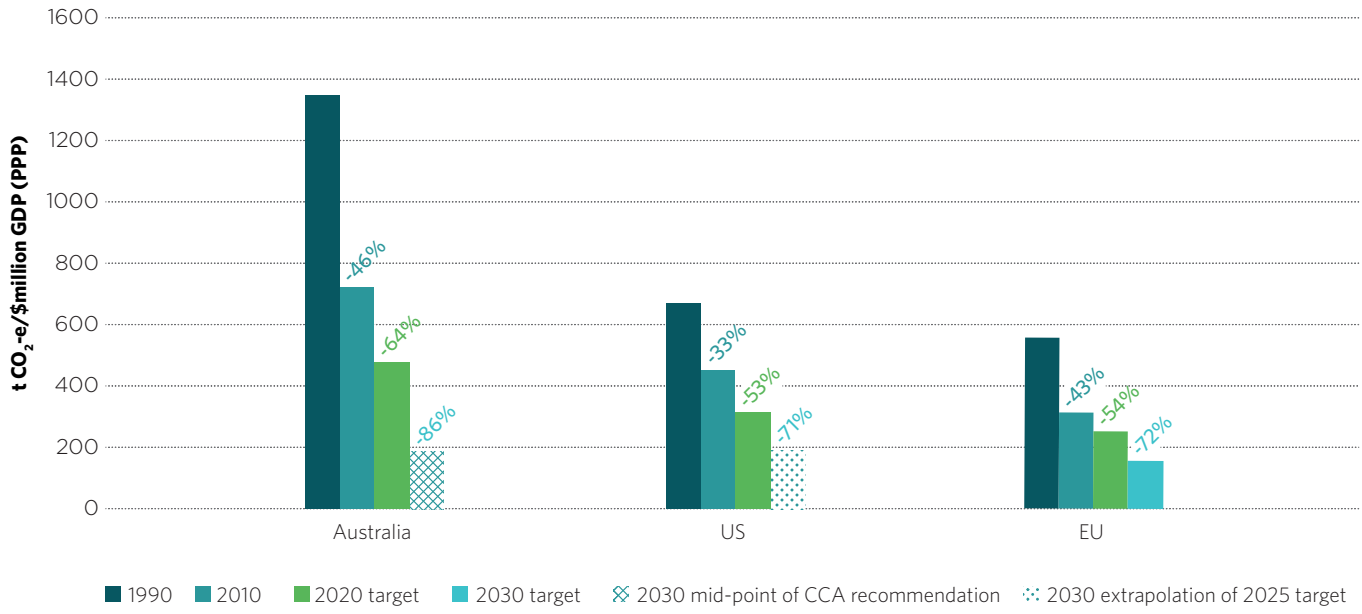
NATURAL RESOURCE ENDOWMENT

This capacity measure is particularly relevant if a country's target limits or excludes the use of international emissions reductions. A country's access to natural resources and technology directly affects its domestic emissions reduction opportunities. In addition, how a country has used its resources may have resulted in reductions in the past, but limit its actions in the future. Norway has low emissions electricity generation because of extensive development of its hydro resources, but further expansion is difficult so future energy demand may be harder to meet from low-emission sources.

The US (like Australia) has identified large natural gas reserves over the last decade and dramatically increased production. This has improved the US' capacity to reduce emissions: greater supply of gas has reduced prices, encouraging fuel switching from coal (a higher emissions fuel).

Globally consistent data on resource endowments is not always available, leading to a reliance on different sources that use different methodologies. Such comparisons may be more difficult and less robust.

FIGURE 3: EMISSIONS INTENSITY FOR SELECTED COUNTRIES, HISTORICAL AND TARGET, AND PERCENTAGE CHANGE FROM 1990 LEVELS



Note: Percentage reductions are expressed as cumulative reductions from 1990 levels in the reference year. Emissions intensity is calculated based on historical emissions, current unconditional 2020 targets and extrapolations of 2030 targets where necessary. EU 2030 target is as announced. US 2030 target is a linear extrapolation from the mid-point of its announced 2025 target range (see Notes and methodology section). Australia's 2030 target is taken as the mid-point of the Authority's recommended 2030 target range of 40-60 per cent below 2000 levels.

Source: Historical greenhouse gas emissions: Australia—Department of the Environment (2015); US and EU: UNFCCC (2014b). 2020 emissions targets: UNFCCC (2014a). 2030 emissions targets: US—The White House (2014); EU—European Commission (2014); Australia—CCA (2014). GDP: OECD (2013), data in constant US$2005 (PPP); EU(28) GDP estimated by CCA based on OECD (2013) and IMF (2014).

A

ADEQUACY

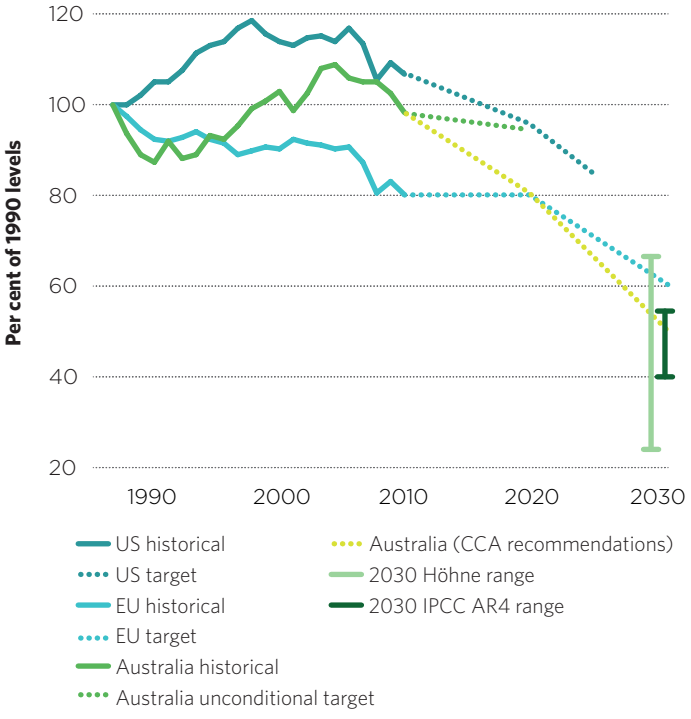
Some measures of effort (including changes in total emissions, emissions intensity or emissions per person) give an indication of progress towards environmental outcomes. Adequacy, on the other hand, involves an evaluation against the ultimate goal: limiting warming and avoiding dangerous climate change. Countries are encouraged to indicate how their post-2020 targets contribute to achieving this objective (UNFCCC 2014, p.1 para 14).

ENVIRONMENTAL EFFECTIVENESS OF EMISSIONS REDUCTIONS

Benchmarking targets against an agreed global goal (or other reasonable benchmark) provides a way to directly assess environmental effectiveness. For example, Höhne and colleagues have identified target ranges for emissions reductions by 2030 required to keep global warming below 2 degrees (Höhne et al. 2014). They identified equitable contributions to the global goal for groups of countries with similar economies and levels of development. If all countries took action in the identified range, the world as a whole would be on track to its collective goal.

Figure 4 shows how the targets of Australia, the EU and the US compare with the identified 2030 target range for Organisation for Economic Co-operation and Development countries. On this measure, the Authority's previously recommended target for Australia and the EU's announced target would be adequate. The US would need to accelerate reductions beyond 2025 to fall within the identified range by 2030.

FIGURE 4: COUNTRIES' EMISSIONS TRAJECTORIES TO 2020 AND 2030 TARGETS, COMPARED WITH ADEQUACY RANGES



Note: Two adequacy ranges are shown. Höhne et al identified a 2030 range for OECD countries (1990 membership), to meet a 2 degree stabilisation target with 50 per cent probability: 33–74 per cent below 1990 levels. The IPCC Fourth Assessment Report (AR4) identified developed country target ranges for 2020 and 2050; the illustrated 2030 range of 45-59 per cent reduction is an interpolation between these. The US 2030 target is an extrapolation from the mid-point of its announced 2025 target range (see Notes and methodology section). Australia 2030 CCA recommended target is taken as the mid-point of the Authority's recommended 2030 target range of 40-60 per cent below 2000 levels (CCA 2014).

Source: Historical greenhouse gas emissions: Australia—Department of the Environment (2015); US and EU—UNFCCC (2014b). 2020 emissions targets: UNFCCC (2014a) and the Authority's recommended target—CCA (2014). 2030 emissions targets: US—The White House (2014); EU—European Commission (2014); Australia—CCA (2014). Adequacy ranges: Höhne et al. (2014), IPCC AR4 (2007, Box 13.7).

R

RESPONSIBILITY

Responsibility is primarily measured in terms of emission levels—in the past, at the present time, and in the future. Developing countries often focus on historical responsibility for emissions, arguing that developed countries have contributed most to the problem, so have greater responsibility to respond. The Authority considers responsibility is relevant to determining a country's 'fair' target—particularly emissions since 1990. In the long term, the Authority considers it fair that all countries have equal rights per person to emit to the atmosphere (CCA 2014, p.115).

TOTAL EMISSIONS

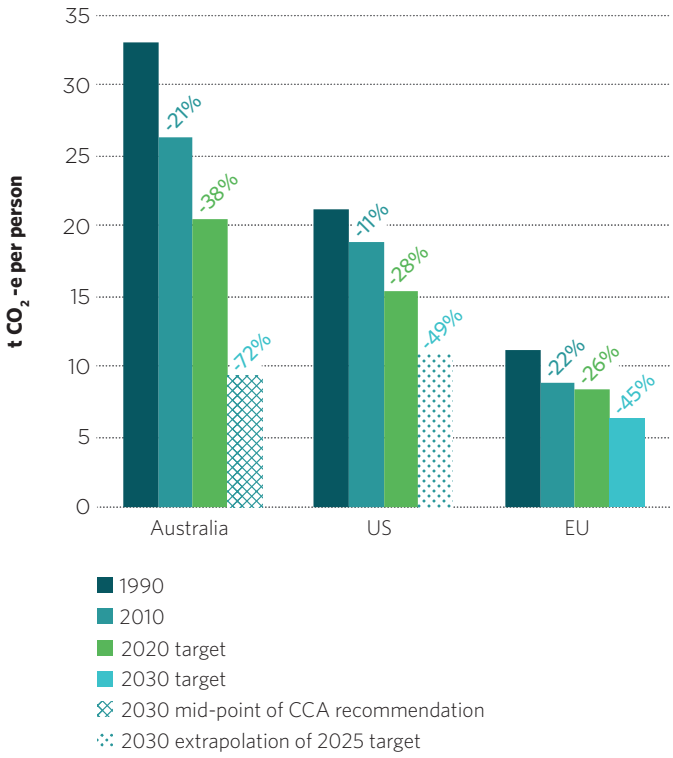
The total level of national emissions provides an indication of responsibility—those emitting more greenhouse gases are contributing more to climate change. It would be extremely difficult to address climate change without significant emissions reductions from the largest emitters. Considered in isolation, however, measures of absolute emissions ignore a country's population, level of economic development and other relevant factors.

EMISSIONS PER PERSON

The level of emissions per person—historical, current and projected—arguably provides a more useful measure of responsibility for comparisons across countries, because it controls for differences in population and population growth rates.

Australia contributed 1.3 per cent of global emissions in 2010 and ranked as the 13th highest emitter. Figure 5 shows it averaged 26 tonnes of emissions per person, much higher than the US or EU, and among the highest of all countries. This metric suggests Australia has high responsibility to reduce its emissions: it would need relatively stronger targets to converge to average levels over time.

FIGURE 5: EMISSIONS PER PERSON, HISTORICAL AND TARGET, AND PERCENTAGE CHANGE FROM 1990 LEVELS



Note: Percentage reductions are expressed as cumulative reductions from 1990 levels in the reference year. Emissions per person are calculated based on historical emissions and current 2020 targets. The EU's 2030 target is as announced. The US' 2030 target is extrapolated from the 2025 target range mid-point (see Notes on data and methodology section). Australia 2030 target is taken as the mid-point of the Authority's recommended 2030 target range of 40–60 per cent below 2000 levels.
Source: Historical greenhouse gas emissions: Australia—Department of the Environment (2015); US and EU—UNFCCC (2014b). 2020 emissions targets: UNFCCC (2014a). 2030 emissions targets: US—The White House (2014); EU—European Commission (2014); Australia—CCA (2014). Historical population: UN (2013). Forecast population: Australia—Treasury (2015); all other countries—UN (2013). HDI: UNDP (2014).

E

EFFORT

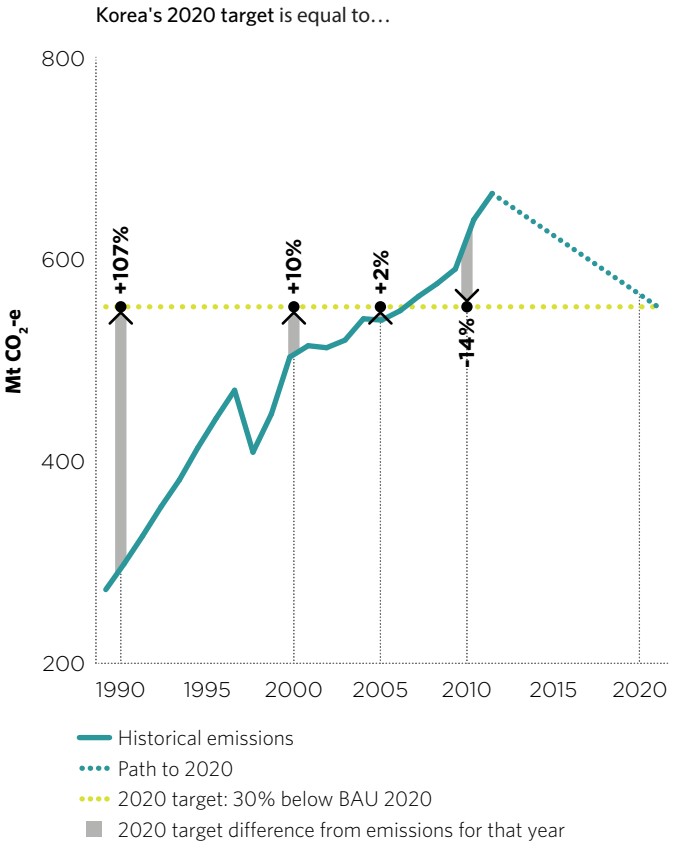
Effort is a particularly important criterion, and attracts substantial attention in target discussions. It can be measured in many different ways. These include the size of the emissions reduction task (reduction in total emissions, emissions intensity or emissions per person), the costs of reducing emissions (the cost per tonne, or the cost to the economy as a whole), and the type of emissions reduction policies a country introduces (including which parts of the economy are covered and how stringent the policies are). The strengths and weaknesses of different metrics are summarised at the end of this section.

CHANGE IN TOTAL EMISSIONS OVER TIME

This is perhaps the most used metric, and the way in which many targets are expressed. It provides a fairly rough measure of effort, as it focuses on changes relative to a fixed base year rather than relative to what emissions might otherwise have been. Underlying emissions trends are typically quite different in developed and developing countries, so change in total emissions is a reasonable metric amongst countries of similar development level, but a poor metric for countries at different development stages. A developing country may be on a trajectory of strong economic and emissions growth, while a developed country may have relatively lower economic growth and be slowly decarbonising through structural change and improving productivity.

Figure 1 showed that in the period to 2020 the EU, Australia and US are each projected to reduce their emissions below 1990 levels, with the EU making greater reductions than Australia or the US. Figure 6 shows that, in contrast, the Republic of Korea has seen a large increase in total emissions from 1990. Korea has undergone rapid economic development since 1990 (the size of its economy has nearly tripled). This pattern of rapid economic and emissions growth is typical of many developing countries. Developed countries tend to follow a flatter trajectory with efficiency improvements balancing growth from increased economic activity. Korea's target requires absolute emissions to peak and then decline by 2020, but they will remain well above 1990 levels.

FIGURE 6: COMPARING REPUBLIC OF KOREA'S TARGET TO DIFFERENT REFERENCE YEARS



Source: Historical greenhouse gas emissions: WRI (2014). Emissions target: UNFCCC (2013).

EMISSIONS REDUCTION COMPARED TO BUSINESS-AS-USUAL (BAU)

Change relative to BAU can provide a better indicator of effort than absolute changes, because it focuses on what emissions would have been without further policy intervention.

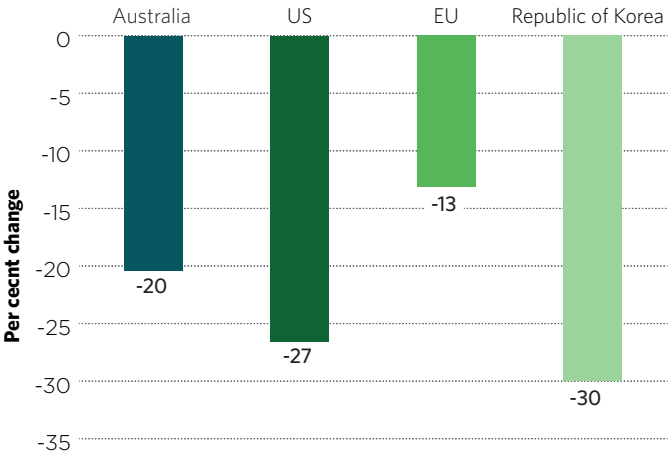
However, it can be challenging to project a consistent set of BAU emissions for different countries, which limits this metric's value for comparisons. BAU projections rely on modelling or other calculations, which are underpinned by many assumptions about the future state of economic activity, technology development and deployment, policy costs and so on. Different models and different assumptions produce different BAU estimates. Specific challenges include:

- BAU estimates can change significantly over time. For example, in 2012, the Australian government estimated Australia's BAU emissions in 2020 would be 22 per cent above 2000 levels. In 2013, it revised this estimate to 17 per cent above 2000. In one year, a change in BAU estimates reduced Australia's emissions reduction task for the period to 2020 by 161 Mt CO_2-e or 21 per cent (CCA 2014, p.133).
- New BAU estimates can take account of the best available information, but necessarily include the effects of past and existing policies. As a result, they tend to conceal effort to date (making countries which have already taken significant action look less ambitious), and highlight only the further effort required (making countries which have done little to date look more ambitious).
- BAU estimates are prone to bias as, by selecting favourable BAU assumptions, a country can present its target in a more favourable light. The difficulty of examining the assumptions behind estimates reduces the transparency and verifiability of this metric.

Measuring emissions reductions relative to BAU can help control for factors unrelated to climate policies that affect both economic activity and emissions levels. This can help isolate the effects of climate policies, and provide a clearer indication of 'mitigation effort'. That said, emissions reductions arising from non-policy factors may still have involved high social and economic costs—for example, emissions reductions arising from economic recessions or natural disasters.

Figure 7 shows how the change from BAU tells a different story to change in total emissions over time. The 2020 targets previously illustrated in Figures 1 and 6 are now compared to BAU. On this metric, Australia's minimum 5 per cent 2020 target implies somewhat less effort than the US. The Republic of Korea's 2020 target requires a relatively strong policy effort—a fact less apparent in Figure 6. The EU target appears comparatively weaker, but its BAU projection reflects substantial pre-existing policies to reduce emissions.

FIGURE 7: PERCENTAGE CHANGE IN EMISSIONS FOR COUNTRIES' TARGETS RELATIVE TO BUSINESS-AS-USUAL EMISSIONS AT 2020



Note: The projections for BAU emissions in this chart are based on modelling by Treasury and DIICCSRTE (2013), except for Republic of Korea which is from national projections.
Source: Republic of Korea—UNFCCC (2013). All other countries—CCA (2014, figure B.3).

CHANGE IN EMISSIONS PER PERSON OVER TIME

Compared to change in total emissions, change in a country's emissions per person controls for population growth, thereby 'levelling the playing field' between countries with high population growth such as Australia and countries or regions with low population growth such as the EU.

Figure 5 showed historical emissions per person and projections consistent with targets. It suggests that while Australia has very high emissions per person, it is reducing them more rapidly than the US and EU, and making more effort than is suggested by looking only at changes in total emissions over time (in Figure 1). For example, while absolute emissions are projected to decline by 8 per cent between 2010 and 2020 in Australia and 13 per cent in the US, emissions per person are projected to decline over the same period by 22 per cent and 19 per cent respectively.

CHANGE IN EMISSIONS INTENSITY OVER TIME

Changes in the emissions intensity of an economy over time provide an indicator of the effort and, to an extent, the environmental effectiveness of a country's policies. Just as emissions per person helps to control for different rates of population growth, emissions intensity helps to control for different levels and trends of economic output. It is important to be aware, however, that changes can also be due to structural shifts in the economy that would have occurred in the absence of climate policies, so improvements in emissions intensity don't necessarily reflect policy effort.

Comparing emissions intensity with change in total emissions to 2020 shows that while the required reduction in Australia's total emissions from 2010 to 2020 is less than that of the US, both countries are required to reduce their emissions intensity at essentially the same rate. This reflects Australia's stronger projected rate of economic growth.

COST OF REDUCING EMISSIONS

Emissions reduction opportunities are commonly reported in terms of their unit cost (dollars for each tonne of emissions avoided or otherwise reduced). Estimates of the unit cost of emissions reductions for different opportunities vary widely due to different methods and assumptions (a similar situation for comparisons with BAU emissions). Cost estimates are underpinned by a range of assumptions about the future, including access to renewable energy technology and consumer preferences.

More importantly, the unit cost of emissions reductions depends strongly on policy design (for example, international trade in emissions reductions can help to equalise the unit cost across countries). A country with a challenging target but efficient, low-cost policies may achieve its goal at lower average unit cost than a country with a more modest target and an inefficient policy mix. As a result, this metric can make countries that use inefficient policies appear to have made more effort. Equating high unit cost with strong effort implicitly assumes a country is working harder to reduce emissions, rather than asking whether it is working smarter to reduce emissions efficiently. Further, costs are often overestimated (Daley & Edis 2010, p.4).

The costs of reducing emissions to meet a target can also be assessed in terms of the total cost to the economy. Total costs are different to unit costs, and a country may simultaneously face relatively low unit costs and high total costs to its economy. This is because total costs arise from the cumulative impact of all emissions reductions achieved throughout the economy, and from changes in the global economy. Total cost therefore reflects not just the impact of meeting the country's target, but also the impact of changes in global production and consumption (which flow through to the country's imports and exports).

Some studies find that Australia faces relatively high total costs. Australia has a relatively high share of energy- and emissions-intensive industries, so faces a bigger task to restructure its economy than many other countries. Similarly, developing countries may face relatively high total costs because agriculture, manufacturing and natural resource extraction (which are typically energy- and emissions-intensive) make up a greater share of their economies than many developed countries.

The estimates of a country's costs to reduce emissions vary widely. The assumptions underlying a model can have a very large impact on its estimated costs of emissions abatement (Hamilton & Quiggin 1997). The different methods and assumptions limit the comparability and verifiability of this measure.

BOX 3: AUSTRALIA'S RELATIVE COSTS

Studies that have considered Australia's total costs relative to other countries include:

- Treasury modelling for the Australian Government (2008) estimated the costs of countries meeting (hypothetical) 2020 targets of comparable emissions reductions relative to BAU. It found Australia faces relatively high costs compared to other developed nations (Table 1).
- McKibbin et al. (2010) estimated the costs of countries' meeting their announced 2020 targets. It found Australia faces a relatively high cost in terms of impact on GDP, but a relatively lower cost in terms of consumption losses (Table 1). This analysis assumed an economy-wide carbon price in each country, and no international trade in emissions reductions.
- den Elzen et al. (2009) took a different approach, estimating the (hypothetical) 2020 targets that would equalise cost across countries, rather than the cost of meeting announced targets. It used two different models.
  - The first estimated that a target of 9 per cent above 1990 levels for Australia and New Zealand would impose the same cost as a 11 per cent reduction target for the US, a 29 per cent reduction target for Japan, and a 34 per cent reduction target for the EU. This model treated Australia and New Zealand as a single region.
  - The second model also found a growth target would impose similar costs on Australia to large reduction targets in other countries.
- Both the McKibbin and de Elzen studies excluded emissions from land use, land use change and forestry. This is an important sector for Australia. Historically, Australia has had very high emissions from deforestation (Department of Environment 2015b); looking forward, Australia may have substantial sequestration potential (Bryan et al. 2014). This has a material impact on both target calculations and cost estimates.

TABLE 1: RELATIVE ECONOMIC COSTS FOR SELECTED COUNTRIES OF ACHIEVING MODELLED 2020 TARGETS (PER CENT CHANGE IN 2020 GDP OR CONSUMPTION, RELATIVE TO BAU)

	GLOBAL STABILISATION AT 550 PPM		COPENHAGEN PLEDGES TO 2020	
Country	**Treasury, GTEM (GDP)**	**Treasury, G-Cubed (GDP)**	**McKibbin et al., (GDP)**	**McKibbin et al., (consumption)**
US	-0.2	-1.0	-2.7	0.0
Japan	0.1	-0.9	-5.1	-3.1
Australia	**-0.9**	**-2.2**	**-6.3**	**-2.0**
EU	-0.2	-1.4	-4.9[1]	-3.1[1]
China	-1.6	-4.8	-3.7	-4.5
India	-0.7	N/A	0.7	1.6
OPEC	-1.9	-10.5	-5.9	-13.2
World	-0.7	-2.3	-3.2	-2.1

Note: [1] McKibbin et al. modelled 19 European countries, which differ somewhat from the EU grouping.
Source: McKibbin et al. (2010) and Australian Government (2008).

STRENGTHS AND WEAKNESSES OF METRICS TO INDICATE EFFORT

METRIC	STRENGTHS	WEAKNESSES
Change in total emissions	Measurable and verifiable CO_2 emissions data is publicly available for most countries. Clear and explicit. Earlier base years reflect early efforts. Recent base years reflect effort still required to meet the target.	Limited data for other greenhouse gases. Rough estimate of effort because changes can be the result of many factors not only deliberate emissions reductions. Sensitive to choice of base year: this can make results confusing.
Reduction compared to BAU	Potentially captures all the effort.	Challenging to measure and validate. Results can be very sensitive to assumptions. Data tends not to be comparable because different models cover different countries and regions. Open to misuse because assumptions inflating BAU emissions make targets appear stronger.
Change in emissions per person	Measurable, verifiable and all countries can be compared. Gives a better indication of effort than change of total emissions because it takes into account population change. Shows whether countries are converging towards equal per person emissions.	Projections rely on assumptions about population changes. May not reflect policy effort because net immigration and net birth rate will also affect results.
Change in emissions intensity	Measurable, verifiable and all countries can be compared. Shows progress toward a key goal: decarbonisation of the economy. Takes into account changes in level of economic activity.	May not reflect policy effort as economies tend to become less emission-intensive as they develop. May mask shift of consumption from domestic to imported goods.
Cost of reducing emissions	Fits closely with many economists' view of actual effort to reduce emissions. Central to domestic financial budget development and prioritisation.	Very difficult to measure and replicate, so comparisons difficult. Results can be very sensitive to assumptions. A country's costs may be strongly influenced by action of other countries. Costs are often overestimated due to tendency to underestimate the rate of changes in technology and broader innovation.

NOTES ON DATA AND METHODOLOGY

1. All emissions estimates used in this guide use global warming potentials (GWPs) from the IPCC Second Assessment Report except for Australia which uses GWPs from the IPCC Fourth Assessment Report.
2. To allow comparisons, the mid-point of the US' 2025 emissions target range (27 per cent reduction from 2005) has been extrapolated to 2030, assuming a continued linear decline in emissions from its 2020 point target through its 2025 point target. This may be over-estimating a target in 2030 given that the 2025 target is based on President's executive action rather than broader ongoing climate policy.
3. Business-as-usual emissions refers to the level that would occur in the absence of additional climate policies.
4. Australia's 2020 target used throughout the Guide is its unconditional target of 5 per cent reduction below 2000 levels, except where otherwise stated.
5. Australia's 2030 target used throughout the Guide is the mid-point (50 per cent) of the Authority's previously recommended 2030 target range, 40-60 per cent below 2000 levels (CCA 2014).

REFERENCES

Aldy, J & Pizer, W 2014, *Comparability of Effort in International Climate Policy Architecture.* Discussion paper 14–62, The Belfer Centre, Harvard.

Australian Government 2008, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation,* Canberra.

Bryan, BA, Nolan, M, Harwood, TD, Connor, JD, Navarro-Garcia, J, King, D, Summers, DM, Newth, D, Cai, Y, Grigg, N, Harman, I, Crossman, ND, Grundy, MJ, Finnigan, JJ, Ferrier, S, Williams, KJ, Wilson, KA, Law, EA, Hatfield-Dodds, S 2014, *Supply of carbon sequestration and biodiversity services from Australia's agricultural land under global change.* In Global Environmental Change 28 (2014) pp. 166–181.

Climate Change Authority (CCA) 2014, *Reducing Australia's Greenhouse Gas Emissions—Targets and Progress Review, Final Report,* Melbourne.

Daley, J & Edis, T 2010, *Markets to Reduce Pollution: Cheaper than Expected,* The Grattan Institute, Melbourne.

den Elzen, M, Höhne, N, Hagemann, M, van Vliet, J, van Vuuren, D 2009, *Sharing developed countries' post 2012 greenhouse gas emission reductions based on comparable efforts,* Netherlands Environmental Assessment Agency (PBL), Report 500114014/2009, Bilthoven, the Netherlands.

Department of Environment 2015a, *Australia's National Greenhouse Accounts: Quarterly Update of Australia's National Greenhouse Gas Inventory, September 2014, data sources* viewed 23 March 2015 http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/publications/quarterly-update-australias-national-greenhouse-gas-inventory-sept-2014.

Department of Environment 2015b, *Australia's National Greenhouse Accounts: Quarterly Update of Australia's National Greenhouse Gas Inventory,* September 2014 , Canberra.

European Commission 2014, *A 2030 framework for climate and energy policies,* viewed 23 February 2015, http://ec.europa.eu/clima/policies/2030/index_en.htm.

Hamilton, C & Quiggin, J 1997, *Economic Analysis of Greenhouse Policy, A layperson's guide to the perils of economic modelling,* The Australia Institute, Canberra.

Höhne, N, den Elzen, M, Escalante, D 2014, *Regional GHG reduction targets based on effort sharing: a comparison of studies.* In *Climate Policy* 14 (1), pp. 122–147.

International Monetary Fund (IMF) 2014, *World economic outlook database,* Washington D.C. viewed 31 December 2014. http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx.

Intergovernmental Panel on Climate Change (IPCC) 2007, *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007,* Cambridge University Press, Cambridge and New York.

McKibbin, W, Morris, A, Wilcoxen, P 2010, *Comparing Climate Commitments: A Model-Based Analysis of the Copenhagen Accord,* Discussion Paper, 10-35, The Belfer Centre, Harvard.

Organisation for Economic Cooperation and Development (OECD) 2013, *Economic outlook database,* viewed 31 December 2014. http://stats.oecd.org.

Republic of Korea Ministry of Environment 2014, *National Greenhouse Gas Emissions Reduction Roadmap 2020,* viewed 25 February 2015. http://eng.me.go.kr/eng/web/board/read.do?menuId=21&boardMasterId=522&boardId=339283.

The White House 2014, *Fact-sheet US China Joint announcement: Climate Change and Clean Energy.* viewed 3 March 2015 http://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c.

Treasury 2015, Population projections for 2015 Intergenerational Report central case, data produced for *Intergenerational Report 2015: Australia in 2055,* Canberra.

Treasury & Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE) 2013, *Climate change mitigation scenarios, modelling report provided to the Climate Change Authority in support of its Caps and Targets Review,* Canberra.

United Nations (UN) 2013, *World Population Prospects—the 2012 revision,* United Nations, New York, viewed December 2014. http://esa.un.org/wpp/Excel-Data/population.htm.

United Nations Development Programme (UNDP) 2014, *Human Development Index, 2013 rankings.* New York, viewed 23 January 2015. http://hdr.undp.org/en/data.

United Nations Framework Convention on Climate Change (UNFCCC) Secretariat 2013, *Compilation of information on nationally appropriate mitigation actions to be implemented by developing country parties, FCCC/SBI/2013/INF.12.*

UNFCCC Secretariat 2014a *Compilation of economy wide emissions reduction targets to be implemented by Parties included in Annex I to the Convention, FCCC/SBSTA/2014/INF.6,* viewed 9 December 2014, http://unfccc.int/resource/docs/2014/sbsta/eng/inf06.pdf.

UNFCCC Secretariat 2014b *Greenhouse Gas Inventory Data,* viewed 10 December 2014. http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php.

UNFCCC 2014, *Lima call for climate action, Decision – /CP.20.* Lima.

World Resources Institute (WRI) 2014, *CAIT 2.0, Climate Analysis Indicators Tool, WRI's Climate Data Explorer.* Washington, D.C, viewed 18 November 2014. http://cait.wri.org.

CLIMATE
CHANGE
AUTHORITY

LEVEL 10
90 COLLINS STREET
MELBOURNE

GPO BOX 1944
MELBOURNE VIC 3001

FREECALL
1800 475 869

EMAIL
ENQUIRIES@CLIMATECHANGEAUTHORITY.GOV.AU

CLIMATE
CHANGE
AUTHORITY.GOV.AU