REPORT

Understanding emission reduction efforts

Approaches to assessing comparative effort

Prepared for
Australian Industry Greenhouse Network (AIGN)

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CANBERRA

Centre for International Economics
Ground Floor, 11 Lancaster Place
Canberra Airport ACT 2609

GPO Box 2203
Canberra ACT Australia 2601

Telephone +61 2 6245 7800
Facsimile +61 2 6245 7888
Email cie@TheCIE.com.au

Website www.TheCIE.com.au

SYDNEY

Centre for International Economics
Suite 1, Level 16, 1 York Street
Sydney NSW 2000

GPO Box 397
Sydney NSW Australia 2001

Telephone +61 2 9250 0800
Facsimile +61 2 9250 0888
Email ciesyd@TheCIE.com.au

Website www.TheCIE.com.au

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Summary

Development of emission targets must be informed

Australia, along with other countries, is currently in the process of setting its Intended Nationally Determined Contribution (INDC). The INDC details the actions a country plans to take to reduce emissions beyond 2020.

Australia's emission reduction target should be set with a clear understanding of the implications of the target for the Australian economy and industries. This understanding should also be informed by comparing Australia's level of effort with the level of effort to reduce greenhouse gas emissions by other countries.

More specifically, relevant information is:

- the amount of abatement the target requires (that is, the volume of emission reduction compared to a situation where there was no target) and
- the cost or impost of achieving that emission reduction.

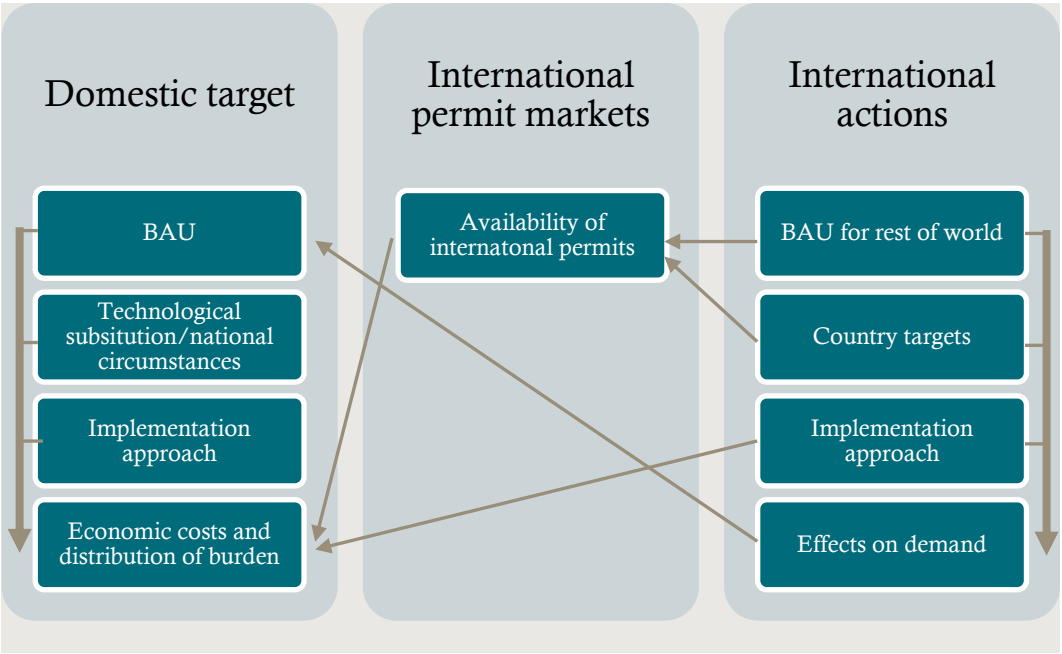
Emission reduction landscape is difficult to navigate

Emission reduction targets, in their various forms of implementation and interactions, are remarkably difficult to fully comprehend and compare. Chart 1 illustrates some of the complexity and interactions that should be considered in any judgement of an appropriate emissions target.

- Within Australia, the economic cost of a target will be determined by the projected business as usual (BAU scenario), the opportunities for substitution and the approach taken to realise the target.
- Costs will also be affected by the actions of other countries.
- The stringency of other countries' targets, combined with their projected BAU conditions as usual will determine the availability of international permits (which may allow Australia to meet its target at lower cost).
- Additionally, international conditions and mitigation efforts will affect demand for Australia's products which will in turn affect Australia's BAU and therefore economic costs of abatement. For example, strong action to reduce emissions internationally is likely to lower the demand for Australian coal. With lower coal production in Australia, BAU emissions may be lower and therefore meeting a specific emissions level target will be less costly (relative to BAU) than otherwise.
- Finally, the approach other countries take to reducing emissions is likely to affect the competitiveness of Australian industry. Emissions reduction policies that impact the cost of producing traded goods in the rest of the world (such as a widely applied

carbon tax) will improve the competitiveness of Australian traded sectors. Achieving the same emission reductions in non-traded sectors (such as electricity generation, or forestry management) will not have the same effect.

1 Determinants of the economic cost of meeting a domestic emissions target



Data source: The CIE

Costs indicate mitigation effort

The most appropriate measure of the level of mitigation 'effort' is the economic cost of climate policies to reach the proposed target. Climate change policies can impose costs through different means, but all policies that induce a change in behaviour effectively impose a cost by requiring a shift to less cost effective, but also less emission intensive, production.

The most significant concern associated with greater action to address climate change is the cost of taking such action. Costs of climate change mitigation are borne by:

- trade exposed industries where they are placed at a competitive disadvantage compared to competing industries in other countries
- domestic consumers where the cost of addressing climate change is reflected in higher domestic prices
- taxpayers where climate change policies are funded by the government.

As cost is the primary justification for limiting the extent of climate change mitigation, cost is clearly a relevant metric for assessing the level of 'effort' a country is making.

Assessing costs is difficult

Assessing the total economic costs of a climate change mitigation target effectively requires two stages.

- Firstly, a projection of emissions under a business as usual scenario is needed.
- Then, the costs associated with the required emission reduction from the business as usual level to the nominated target are estimated.

While assessing the costs of a particular emission reduction target is complex, there are established economic models that are designed to undertake this analysis. These models (computable general equilibrium models) are widely used for analysing climate change policy as well as a wide range of other economic issues, in particular trade policy.

Alternative metrics aren't informative

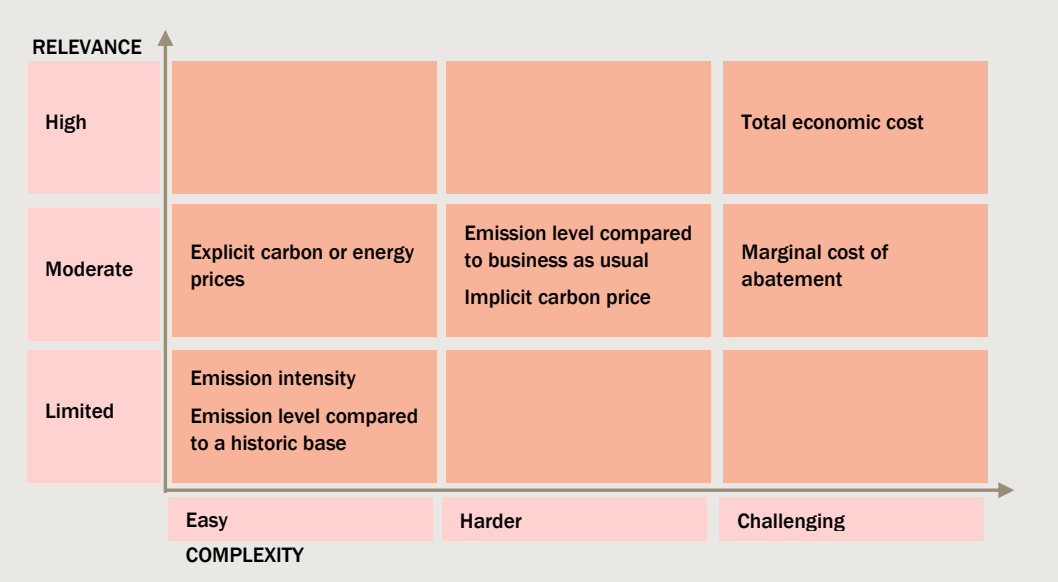
While there are several alternative methods for comparing emission reduction targets, the alternative metrics aren't relevant for understanding comparative effort.

The main alternative metrics are:

- emissions targets relative to a historical base year
- emissions targets specified in terms of emission intensity (or emissions per capita)
- emissions targets relative to business as usual emissions
- carbon prices
- energy prices
- marginal cost of abatement.

Further explanation of these metrics and their relative merits is provided in body of this document. An assessment of these metrics finds a trade off between the complexity of a metric and its relevance. Chart 2 illustrates this trade off. Evaluating the economic cost of an emissions target is relatively difficult as it requires information and assumptions about future emissions and economic structures and costs, but alternative metrics don't provide the required information to suitably understand and assess an emissions target.

2 Trade off between relevance and complexity of metrics for effort comparison



Data source: The CIE

1 Importance of measuring emission reduction effort

Background

Australia, along with other countries, is currently in the process of setting its Intended Nationally Determined Contribution (INDC). The INDC details the actions a country plans to take to reduce emissions beyond 2020. The mitigation goals will eventually be transformed into a global agreement under the UNFCCC.

Combined, the national targets are aimed at limiting global temperature increases to less than 2 degrees Celsius above pre-industrial levels. The targets are to reflect equity according to the Common but Differentiated Responsibilities and Respective Capacities principle.[1]

The Australian Government has stated[2], in determining the post-2020 target, it will consider:

- Australia's national circumstances, which includes consideration of Australia's emissions reduction opportunities
- the scope and nature of other countries' targets.

These considerations highlight the need to assess the level of effort associated with emission reduction targets in Australia and other countries.

Comparing effort

To date, most comparisons of climate policies have looked at the 'top line' target, that is, a reduction in a particular year, relative to emission levels at some point in history. This type of comparison has the potential to be very misleading. It does not account for differences in emissions profiles, economic structures or expected future emissions. Such a comparison therefore, does not provide an indication of mitigation effort. A minimum level of comparison between countries is to consider the emission target relative to expected business as usual (BAU) emissions.

Overall economic effort required to achieve a particular target is a more relevant approach to comparing mitigation targets. This economic effort (cost) incorporates the factors that determine BAU emissions, as well as other factors including broad economic

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1 GIZ 2014, *Intended Nationally Determined Contributions (INDCs) – Factsheet*, http://mitigationpartnership.net/sites/all/modules/contributed/pubdlcnt/pubdlcnt.php?file=http://mitigationpartnership.net/sites/default/files/indc-factsheet_final_tf2.pdf&nid=3416

2 Department of the Prime Minister and Cabinet 2015, *Setting Australia's post-2020 target for greenhouse gas emissions – Issues paper*, March.

structure. Box 1.1 shows that the relationship between these alternative metrics is not particularly strong. Conclusions drawn from a comparison of emission reductions are going to be different to those drawn from a comparison of carbon prices or economic costs.

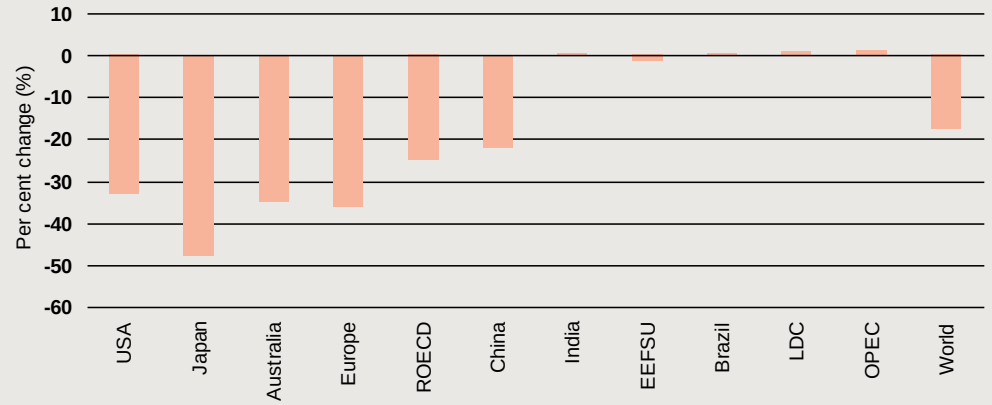
1.1 Emission reduction targets and economic burden

There is a complex relationship between abatement targets, implicit carbon prices and changes in GDP (as a measure of resource movements or economic burden). The set of charts below shows a comparison of Copenhagen targets based on results modelled using a global general equilibrium model (G-Cubed).

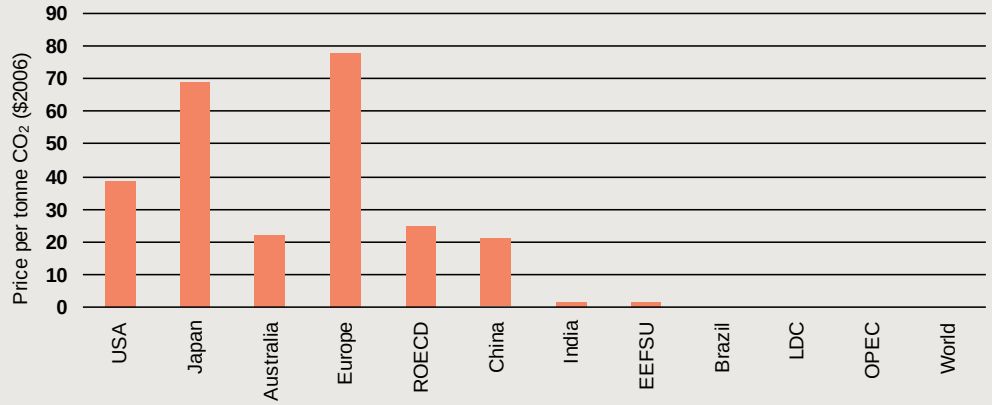
The charts show emission targets, expressed relative to business as usual, the carbon price needed within each individual country to achieve the target, and the effect on GDP.

The results demonstrate that, there is only a very broad relationship between emission reductions, the carbon price and the impact on GDP. Thus, comparing emission reduction targets (even when placed on a common basis), or even comparing economywide carbon prices, does not necessarily provide an indication of the relative economic burden of emission reduction efforts.

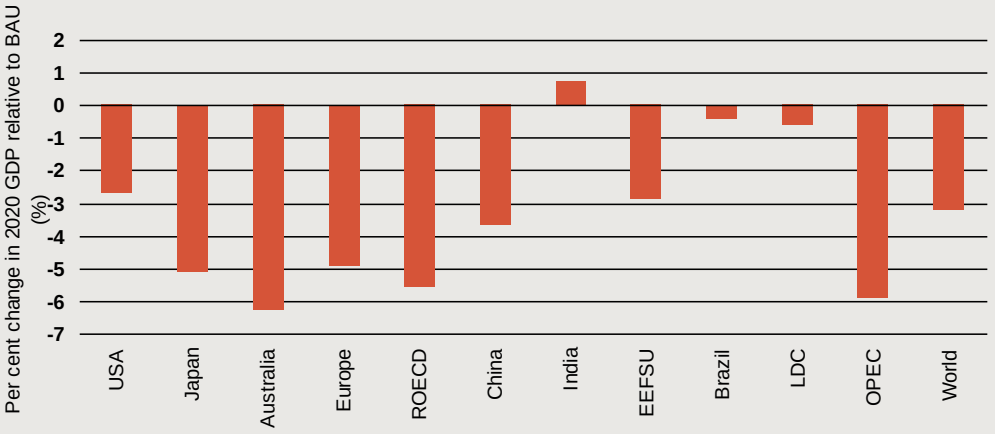
Reduction in emissions in 2020 relative to BAU



Carbon price in 2020



Reduction in GDP in 2020 relative to BAU



Note: ROECD = Rest of the OECD; EEFSU = Eastern Europe and former Soviet Union; LDC = Less developed countries.

Data source: McKibbin et al Comparing climate commitments: a model based analysis of the Copenhagen Accord. (http://belfercenter.ksg.harvard.edu/files/McKibbin-DP-June2010-final.pdf)

Capacity to reduce emissions may be indicated by a country's income or level of development, their emission intensity or endowment of natural resources. A highly developed, or high income, country will have greater capacity to invest in low emission activities and infrastructure, and where international emission reductions are relevant, can fund emission reductions in other countries. A low emission intensity would indicate there are fewer opportunities to reduce emissions without reducing economic activity. Computable general equilibrium models capture this wide range of relevant information and produce an estimate of economic cost accordingly.

Measuring effort

A variety of measures have been suggested, and used, to gauge the level of effort countries devote to emission reductions. No single metric is able to capture the full complexity of greenhouse gas mitigation programs. Various metrics have been used and each have their advantages and disadvantages, but some clearly have greater value than others.

What makes a good metric?

A good metric should be comprehensive, measurable, replicable and universal.[3] Most importantly, the metric should reflect effort.

Ideally, a metric will be able to characterise the entire policy framework for reducing greenhouse gas emissions. Such a comprehensive metric should also ensure that changes in greenhouse gas emissions not determined by policy are not included in the measure of effort. Measures of emissions that are relative to a historic base capture all changes in emissions, including those not due to deliberate mitigation effort. Explicit carbon prices, on the other hand, may not capture all the effort if policies are implemented in addition to a carbon pricing mechanism.

A metric should be able to be applied to all countries (or all countries of interest). Assessing the level of effort being applied in other countries will ensure that Australia's target is fair, and will also provide insight into how much Australia may be affected by the actions in other countries.

A metric will be more trusted and accepted if it is transparent, measurable and able to be replicated. Any comparison, and the conclusions drawn from the comparison, will carry more weight if the metric used is able to be clearly observed and/or replicated using publically available information.

3 Aldy, J.E. and Pizer, W. A. 2014, *Comparability of effort in international climate policy architecture,* Harvard Project on Climate Agreements Discussion Paper 14-62, January.

What can be measured?

Emissions

The simplest measure of action to reduce greenhouse gas emissions is to measure emission levels. Emission levels is the metric widely used to articulate the level of action countries are taking, and have been the focus of international agreements – Kyoto Protocol, Copenhagen Accord and Cancun Agreements. Specifying a future level of emissions is pertinent for specifying a target but less relevant for comparing mitigation efforts.

Approaches to specifying emission levels include:

- comparisons to a historical base year
- emission intensity or emissions per capita targets
- emission reductions relative to a BAU.

Comparisons relative to a historical base year are most commonly used to specify targets, but provide the least robust indication of the level effort or the implications of an emission reduction policy.

Prices

Price indicators reflect the implications of an emission reduction policy at the margin. Prices may include an explicit carbon price (realised through a tax or emissions trading policy), an implicit carbon price, or energy taxes or prices. A carbon price is not a comprehensive metric as it is likely to only apply to some sectors of the economy or operations of a certain size, and there may be counteracting policies that subsidise emission producing activities that would not be captured using a carbon price.

Costs

The economic costs of mitigation cannot be directly observed, but are the most relevant measure of effort. Costs capture the full mitigation effort, rather than effort at the margin. A simple approach to measuring costs uses a partial equilibrium analysis, based on estimated emission abatement and marginal costs. More comprehensive estimates use a general equilibrium approach which captures the indirect effects on all sectors of the economy as well as trade effects.

Alternative metrics

Table 1.2 summarises the common metrics used to measure and compare mitigation effort. Generally speaking, there is a trade off between the complexity and relevance of mitigation effort metrics. Those metrics that are simple are generally not very useful in comparing effort and provide no insights into the implications of a particular target or policy. On the other hand, the metric that is likely to be most relevant or useful in illustrating effort is the most complex and requires the use of economic models.

1.2 Measures of effort: advantages and disadvantages

Measure of effort	Advantages	Disadvantages
Emissions		
Level of emissions compared with historical base year	Straightforward to estimate from national emissions inventories	Limited usefulness, particularly in comparing effort between countries as a variety of non-effort related factors will determine the comparison. Highly sensitive to the selected base year
Emissions intensity (either at a point in time or over time)	Straightforward to estimate from national emissions inventories and national accounts data, indicates degree of decarbonisation	Limited usefulness, particularly in comparing effort between countries. Emission intensity driven by a wide variety of factors
Abatement target relative to business as usual emissions expectations	Puts abatement targets on a common basis and is an important prelude to understanding effort, fully captures the relevant emission abatement	More complex to estimate, requires business as usual projection, not a measure of effort
Prices		
Carbon prices; explicit or implicit	Likely to be useful to provide a picture of the range of outcomes around the world, explicit prices are easy to observe	Marginal (not total) measure, not necessarily exactly reflecting effort, complex to estimate implicit prices
Energy prices	High level energy prices are observable, may provide an initial point to compare effort of similar countries	Not comprehensive, can be complex to isolate the policy relevant component of prices, marginal measure and can be shaped by factors other than effort
Costs		
Marginal cost of abatement curves	Integral of the curve provides a measure of total cost, bottom up development can incorporate significant detail and specifics	Complex and difficult to interpret appropriately, uses a partial equilibrium framework.
Integrated estimate of economic cost of abatement target	The measure that seriously approaches the economic concept of effort and most likely to be useful	Most complex, requires an integrated economic model. Note that while these models are complex, they are often commonly used for policy analysis

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Implications of international emission reduction policies

The government's current policy position is set in the context of other countries' actions:

> "the target will represent Australia's fair share of the global effort"[4].

Australia's emission reduction goal, therefore, should be framed by the commitments of other countries. Additionally, Australia's trade exposed sectors will be affected by both

4 Department of the Prime Minister and Cabinet 2015, *Setting Australia's post-2020 target for greenhouse gas emissions – Issues paper*, March, p6.

Australia's and other countries' targets. Understanding the overall impact on Australia of the post-2020 international climate regime needs to consider other countries' targets.

It is not just the level of emission reduction in other countries that is relevant, but also:

- the policy detail on how the target is proposed to be reached
- the burden of the policies on the economy and individual industries
- the likelihood of the proposed policies being implemented and the target reached.

The effects of climate change policies on Australian and other industries are potentially profound. To the extent that climate policy raises energy prices, prevents or discourages certain economic behaviour and encourages new economic activity it requires:

- industry to adjust
- industry to take up new opportunities, or
- institutional and infrastructural change.

How are targets actually reached?

Understanding how a country plans to meet their target has two major implications. Firstly, the proposed approach may determine whether meeting the target is considered to be feasible and/or likely. If there are no clear means by which a target will be reached, or the target is overly ambitious and the target is therefore unlikely to be reached, then the target itself holds little value or meaning.

Secondly, how the emission reductions are achieved (in both Australia and other countries) has implications for the impact on Australia's trade exposed sectors. This has implications for the overall cost, or burden, of Australia's climate change policy, and the distributional impacts of any policy or target.

Table 1.3 summarises the INDC submissions to date. It shows the range of proposed targets, and how they may be achieved. Where details are provided, each of the countries are adopting significantly different approaches to meeting their targets. The different approaches (emissions trading, regulations and forest management) make comparisons difficult.

1.3 Summary of INDC submissions to the UNFCCC to date

Country	Target	Proposed measures to achieve target	Use of international market mechanisms
EU	40 per cent reduction by 2030, compared to 1990	Emissions trading and other un-specified legislative instruments	No
US	26-28 per cent reduction by 2025, compared to 2005	New and existing standards and regulations on fuel standards, building sector emissions, high-GWP HFCs, power plants and methane emissions from land fill and the oil and gas sector	No
Russia	25-30 per cent reduction by 2030, compared to 1990	High reliance on forestry management	No
Switzerland	50 per cent reduction by 2030, compared to 1990	Unspecified (new and existing measures)	Yes (although most reductions are to be achieved domestically)
Norway	40 per cent reduction by 2030, compared to 1990	Collective delivery with the EU (including emissions trading)	Only through the EU ETS
Mexico	22 per cent reduction by 2030, compared to BAU (target increasing to 25 per cent if Black Carbon is included)	Unclear	Yes
Gabon	50 per cent reduction by 2015, compared to BAU	Unclear	Unclear

Source: Individual country INDC submissions to the UNFCCC, http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx (accessed 16 April 2015)

2 Metrics for comparing mitigation effort

Emissions: reductions relative to historical base year

The most simple and widely used measure of emission reductions is a change in emissions relative to an arbitrarily selected historical base year (for example, a 5 per cent reduction relative to 2000 levels by 2020). This measure provides information about the target volume of emissions at a particular point in time. It doesn't, however, provide any insight into the effort required to meet the target. Furthermore, due to its high sensitivity to the selected base year, the metric is not useful for comparing the actions of different countries.

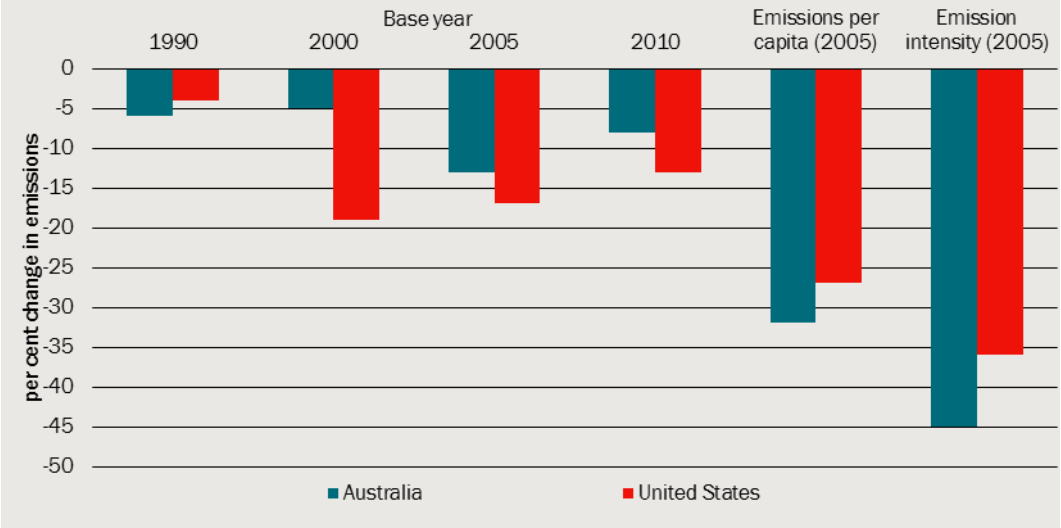
2.1 Emissions compared to historical base year: advantages and disadvantages

Advantages	Disadvantages
Simple	No indicator of deliberate abatement (compared to what would otherwise be)
Measurable and verifiable	Highly sensitive to the base year chosen
Publically available data	Not an indicator of 'effort'

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Using this measure to compare targets of different countries mostly reflects historical emission levels. Emission reductions will appear more significant if the chosen base year was, for some reason, a year of high emissions (due to higher rates of economic activity for example). Chart 2.2 illustrates the impact of changing the base year of the emission reduction target. As the chart shows, Australia's target appears more ambitious than the US when reported using a 1990 base year, but appears significantly less ambitious using the 2000 base year.

2.2 Effect of changing the base year on emission targets



Data source: Climate Change Authority (2015) *Comparing Countries' Emissions Targets: A practical guide*, March.

Emissions: reduction in intensity

Some countries (particularly developing countries) have reported emission reduction targets in terms of emission intensity. That is, they aim to reduce the emissions per unit of GDP. This type of target controls for different rates of economic growth. Therefore, a comparison of two targets specified in terms of emissions intensity will appear more favourable for a rapidly growing economy compared to emission targets specified relative to a historical base.

This is a slightly better measure of abatement effort (compared to emission levels relative to a historical base year) as it reflects a change in the economic structure (decarbonisation of an economy). However, not all reductions in emission intensity would be a result of policy effort (emission intensity generally tends to decline as economies grow) and therefore it is not a true measure of abatement effort. Comparing emission intensities of different countries requires assumptions about exchange rates, and the implications of future targets depend on whether the targets are specified in real or nominal terms. Again, targets specified relative to a historical level are highly dependent on the selected base year.

2.3 Emissions intensity: advantages and disadvantages

Advantages	Disadvantages
Relatively straightforward	Poor indicator of deliberate abatement effort
Measurable and verifiable	Highly sensitive to the base year chosen
Publically available data	
Indicates change in economic structures (decarbonisation)	

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Measures of emissions per person are similar to those of emissions intensity, but rather than controlling for economic growth, the measure controls for population growth. Using an emissions per person target will, relative to an absolute emissions measure, lead to greater apparent effort by countries with high population growth.

Emissions: reduction relative to business as usual

Measuring emission reductions relative to an estimated business as usual (BAU) scenario fully captures the extent of policy driven emission abatement. Targets reported relative to BAU, however, require a projection about future emissions which is inherently uncertain and subject to assumptions (including whether or not to incorporate existing mitigation efforts). Furthermore, the change relative to a future forecast cannot actually be observed.

The measure avoids the biases of comparisons using other metrics – driven by the reliance on historical emission levels – and, as with the emission intensity measure, does not lead to unfavourable comparisons for rapidly growing economies.

Measuring emission reductions relative to BAU is the most comprehensive measure of emission reductions, as it accounts for actual emission reductions achieved by policy. Despite this, the measure does not incorporate any indication of the relative difficulty for countries to achieve a reduction in emissions. A country endowed with abundant, unused, low emission, energy resources is likely to find reducing emissions relatively less burdensome than a country without such endowments.

2.4 Emissions relative to BAU: advantages and disadvantages

Advantages	Disadvantages
Fully captures relevant emission abatement	Requires modelling and assumptions
Avoids biases related to choice of base year	Change cannot be observed – difficult to measure and validate
	Does not capture burden of abatement

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Prices: carbon

Carbon prices may either be explicit prices imposed through a carbon tax or an emissions trading scheme, or they may be implicit carbon prices which reflect the penalty or cost imposed by other policies for the production of greenhouse gas emissions.

A carbon price measures the marginal cost of climate change mitigation for the relevant sector(s). The carbon price is an indicator of the effort a country is putting into emissions abatement. As abatement opportunities that cost less than the carbon price are assumed to be realised, a higher carbon price indicates either greater abatement (exhausting low cost opportunities) or a lack of low cost abatement and therefore greater difficulty in reduction emissions. The carbon price, therefore, also reflects the economic structures and national circumstances of each country.

However, a carbon price is not a comprehensive measure. Policies that impose a carbon price (explicit or implicit) often do not cover all sectors of an economy. Accordingly, any comparison of carbon prices between countries should ensure a similar sectoral coverage. The pricing signal from an explicit carbon price may also be clouded by other policies (such as tax adjustments, subsidies), which will mean the effective carbon price differs from the observed, nominal carbon price.

2.5 Carbon prices: advantages and disadvantages

Advantages	Disadvantages
Indicator of marginal cost/effort	Not a comprehensive measure
Avoids biases related to choice of base year	Marginal, not total, measure
Explicit prices easily observable	Comparisons require assumption regarding exchange rates etc
	Implicit carbon prices are not directly observed

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Prices: energy

Comparing fossil fuel based energy prices has the advantage that it is relatively straight forward and energy prices are observable. Energy prices provide an indication of the incentives in the economy to find energy saving opportunities. High energy prices will drive energy efficiency improvements. An advantage of using energy prices as a measure of effort over carbon prices is it will capture the effects of additional policies (beyond the carbon price) that affect energy prices and therefore abatement effort. This may include the implicit costs of meeting regulations and standards in energy production.

Energy prices, however, are also not comprehensive measures. They only consider the energy sector and not the impact of any consumption-related policies. Furthermore, differences in energy prices may reflect factors that are not related to policy choice such as particular endowments of natural resources or transport costs.

2.6 Energy prices: advantages and disadvantages

Advantages	Disadvantages
Indicator of marginal cost/effort	Not a comprehensive measure
Explicit prices easily observable	Marginal, not total, measure
Captures impacts of policies other than explicit carbon pricing	Adjustments and benchmarking required to distil the policy relevant aspects of the price

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Costs: marginal abatement cost curves

Marginal abatement cost curves have been used in the past as an indicator of the relative cost of emission reduction in various countries. The development and underlying assumptions of the curves are often not transparent and marginal abatement cost curves developed by different groups vary widely.

Furthermore, the marginal abatement cost curves are developed in a partial equilibrium framework which can lead to misleading conclusions. The partial equilibrium framework means interactions between sectors of the economy are not captured. In some cases, abatement measures may conflict and in other cases there may be synergies between measures. The combined impact of two abatement measures may be either more or less than their sum.[5] The curves are generally a snapshot in time and therefore do not reflect dynamic change or path dependency of abatement measures.

A sophisticated approach to developing cost curves is the GAINS model developed by IIASA to estimate marginal cost curves for a range of countries and regions[6]. The model includes system modules that link that various parts of the economy to ensure some consistency in the model results. This means that the marginal abatement cost curves developed using their models are internally consistent, assuming low cost abatement opportunities are realised first. The costs are also prepared relative to a future baseline (rather than current levels). Despite this additional complexity of the GAINS model to address activity consistency, it does not capture indirect costs, macro-economic feedbacks, employment effects or changes in trade flows.[7]

5 See Ekins et al. 2011, *Marginal Abatement Cost Curves: A call for caution*, A report by the UCL Energy Institute commissioned by Greenpeace UK, April.

6 See http://gains.iiasa.ac.at/models/index.html.

7 Wagner et al. 2012, 'Sectoral marginal abatement cost curves: implications for mitigation pledges and air pollution co-benefits for Annex I countries', *Sustainability Science,* 7(2):169-184.

2.7 Marginal abatement cost curves: advantages and disadvantages

Advantages	Disadvantages
Indicator of effort	Not always-transparent
Sophisticated versions (such as GAINS) allow a wide variety of comparisons	Partial equilibrium framework
	Sometimes simplistic presentation leads to misinterpretation

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Insights from marginal cost studies

Notwithstanding the limitations of the marginal cost curve approach as a measure of mitigation effort, the cost curves developed using the GAINS model provides some relevant insights.

- The marginal cost of abatement depends on the baseline (business as usual) assumptions – particularly economic development and future energy price assumptions that determine future energy consumption patterns (and therefore emissions).
- The marginal cost curves change over time. For low levels of abatement, the marginal cost of abatement for Annex I countries is lower in 2020 than 2030 but this relationship reverses for higher levels of abatement. This would imply that is cost effective to start abatement efforts, up to a point, earlier rather than later (but then to delay some abatement until later).
- Marginal abatement cost curves for the Annex I countries intersect. The different shapes of the curves reveal the different sectoral makeup of the countries, and the different mitigation potentials for the sectors. Any comparisons between countries based on marginal measures will therefore depend on the level of abatement being considered.

Costs: total economic

The total economic cost of meeting an emissions target is the best measure of mitigation effort. A measure of the total economic cost of abatement can be generated using an economic model (computable general equilibrium, CGE, model) that firstly estimates the business as usual level of emissions based on the current structure and endowments of a country. The model then calculates the cost that will be incurred (relative to the business as usual, BAU, scenario) in order to achieve a given abatement target.

The cost of meeting an emissions target will depend on the energy intensity of the economy, the emission intensity of energy, the availability (and relative costs) of substitute sources of energy or economic activity and the size of the abatement task (relative to BAU). The costs estimated using computable general equilibrium models reflect the additional resources expended (compared to BAU) to meet the target.

Because the models have representations of all the major sectors of the economy, and different regions of the world, they are able to capture interactions between sectors and countries.

The development of these CGE models is complex, however, there are a number of established models that are in use for a variety of policy analysis tasks, including assessing climate change policies. The Australian Government has used these models in the past to estimate the cost of abatement in Australia and other countries.

2.8 Total economic costs: advantages and disadvantages

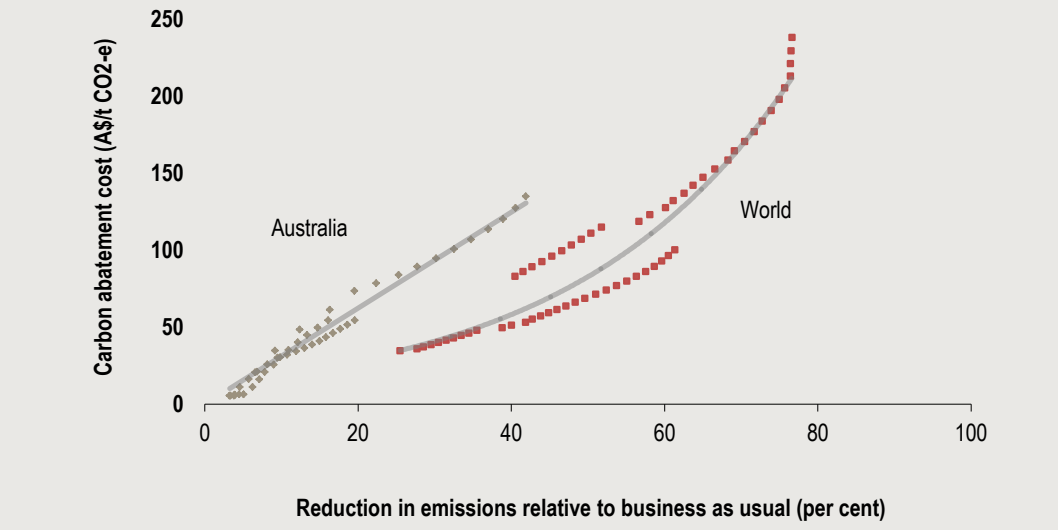
Advantages	Disadvantages
Best indicator of total effort – economic burden	Complex – requires use of models
Reflects actual abatement	
Reflects economic structures and national circumstances	
General equilibrium framework (whole of system analysis)	

Source: CIE, based on a variety of reports, including Aldy and Pizer 2014, *Comparability of Effort in International Climate Policy Architecture*, Harvard Project on Climate Agreements Discussion Paper 14-62, January, and Climate Change Authority 2015, *Comparing Countries' Emissions Targets: A practical guide*, March.

Available evidence on economic costs

Chart 2.9 shows the relationship between the amount of abatement (in terms of the reduction in emission relative to business as usual) and the cost per unit of abatement (in \$/t CO_2-e). This is the marginal abatement cost curve implied by a number of simulations presented in Commonwealth Treasury modelling. The difference between the Australian and World abatement cost curves clearly shows that — when expressed on a common basis and over the range covered — the Australian cost of abatement is higher than the World cost of abatement. A key difference between these marginal abatement cost curves and that estimated by the GAINS model is that these curves capture all relevant economic costs including indirect costs, macro-economic feedbacks and changes in trade flows that are not included in the GAINS model.

2.9 Emissions reduction cost curves



Note: Fitted lines presented for illustration.

Data source: CIE derivation from Commonwealth of Australia 2013 *Climate Change Mitigation Scenarios* charts 2.4, 2.6, 3.1 and 3.6.

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