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# Meeting our Paris Commitment

## Modelling shows 66-75% renewable energy generation required to meet Australia’s emissions target and avoid transferring major burden onto other sectors.

***If Australia is to achieve the Abbott Government’s climate targets new energy policies will be required. Existing government modelling shows that renewable energy generation of 75% in 2030 could be required if an abatement cost or long-term incentive approach guides climate policy.***

Discussion paper

**Rod Campbell**
**September 2017**

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# Summary

Under the Abbott Government, Australia signed the Paris climate agreement, committing to reduce carbon emissions by 26-28% below 2005 levels by 2030. The electricity sector will play a significant role in meeting these targets, as it accounts for 35% of the country's total emissions.

A central question concerning the electricity sector's role in meeting Australia's mitigation targets is whether it should reduce its emissions by 26-28%, consistent with the national target, or whether it should shoulder a larger part of the abatement task.

While an equal proportion approach has the benefit of simplicity, it is inefficient because it will push the abatement task onto other industries, where the costs of abatement are higher. The electricity sector can turn to renewable energy which is already commercially available, while other sectors such as agriculture, construction and manufacturing do not have similarly available and cost-effective options. Because of this it has long been assumed that the electricity sector would reduce emissions by more than other parts of the economy.

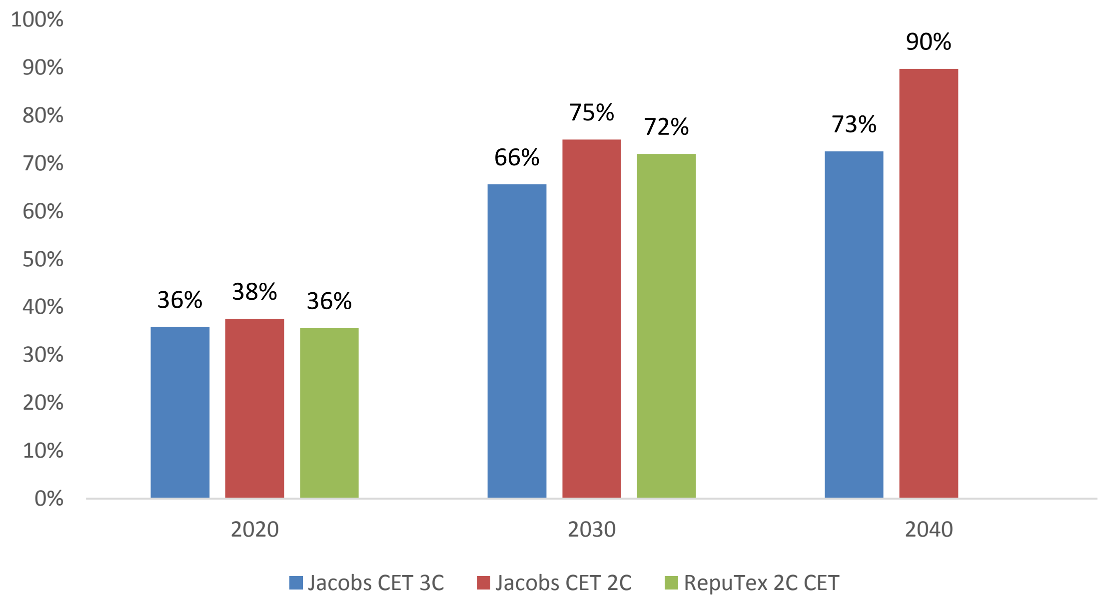
Alternatives to a proportional approach include setting policy with reference to costs of abatement, or to incentives for long term investment.

Government agencies have conducted modelling exercises that consider the size of the task of the electricity sector, what policies could help achieve this and what level of renewable energy generation would result from these policies. This report collates and compares the results of these modelling exercises, showing the likely outcomes from current policy options.

A key result is that under the more efficient abatement cost and long-term investment signal approaches, the electricity sector will need to reduce emissions by between 40%-55% below 2005 levels in 2030.

The level of renewable energy penetration required to achieve emissions reductions of this magnitude under a CET-like policy have been estimated in separate assessments by well-known consultants Jacobs Group and RepuTex, with results summarised in the chart below:

**Renewable penetration, with 40%-55% CET**




Source: Jacobs (2017) *Report to the independent review into the Future Security of the National Energy Market: Emission mitigation policies and security of electricity supply* and Reputex (2017) *It's the economics, stupid*

These studies show that if an abatement cost approach is used to set the 2030 electricity sector target, and a CET-like policy is used to achieve it, renewable penetration is likely to be in the order of 66-75% by 2030.

# 1. Introduction

Under the Paris Climate Change Agreement, all parties are required to submit and maintain nationally determined contributions (NDCs) that they intend to achieve and 'pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions'. Collectively, the successive NDCs are intended to realise the agreement's objective of 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels'.[1] Australia's first NDC, which was officially submitted in November 2016, commits it to an economy-wide emission reduction target of between 26-28% below 2005 levels by 2030. Although expressed as a single year target, the Australian Government intends to develop it into an emissions budget covering 2021-2030, meaning there will be a target level of cumulative emissions over this period.[2]

The Australian Government currently has a number of policies that are intended to reduce greenhouse gas emissions, including the Emission Reduction Fund (ERF), Large-scale Renewable Energy Target (LRET) and the minimum energy efficiency standards set under the *Greenhouse and Energy Minimum Standards Act 2012* (Cth). There are also a number of state, territory and local government policies that aim to abate emissions like the Victorian and Australian Capital Territory (ACT) renewable energy target schemes, and the energy efficiency schemes that operate in Victoria, South Australia, New South Wales and the ACT. Despite the existence of these policies, additional measures are likely to be required to meet the 2030 targets. The Australian Government's latest projections suggest emissions will have to be reduced by a further 842-1202 million tonnes (Mt) of carbon dioxide equivalent ($CO_2$-e) to meet the NDC commitments.[3]

In addition to the need for measures to reduce emissions, the Australian Government has faced pressure to respond to the escalating crisis in the electricity sector. In recent years, the National Electricity Market (NEM) has been beset by rapidly increasing prices, which have adversely affected residential, commercial and industrial electricity

[1] *Paris Agreement,* p 2, http://unfccc.int/files/home/application/pdf/paris_agreement.pdf

[2] See for e.g. Department of Foreign Affairs and Trade (2015) *Australia's intended Nationally Determined Contribution to a new climate change agreement,* http://dfat.gov.au/international-relations/themes/climate-change/submissions/Pages/australias-intended-nationally-determined-contribution-to-a-new-climate-change-agreement-august-2015.aspx

[3] Department of the Environment and Energy (2016) *Australia's emissions projections 2016,* p 8, https://www.environment.gov.au/system/files/resources/9437fe27-64f4-4d16-b3f1-4e03c2f7b0d7/files/aust-emissions-projections-2016.pdf

consumers. The escalating prices are attributable to a combination of factors, particularly high gas prices, increased retail margins, the closure of aging coal-fired generators and a lack of investment in new generation capacity beyond that supported by the LRET. One of the major reasons for the generation investment drought is the absence of stable long-term climate policy signals. Fluctuations in climate policy over the past decade have created uncertainty, undermining the ability of investors to judge the economic viability of alternative energy investments. Those considering investments in fossil fuel generators have been concerned about potential increases in the stringency of climate policy constraints. Similarly, those considering investments in low emissions generators have been stymied by the absence of short-term incentives outside of the LRET and uncertainty about the longer-term trajectory of climate policy.

To address the challenges facing the electricity sector, the Australian Government commissioned the Independent Review into the Future Security of the National Electricity Market, led by the Chief Scientist, Dr Alan Finkel (Finkel Review).[4] The Review highlighted the adverse impacts of ongoing policy uncertainty and called for long-term policy stability and clarity.

> Uncertainty related to emissions reduction policy and how the electricity sector will be expected to contribute to future emissions reduction efforts has created a challenging investment environment in the NEM. Ageing generators are retiring from the NEM, but are not being replaced by comparable dispatchable capacity. Policy stability is required to give the electricity sector confidence to invest in the NEM.
>
> Reliability in the NEM will be strengthened by establishing a framework for an orderly transition to a low emissions future. This must include a long-term emissions reduction target for the electricity sector, a credible and enduring mechanism for the sector to achieve the emissions reduction trajectory and better management of generator closures.[5]

To address concerns about policy uncertainty, and drive emissions reductions, the Finkel Review made a number of recommendations, the most relevant of which were:

- the Australian and State and Territory governments agree to an emissions reduction trajectory for the NEM; and

[4] Finkel (2017) *Independent review into the Future Security of the National Electricity Market*, http://www.environment.gov.au/system/files/resources/1d6b0464-6162-4223-ac08-3395a6b1c7fa/files/electricity-market-review-final-report.pdf

[5] Finkel (2017) *Independent review into the Future Security of the National Electricity Market*, p 33

- the Australian Government introduce a Clean Energy Target (CET) to help meet Australia's Paris Agreement commitments and improve security and reliability in the electricity sector.[6]

A CET is a type of tradeable permit scheme in which new electricity generators (or existing generators who generate above a historic baseline) receive certificates for electricity they generate as long as their emissions are below a threshold per unit of electricity (emissions intensity). Depending on the emissions intensity of their generation, they are awarded more or less of these certificates. The emissions intensity threshold mooted in the Finkel Review was 0.6 tonnes of carbon dioxide equivalent ($CO_2$-e) per MWh, meaning a generator with an emissions intensity of 0 t$CO_2$-e/MWh would receive 1 certificate per MWh, a generator with an emissions intensity of 0.3 t$CO_2$-e/MWh would receive 0.5 of a certificate per MWh, and a generator with an emissions intensity of ≥0.6 t$CO_2$-e/MWh would receive no certificates. Generators who receive CET certificates would sell them to electricity retailers, who would be required by law to purchase a prescribed number each year. The cost of purchasing these certificates would be passed onto electricity consumers through their electricity bills.

This process is similar to the LRET, under which eligible generators are awarded one 'large-scale generation certificate' (LGC) for each MWh of generation. Retailers are required to buy a set number of LGCs each year from eligible generators. The two main differences between the LRET and a CET are:

- a CET awards certificates in proportion to the extent to which their emissions intensity is below the prescribed threshold (under the LRET, eligible generators receive 1 LGC for each MWh of generation); and
- under a CET, the generation target, which determines the number of certificates retailers are required to purchase, is calibrated to achieve an emissions target for the electricity sector (under the LRET, the target is set to achieve a prescribed amount of eligible generation).

To give effect to the Finkel Review's recommendations and implement the CET, the Australian Government must set an emissions reduction trajectory for the electricity sector. The Review only considered the trajectory briefly, commenting:

> At a minimum, the electricity sector should have a trajectory consistent with a direct application of the national target of 26 to 28 per cent reduction on 2005

[6] Finkel (2017) *Independent review into the Future Security of the National Electricity Market*, p 21 onwards

levels by 2030, as per Australia's international obligations under the Paris Agreement.[7]

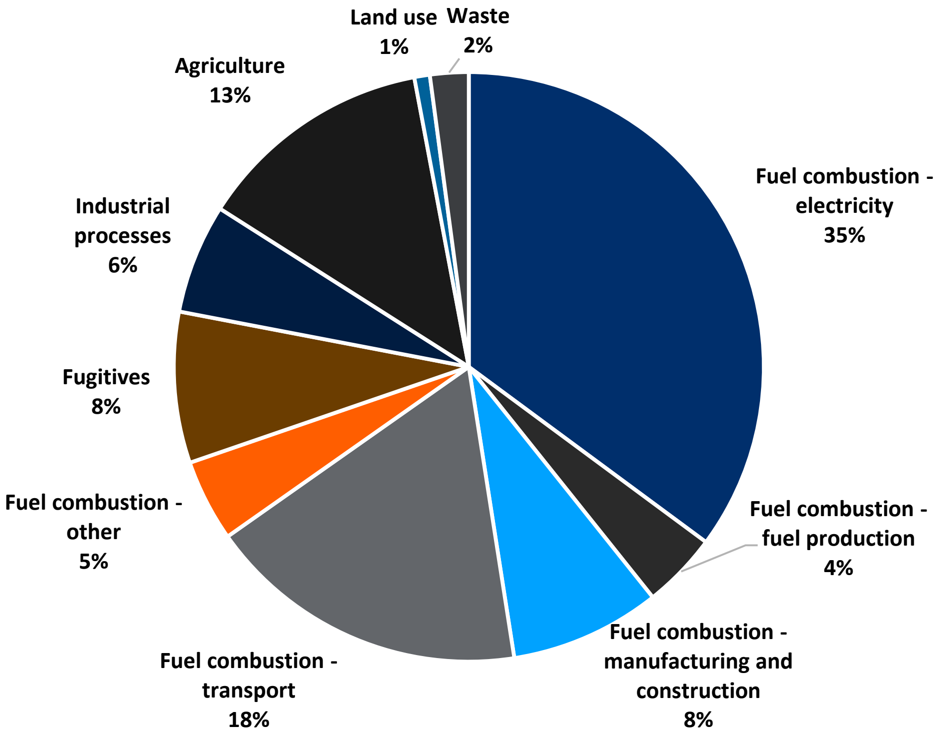
This report considers what emission reduction targets should be adopted for the electricity sector and what amount of renewable energy generation is likely to be required to meet them. Both issues are of high current policy interest. The Australian Government is currently considering whether to implement the proposed CET and what targets it might set for the electricity sector as part of its 2017 Climate Policy Review. The Opposition has signalled 'in principle' support for a CET and has committed to a 50% renewable energy target by 2030, which has been ridiculed by the Government and conservative commenters. The remainder of the report is set out as follows. Section 2 provides background information on Australia's greenhouse gas emissions and the current generation mix in Australia's electricity sector. Section 3 analyses what emission reduction targets should be adopted for the electricity sector. The analysis draws on the major climate change modelling exercises undertaken by and for the Australian Government and Australian Government agencies over the past decade, and recent modelling by RepuTex. Section 4 looks at the required level of renewable energy penetration under a CET to achieve alternative electricity sector targets and section 5 concludes.

[7] Finkel (2017) *Independent review into the Future Security of the National Electricity Market*, p 86

# 2. Australia's emissions and electricity generation

Approximately 70% of Australia's emissions come from the combustion of fuels for energy, with the remainder coming from a combination of agriculture (mainly methane from animals' digestion and methane and nitrous oxide emissions associated with manure and soils), fugitive emissions from mining and oil and gas production, industrial processes like metal, cement and chemical production, waste and the net emissions from land use (e.g. net carbon dioxide emissions and sequestration associated with deforestation and native forest harvesting, and agricultural soils) (Fig. 1). Fuel combustion associated with electricity generation is the largest single source of emissions. In 2015, it constituted 35% of Australia's emissions, or 189 $MtCO_2$-e.

**Figure 1. Australia's emissions, by sector, 2015 (total 538 $MtCO_2$-e)**



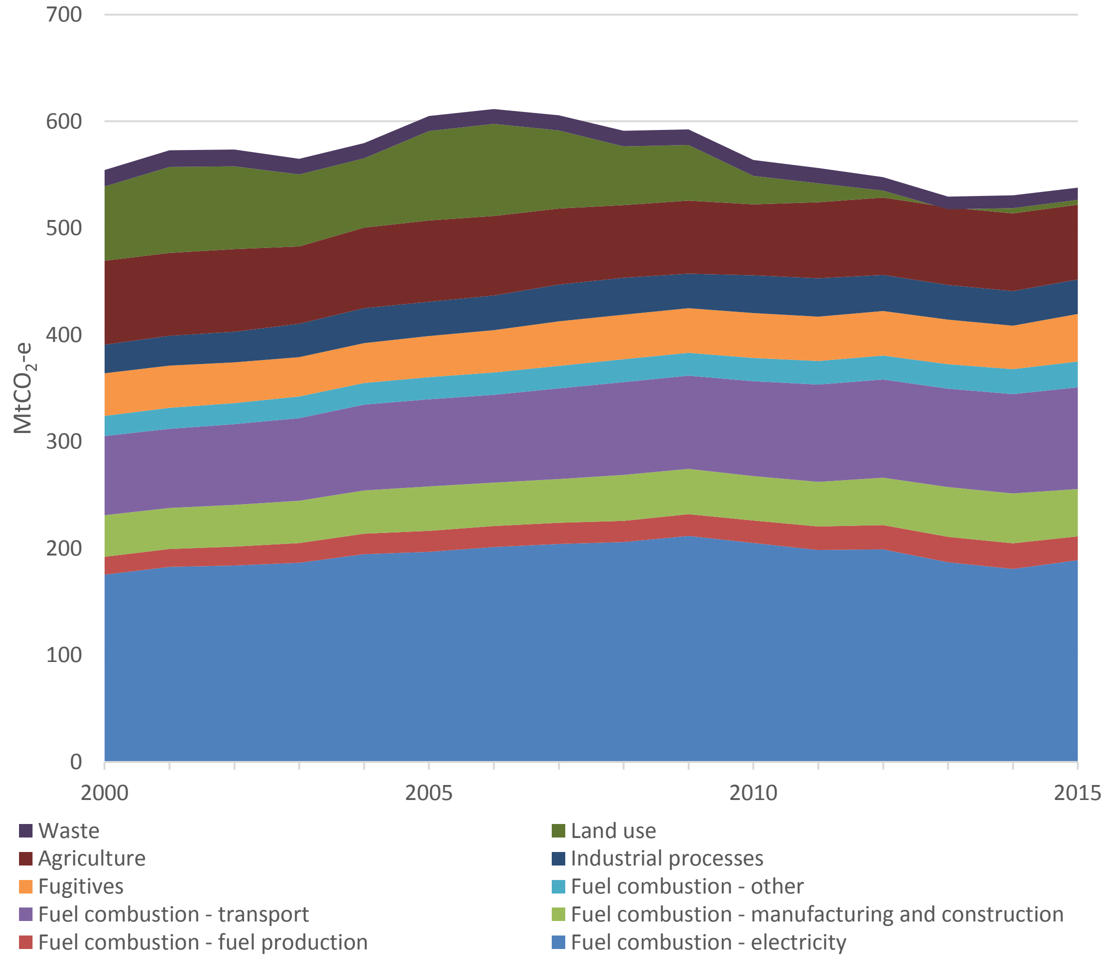

Source: Department of the Environment and Energy (2017)[8]

As Figure 2 shows, over the period 2000-2009, there was steady growth in emissions across the energy sector, including from electricity generation. After 2009, the rate of

[8] Department of Environment and Energy (2017) *Australian Greenhouse Emissions Information System* (AGEIS). http://ageis.climatechange.gov.au/.

growth in these sectors slowed and, in the case of the electricity sector, they declined, falling from 211 $MtCO_2$-e to a low of 181 $MtCO_2$-e in 2014. After the repeal of the carbon pricing mechanism in 2014, electricity sector emissions increased in 2015, mainly as a consequence of a decline in hydroelectric generation. Since then, electricity sector emissions have remained relatively stable.

**Figure 2. Australia's emissions, by sector, 2000-2015, $MtCO_2$-e**



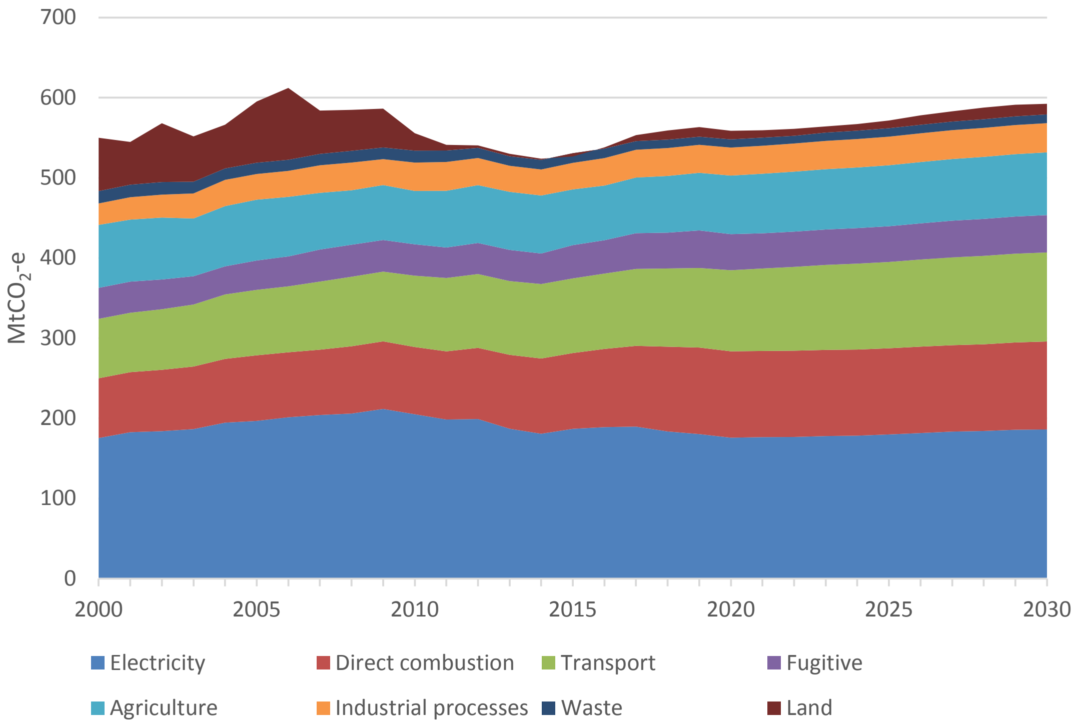

Source: Department of the Environment and Energy (2017)[9]

Going forward, the Department of the Environment and Energy projects that, in the absence of new policies, electricity sector emissions will fall in the near-term, dropping to 176 $MtCO_2$-e in 2020, before gradually climbing back to 186 $MtCO_2$-e in 2030 (Fig. 3). Outside of the electricity sector, emissions are expected to increase by 20% over the period 2015-2030, driven mainly by increasing emissions from gas production, coal mining, transport and the beef industry. As noted above, continued growth in

[9] Department of Environment and Energy (2017) *Australian Greenhouse Emissions Information System* (AGEIS). http://ageis.climatechange.gov.au/.

emissions to 2030 is expected to leave an abatement task of between 842-1202 $MtCO_2$-e to meet the 26-28% 2030 targets. This will require a suite of new policies, potentially covering all relevant sectors of the economy.

**Figure 3. Australia's emissions, actuals 2000-2015, projections 2016-2030, $MtCO_2$-e**




Source: Department of the Environment and Energy (2017) Australian Greenhouse Emissions Information System (AGEIS); Department of the Environment and Energy (2016) Australia's emissions projections 2016.

# 3. Electricity sector and emission targets

In the absence of an economy-wide carbon price, there is a need for a sector-based approach, where the national abatement task is divided between the sectors and policy instruments are tailored to the characteristics of each sector. The division of the national abatement task between the sectors involves setting sector-specific emission reduction targets, as is proposed for the electricity sector under the CET.

There are three main competing approaches to setting sectoral emission reduction targets:

- equal proportional reduction approach, where the economy-wide emission reduction target is applied equally to all sectors;
- abatement cost approach, where sectoral targets are calibrated on the basis of the economy-wide target and the relative costs of reducing emissions in each sector;
- long-term investment signal approach, where targets for capital-intensive sectors, like the electricity sector, are calibrated to a long-term decarbonisation goal.

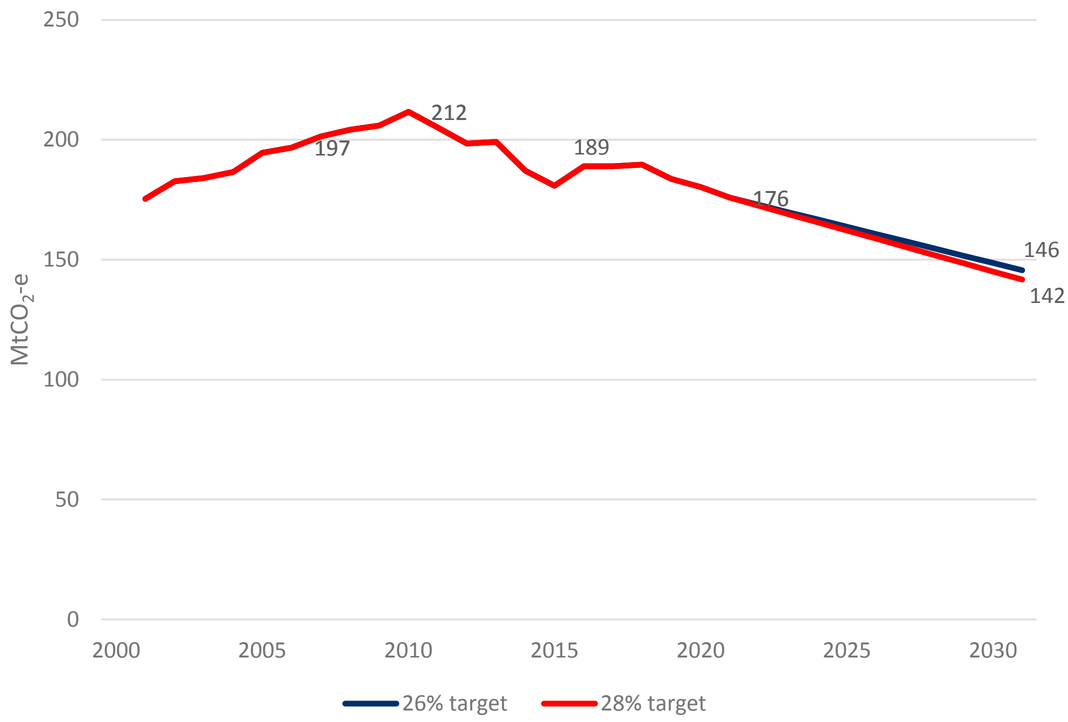
In the following sections, we consider how these approaches would apply to the determination of electricity sector targets for the proposed CET.

## EQUAL PROPORTIONAL REDUCTION APPROACH

The equal proportional reduction approach involves the application of the economy-wide emission reduction target to each sector on an equal basis, regardless of the relative abatement costs in each sector. Hence, if Australia pursues a 28% economy-wide reduction in emissions below 2005 levels, the electricity sector will be required to reduce its emissions by 28% relative to 2005 levels by 2030.

On the basis of the most recent emissions estimates, the application of a simple equal proportional reduction approach would result in an electricity sector target under the CET of between 142-146 $MtCO_2$-e for 2030, corresponding to the 26-28% below 2005 range (Fig. 4).

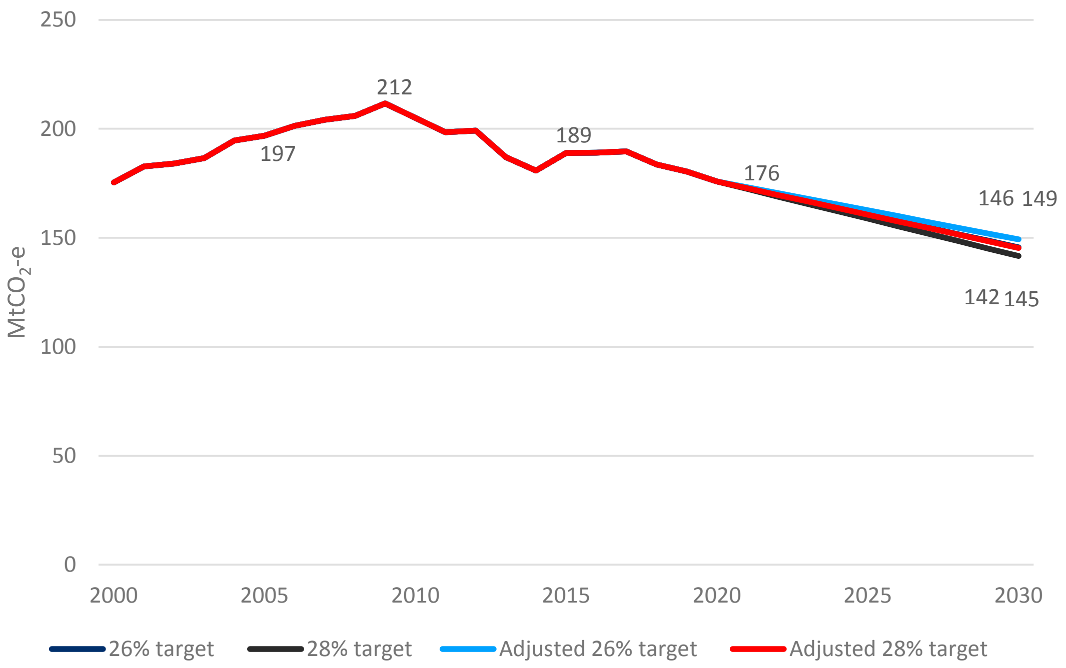
**Figure 4. Simple equal proportional reduction approach**




Source: Department of the Environment and Energy (2017) Australian Greenhouse Emissions Information System (AGEIS); Department of the Environment and Energy (2016) *Australia's emissions projections 2016*; and author calculations.

One complication associated with the application of the equal proportional reduction approach is the treatment of 'carryover' amounts from Kyoto Protocol. Australia's cumulative emissions over the first commitment period of the Kyoto Protocol, 2008 to 2012, were 128 $MtCO_2$-e below its assigned amount. Under the Protocol's rules, Australia was entitled to carry the 128 $MtCO_2$-e forward and use it to meet its targets in the second commitment period, 2013-2020. The Australian Government is currently projecting it will meet its second commitment period target, after accounting for the carryover and other adjustments, by 207 $MtCO_2$-e. It is currently unclear whether Australia intends to carry this amount forward into the 2020-2030 period. The inclusion of the carryovers converts the 26% and 28% 2030 targets to 24% and 26% respectively, all below 2005. For the electricity sector, this results in 2030 targets of between 146-149 $MtCO_2$-e (Fig. 5).

**Figure 5. Equal proportional reduction approach with carryovers**




Source: Department of the Environment and Energy (2017) Australian Greenhouse Emissions Information System (AGEIS); Department of the Environment and Energy (2016) *Australia's emissions projections 2016*; and author calculations.

## ABATEMENT COST APPROACH

The main attraction of the equal proportional reduction approach is its simplicity. Its primary disadvantage is it is likely to be inefficient as it does not account for the costs of abating emissions in each sector or the viability of designing policies that effectively capture these opportunities. The supply-side of the electricity sector is known to have some of the cheapest and most accessible abatement in the economy. This is because of the availability of mature low-emissions generation technologies and the concentrated nature of the sector, which lowers the degree of difficulty in designing effective policies to motivate their uptake. A further benefit associated with supply-side electricity sector abatement is it can catalyse emissions reductions in other sectors. In particular, decarbonisation of the electricity sector can drive emissions reductions through fuel switching in the transport and manufacturing sectors.

Due to this, there is a risk that, if the equal proportional reduction approach is adopted, it will shift a disproportionate amount of the abatement task onto other sectors like manufacturing, agriculture and the land sector where there are fewer low-cost and scaleable ways of reducing emissions, other than by cutting production. This would increase the economy-wide costs of meeting Australia's mitigation commitments. The Finkel Review explicitly acknowledged this, stating:

> It may be appropriate for governments to ask the electricity sector to do more than a direct application of the national target. The electricity sector may have more economically viable opportunities to reduce emissions than other sectors. Moreover, emissions reduction efforts through electrification in transportation and industrial processes will be enhanced by lowering the emissions intensity of the electricity sector.[10]

To test this, we compared the comparative levels of national and electricity sector abatement from three climate change policy modelling exercises conducted over the period 2008 to 2016:

- the Commonwealth Treasury and Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education modelling undertaken as part of the Climate Change Authority's 2014 Targets and Progress Review (CCA 2014);[11]
- the Commonwealth Treasury modelling undertaken to inform the *Clean Energy Future* package, which appeared in the Strong Growth, Low Pollution report of 2011 (SGLP 2011);[12] and
- the Commonwealth Treasury modelling undertaken for the purposes of the Australia's Low Pollution Future report in 2008 (ALPF 2008).[13]

From the three modelling exercises, five relevant scenarios were identified: two that were classified as ambitious (i.e. consistent with keeping the increase in the global average surface temperature to 2°C)[14] and three that were classified as unambitious (i.e. not consistent with keeping the increase in the global average surface temperature to 2°C).[15] We then compared the level of national and electricity sector abatement (reference level emissions minus mitigation scenario emissions) in each

[10] Finkel (2017) *Independent review into the Future Security of the National Electricity Market*, p 86

[11] In Climate Change Authority (2014) *Reducing Australia's greenhouse gas emissions – Targets and progress review: Final report*, http://climatechangeauthority.gov.au/reviews/targets-and-progress-review-3

[12] In Commonwealth of Australia (2011) *Strong growth, low pollution: Modelling a carbon price,* *http://carbonpricemodelling.treasury.gov.au/content/report.asp*

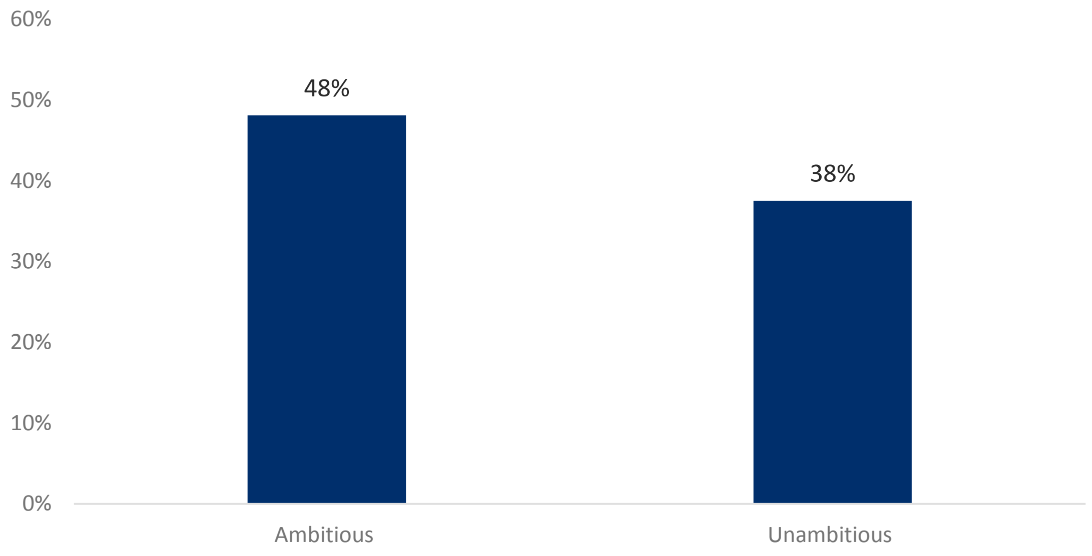
[13] Australian Treasury (2008) *Australia's low pollution future: The economics of climate change mitigation,* http://lowpollutionfuture.treasury.gov.au/

[14] The SGLP (2011) and CCA (2014) High Price scenarios.

[15] The CPRS-5 (ALPF 2008), Clean Energy Future (CEF) (SGLP 2011) and Central Policy (CCA 2014) scenarios.

scenario. The average proportion of national abatement provided by the electricity sector to 2030 in the ambitious and unambitious scenarios is shown in Figure 6.

**Figure 6. Electricity sector share of abatement task, average of scenarios**



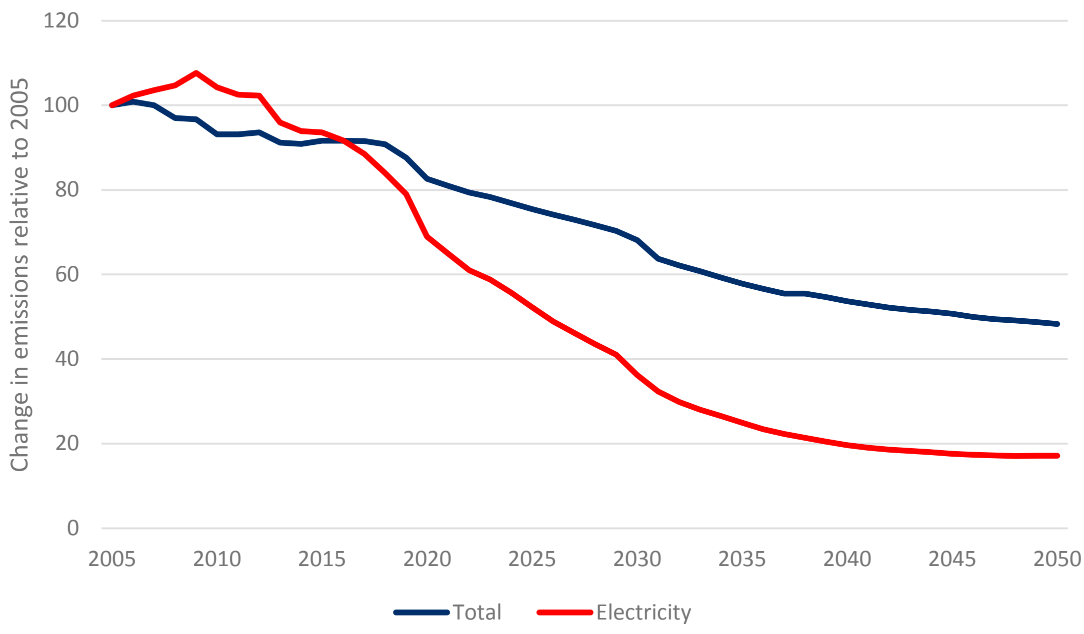

Source: Author's calculations based on CCA 2014, SGLP 2011, ALPF 2008

Figure 6 suggests a least-cost path to achieving national mitigation commitments is likely to involve the electricity sector making a disproportionate contribution to the abatement task. Despite the electricity sector comprising 33% of national emissions in the base years of the modelling, its average contribution to the abatement effort to 2030 under the ambitious scenarios was 48% and 38% under the unambitious scenarios.

The abatement cost approach is built on premise that it is in the best interests of society to minimise the economy-wide costs of achieving mitigation commitments. To achieve this, it calibrates sectoral targets on the basis of the relative costs of reducing emissions in each sector. The aim is to ensure total net emissions add up to the economy-wide target but sectors with relatively low abatement costs would be required to achieve higher proportional emission reductions than sectors with relatively high abatement costs. By setting sectoral targets on the basis of abatement costs, this approach ensures the mitigation commitments are achieved at or near least cost.

To provide insights on what the electricity sector target for the CET should be relative to 2005 emissions under the abatement cost approach, we analysed the change in total national emissions and electricity sector emissions relative to 2005 from each of the five scenarios identified above, as well as an additional 'ambitious' scenario from the Victoria University computable general equilibrium (CGE) modelling undertaken as part of the Climate Change Authority's 2016 Special Review into Australia's emissions reduction policies (CCA 2016).[16] The mean results from the six scenarios are presented in Figures 6 and 7, and tables 1 and 2. The results confirm that the adoption of an abatement cost approach to setting targets for the purposes of the CET is likely to result in the electricity sector having to make disproportionate reductions in emissions. Across all six scenarios, the reductions in electricity sector emissions relative to 2005 levels were greater than the reductions in total national emissions.

**Figure 6. Ambitious scenarios, reductions in total national and electricity sector emissions relative to 2005**




Source: Author's calculations based on CCA 2014, SGLP 2011, ALPF 2008 and CCA 2016

Figure 6 shows that under an abatement cost approach where Australia meets its emissions reduction targets, electricity sector emissions decline by a far greater proportion than overall emissions. The difference between percentage reduction in total abatement and electricity sector abatement for selected years is presented in Table 1 below:

[16] Victoria University (2016) *Simulation of the effects of greenhouse gas mitigation policies for the Australian electricity sector,* http://climatechangeauthority.gov.au/reviews/special-review/modelling-illustrative-electricity-sector-policies The scenario included was the Victoria University (2016) Reference Case, involving the application of an economy-wide carbon price consistent with achieving a 2°C outcome.

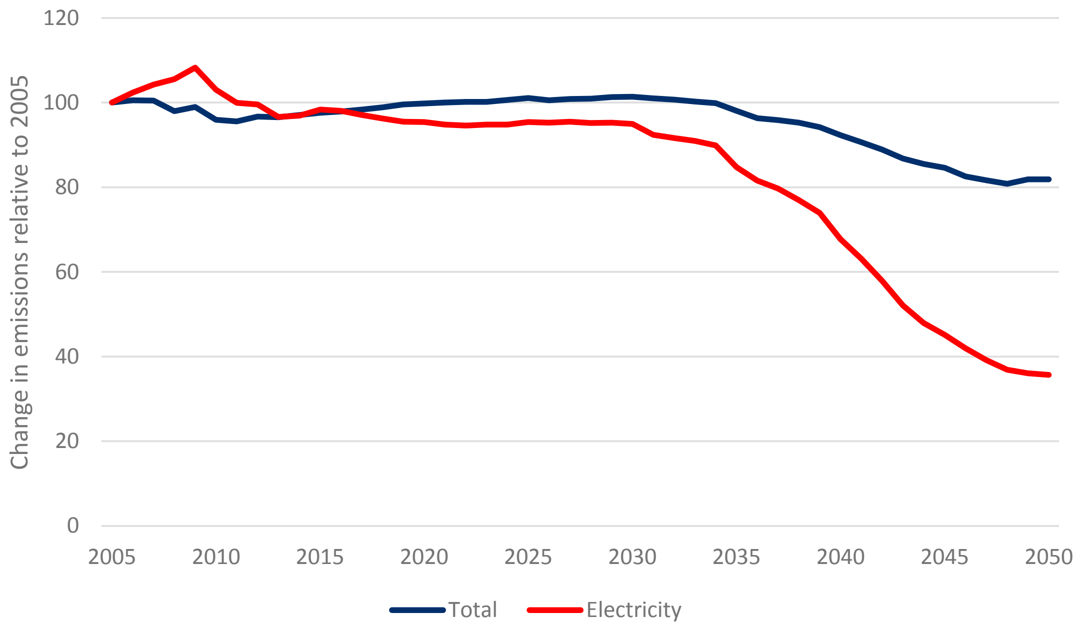
**Table 1. Ambitious scenarios, percentage point difference between reductions in total national and electricity sector emissions relative to base year**

| | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **Mean** | 14 | 32 | 34 | 31 |

Source: Author's calculations based on CCA 2014, SGLP 2011, ALPF 2008 and CCA 2016

Figure 7 and Table 2 present the same calculations for the unambitious scenarios modelled in CCA 2014, SGLP 2011 and ALPF 2008

**Figure 7. Unambitious scenarios, reductions in total national and electricity sector emissions relative to 2005**




Source: Author's calculations

**Table 2. Unambitious scenarios, percentage point difference between reductions in total national and electricity sector emissions relative to base year**

| | 2020 | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **Mean** | 4 | 6 | 25 | 46 |

Source: Author's calculations

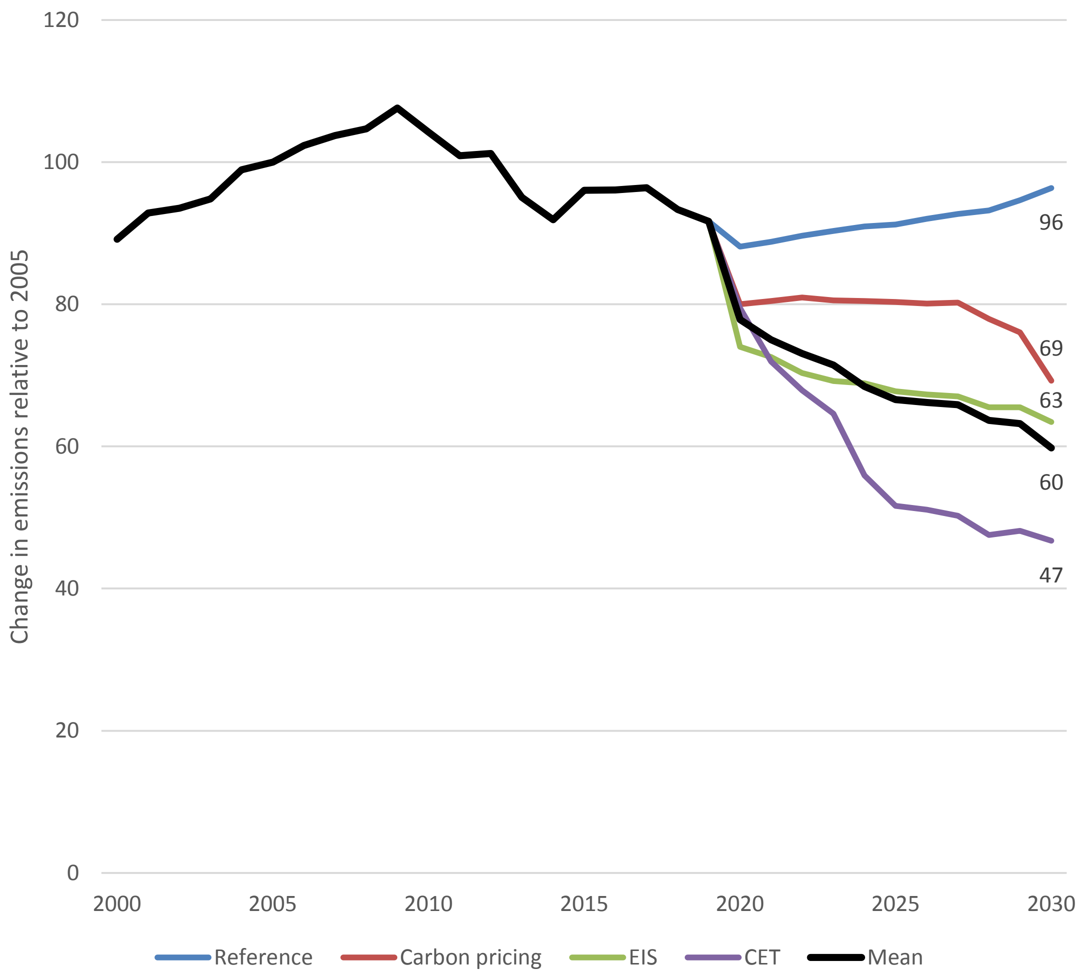
If Australia remains committed to its current 2030 (26%-28%) targets, an electricity sector target consistent with the abatement cost approach could be estimated using the percentage point difference from the unambitious scenarios identified in Table 2. For example, the average difference from the three scenarios at 2030, 6%, could be added to the 28% target, providing an electricity sector target of 34%.

Although this approach has the benefit of simplicity, it has a number of weaknesses that stem from the nature of the scenarios on which it is based, particularly the fact the scenarios all assume the relatively early deployment of an economy-wide carbon price. The early commencement of the carbon price allows for lower levels of abatement in the earlier decades. The delay in the deployment of a comprehensive policy to reduce emissions after the repeal of the carbon price in 2014 has necessitated more ambitious mitigation over the coming years. The dated nature of the modelling (2008, 2011 and 2014) also reduces its reliability; for example, more recent analysis captures the significant changes in the cost and viability of alternative technologies, and the changes in sectoral emissions over the past decade.

As part of the Climate Change Authority's 2016 Special Review, the Jacobs Group modelled scenarios consistent with achieving a 3°C global temperature outcome.[17] The results from this modelling provide a better approximation of the magnitude of the emissions reductions required in the electricity sector to meet the current 26-28% 2030 targets using an abatement cost approach. The modelling was conducted using a single carbon price path to devise an emissions budget for the electricity sector of approximately 2,800 Mt$CO_2$-e to 2050. The performance of different policy instruments in meeting the budget was then compared. The instruments compared included a carbon price, emissions intensity scheme (EIS), and a CET (only it was called a Low Emissions Target (LET)). The change in electricity sector emissions relative to 2005 under the 3°C reference, carbon price, EIS and CET scenarios are shown in Figure 8, along with the mean from the three mitigation scenarios.

[17] Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report,* http://climatechangeauthority.gov.au/reviews/special-review/modelling-illustrative-electricity-sector-policies

**Figure 8. Change in electricity sector emissions under the Jacobs 3°C reference, carbon price, EIS and CET scenarios, relative to 2005**




Source: Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report*

Figure 8 shows the mean reduction in emissions in 2030 on 2005 levels across the three scenarios to 60% of 2005 levels. However, under the CET, the required reduction in electricity sector emissions was 53%. Based on these data, an abatement cost derived 2030 electricity sector target for the purposes of the CET is likely to have to be a minimum of 40% below 2005 levels, and possibly around 50%, just to meet the unambitious 26-28% Paris commitments.

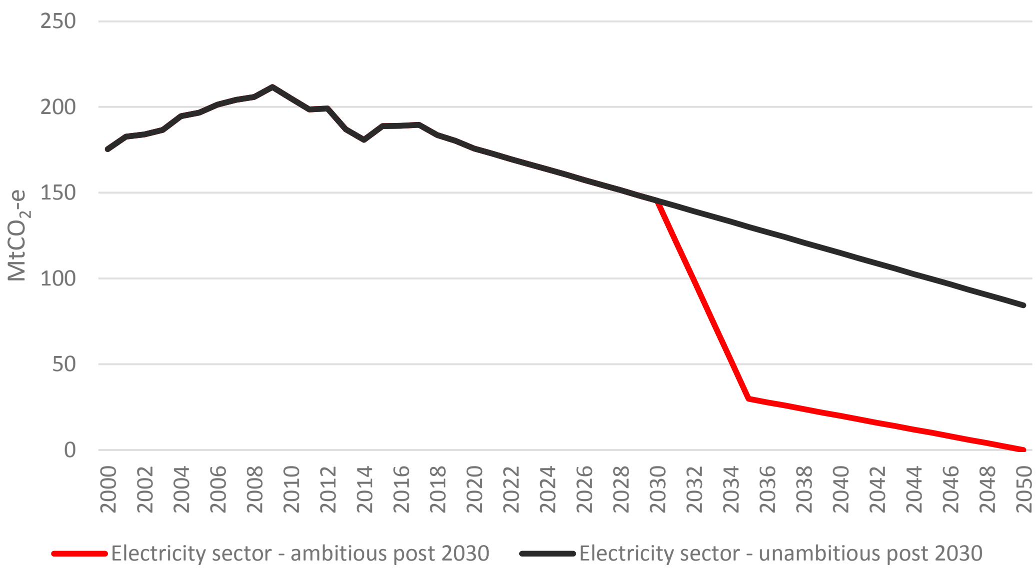
# LONG-TERM INVESTMENT SIGNAL APPROACH

An inherent weakness of both the equal proportional reduction and abatement cost approaches is they could create investment uncertainty in capital-intensive sectors like the electricity sector because of inconsistencies between short-term policy settings and long-term policy expectations.

Under the equal proportional reduction and abatement cost approaches, the electricity sector emission targets are likely to be calibrated to meet the 2030 economy-wide target. However, due to the unambitious nature of Australia's 2030 mitigation targets, it is likely there will have to be a rapid escalation of the abatement effort after 2030 in order for Australia's contribution to be consistent with the Paris Agreement's objectives. This creates uncertainty for investors in the electricity sector, as they are unable to gauge whether the long-term policy settings will be consistent with the Paris Agreement.

Electricity generation assets have long economic lives. This means investors need to consider both existing and future carbon-energy policy settings. The apparent incongruity between Australia's 2030 mitigation targets and the long-term commitments embodied in the Paris Agreement create uncertainty. Investors do not know whether the unambitious approach embodied in the 2030 targets will persist, or whether policy settings will be modified to give effect to the Paris Agreement's commitments. As the hypothetical scenarios in Figure 9 illustrate, the post-2030 policy settings could remain unambitious, which might translate into a gradual decline in electricity sector emissions under the CET through to 2050 and beyond. Alternatively, there may be a rapid increase in the level of ambition, requiring a sharp drop in electricity sector emissions in the 2030s and zero emissions by 2050. The uncertainty about post-2030 policy settings could deter investment and increase the cost of capital, with flow on effects for the price of electricity in the market.

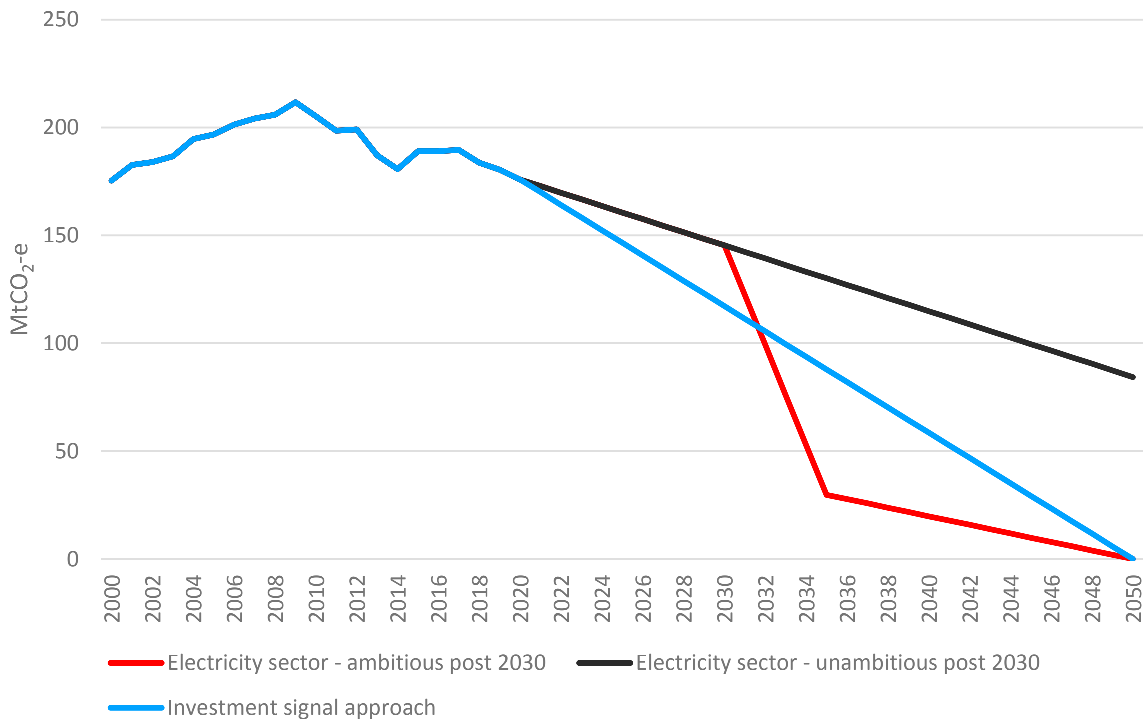
**Figure 9. Electricity sector emissions under possible future policy settings**



Source: Author's calculations

The long-term investment signal approach is designed to avoid this uncertainty by setting the emission targets for the electricity sector in a manner consistent with the long-term objective of decarbonisation at or before 2050. Figure 10 illustrates the basic premise behind the approach. Rather than facing the prospect of abrupt future changes in emissions, investors face a long-term emission path that provides them with certainty about policy settings over coming decades.

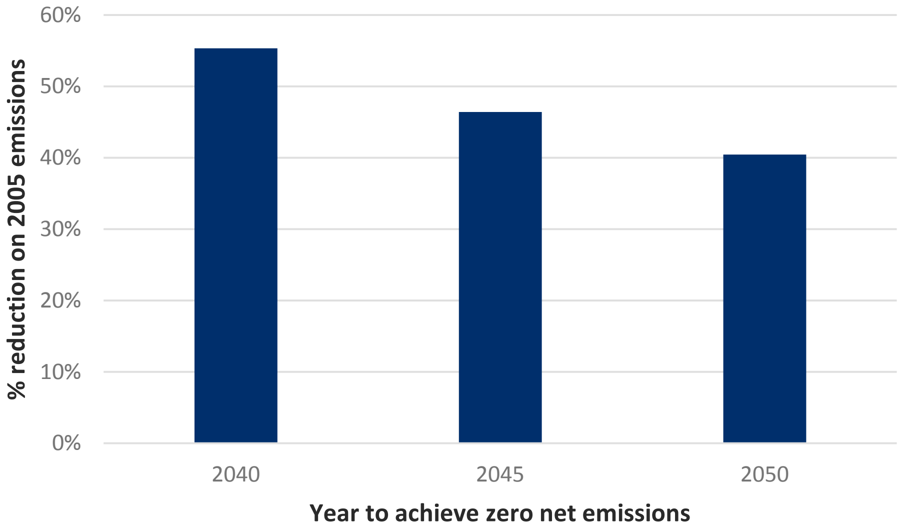
**Figure 10. Electricity sector emissions under possible future policy settings, including a long-term investment signal**




Source: Author's calculations

We estimated the 2030 electricity sector targets that would be consistent with a long-term investment signal approach by assuming a linear decline in electricity sector emissions from 2020 to net zero emissions in 2040, 2045 and 2050. The results are shown in Figure 11.

**Figure 11. 2030 CET target for the electricity sector under long-term investment signal approach**




Source: Author's calculations

Figure 11 shows that if net zero emissions are to be achieved between 2040 and 2050, the electricity sector will need to reduce its emissions by 40-55% by 2030 under a long-term investment approach. This is a far greater share of emissions than the current overall targets of 26-28% by 2030.

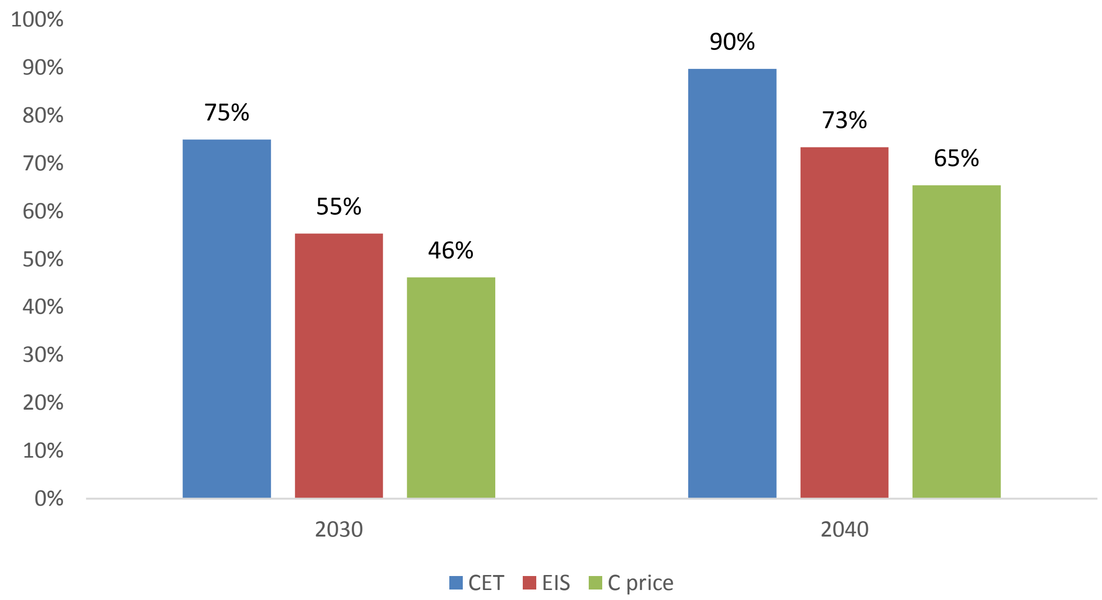
# 4. Renewable energy penetration

## INFLUENCE OF POLICY INSTRUMENT ON RENEWABLES PENETRATION

Meeting any reasonable 2030 electricity sector target is likely to require a significant increase in the proportion of electricity generation provided by renewable energy generators (renewable energy penetration). In addition to the magnitude of the electricity sector target, the other major determinant of the extent of renewable energy penetration is the nature of the policy instrument(s) used to achieve the target.

The different incentives provided by different policy instruments results in different patterns of abatement, and sources of electricity generation, through time. This issue was explored by the Climate Change Authority in its 2016 Special Review. As noted above, as part of the review, the Jacobs Group was commissioned to conduct modelling to compare the performance of different policy instruments in meeting specific emission constraints for the electricity sector. The instruments compared included a carbon price, EIS and a CET. Under Jacobs' 2°C scenarios, with a CET, the proportion of electricity generated by renewables was 75% in 2030, compared to 55% with an EIS and 46% with a CET (Figure 12). The pattern was the same in 2040: renewable energy penetration under the CET was 90%, 73% with an EIS and 65% with a carbon price. Similar results were observed in Jacobs' 3°C scenarios.

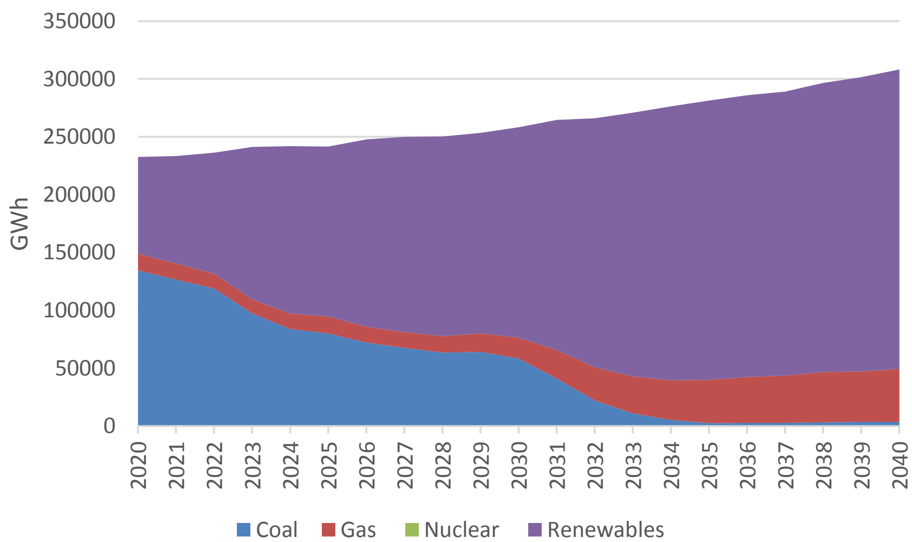
## Figure 12. Renewable generation share by policy instrument




Source: Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report*

The reason for the observed differences in renewable energy penetration relate to how the policy instruments affect the relative competitiveness of thermal and renewable generators in the electricity market. Of particular importance is the incentives provided for the deployment of new gas generation. As shown in Figures 13, 14 and 15, a CET provides less of an incentive for gas generation than an EIS or a carbon price.

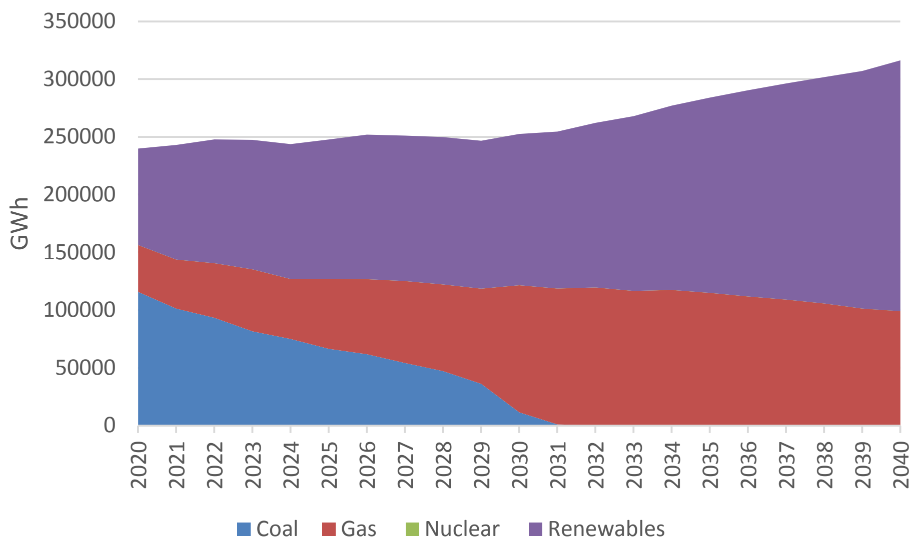
## Figure 13. Generation mix under CET, 2°C scenario



Source: Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report*

Figure 13 shows that under a CET the vast bulk of the generation mix is renewable from the mid-2020s. Only a small amount of gas generation is developed before coal-fired generation ends in the early 2030s. By contrast, Figure 14 shows that under an EIS, larger volumes of gas generation are developed earlier, forcing coal out of the mix in 2030 and maintaining a large share of generation out to 2040.

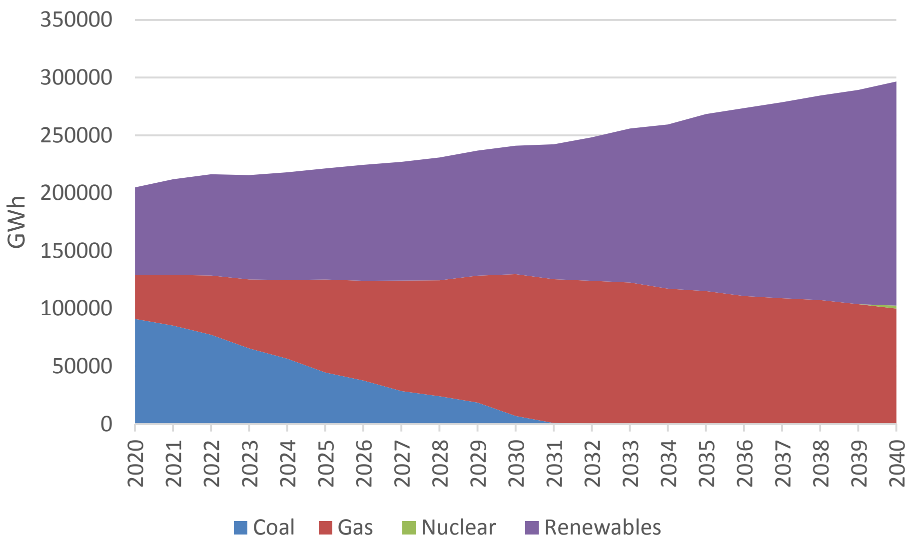
**Figure 14. Generation mix under EIS, 2°C scenario**




Source: Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report*

As with the EIS modelled in Figure 14, Figure 15 below shows that under a carbon price, substantially more gas-fired generation is expected to be developed through the 2020s and persist into the 2030s:

**Figure 15. Generation mix under a carbon price, 2°C scenario**




Source: Jacobs (2017) *Modelling illustrative electricity sector emissions reductions policies: Final report*

The overall message from the Jacobs modelling for the CCA is clear – a CET-like policy is likely to bring in the largest share of renewables. This would come particularly at the expense of gas, with coal-fired generation also lasting longest under a CET.

# RENEWABLES PENETRATION UNDER AN EQUAL PROPORTIONAL REDUCTION APPROACH

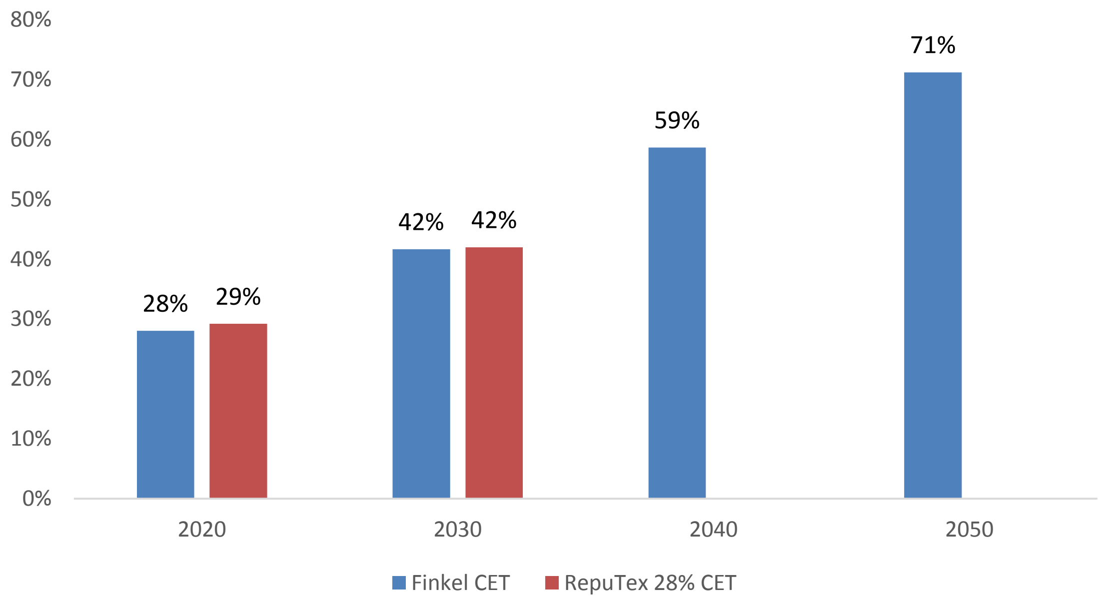
The generation mix under an equal proportional approach with a CET was modelled as part of the Finkel Review[18] and separately by consultancy, RepuTex.[19] Both found renewable energy would comprise approximately 42% of generation in 2030 (Fig. 16).[20] The Finkel Review's modelling also found that, in an unambitious scenario that saw electricity sector emissions decline linearly to near 60 $MtCO_2$-e in 2050, renewable generation would rise to over 70% by mid-century.

[18] Jacobs (2017) *Report to the independent review into the Future Security of the National Energy Market: Emission mitigation policies and security of electricity supply,* http://www.environment.gov.au/energy/publications/electricity-market-final-report

[19] Reputex modelled this with its National Electricity Market & Renewable Energy Simulator, with the results published in Reputex (2017) *It's the economics, stupid,* http://www.reputex.com/research-insights/update-its-the-economics-stupid-wholesale-price-scenarios-in-the-nem-to-2030/

[20] The modelling covered the National Electricity Market (NEM) only. The NEM accounts for approximately 80% of Australia's electricity consumption.

**Figure 16. Renewable generation under 28% CET**

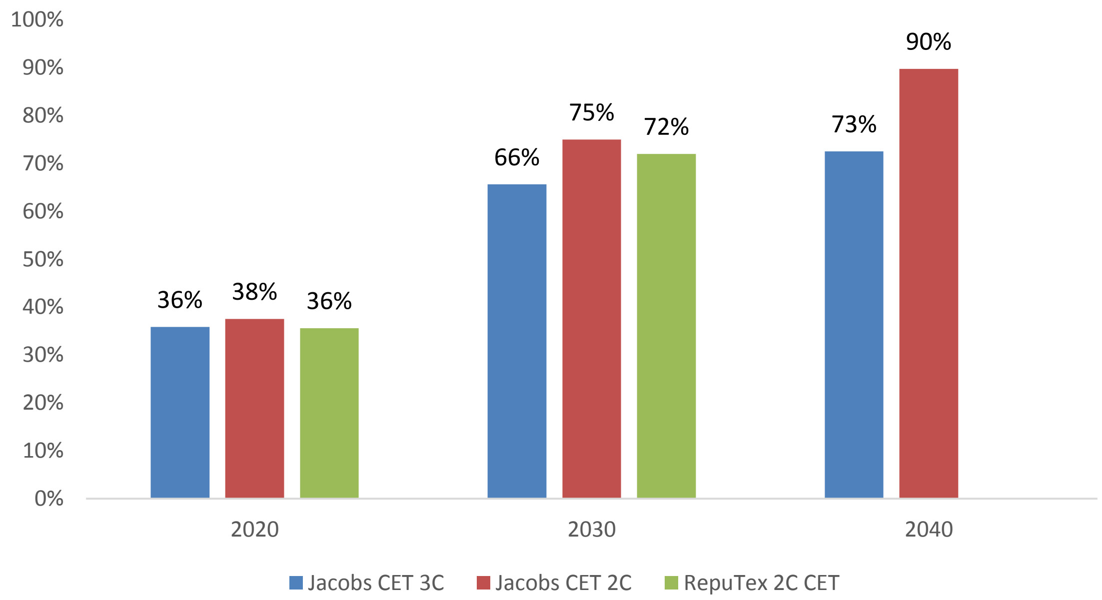



Source: Jacobs (2017) *Report to the independent review into the Future Security of the National Energy Market: Emission mitigation policies and security of electricity supply* and Reputex (2017) It's *the economics, stupid*

# RENEWABLES PENETRATION UNDER AN ABATEMENT COST AND LONG-TERM INVESTMENT SIGNAL APPROACHES

Both the abatement cost and long-term investment signal approaches are likely to require 2030 emission reduction targets for the electricity sector of between 40%-55% below 2005 levels. The level of renewable energy penetration required to achieve emissions reductions of this magnitude under a CET-like policy have been modelled on several occasions in recent times, most notably by the Jacobs Group as part of the Climate Change Authority's 2016 Special Review into Australia's emissions reduction policies and RepuTex (2017). As shown in Figure 17, these two modelling exercises found renewable energy would comprise between 66% and 75% of generation in 2030.

**Figure 17. Renewable penetration, with 40%-55% CET**




Source: Jacobs (2017) *Report to the independent review into the Future Security of the National Energy Market: Emission mitigation policies and security of electricity supply* and Reputex (2017) It's *the economics, stupid*

The implication from this is that, if an abatement cost approach is used to set the 2030 electricity sector target, and a CET-like policy is used to achieve it, renewable penetration is likely to be in the order of 66-75% by 2030. This is substantially higher than Federal Labor's current target of 50% renewable energy by 2030.

# 5. Conclusion

Australia's climate and energy debate continues to degenerate. As this conclusion is being written, Federal Parliament Question Time is being told that the Liddell power station should remain open to 2027, possibly at taxpayer expense, as renewable energy penetration has caused problems with energy security.

There are many problems with this view and they are being widely aired in the media and by non-government politicians. But it is ironic that government-commissioned modelling shows that the policies that would minimise renewable energy penetration such as carbon pricing and an EIS have already been rejected. All that remains is the CET that would bring in the largest share of renewable generation, or the prospect of failing to meet our Paris climate targets.