Australia can cut emissions deeply and the cost is low

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Summary

Australia's national interest is in strong global climate change action. As one of the most vulnerable developed nations, it is in Australia's interest to push for faster and stronger global climate action. Australia is not expected to be ahead of the pack, but will be expected to pull its weight. We can cut greenhouse gas emissions while maintaining strong economic growth.

Australia can undertake ambitious emissions reductions and could even reach net zero emissions by 2050. Deep cuts in national emissions can be achieved by promoting energy efficiency, moving to a zero-carbon electricity system, switching from direct use of fossil fuels to decarbonised electricity, and improvements in industrial processes. Remaining greenhouse gas emissions could be fully offset through carbon farming and forestry. At the heart of a low-carbon strategy for Australia is a carbon-free power system. Australia has among the best prerequisites in the world for moving to a fully renewable electricity supply.

Australia's economy will continue to grow as deep cuts to greenhouse gas emissions are made. The economic cost even of strong climate action in Australia is small relative to ongoing economic growth. All major economic modelling studies project that Australia's economy will grow to approximately two and a half times its current size by 2050, while emissions are cut. Using international emissions units can help Australia achieve a given target at lower cost. But it must be assured that they represent genuine reductions, and financing overseas mitigation action may mean missing out on domestic co-benefits such as productivity gains and improved local environmental quality. Cutting emissions is getting cheaper, and achieving given targets tends to be cheaper than expected. Future mitigation is likely to be even cheaper than models have previously predicted. The estimated cost of cutting emissions is dropping with each successive study as the development and reduction in cost of low-emissions technologies consistently outpace projections. The costs of some carbon-free technologies, including solar and wind power, have fallen much faster than expected. For example, large-scale solar panel power stations are already only half the cost that the Treasury's 2008 and 2011 modelling studies estimated they would be in the year 2030.

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Cutting emissions can have significant co-benefits, in addition to lessening future climate change. Major co-benefits of saving energy and replacing fossil fuels with zero-carbon alternatives include reduced air pollution and improved health outcomes especially in urban areas, as well as increased energy security in some countries. The co-benefits in many cases will more than cover the costs, even before considering their benefit for the global climate. For example, the benefits of the US Clean Air Act are estimated to be 30 times larger than the costs. The Co-benefits of climate action for Australia are not well researched. Co-benefits are a key driver of a switch away from coal in many countries, including China. Understanding the importance of co-benefits is important to evaluate and anticipate climate change policy developments in other parts of the world.

Achieving deep cuts in emissions at low cost and high benefits will require clear, stable and economically efficient policy settings. The task for government in pursuing Australia's interest in strong global climate action is to set appropriate targets for 2025 and beyond that are consistent with Australia's real potential and circumstances, position Australia for deeper cuts to 2050, and to identify policy approaches that can support such a transition.

1. Australia's post-2020 emissions target choice

All countries have been called on to submit a pledge for their 'intended nationally determined contributions' to future global climate action, ahead of the Paris UN climate conference. The government process for deciding Australia's post-2020 greenhouse gas emissions target is underway, including through a task force under the Department of the Prime Minister and Cabinet which co-ordinates a review of Australia's emissions targets.

A substantial amount of relevant research and analysis specifically for Australia exists, undertaken by Australian Government agencies, universities and think tanks. Recent international analyses are also highly relevant for Australia's decision about a post-2020 emissions target.

This report summarises key findings from previous studies and highlights findings that are relevant for Australia's decision about a post-2020 emissions target. The brief focuses on the technical opportunities, economic costs and benefits from reducing Australia's emissions, including to very low levels over coming decades. A companion brief to be released later will investigate the case for acting early.

The context is Australia's interest in strong global climate change action, as set out in the task force issues paper[2], and the commitment by Australia's federal government to an international climate agreement that can keep global temperature rise to two degrees. It is also situated in the context of the United States and European Union having announced their post-2020 emissions targets – a reduction of 26 to 28% at 2025 relative to 2005 and of 40% at 2030 relative to 1990 respectively – and China's announcement that its carbon dioxide emissions will stop growing by 2030.

[2] Department of Prime Minister and Cabinet, (2015), "Setting Australia's post-2020 target for greenhouse gas emissions", (Australian Government).

2. Australia can cut emissions deeply

Australia is capable of undertaking deep cuts to emissions, or even reaching net zero emissions, over coming decades. Numerous in-depth studies have shown that deep emissions cuts are technically feasible, and can be achieved at a low cost.

Australia has practically unlimited opportunities for the supply of energy from renewable sources, with fewer geographical and physical constraints than most other countries. Australia is the sunniest and windiest continent. Australia's potential for renewable energy generation has been estimated at 500 times greater than its current power generation capacity.[3]

What the major reports say

"*Australia has extensive opportunities to reduce emissions at a relatively low cost*" - **Climate Change Authority**[4]

"*Australia can achieve net zero emissions by 2050 and live within its recommended carbon budget, using technologies that exist today, while maintaining economic prosperity*." - **ClimateWorks Australia/ANU**[5]

"Australia's energy needs can be met with 100% renewables". **University of Melbourne Energy Research Institute**[6]

"The Australian economy has good prospects of reducing emissions by 80 % (under a 550 stabilisation scenario) or 90% (under a 450 scenario) by mid-century, alongside continued strong growth in living standards." – **The Garnaut Climate Change Review**[7]

"*Australia's wide range of low-emission technology options suggests electricity generation could deliver large emission reductions over time, even if some technologies do not prove cost-effective.*" –**Australian Treasury**[8]

"Renewable energy technologies, a critical element of the low-carbon pillar of global energy supply, are rapidly gaining ground" – **International Energy Agency**[9]

Australia also has abundant opportunities to improve energy productivity. Energy efficiency in buildings, transport and industry can be improved substantially. In many cases, the energy cost savings are greater than the upfront costs, but institutional barriers or established practice have stood in the way. Further, there are opportunities to improve industrial and agricultural processes outside energy use, and a vast potential for increased sequestration of carbon dioxide in vegetation.

[3] The Climate Council, (2014), "The Australia Renewable Energy Race: Which States are Winning or Losing?" (The Climate Council): 4

Pillars of decarbonisation

Accordingly, the four pillars of a pathway to decarbonisation, as identified by a recent report by ClimateWorks Australia and ANU[10], with a similar approached mapped out by the University of Melbourne Energy Research Institute[11], are:

1. Ambitious energy efficiency improvements throughout the economy.

2. Low carbon electricity supplied by either 100% renewables or a mixture of renewable energy and carbon capture and storage (CCS).

3. Electrification and fuel switching towards biofuels and gas.

4. Reducing non-energy emissions through carbon farming and forestry, process improvements and CCS in energy intensive industrial applications.

For the global energy sector, the International Energy Agency finds that achieving the 2 degree target "will entail a substantial transformation in the ways we produce and consume energy, involving major improvements in energy efficiency and a switch to low carbon energy sources and technologies".[12]

Importantly, Australia does not need to rely on technological breakthroughs to achieve major reductions in emissions. The technologies required for decarbonisation are either available or under development and further work in commercialising and deploying existing technologies will reduce their cost, and improve their performance.[13]

It is a reasonable expectation that new technologies that can save emissions will become available over coming decades, making the task even easier. But decarbonisation does not rely on unproven technologies.

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[4] CCA, (2014), "Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review—Final Report," (Climate Change Authority, Melbourne).
[5]Climate Works Australia and ANU, (2014),"Pathways to Deep Decarbonisation in 2050: How Australia can Prosper in a Low Carbon World," (Climate Works Australia and the Australian National University (ANU)): 4
[6] University of Melbourne Energy Research Institute, (2010), "Zero Carbon Australia Stationary Energy Plan: Synopsis," (Beyond Zero Emissions Australia in collaboration with the Energy Research Institute).
[7] R. Garnaut, (2008), "The Garnaut Climate Change Review" (Cambridge University Press, Melbourne): 565
[8] Australian Treasury, (2008),"Australia's low pollution future: the economics of climate change mitigation," ed. Department of Treasury: 3
[9] IEA, (2014), "World Energy Outlook 2014," (Paris, International Energy Agency (IEA)).
[10] Climate Works Australia and ANU, (2014)
[11] University of Melbourne Energy Research Institute, (2010): 2
[12] IEA, (2014), "World Energy Outlook 2014," (Paris, International Energy Agency (IEA)).
[13] Climate Works Australia and ANU, (2014): 4

Zero carbon electricity

At the core of a low emissions economy is a very low emissions energy system, and at the core of this is a decarbonised electricity supply. While other countries may need, or choose to rely on, nuclear power and possibly CCS to achieve this, Australia could produce all required electricity from renewable power, with some limited use of fossil fuels in specialised local applications.

This is because of the abundant technical potential for renewable energy sources in Australia, including not just solar and wind power, but also wave and geothermal power, and biomass from agricultural residue and plantations.

100% renewable energy can be supplied through a combination of already available technologies such as wind, solar panels, and concentrating solar thermal. Peaks in demand or troughs in supply can be covered by molten salt storage attached to solar thermal plants – technology that is already in operation in some countries – and biomass-fired generators and existing hydropower. Analysis by the University of Melbourne Energy Research Institute in 2010 found that this combination could provide a completely reliable energy grid within a decade.[14]

Modelling by the University of New South Wales (UNSW) in 2012 found that a 100% renewable energy mix by 2030 is possible with existing commercially available technologies.[15] A fully renewable option was shown to have lower emissions and a similar cost to options involving large-scale gas or CCS.[16]

Earlier work by the Australian Treasury found that the commercial availability and deployment of CCS could reduce the potential cost of emissions reduction to some degree, but that the overall emissions levels for a given level of effort would not vary greatly as a result.[17]

An ambitious, technically feasible and economically viable decarbonisation scenario for Australia can be found in the 'Deep Decarbonisation Pathways' report, underpinned by modelling by the CSIRO and Victoria University.[18]

CSIRO modelling for the 'Pathways to Deep Decarbonisation' estimates that in a transition to a 100% renewable energy grid, large-scale renewable energy generation using solar, as well as wind, geothermal and wave power grows steadily over coming decades. The majority of growth in on-site renewables will be solar photovoltaic (PV) due to its low cost and commercial availability. Natural gas is a transition fuel in these scenarios and the use of natural gas would expand in the short-term and be phased out by 2050. Brown coal-fired power generation is projected to be phased out

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[14] University of Melbourne Energy Research Institute, (2010).

[15] B. Elliston, M. Diesendorf and I. MacGill, (2012), "Simulations of scenarios with 100% renewable electricity in the Australian National Electricity Market," Energy Policy, 45.

[16] B. Elliston, I. MacGill, and M. Diesendorf, (2013) "Comparing least cost scenarios for 100% renewable electricity with low emission fossil fuel scenarios in the Australian National Electricity Market," In press for Energy Policy.

[17] Treasury, (2011), "Strong Growth, Low Pollution: Modelling a Carbon Price," ed. Department of Treasury; Climate Works Australia and ANU, (2014).

[18] Climate Works Australia and ANU, (2014).

rapidly, while black coal-fired power would decline throughout the 2020s and be phased out during the 2030s.[19]

Renewable energy technologies are rapidly gaining ground in energy sector investment globally. Global investment in renewable energy generation capacity – mostly solar and wind - is estimated at US$270 billion in 2014, with US$83 billion of this invested in China.[20] The International Energy Agency[21] expects that "with rapid cost reductions and continued support, renewables account for almost half of the increase in total electricity generation to 2040".

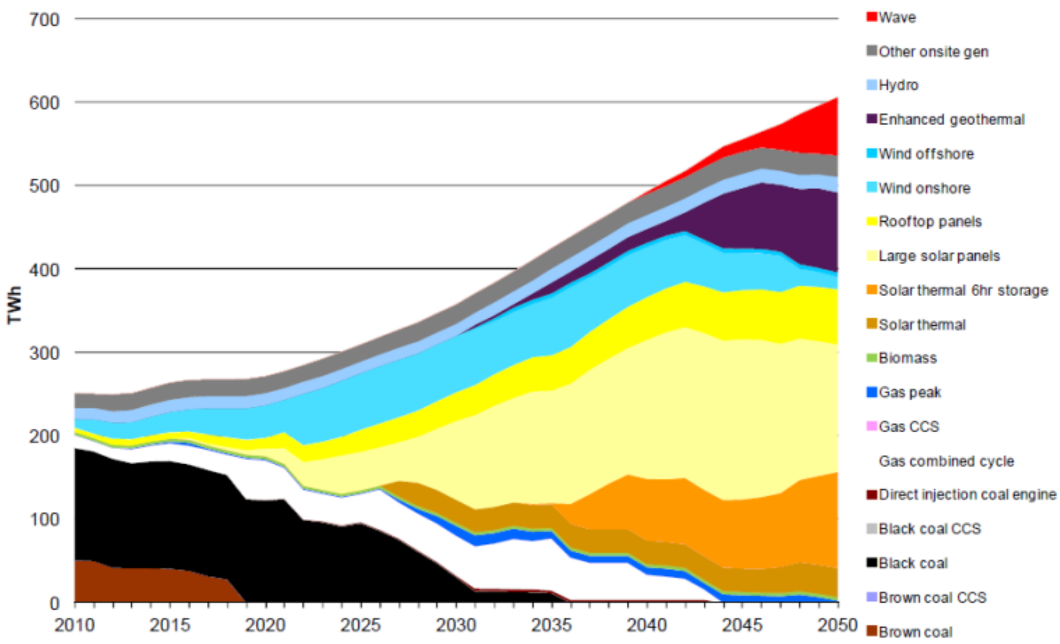

Figure 1: Transition to a 100% renewable grid by 2050 (source: CSIRO for Climate Works Australia and the ANU, 2014)[22]

The combination of energy efficiency, low carbon electricity, electrification of buildings and transport, and improvement in the emissions intensity of industrial processes could reduce Australia's greenhouse gas emissions dramatically, even as mining and agriculture expand. In the most recently published scenario, gross emissions are reduced to 3 tonnes of carbon dioxide equivalent per capita in 2050, from the current level of 24 tonnes per person per year.[23]

[19] P. Graham, and S. Hatfield-Dodds, (2014), "Electricity sector", in Climate Works Australia and ANU, (2014),"Pathways to Deep Decarbonisation in 2050: How Australia can Prosper in a Low Carbon World – Technical Report," (Climate Works Australia and the Australian National University (ANU))
[20] McCrone et al, (2015), "Global Trends in Renewable Energy Investment", (Frankfurt School – UNEP Collaborating Centre for Climate & Sustainable Energy, Bloomberg New Energy Finance, Frankfurt).
[21] IEA, (2014).
[22] P. Graham, and S. Hatfield-Dodds (2014): 31
[23] ClimateWorks and ANU, (2014).

Less than half of these emissions are from the energy sector, coming instead from industrial processes, agriculture and livestock, and fugitive gases. Latest research by CSIRO indicates that there is more than enough potential for carbon plantings and forestry to offset these levels of emission.[24]

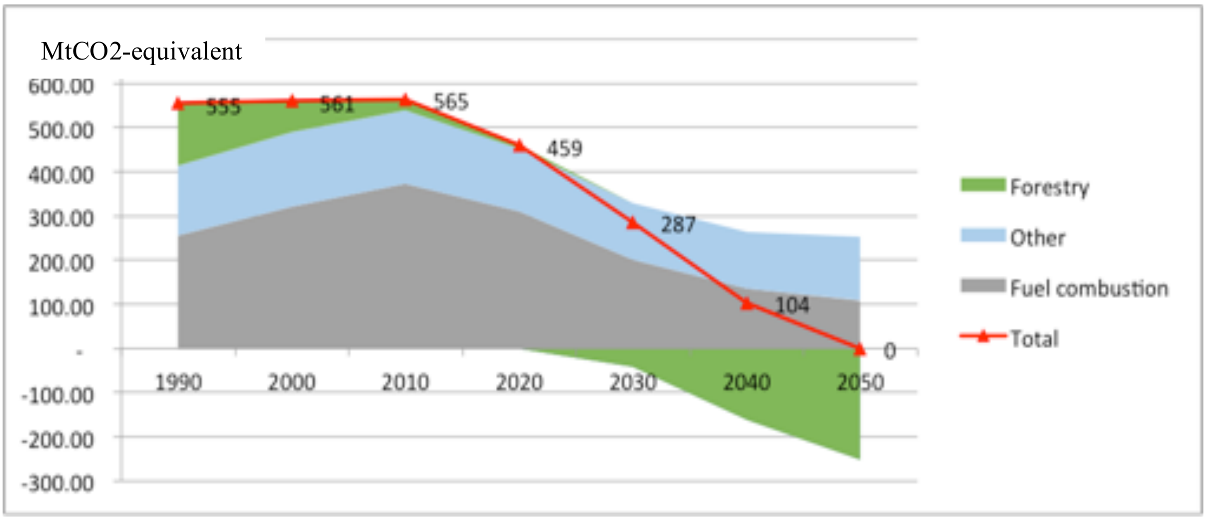

Figure 2: Australia's greenhouse gas emissions by source under a decarbonisation scenario (source: Climate Works Australia and the ANU, 2014)[25]

Managing electricity sector transition

The speed of the transition to near zero carbon electricity has significant implications for total costs. Achieving a very rapid transition to a zero-carbon electricity sector before 2025 or 2030 would require early retirement of significant existing power generation assets. A more gradual transition to a near-zero carbon system, by around 2040, would take advantage of natural asset turnover and be more cost effective, and would be combined with early targeted retirement of Australia's most emissions intensive power stations. Almost all of Australia's existing electricity generation assets will be retired before 2050 in any case.

In addition to timing, achieving the lowest cost transition for electricity users will require clear and stable policy settings that support investment in renewables, and avoid potential 'carbon lock-in' that would arise from new investment in carbon intensive power supply – unnecessarily risking future stranded assets.

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[24] S. Hatfield-Dodds, B.A. Bryan, and M. Nolan, (2014), "Agriculture and forestry sector," in Climate Works Australia and ANU, (2014),"Pathways to Deep Decarbonisation in 2050: How Australia can Prosper in a Low Carbon World – Technical Report" (Climate Works Australia and the Australian National University (ANU)).
[25] Climate Works Australia and ANU, (2014): 10

3. The economy keeps growing as emissions fall

Over the last 20 years, Australia has grown its economy effectively without increasing its greenhouse gas emissions. The emissions intensity of the economy – the ratio of Australia's greenhouse gas emissions to GDP – has halved since 1990.[26]

Economic modelling consistently shows that reducing greenhouse gas emissions in the future will involve only modest economic costs to the Australian economy. All economic modelling, without exception, has shown that Australia can achieve ambitious mitigation targets in the near-term and longer-term while continuing to grow the economy.

The economy keeps growing as emissions fall

Continued economic growth is predicted across all major studies, even under the scenario of deep emissions cuts. Table 1 summarizes the macroeconomic results from four major modelling exercises between 2007 and 2014. Annual GDP growth is modelled at 0.1% to 0.2% per year lower under scenarios that see domestic emissions at 2050 fall by between 42% to 100% (before accounting for international emissions credits). Meanwhile, the economy is projected to grow to be around 2.5 times the size it is today, even under a scenario of complete decarbonisation. All of these modelling scenarios assume that the rest of the world takes commensurate action to cut emissions, Australia is not going it alone.

In the reference case for all of these studies, emissions continually rise if left unchecked.

Study	**Annual average economic growth rate relative to reference case**		**GDP at 2050 relative to 2010 (ignoring climate change impacts)**		**Emissions at 2050 relative to 2010**	
	GDP	**GNI**	**Reference case (unchecked emissions growth)**	**Low emissions scenario**	**Domestic**	**Net Emissions in 2050 relative to 2010**
2014 DDPP Scenario	-0.19%	-0.12%	261%	254%	-100%	-100%
2011 Treasury	-0.21%	0.19%	275%	270%	-42%	-80%
2008 Treasury	-0.14%	0.17%	247%	241%	-69%	-90%
2007 Climate Institute	-0.10%	N/A	256%[27]	244%[28]	-66%[29]	-100%

Table 1: Macroeconomic estimates from major modelling exercises for deep emissions reductions from 2010 to 2050.

[26] CCA, (2014): 97
[27] Relative to 2005.
[28] Relative to 2005.
[29] This figure is relative to 1990 emissions levels.

Note: GDP at 2050 relative to 2010 is calculated by applying the annual average growth rates over the projection period. The individual reports use different base years.

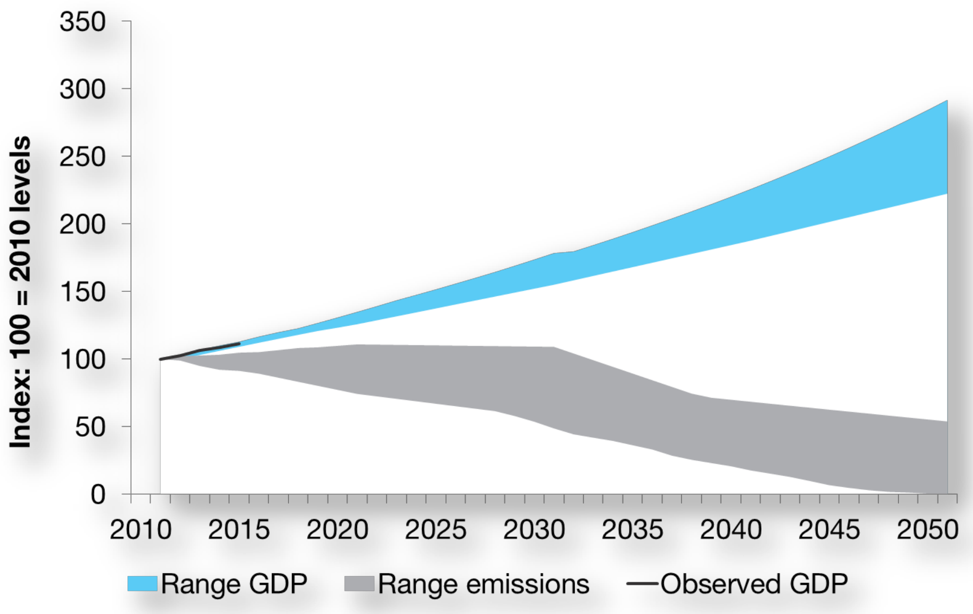

Figure 3: Range of emissions and GDP for Australia under emissions reductions scenarios, various modelling exercises. Source: re-drawn The Climate Institute, compiled from various modelling exercises.[30]

Emissions reductions are achieved through changing practices and technologies within sectors, not through significant changes to Australia's economic structure.

Most economic modelling indicates that ambitious mitigation action does not dramatically change the structure of the Australian economy, and that all industries that are growing in the base case -- including mining -- continue to grow in low emissions scenarios. Some sectors such as food, vehicle, clothing, textiles and footwear manufacturing, as well as agriculture, all improve under mitigation driven by carbon pricing.[31]

The composition of the Australian economy is primarily driven by Australia's comparative advantage and by broader structural trends. In comparison, the impact of national and global emissions reductions policies are small. This is evident in a comparison of average annual growth rates of different sectors of the Australian economy as modelled by the Treasury (see Figure 4 below).[32]

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[30] E. Jackson, (2014), "Australia's post 2020 emissions challenge: Our role in the international cycle of growing ambition," Policy Brief, (The Climate Institute).
[31] Treasury, (2011): 104
[32] Treasury, (2011): 104

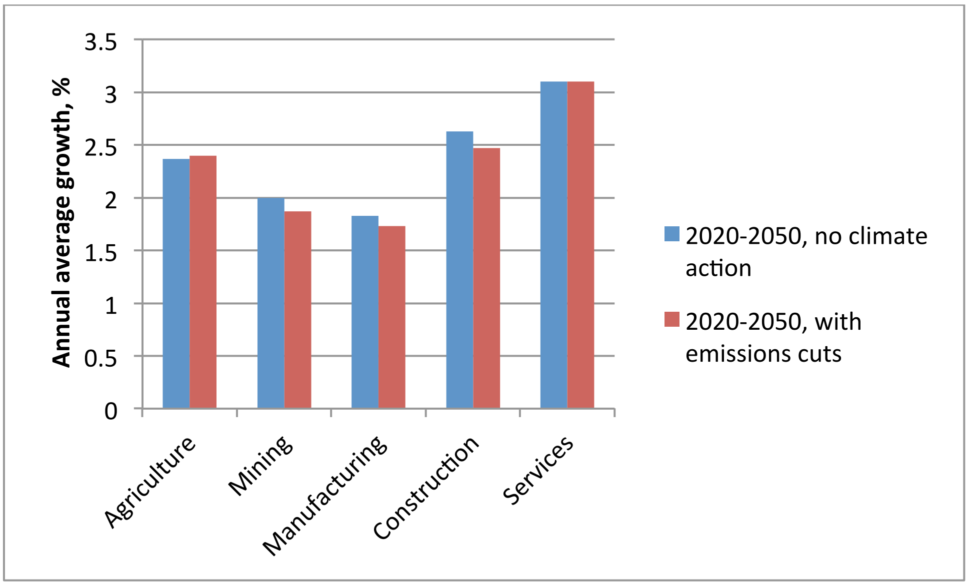

Figure 4: Annual average growth rates of different sectors in Australia during 2020-2050 (adapted from Treasury 2011, Chart 5.14)[33]

International emissions units can help reduce costs, but might also forgo co-benefits

An overall cost-effective way of achieving a low emissions global economy may involve some countries going below their targeted emissions levels, and selling emissions units to countries where achieving a given national emissions target would be more costly.

Most Australian analyses assume access to some form of international emissions units, and find that Australia would be a net buyer of international credits from other countries. Thus Australia would finance extra emissions reductions actions in other countries where it is cheaper than cutting emissions at home. Imported emissions units could cover for difficult-to-avoid emissions, and are particularly relevant to offsetting emissions from export driven activities such as agriculture and mining.

The use of international permits can lower the overall economic costs of mitigation. The extent of such cost savings depends on the future price of emissions permits globally, and the volume of international credits purchased.[34] The use of emissions units from other countries are behind much of the difference between estimated effects on GDP and GNI in the modelling results summarized in Table 1 and Figure 5 (below). Greater reliance on international emissions units will reduce the impact of mitigation on domestic economic activity (as measured by GDP), all else equal, and results in a larger gap between GDP and national income (as measured by GNI), which accounts for international financial transfers.[35]

In considering a near-term target, a major advantage of allowing access to international units is that it allows a more ambitious target to be achieved without imposing any significant additional economic impacts, as a stronger Australian target is unlikely to significantly change prices of

[33] Treasury (2011): 104
[34] Treasury (2008); (2011); CCA, (2014).
[35] Vivid Economics, (2013), "The costs and benefits of greater Australian emissions reduction ambition," (Report Prepared for WWF Australia); Treasury, (2011); (2008); Climate Works Australia and ANU, (2014).

international units. A higher target then does not result in higher marginal abatement costs in Australia, and the additional reductions are met through additional international units.[36]

There are complexities to consider with regard to international trade in emissions units. Governance and certification must ensure that the international units represent genuine abatement.[37] And it should be recognised that achieving Australia's abatement targets through international units may forgo co-benefits within Australia (see below Figure 6), depending on the details of how this abatement would be achieved domestically in the absence of international units.

4. Cutting emissions is getting cheaper

A trend across existing studies is for the estimated costs to decrease with each updated modelling exercise.

For example, the most recent modelling exercise, the 'Pathways to Deep Decarbonisation' report shows similar macroeconomic costs as previous modelling exercises, but for a much deeper cut in domestic emissions to 2050 (Table 1).

The trend is even clearer for economic cost estimates for achieving a 25% emissions reductions target at 2020 on 2000 levels. The cost estimates fell by about one third between the Garnaut Review in 2008 and the Treasury modelling in 2011; by another two thirds in a report prepared by Vivid Economics for WWF-Australia in 2013, using a very similar but updated modelling suite; and by another third in modelling published by the Climate Change Authority in 2014.[38]

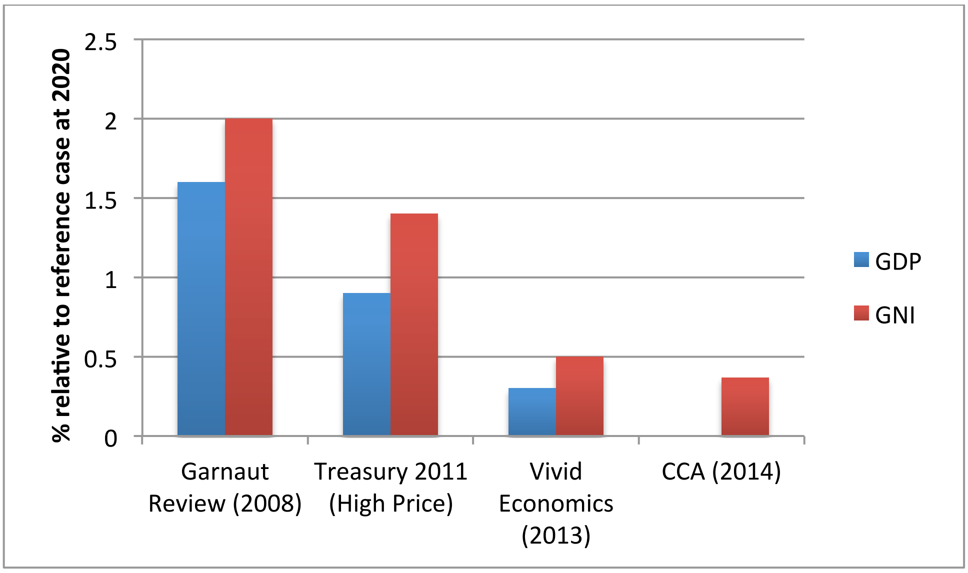

Figure 5: Modelling estimates of macroeconomic costs of achieving a 25% emissions reduction target at 2020, relative to 2000.[39] [40]

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[36] CCA, (2014).
[37] R. Garnaut, (2011), The Garnaut Review 2011: Australia in the global response to climate change (Cambridge University Press): 71
[38] R. Garnaut (2011); Treasury, (2011); Vivid Economics, (2013); CCA, (2014).
[39] R. Garnaut, (2008); Treasury, (2011); Vivid Economics, (2013); CCA, (2014).

There are two primary reasons for the fall of costs across models over time: the underlying growth in the drivers of greenhouse gas emissions is slower than expected, and innovation and cost reductions in some low-emissions technologies is proving to be much more effective than previously anticipated.

Emissions growth is beginning to slow, both regionally and globally. The International Energy Agency (IEA) recently reported that in 2014 carbon dioxide emissions stalled; the first time in 40 years that a reduction or halt in carbon emissions occurred while the world economy continued to grow.[41] Part of the reason lies with China, which over the last decade was the main driver of rising global greenhouse gas emissions. China's economic growth is slowing, and the country is decoupling economic growth from GHG emissions, in a deliberate effort to move to a lower-carbon growth model.[42]

The second reason for the slowed growth is that technology is being developed much more quickly, and deployed more easily, than previously predicted.[43] Economic analysis has typically been pessimistic when it comes to the ability of industries to innovate and create low-carbon technologies. As a result, governments and industry tend to overestimate the cost of pollution reduction measures. This is evident when comparing prospective cost estimates and actual outcomes for the EU emissions trading scheme as well as the Australian renewable energy target.[44] As the Grattan Institute observed, "markets are likely to deliver more innovation at lower cost than governments expect".

Low-carbon technology costs have fallen much faster than expected – illustrated by the fact that the cost of large-scale solar PV is already today around half the cost that was projected for 2030 (Figure 6).[45] The more recent modelling exercises for the Climate Change Authority and Deep Decarbonisation Pathways project assume 2030 costs of around A$2000 and A$1400 per kilowatt respectively. Projected costs for wind power installations by 2030 have also fallen significantly. By contrast, projections of coal and gas CCS have increased or remained stable.[46]

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[40] Note: CCA cost estimate has been scaled up to approximate costs for a 25% reduction target based on projected costs for a 19% target shown in the CCA report.

[41] IEA, (2015),"Global energy-related emissions of carbon dioxide stalled in 2014," (International Energy Agency (IEA), Paris) http://www.iea.org/newsroomandevents/news/2015/march/global-energy-related-emissions-of-carbon-dioxide-stalled-in-2014.html. Accessed 10th of April 2015.

[42] R. Garnaut, (2014), "China's role in global climate change mitigation," China & World Economy 22(5).

[43] N. H. Stern, (2007),The economics of climate change: the Stern review (Cambridge University Press); R, Garnaut, (2008).

[44] J. Daley, and T. Edis, (2010), "Markets to Reduce Pollution: Cheaper than Expected," (The Grattan Institute, Melbourne).

[45] Modelling undertaken for the Australian Treasury in 2008 and 2011 assumed that capital costs for large-scale solar PV plants at 2030 would be between A$5000 to A$6000 per kilowatt of capacity. In reality, costs in 2012 were already below A$3500. The estimated average cost of different technologies, such as solar thermal with and without storage, has dropped by over A$50/MWh between the 2012 and 2013 Australian Energy Technology Assessment.

[46] P. Graham, and S. Hatfield-Dodds, (2014): 31

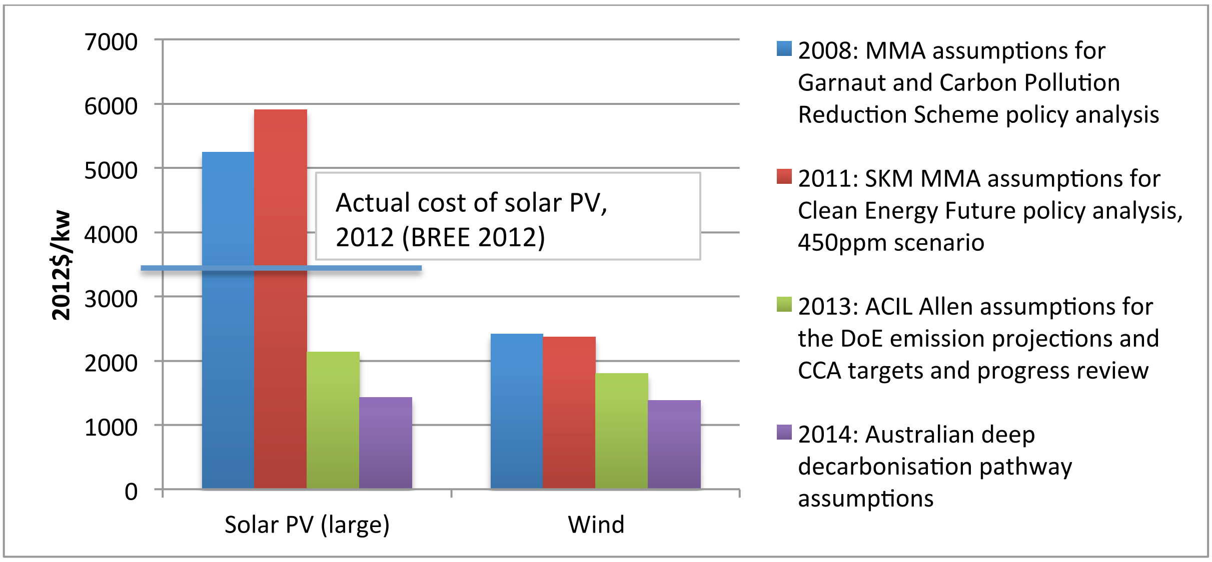

Figure 6: The falling cost of renewable energy technologies: assumptions about electricity generation technology capital cost assumptions for 2030. Redrawn from CSIRO (technical report for CWA/ANU).[47] Actual cost line is for solar only.

5. Cutting emissions has other benefits

It is well documented that the expected benefits of avoided climate change impacts significantly outweigh the costs of mitigation both globally[48] and in Australia.[49] The future benefits from lessened adverse impacts of climate change are the principal reason why the world community aims to cut global greenhouse gas emissions.

As laid out in the Garnaut Climate Change Review[50] and more recently by the Climate Change Authority's Targets and Progress Review[51], these benefits include not only avoided damages on economic activities reflected in markets, but also lesser damages to non-market values such as the existence of natural and cultural icons such as the Great Barrier Reef or agriculture in the Murray-Darling basin, and an insurance benefit in reducing the risk of catastrophic outcomes.

Could cutting emissions increase economic growth?

The conventional approach of economic modelling is to approach mitigation as a welfare-decreasing activity, the costs of which are balanced against the expected future benefits from reduced climate change damages.

In this framing, immediate benefits and co-benefits of mitigation may be undervalued or ignored.[52] Often there are distinct benefits to moving towards a low carbon economy that are not, or inadequately, represented in economic models. Most models that have been used to assess emissions reductions scenarios for Australia ignore ways that emissions reductions could boost

[47] P. Graham, and S. Hatfield-Dodds, (2014): 31
[48] Stern, *(2007)*.
[49] R, Garnaut, (2008); (2011).
[50] Garnaut, (2008).
[51] CCA, (2014).
[52] F. Teng and F. Jotzo, (2014), "Reaping the Economic Benefits of Decarbonization for China," China & World Economy 22(5): 53

productivity, and so are predisposed to find that economic growth is slower with emissions reductions.

This may not necessarily be the case. For example, the New Climate Economy Report highlights the potential for greater energy efficiency to free up resources leading to greater productivity, and for low-emissions policies to stimulate innovation, leading to broader economic benefits.[53] Research by Vivid Economics found that each 1% increase in energy productivity increases per capita GDP by 0.1%, on average.[54] Analysis for Australia indicates large potential for productivity-enhancing energy efficiency improvements.[55]

Moreover, many models make simplified assumptions about the fiscal aspects of climate change policy. Where policy instruments such as emissions trading produce revenue for governments, this can be used to cut other taxes, in turn increasing economy-wide efficiency. For example, Hatfield-Dodds calculated that the impact on Australia's GDP of a 15% reduction target at 2020 on 2000 levels could be halved through using the revenue from a carbon price for targeted tax reform.[56]

Co-Benefits of Mitigation

Beyond direct economic effects, moving to cleaner energy systems and industrial structures can have important positive side effects, or co-benefits.

The health co-benefits of greenhouse gas mitigation, such as increased productivity and avoided mortality, can be very large. Previous studies have estimated health co-benefits to range from a portion of mitigation costs through to exceeding them.[57] Macroeconomic modelling by the US Environmental Protection Agency (EPA) observed that the benefits from air quality improvements for the *1990 Clean Air Act,* estimated at A$2 trillion by 2020, significantly outweighed the estimated costs of A$65 billion.[58] Recent modelling using new data on chronic mortality, fine particulates and ozone, estimates that the average marginal benefit of mitigation globally is between US$60-350 per tonne of CO2e due to avoided mortality.[59] Another study found that the gross damage caused by air pollution from coal-fired electricity generation alone was 0.8 to 5.6 times the value added to the economy.[60]

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[53] GCEC, (2014), "Better Growth, Better Climate: The New Climate Economy Synthesis Report," (Washington, DC: The Global Commission on the Economy and the Climate).
[54] Vivid Economics, (2013), Energy Efficiency and Economic Growth, (Report prepared for the Climate Institute, London).
[55] O. Kember, (2013), "Boosting Australia's Energy Productivity," policy brief, (The Climate Institute).
[56] S. Hatfield-Dodds, (2011), "Assessing the effects of using a share of carbon price revenues for targeted tax reform: A report to the Garnaut Review 2011 Update," (Canberra: CSIRO Energy Transformed Flagship).
[57] A. Markandya et al., (2009), "Public health benefits of strategies to reduce greenhouse-gas emissions: low-carbon electricity generation," The Lancet 374: 9706; S. C. Anenberg et al., (2012), "Global air quality and health co-benefits of mitigating near-term climate change through methane and black carbon emission controls,"; G. Nemet, T. Holloway, and P. Meier, (2010), "Implications of incorporating air-quality co-benefits into climate change policymaking," Environmental Research Letters 5(1).
[58] EPA, (2011), "Summary Report: The Benefits and Costs of the Clean Air Act from 1990 to 2020," ed. U.S. EPA: 2
[59] J.J. West, et al., (2013), "Co-benefits of Global Greenhouse Gas Mitigation for Future Air Quality and Human Health," Nature Climate Change 3(10).
[60] N.Z. Muller, R. Mendelsohn, W. Nordhaus, (2011), "Environmental accounting for pollution in the United States economy,"The American Economic Review 101: 1649

Energy security can also be an important co-benefit for some countries. For fossil fuel importing countries, increasing the role of renewable energy means less exposure to fuel price fluctuations in international markets and less exposure to the risk of physical supply disruptions. The most recent IPCC assessment report observes that the use of renewable energy often leads to “improved energy access and security” that helps reduce dependence on imported fossil fuels and promote other co-benefits in terms of health and employment.[61]

Co-benefits are a key factor in China’s efforts to cut the growth in coal use and other fossil fuels. Major drivers of China’s policies include health benefits of reduced air pollution but also energy security and economic productivity.[62] Research has found that air pollution has reduced the average life expectancy in Northern China by 5.5 years, leading to a combined loss of more than 2.5 billion years of life expectancy.[63]

Health co-benefits could be significant for Australia as well, although research is sparse. In one of the few available studies on health co-benefits within Australia a CSIRO project found that the use of active transport in Australia could have significant benefits both in terms of increasing physical activity and health leading to lower rates of obesity, as well as reducing the impacts of greenhouse gas particulates such as respiratory diseases, leading to both reduced mortality and health expenditure.[64]

Co-benefits such as energy security, increased innovation and a reduced vulnerability to price shocks are difficult to measure but could also be significant. Estimating the monetary value of co-benefits turns some emissions reduction options from net costs to net benefits, even before considering their effect on reduced climate change, as indicatively computed in a global ‘marginal benefit curve’ prepared by the New Climate Economy project.[65] This analysis shows that number of emissions reductions options with net costs in the narrow economic sense become net benefits when co-benefits are taken into account. For energy efficiency options, many of which are inherently cost-saving, the inclusion of co-benefits can as much as triple the overall benefit.

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[61] IPCC, (2014), "Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change," ed. O. Edenhofer, R. , et al. (Cambridge, UK and New York, NY, USA): 69

[62] F. Teng, and F. Jotzo, (2014).

[63] Y. Chen, et al., (2013), “Evidence on the impact of sustained exposure to air pollution on life expectancy from China’s Huai River policy,” Proceedings of the National Academy of Sciences, 110(32).*110*(32), 12936-12941.

[64] B. Giles-Corti et al., (2010), "The co-benefits for health of investing in active transportation," 21(6) New South Wales public health bulletin.

[65] GCEC, (2014): 25

6. Achieving the transition to a low-carbon, high-growth Australia

The available evidence shows that Australia has the physical and technological opportunities to greatly reduce greenhouse gas emissions over coming decades, and that doing so can be done while the economy continues to grow rapidly. The future costs of emissions reductions may well turn out to be lower than estimated now, and the co-benefits of emissions reductions may offset many of the remaining costs.

Achieving this outcome will require predictable and economically efficient policy settings. If there is uncertainty about future policy settings, investment can stall, as is currently the case with regard to Australia's Renewable Energy Target. Similarly, the carbon pricing mechanism that was in place from mid-2012 to mid-2014 resulted in changes in operational decisions that led to lower emissions, but probably did not have large impacts on investment decisions because its political future was uncertain.[66]

Achieving a high-growth low-emission economy will require clear, stable, and cost-effective policy settings. Owners of carbon intensive assets may oppose change. The public should recognize self interested lobbying for what it is, and understand that new low-carbon industries will emerge over time. Policy settings can guard against any adverse impacts on emissions intensive exporters and transitional assistance can be provided. Change in some industries, such as the shift from coal to renewables, will have strongly felt impacts in some regions. Australian governments have a role in assisting with such transitions, as they did in many previous instances of economic change. To the extent that vulnerable groups in society are negatively affected, for example if living costs rise for low-income earners, there is a case for compensating changes in the tax and welfare system.

Finally, a transition to a low-carbon economy will take time and a clear direction. The task for government in pursuing Australia's interest in strong global climate action is to set appropriate targets for 2025 and beyond that are consistent with Australia's potential and circumstances, to position Australia for deeper cuts to 2050, and to identify policy approaches that can support such a transition. Given the low and decreasing costs, and expected co-benefits, deep cuts to emissions through to 2050 in the context of international action are clearly in the national interest.

[66] M, O'Gorman, and F. Jotzo, (2014), Impact of the carbon price on Australia's electricity demand, supply and emissions. Working paper 1411, (Centre for Climate Economics and Policy, Crawford School of Public Policy, The Australian National University (ANU)).