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An evaluation of the targets and timetables of proposed Australian emissions reduction policies

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ABSTRACT

This paper evaluates Australia's proposed emissions reduction policies in terms of the implied rates of decarbonization of the Australian economy for a range of proposed emissions reduction targets. The paper uses the Kaya Identity to structure the evaluation, employing both a bottom-up approach (based on projections of future Australian population, economic growth, and technology) as well as a top-down approach (deriving implied rates of decarbonization consistent with the targets and various rates of economic growth). Both approaches indicate that the Australian economy would have to achieve annual rates of decarbonization of 3.8–5.9% to meet a 2020 target of reducing emissions by 5%, 15% or 25% below 2000 levels, and about 5% to meet a 2050 target of a 60% reduction below 2000 levels. The paper argues that proposed Australian carbon policy proposals present emissions reduction targets that will be all but impossible to meet without creative approaches to accounting as they would require a level of effort equivalent to the deployment of dozens of new nuclear power plants or thousands of new solar thermal plants within the next decade.

1. Introduction

On December 12, 2007 Australian Prime Minister Kevin Rudd, having been sworn into office only the week before, gave a rousing speech at the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change, held in Bali, Indonesia. Rudd explained that Australia was ready to commit to binding targets for emissions reductions:

> The Government has committed to reducing Australia's greenhouse gas emissions by 60 per cent on 2000 levels by 2050. Last year – when my party was not in government – we commissioned a major study to help us to set shorter term targets along the way. This study, the Garnaut Review, will report in mid 2008. Together with modelling underway in the Australian Treasury, and also critically, informed by the science, this Review will drive our decisions on short and medium term targets. These will be real targets. These will be robust targets. And they will be targets fully cognisant of the science. And they will set Australia firmly on the path to achieving our commitment of a 60 per cent reduction in emissions by 2050. But it is not enough just to have targets. We have to be prepared to back them with sustained action – because targets must be, must be translated into reality. Australia will implement a comprehensive emissions trading scheme by 2010 to deliver these targets (Pm.gov.au, 2007).

At Bali, Prime Minister Rudd was met with ''long and loud applause'' (Grattan et al., 2007). However, despite signing the Kyoto Protocol as his first official act as Prime Minster and delivering the Bali speech, Australia soon found itself facing international criticism for its failure to announce any short-term targets at Bali meeting (Grattan, 2007).

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Upon the release of an interim draft of the Garnaut Review in February, 2008, commissioned by the Australian government to inform its climate policy deliberations, Professor Garnaut called for Australia to increase its targets beyond those mentioned at Bali: "Australia should be ready to go beyond its stated 60% reduction target by 2050 in an effective global agreement that includes developing nations (Daley, 2008). Immediately thereafter, Prime Minster Rudd's government appeared to distance itself from the report. Climate Change Minister Penny Wong said of the report's conclusions, "We welcome Professor Garnaut's input. . . . of course we will also be looking at other inputs, such as modelling from the Australian Treasury", prompting the leader of the Australian Green party to complain that, "Penny Wong has reduced Ross Garnaut to 'input'" (Porteous and Williams, 2008). Garnaut's draft report was issued on July 4, 2008 and the final report was released on September 30, 2008.

Less than two weeks after the draft Garnaut review was released the Rudd government released a "Green Paper" outlining its initial plans for a Carbon Pollution Reduction Scheme (CPRS), a policy based on a cap-and-trade approach to emissions reductions along the lines of the European Emissions Trading Scheme (ETS). A "White Paper" outlining the final plans for the proposed CPRS was subsequently released in December, 2008, as the Australian government announced a emissions reductions target of between 5% (unilaterally) and 15% (in concert with other nations) reduction below 2020 levels, and a proposed 60% reduction by 2050 (Commonwealth of Australia, 2008). In the face of severe criticism for its lack of ambition (Foley, 2008) the government justified its target in terms of the implications for per capita emissions, which it argued were on par with those promised by other nations. It was not long before the Rudd government responded to its critics who said that the targets were not ambitions enough. In May, 2009 the interim target was increased to a 25% reduction and the proposed starting implementation date for the CPRS was delayed to 2011, justified on the need to allow the economy to regain strength in the aftermath of the global financial crisis (Australian Government, 2009a).

In August 2009, the Australian Senate voted down the CPRS, prompting the government to split the renewable energy provisions from the ETS. The renewable energy package was subsequently passed into law. In November, 2009 the opposition Liberal Party saw a revolt over the proposed CPRS, resulting in a change in party leadership and a subsequent second defeat for the ETS in the Senate. In April, 2010 the Australian government shelved the emissions trading legislation until 2013, leaving its future status highly uncertain (Kirk, 2010). One consequence of this decision was a dramatic loss in public support for Prime Minister Rudd, contributing to his ouster by the Labor Party and replacement by Julia Gillard. Gillard, who was among those who recommended postponing the emissions trading legislation, inherited the expectations and promises for action on climate change.

Gillard was narrowly retained as prime minister following a historic election in August, 2010, based on the slimmest of parliamentary majorities. Gillard subsequently appointed a new committee to consider options for Australia's climate policy. While debate over policies such as emissions trading and a potential carbon tax is sure to continue in Australia for an extended period despite its legislative uncertainty, it is possible to conduct an assessment of the targets implied by proposed versions of the ETS. This paper provides an evaluation of Australia's proposed emissions reductions targets. How realistic are Australia's proposed emissions reductions goals on the short and long term? This paper focuses on emissions reductions targets of 5%, 15% and 25% from 2000 levels by 2020 (Australian Government, 2009b).

The paper argues that Australia's emissions reductions policy proposals are based on targets that will be all but impossible to meet without creative approaches to accounting. Australia provides yet another case study in the enormous difference between the rhetoric and the practice of emissions reductions.

2. Methodology of evaluation

The methodology employed here was employed in Pielke (2009a,b) to structure similar analyses of the United Kingdom's Climate Change Act and the Japanese "Mamizu" climate policy.[1] It draws upon Waggoner and Ausubel (2002) who argue that understanding the ability to influence environmental outcomes through policy requires "quantifying the component forces of environmental impact and integrating them". For carbon dioxide emissions relationship of forces leading to carbon dioxide emissions has been called the Kaya Identity, and it can be used to decompose the factors that lead to carbon dioxide emissions from the production and use of energy in the global economy. The identity is comprised of two primary factors: economic growth (or contraction), typically represented in terms of GDP, and changes in technology, typically represented as carbon dioxide emissions per unit GDP.

Each of these two primary factors is typically broken down into a further two sub-factors. GDP growth (or contraction) is comprised of changes in *population* and in *per capita GDP*. Carbon dioxide emissions per unit GDP is represented by the product of *energy intensity*, which refers to energy per unit of GDP and *carbon intensity*, which refers to the amount of carbon per unit of energy.

Together the four factors of the Kaya Identity explain the various influences that contribute to increasing atmospheric concentrations of carbon dioxide, as follows:

(1) Carbon dioxide emissions = population × per capita GDP × energy intensity × carbon intensity
(2) P = total population
(3) GDP/P = per capita GDP
  a. GDP = economic growth (contraction) = P × GDP/P = GDP
  (4) Energy intensity (EI) = TE/GDP = total energy (TE) consumption/GDP
  b. Carbon intensity (CI) = C/TE = carbon emissions/total energy consumption

[1] The methodological description is reproduced here as this paper is intended as a stand-alone analysis. Readers familiar with Pielke (2009a,b) can skip to the next section.

(5) EI × CI = "carbon intensity of the economy" = TE/GDP × C/TE = C/GDP.

Thus, according to the logic of these relationships, carbon accumulating in the atmosphere can be reduced only by reducing (a) population, (b) per capita GDP, or (c) carbon intensity of the economy. Most proposals advanced by governments and in international negotiations focus on actions that will lead to the reduction of the carbon intensity of the economy (whether or not they are explicitly presented as such), which in this paper is referred to as "decarbonization". Policies to reduce population or that result in economic contraction are not generally considered by governments as a strategy of emissions reductions. Thus, the Kaya Identity provides a straightforward and useful way to evaluate the proposed and actual performance of policies focused on decarbonization and which are typically called mitigation policies.

The factors of the Kaya Identity can be used to evaluate these estimates in terms of what is required to achieve the identified goals. The factors can be integrated individually, in "bottom up" fashion based on independent projections for growth in population (2) and per capita GDP (3), to estimate implied rates of decarbonization (5). The overall goal can also be disaggregated in a "top down" manner, starting with overall GDP growth (a) and deriving implied rates of decarbonization (5) consistent with a specified target.[2] The following sections consider each approach from a base year of 2006, which in most cases is the latest year for which data necessary for the analysis is available.

3. Evaluating Australian climate policy: part 1, a bottom up analysis

The first factor in the Kaya Identity is overall population, since more people means more emissions, all else equal. In 2008, the UN published its World Population Prospects and projected an Australian growth rate of 1.0% per year to 2020 and 0.7% to 2050 (United Nations, 2009). If these rates were to occur to 2020 and 2050, then Australia would have about 23.7 million people in 2020 and 28.7 million in 2050, representing an increase of almost 2.2 and 7.2 million people respectively from 2010. The Australian government has much more aggressive population projections than those of the UN: "Australia's estimated resident population (ERP) at 30 June 2007 of 21.0 million people is projected to increase to between 30.9 and 42.5 million people by 2056" (Australian Bureau of Statistics, 2008). A population of 40 million in 2050 would be about 20.5 million more than in 2010, and represent an annual growth rate of about 1.6% per year. The very large differences in projections underscore uncertainties in population projections.

In 2005 Australian carbon dioxide emissions were about 19.4 t per person. If a 2050 population of 28.7 million had per capita emissions of 19.4 t, then total Australian emissions would be about 557 Mt of carbon dioxide, about 55% higher than 2000 levels of about 360 Mt. A 2020 population of 23.7 million at 19.4 t of carbon dioxide per person would result in about 459 Mt of carbon dioxide, about 28% below 2000 levels. A population of 40 million in 2050 would have 776 Mt of carbon dioxide emissions at 19.4 t per person, or 216% higher than 2000 levels. So an increasing population would mean that Australia's emissions will increase, all else equal. Population growth compounds the difficulty of meeting national targets for emissions reductions.

The second factor in the Kaya identity is economic activity. All else being equal more economic activity means more emissions. From 1990 to 2006 Australia averaged 3.4% per year annual GDP growth (in constant currency, i.e., inflation adjusted).[3] If overall growth to 2050 is expected to occur at its historical average of 3.5% per year, and population is growing by 0.7–1.6% per year, then this implies a per capita GDP growth rate of 1.9–2.8% per year. Of course, governments strive for higher growth rates and a vibrant economy, just as they are now doing around the world to stimulate economic growth. For purposes of the present discussion, let us assume that future per capita GDP growth in Australia increases at 3.0% per year, reflecting a value in between the UN and Australian government population projections, and below its historical performance. This level of growth would add another 1000 Mt of carbon dioxide to the 2050 total, for a total of about 1361 Mt, about 3.8 times higher than 2000 emissions and about 6.3 times a 2050 target of a 60% reduction from 2005 levels. In 2020 this rate of growth would add about another 201 Mt of carbon dioxide emissions, for a total of 561 Mt, or 56% above 2000 emissions.

The third factor is technological change. As described above, technological change includes increased energy efficiency in the economy and in reduced carbon intensity of energy. According to data from the United States Energy Information Agency from 2001 to 2006 on Australian total primary energy production, Australian energy intensity[4] decreased by about 1.4% per year, while the carbon intensity[5] of the energy supply increased by about 0.6% per year over the same period. However, the Australian economy did not decarbonize from 1995 to 2006, and, in fact recarbonzied from 2003 to 2006, so annual rates of decarbonization can be a bit misleading. Overall, the decarbonization of the Australian economy has occurred at an average rate of less than 1% per year based on US EIA data from 2001 to 2006.

Using a bottom up analysis, the combined effects of Australian population and per capita economic growth of 3.0% per year imply that to meet a 2020 emissions reduction target of 5%, 15% or 25% below 2000 levels would require that the combined effects of increasing energy efficiency and reduced carbon intensity of energy occur at an average annual rate of 4.3%, 5.0% and 5.9% respectively to 2020 and 5.2% to 2050 for a 60% reduction target.

[2] The terminology of "bottom up" and "top down" is simply descriptive of the approach used in this paper.

[3] GDP data from Maddison (2008).

[4] International Energy Statistics available at http://www.eia.doe.gov/emeu/international/contents.html, energy efficiency is the inverse of energy intensity, so an increase in efficiency is the same as a decrease in intensity, and vice versa.

[5] Calculated using energy and carbon dioxide data from the US Energy Information Administration.

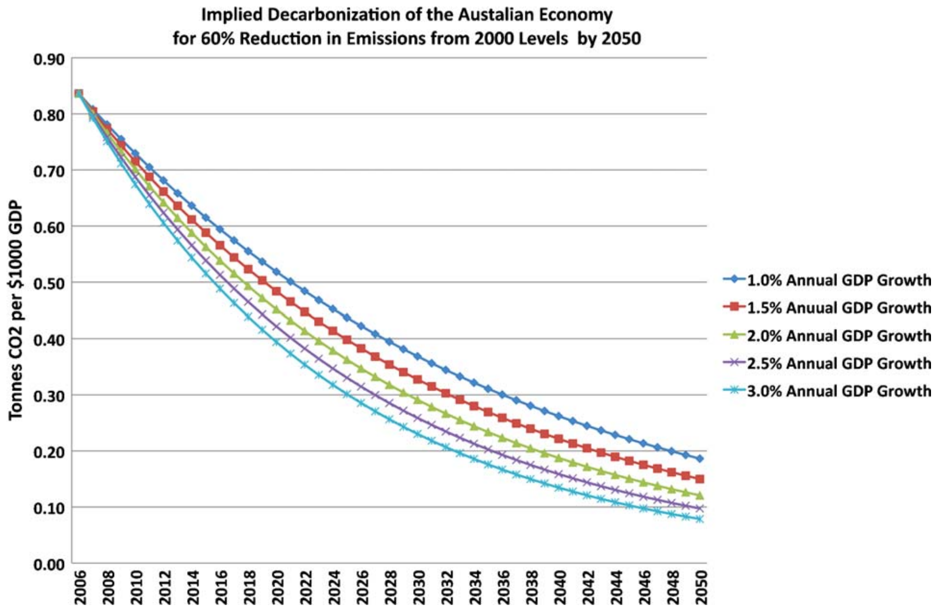

Fig. 1 – Implied rates of decarbonization of the Australian economy for a 60% reduction in emissions from 2000 levels by 2050 for various rates of GDP growth, 2007–2050.

4. Evaluating Australian climate policy: part 2, a top down analysis

A top down analysis begins with assumptions of future economic growth, which integrates future population growth and per capita economic growth, and then works backwards to determine what rate of decarbonization of the economy would be necessary to meet the future emissions target. In 2006 Australia produced 0.84 t of carbon dioxide for every $1000 of GDP.[6] Fig. 1 shows required rates of decarbonization of the Australian economy from 2007 to 2050 (for various rates of assumed GDP growth) implied by a target of a 60% reduction in carbon dioxide emissions from 2000 levels.

The top down analysis uses a range of assumptions for future economic growth. In this analysis, five rates were used from 1 to 3% per year, which spans a wide range of possibilities. Fig. 1 shows that in one sense the choice of rates is not particularly important because the carbon intensity of the economy would have to decline to below 0.20 under all assumptions.

The figure shows that the carbon intensity of the Australian economy would have to reach a level of 0.08–0.19 t of carbon dioxide per $1000 of GDP by 2050, from 0.84 in 2006. Fig. 2a–c shows the same information for 2020 implied by targets of 25%, 15% and 5% reduction in carbon dioxide levels from 2000 levels. The figure shows that the carbon intensity of the Australian economy would have to be cut by about a quarter to more than half by 2020, depending upon assumptions, from its value of 0.84 in 2006.

Fig. 3 below shows the actual annual rate of decarbonization of the Australian economy from 1980 to 2006 as well as the annual average rates of decarbonization implied by the 2020 and 2050 targets assuming an average 2.5% annual GDP growth. A 2.5% growth rate is simply chosen as illustrative, but may be more realistic in the near term than the higher rate suggested by the bottom up analysis due to the global economic slowdown in recent years. Higher rates of future GDP growth would result in higher implied rates of decarbonization.

The rates of decarbonization of the Australian economy implied by the top down analysis for a 25% reduction target from 2000 levels are 5.4% per year for the 2020 target and 4.8% for the 2050 target. These numbers are substantially higher than the rates of decarbonization observed from 1980 to 2006 and 2001 to 2006, as summarized in the table below, along with the rates derived for the bottom up analysis (Table 1).

5. Australian targets in context

The Australian targets imply that Australia would have to achieve the 2006 emissions intensity of Japan by 2016 for a 25% reduction target, by 2018 for a 15% reduction target or 2020 for a 5% reduction target.[7] Japan has a highly efficient economy on several small islands with almost no domestic energy resources. Japan also operates the third most nuclear power plants after the United States and France. In other words, in many important respects Japan could not be more different than Australia in terms of the role of emissions in its economy.

[6] Carbon dioxide data is available at: http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls. Data on GDP, converted to 1990 Gheary-Khamis dollars (to facilitate international comparisons) is available at: http://www.ggdc.net/maddison/Historical_Statistics/vertical-file_09-2008.xls. The 1990 Gheary-Khamis dollars are the units used throughout this paper.

[7] These numbers reflect the assumptions of the bottom up approach.

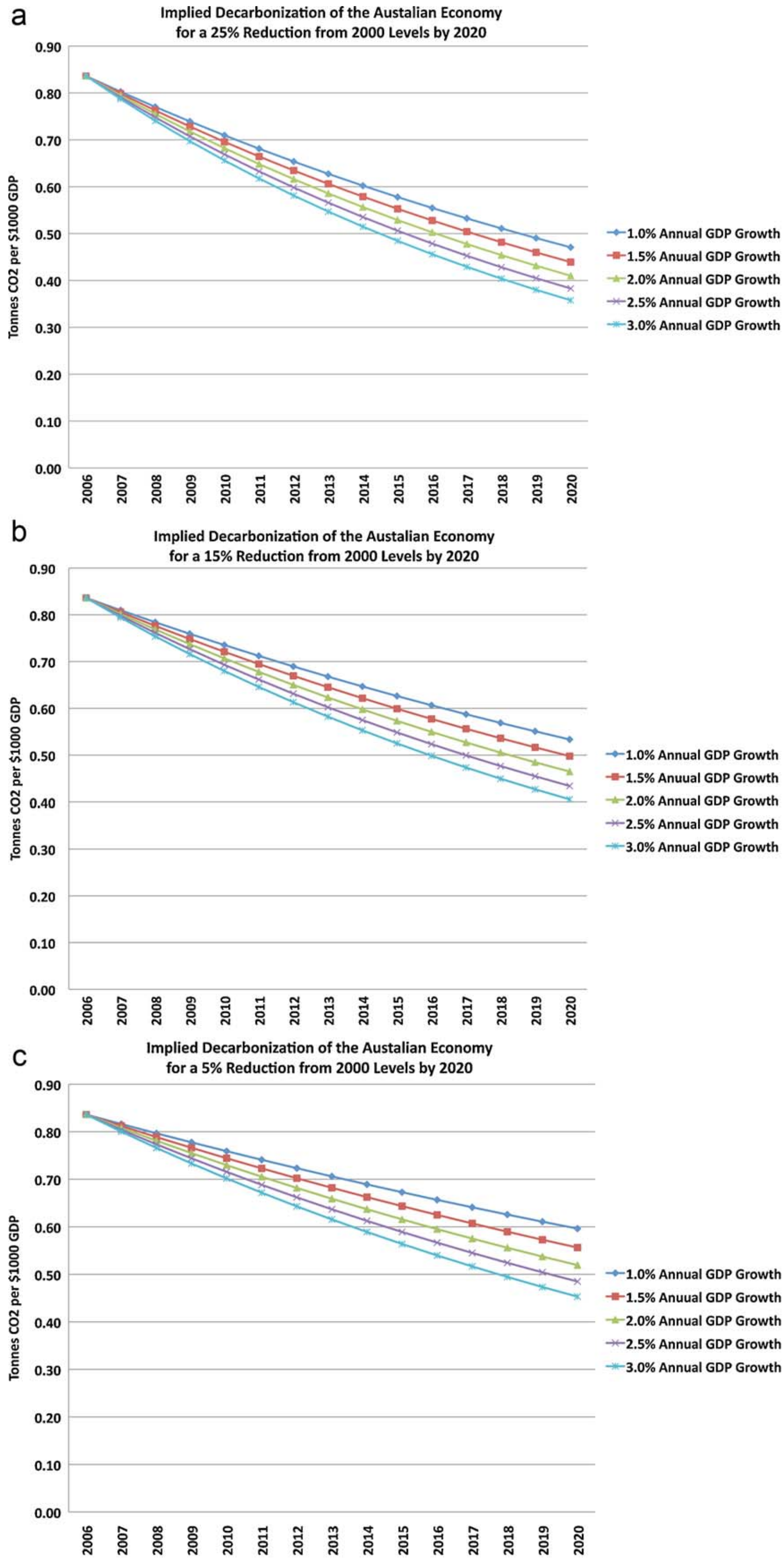

Fig. 2 – (a) Implied rates of decarbonization of the Australian economy for various rates of GDP growth, 2007–2020, for a 25% emissions reduction target. (b) Implied rates of decarbonization of the Australian economy for various rates of GDP growth, 2007–2020, for a 15% emissions reduction target. (c) Implied rates of decarbonization of the Australian economy for various rates of GDP growth, 2007–2020, for a 5% emissions reduction target.

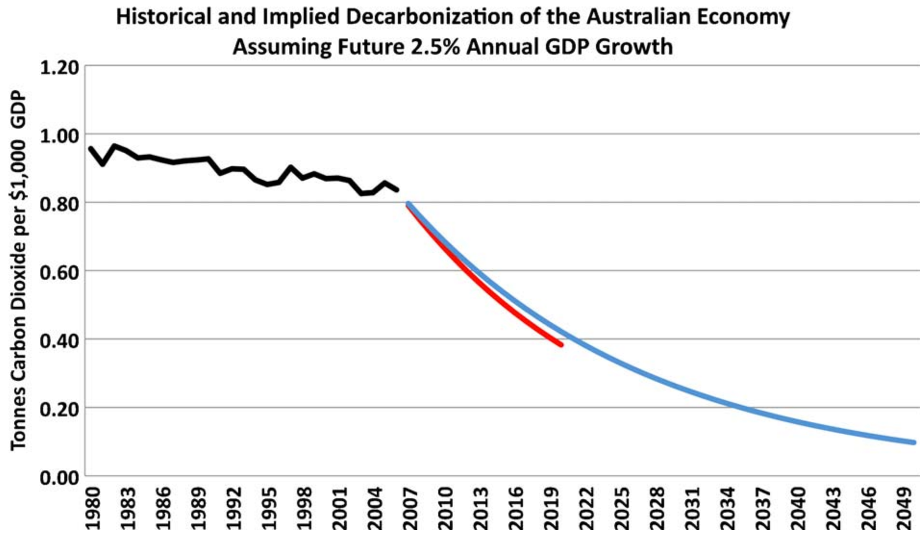

Fig. 3 – Past rates of decarbonization of the Australian economy, 1980–2006, and implied rates of decarbonization assuming 2.5% annual GDP growth for the 2020 (25% reduction target in red) and 2050 targets (60% reduction target in blue). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 1 – Rate of decarbonization of the Australian economy observed (first two columns) for 1980–2006 and 2001–2006, and implied (third and fourth columns) by the 2020 and 2050 targets under the bottom up and top down approaches.

	1980–2006 (%)	2001–2006 (%)	2007–2020 (%)	2007–2050 (%)
Actual	−0.5	−0.7		
Bottom up (5% reduction target 3.0% GDP growth)			−4.3	
Bottom up (15% reduction target 3.0% GDP growth)			−5.0	
Bottom up (25% reduction target 3.0% GDP growth)			−5.9	
Bottom up (60% reduction target 3.0% GDP growth)				−5.2
Top down (5% reduction target, 2.5% GDP growth)			−3.8	
Top down (15% reduction target, 2.5% GDP growth)			−4.6	
Top down (25% reduction target, 2.5% GDP growth)			−5.4	
Top down (60% reduction target, 2.5% GDP growth)				−4.8

To think that Australia could achieve Japanese levels of decarbonization within the next decade strains credulity.

Another way to look at the challenge of decarbonizing the Australian economy is in terms of its energy mix. Fig. 4 shows the 2004 energy mix for Australia (US Energy Information Administration, 2009).

It is straightforward to convert the energy mix into greenhouse gas emissions by multiplying the amount of energy consumed (measured as quadrillion BTUs or one quad) by the amount of carbon emitted per quad for each fuel.[8] According to the US Energy Information Administration (2008), in 2004 Australia emitted about 391 Mt of carbon dioxide from 5.3 quads of consumption, with the mix shown in Fig. 4. Multiplying the carbon dioxide generated per quad (from footnote 8) by the proportion of energy from each fuel source results in 390 Mt of carbon, essentially the same as that reported by the US Energy Information Administration.

With this information it is then possible to perform a simple sensitivity analysis describing what it would take to decarbonize the Australian economy to a level consistent with a particular emissions reduction target. In 2004 Australia produced 0.83 t of carbon dioxide emissions per $1000 (US) (essentially the same as in 2006). For this to be cut in half over the next decade or less – as implied by the 5%, 15% and 25% 2020 targets – would require that nearly all Australian coal consumption be replaced by a zero-carbon alternative such as nuclear or renewable. If an average nuclear plant provides 750 MW of electricity (World Nuclear Association, 2007) and one quad is equivalent to 11,000 MW of electricity (produced over one year, American Physical Society, 2010) then about 15 nuclear power plants would provide one quad. Coal provided 2.4 quads for Australia in 2004, meaning that this could be replaced by about 35 nuclear power plants.

Of course, Australia's energy consumption has increased since 2004 and is expected to increase in the future. If Australia's demand for energy increases by 1.5% per year to 2020 then an additional 1.4 quads of energy will be needed, implying the equivalent of 21 additional nuclear power plants, or a total of 56. These assumptions can be adjusted to explore

[8] These can be calculated from the data at: http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/CO2_coeff.xls. In the analysis that follows I use 94.44 Mt of carbon dioxide per quad from coal, 70.00 for petroleum and 53.06 for natural gas.

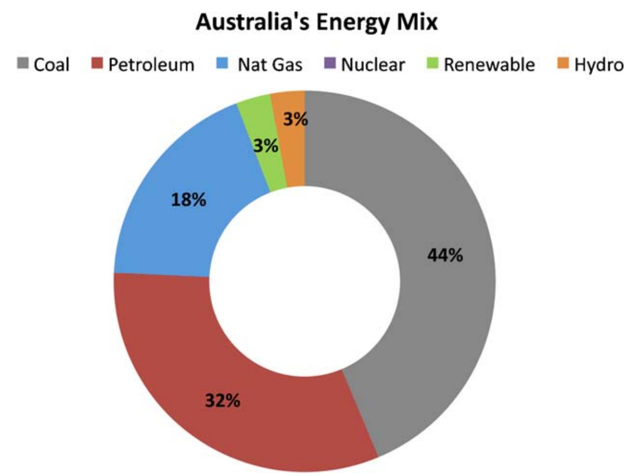

Fig. 4 – Australia's 2004 energy mix showing the consumption of 5.3 quadrillion BTUs. There was no nuclear power in Australia in 2004.

the implications of aggressive energy efficiency programs or expansion of renewable energy technologies (or other assumptions, such as the expansion of natural gas). For instance, if demand is held constant at 2004 levels and renewable energy comprises 20% of the total mix, then only 13 equivalent nuclear power plants would be needed by 2020. Different assumptions will of course lead to different results, and the ones presented above are intended to be illustrative of the magnitude of the decarbonization challenge under a reasonable set of assumptions. The conclusion that the magnitude of the challenge is enormous is not particularly sensitive to these assumptions.

Several Australian readers of an early version of this paper commented that a comparison of nuclear power plant equivalents, even if hypothetical, would not make much sense to many readers as Australia has a long history of opposition to nuclear power plants. The same sort of hypothetical sensitivity analysis can be conducted with technologies based on existing solar power plants. The Cloncurry Solar Thermal Power Plant in Queensland is expected to provide 10 MW of electricity when completed (Renewable Energy Development, 2008). One quad (at 33% efficiency) of energy implies 3333 Cloncurry plants. Providing 3.8 quads implies 12,667 Cloncurry equivalent plants, or about 24 such plants coming online every week from 2010 to 2020.

What this sensitivity analysis clearly indicates is that under a wide range of scenarios Australia would need to undertake a herculean effort comparable to the level of effort required to build and put into service dozens or more nuclear power plants by 2020 or thousands of solar thermal plants. Were this ''level of effort'' to be expressed in terms of windmills or other existing technologies the magnitude would be equally as daunting. When coupled with very aggressive efficiency and renewable objectives the level of effort is still enormous. Australia, of course, has no nuclear power plants, and the technology is hotly debated, so even building one plant would be an enormous achievement.

The point being made here of course is not about nuclear power or even solar thermal plants, but about the enormous level of effort needed to meet the proposed short-term targets for Australian emissions reduction. The magnitude of the effort required helps to explain why policy makers look to offsets and other accounting schemes to achieve targets. Regardless of the nature of the legislation ultimately adopted in Australia, the actual decarbonization of the Australian economy will all but certainly fall short of the rates needed to hit the emissions reduction targets.

6. Conclusion

To summarize, the annual rates of decarbonization of the Australian economy implied by the bottom-up and top-down analyses suggest rates that are beyond those achieved by any major economy in recent decades over sustained periods of time. Japan achieved a rate of decarbonization of about 4.4% from 1980 to 1986 but was unable to sustain that high rate, seeing it subsequently drop to closer to 1% per year (Pielke, 2009b). In proposing to do that which has never been done, Australia is joining the United Kingdom and Japan (and others, including the European Union and United States) with aggressive emissions reductions targets and timetables that appear to be fanciful at best. Australia's targets imply a level of decarbonization about that of Japan's (in 2006) by 2020, or the equivalent level of effort to building and putting into service dozens of new nuclear power plants or many thousands of solar thermal plants.

However, just because something has not been achieved before does not mean that it is impossible. Indeed, if the world is to decarbonize its economy to a level consistent with low stabilization targets it will require an unprecedented pace of transformation of the global energy system. A risk of proposing aspirational goals is that policy makers will look for ways to avoid meeting the objectives while maintaining the appearance of accountability to formal goals, at least during their time in office. Stanford's David Victor explains, ''setting binding emission targets through treaties is wrong-headed because it 'forces' governments to do things they don't know how to do. And that puts them in a box, from which they escape using accounting tricks (e.g., offsets) rather than real effort'' (Victor, 2009).

Australia has a very carbon intensive economy, thus its ability to dramatically accelerate the decarbonization of its economy offers the promise of many valuable lessons for other countries around the world. However, a focus on targets and timetables for emissions reduction that will be impossible to meet in practical policy implementation runs the risk of engendering public cynicism and even opposition. Currently the nature of international climate politics is such that aggressive promises are met with applause, regardless of their feasibility. When asked if it mattered whether Australia had passed ETS legislation in time for the 2009 Copenhagen meeting, the head of the United Nations Framework Convention on Climate Change responded: ''Quite honestly, no. What people care about in the international negotiations is the commitment that a government makes to take on a certain target'' (NEWS.com.au, 2009).

While the international process rewards promises, a better strategy for climate policy would be to focus to a greater extent on performance. Australian policies for decarbonization could serve as experiments with a clear-eyed recognition that the pace of decarbonization simply cannot be known until those experiments are implemented and evaluated. Departing from conventional wisdom of the international process would take bold leadership and a willingness to clearly explain the simple mathematics of emissions reductions, such as presented in this paper. From this perspective the renewable energy package passed by the Australian government in August 2009 likely offers far more prospects for learning about the practical challenges of decarbonization and meeting aggressive goals for stabilization of atmospheric concentrations of carbon dioxide than does an Australia ETS, whatever its eventual fate. The political challenges thus far facing passage of emissions reduction legislation in Australia, and its almost certain destiny to fail to achieve emissions reduction targets of the magnitude described here, should serve as an important lesson to climate policy makers around the world.

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