

# **WEAKNESSES AND REFORM OF AUSTRALIA'S RENEWABLE ELECTRICITY SUPPORT**

**Greg Buckman**

As climate change awareness increases so too does the importance attached to renewable electricity generation as a means of reducing greenhouse gas emissions. For instance, Diesendorf's proposal for a course by which Australia could achieve a 30% reduction on its projected 2020 level of greenhouse gas emission, envisages renewable electricity accounting for a third of the reduction with increased electricity use efficiency accounting for a further fifth (Diesendorf (2007)). Renewable electricity has significant potential to reduce greenhouse gas emissions in Australia which has high per capita greenhouse gas emissions, high electricity sector emissions, low utilisation of renewable electricity and abundant renewable electricity resources. However, current renewable electricity generating costs are significantly higher than those of electricity generated by fossil fuels without a carbon price. There are several ways renewable electricity can be supported so that its generating cost disadvantage is bridged. These include subsidisation from government budgets, greenhouse gas emissions licence trading and carbon taxes.

The most popular form of renewable electricity support is to finance subsidies through increased electricity prices with the support directed to renewable electricity generators through either Feed-in Tariffs – where governments mandate the amount of subsidy that must be paid for different types of renewable electricity and markets determine how much of each will be generated – or Renewable Portfolio Standards, where governments mandate how much renewable electricity will be generated and markets determine the amount of subsidy that will be paid for it. Since 2001, Australia has mainly used a Renewable Portfolio Standard to

subsidise its renewable electricity. If Australia is to meet its post-Kyoto greenhouse gas obligations, which will probably involve major cuts to its electricity emissions, it is likely to have to embrace major generation of renewable electricity. However, there is entrenched political opposition to this, particularly from major industrial electricity users, electricity retailers and politicians fearful of a consumer backlash against rapidly rising electricity prices.

There has been limited contemporary academic, or government, examination of integrated renewable electricity policy in Australia, especially in terms of how it should be designed to facilitate major reductions in the country's greenhouse gas emissions, and how different renewable electricity types should be supported. Kent and Mercer (2006) analysed the original version of Australia's Renewable Portfolio Standard, and Saddler *et al* (2007) mapped scenarios for how renewable electricity and energy efficiency can be used to lower Australia's greenhouse gas emissions, but there has been little analysis since. Kann (2010) examined the specific issue of wind finance, Valentine (2010) examined wind support in Australia, MacGill (2009) analysed the integration of wind into the national electricity market and Jakrawatana *et al* (2009) discussed regional bioenergy systems but none considered overall renewable electricity policy in an integrated way. At a government level, there was significant official review of overseas Renewable Portfolio Standard design before Australia's original Renewable Portfolio Standard was introduced in 2001, and again when it was reviewed in 2003, but there has been none since.

This article discusses, and analyses, the significance of electricity generation emissions in Australia's overall greenhouse performance, its renewable electricity generation record, the flaws in the country's Renewable Portfolio Standard that stop it supporting a large amount of a wide range of renewable electricity types and the political forces that have shaped these features. The next section of this paper examines Australia's electricity sector greenhouse gas emissions and historic use of renewable electricity. The following sections consider the performance of Australia's Renewable Portfolio Standard since it began in 2001; its ongoing weaknesses and possible changes that can be made to enable it to support a wide range of renewable electricity types. The article then

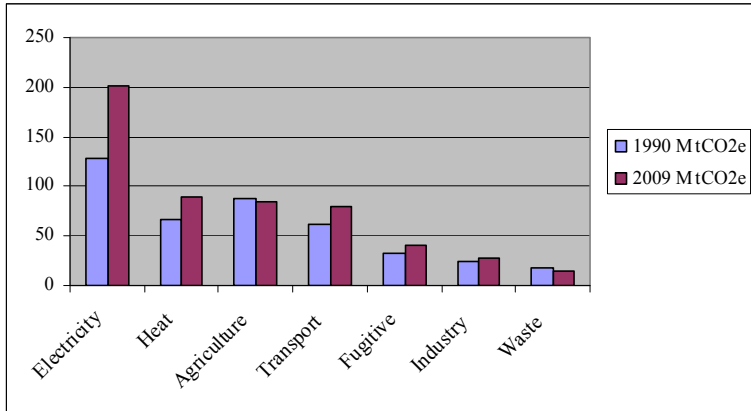
examines possible changes to Australia's renewable electricity target to enable it to achieve major greenhouse gas emission reduction and the political forces that influence Australia's renewable electricity policy.

## **Australia's Electricity Sector Greenhouse Gas Emissions**

All sides of the climate change debate in Australia distort, at times, the country's greenhouse gas emission statistics. People in favour of climate change action often erroneously claim that Australia has the highest *per capita* greenhouse gas emissions in the world. Those against action often argue that the country's greenhouse gas emissions are insignificant on a global scale. In fact, in 2006 Australia's per capita level of greenhouse gas emission, including land-use change, of 28.1 t CO<sub>2</sub>e/yr, was the sixth highest in the world and was the highest amongst developed countries. It was also approximately four times the global per capita average and was about twice the average for developed countries belonging to the Organisation for Economic Cooperation and Development (OECD) (Garnaut 2008a: 153). Even though the country's domestic greenhouse gas emissions were equal to about 1.5% of the global total in 2005, they were still the seventeenth highest of any country in the world (World Resources Institute 2009).

A major driver of Australia's relatively high level of greenhouse gas emissions is electricity generation. As shown in Figure 1, in 2009 it accounted for the largest share of the country's greenhouse gas emissions: 202 Mt CO<sub>2</sub>e/yr, or 38% of the country's net national greenhouse gas emissions (excluding land use, land use change and forestry) of 537 Mt CO<sub>2</sub>e/yr (Department of Climate Change (DCC) 2010: 3). Electricity generation is also one of the country's fastest growing greenhouse gas emission sources. In 1990 it accounted for 129 Mt CO<sub>2</sub>e/yr, or 31% of the nation's net greenhouse gas emissions of 416 Mt CO<sub>2</sub>e/yr (DCC 2008: 2). This means between 1990 and 2009 Australia's net national greenhouse gas emissions increased by 28% while its electricity generation emissions increased by double that rate: 57%.

**Figure 1: Australia's Non-Land Clearing  
Greenhouse Gas Emission Sources, 1990 and 2009**



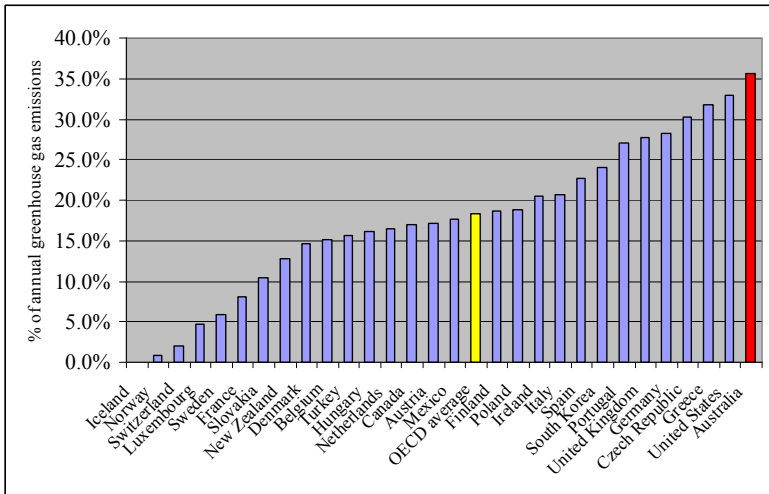
Source: DCC 2010.

Australia's electricity generation greenhouse gas emissions have increased to a point where they now account for a larger share of the nation's net emissions than they do in any other OECD country. As Figure 2 shows, the proportion of national greenhouse gas emissions contributed by electricity generation was 36% of Australia's in 2000, nearly twice the (unweighted) OECD average of 18% (World Resources Institute 2009, International Energy Agency (IEA) 2009).

A large part of the reason for the high contribution of electricity generation to Australia's greenhouse gas emissions is its greenhouse gas intensity. The greenhouse gas emission intensity of the country's electricity generation is the highest of any country in the OECD. In 2000, it took 0.86 kg of CO<sub>2</sub> to generate each MWh of electricity in Australia, 2.4 times the OECD average of 0.36 kg (World Resources Institute 2009). In 1971, however, the greenhouse gas intensity of Australia's electricity supply was similar to the OECD average (Garnaut 2008a: 153). This means the influences that have made electricity such a large contributor to Australia's greenhouse gas emissions have become more pronounced in the last two decades of the 20<sup>th</sup> century. These influences

are mainly its dependence on coal and its relatively modest use of renewable electricity.

**Figure 2: Proportion Of OECD Nations' Greenhouse Gas Emissions Accounted for by Electricity Generation, 2000**



Source: World Resources Institute 2009, IEA 2009.

In 2006, Australia was the second-most coal dependent OECD country with respect to electricity generation. In that year, coal (both black and brown) supplied 76% of the country's electricity generation, compared to an OECD (unweighted) country average of 37% (IEA 2009). The flipside of Australia's high use of coal for electricity generation is its low use of renewable sources for electricity. In 2006, 8% of Australia's electricity generation was supplied by renewable electricity compared to an OECD (unweighted) average of 16% (IEA 2009). However, the proportion of Australia's electricity supplied by renewable electricity has not always been low. In the mid 1960s, when hydro-electric development was at its peak in the Snowy Mountains and Tasmania, the share of electricity in Australia generated by renewables reached a high of 23% in 1965, but it

declined to 9% by 2000 (MRET Review Panel 2003: 10). This reduction contributed to both Australia's low renewable electricity generation market share as well as its relatively high electricity generation greenhouse gas intensity.

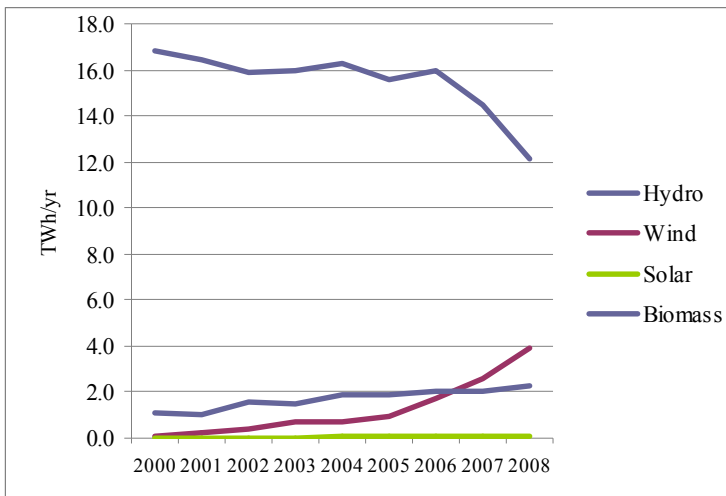
## **Renewable Electricity Under the Renewable Portfolio Standard**

The slide in Australia's use of renewable electricity since the 1960s has been arrested by its use of a Renewable Portfolio Standard. The country first began using a Renewable Portfolio Standard in 2001, then known as the Mandatory Renewable Energy Target (MRET). It was an initiative announced by the Howard federal government as part of a package of measures it brought to the 1997 negotiation of the Kyoto international greenhouse gas emission reduction protocol. The additional renewable electricity that MRET sought to support was expressed not as a share of electricity generation, but as a specific amount of generation: 9.5 TWh/yr by 2010. It was thought that this would roughly increase the nation's renewable electricity market share by about two percentage points by 2010, from 10.5% of grid-connected electricity generation in 1996-97 to 12.5% in 2010 (Renewables Target Working Group 1999: 8-24). However, this projected growth assumed relatively modest growth in Australia's electricity consumption. The actual growth after MRET's introduction was much higher than anticipated, with the result that the mechanism only managed to slow the rate of decline in the country's percentage use of renewable electricity. By 2007-08, Australia's renewable electricity was equal to 6.9% of all grid and off-grid electricity generation (18.4 TWh/yr out of 265.3 TWh/yr of total generation). It is impossible to calculate the renewable electricity market share of grid-connected electricity (only) from published data: off-grid generation accounts for about 10% of all electricity generation (Australian Bureau of Agricultural and Resource Economics (ABARE) 2010a).

Although MRET did not increase the country's renewable electricity market share, it was successful in diversifying Australia's renewable electricity generation, although hydro generation still generates about two-thirds of the nation's renewable electricity. As shown in Figure 3, between 2000 and 2008 hydro generation declined from 17 TWh/yr to 21

TWh/yr (largely because of rainfall decline) but wind generation increased from 0.1 TWh/yr to 12 TWh/yr over the same period (ABARE 2010a). Compared to the European Union and the USA, Australia's renewable electricity is still relatively undiversified (Buckman and Diesendorf 2010), but MRET made a start in broadening its base.

**Figure 3: Generation of Different Renewable Electricity Types in Australia, 2000 to 2008**



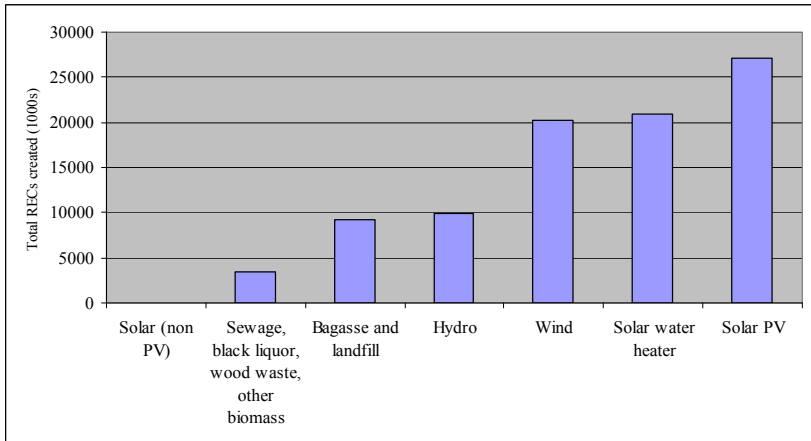
Source: ABARE 2010a.

As well as high growth in electricity consumption, another force behind MRET's inability to lift Australia's renewable electricity market share has been its support of solar and heat pump water heaters which do not generate renewable electricity. This has significantly thwarted the renewable electricity support power of the country's Renewable Portfolio Standard.

MRET, like all Renewable Portfolio Standard mechanisms, imposes a responsibility on electricity retailers to source a predetermined share of their electricity from renewable electricity. Renewable electricity generators can sell their power directly to retailers, via contracts, to

enable the retailers to discharge this responsibility, or the generators can sell to the retailers indirectly, through open market sales of tradable certificates. Both types of sale result in the creation of Renewable Energy Certificates under Australia's Renewable Portfolio Standard, each of which represent one MWh of renewable electricity generation.

**Figure 4: Valid Renewable Energy Certificates Created Under Australia's Renewable Portfolio Standard, April 2001 to December 2010**



Source: Green Energy Markets 2010a.

Figure 4 shows the number of Renewable Energy Certificates created by different types of renewable electricity, and non-renewable electricity, since MRET began in April 2001 (up to December 2010). As can be seen, solar water heaters created the second largest proportion of Renewable Energy Certificates over the period (23%) after solar PV (30%), while wind (22%), and hydro (11%) were the next largest creators of certificates (Green Energy Markets 2010a). The renewable electricity sources that have lost out from Australia's Renewable Portfolio Standard, to date, have been concentrating solar thermal (large scale solar: the 'solar-non PV' category of Figure 4) and geothermal (which



isn't shown in Figure 4). Of the 90.8 million certificates created by December 2010, only 14 had been created by concentrating solar thermal and none by geothermal technology (Green Energy Markets 2010a). The problem with excluding these types of renewable electricity from support is that, as explained later in this article, solar and geothermal have a lot more generating capacity than other types of renewable electricity in Australia and will necessarily have to be a major part of any ambition to eventually generate a majority of the country's electricity from renewable electricity.

Another problem created by the large number of solar water heater Renewable Energy Certificates is that they have pushed down the price of certificates and have made the price fairly volatile. Between September 2006 and March 2008 certificate prices went from a low of A\$8 each to a high of A\$53, then fell as low as A\$28 by October 2009, largely as a result of the high number of solar water heater certificates. Their price has since recovered, somewhat, to about A\$35 but by early December 2010 had fallen to A\$28.50 (Green Energy Markets 2010b). Uncertain subsidy levels are a weakness of Renewable Portfolio Standard mechanisms not found in Feed-in Tariffs. Finon (2006: 330) argues that Renewable Portfolio Standard tradable certificate prices represent a 'regulatory risk' not found in the Feed-in Tariff mechanism.

## **Ongoing Weaknesses In Australia's Renewable Electricity Support**

Australia's Renewable Portfolio Standard is not its only form of renewable electricity support but it remains the country's main one. Beginning in 2008, state and territory governments in Australia introduced Feed-in Tariffs. However, their renewable electricity support potential is limited. This is because all, apart from the ACT and Victorian ones, only cover small-scale generation. Moreover, apart from the ACT and New South Wales, they extend limited subsidies because they are based on the amount of generation fed into the grid net of household electricity use. Most overseas Feed-in Tariffs are based on the gross amount fed into the grid, exclusive of household use. Also, the Australian Feed-in Tariffs, other than in the ACT and New South Wales, are restricted to solar photovoltaic generation.

The federal government provides additional renewable electricity support through subsidies paid for from its recurrent budgets. However, much of this is for research and development. A significant exception is the Solar Flagships program which aims to eventually subsidise the construction of 1,000 MW of large scaled solar generation (although it has only provided funding, to date, for 400 MW). This means renewable electricity support in Australia continues to be mainly provided through its Renewable Portfolio Standard.

Apart from the ongoing price-suppressing influence of solar water heater Renewable Energy Certificates, another major ongoing weakness of Australia's renewable electricity support mechanism is its failure to support a wide range of renewable electricity types. The Renewable Portfolio Standard was developed in the USA in the late 1990s but is only designed to support the least expensive types of renewable electricity. Because governments set its targets, with markets left to determine how the renewable electricity for the targets will be sourced, the Renewable Portfolio Standard mechanism has no inbuilt incentive for anything but the least expensive types of renewable electricity to be used to fill its targets. Although this was a political strength of the mechanism ten years ago, it has come to be seen as a weakness as renewable electricity is increasingly seen as a major means of reducing greenhouse gas emissions. In 2008, for instance, the United Kingdom government said the effectiveness of its Renewable Portfolio Standard (which it began using in 2002) had 'been hampered by the fact that it did not incentivise a sufficiently wide range of technologies' (Department for Business Enterprise and Regulatory Reform 2008a: 91).

As shown in Table 1, wind and biomass currently have generating costs significantly lower than solar thermal and geothermal so a Renewable Portfolio Standard that extends the same subsidy to all renewable electricity types cannot be expected to support solar and geothermal. The wide cost ranges for large solar and hot rock geothermal, shown in Table 1, reflect their current lack of commercial and widespread use.

**Table 1: Current Generating Costs of Commercial Renewable Electricity.**

<b>Technology</b>	<b>Generating cost: A\$/MWh</b>
Biomass	\$50 - \$120
Wind	\$70 - \$90
Solar thermal	\$120 - \$150
Geothermal (Hot Rock)	\$40- \$500

*Source: Boyd et al 2007.*

## **Reform to Support a Wide Range of Renewable Electricity**

Australia has renewable electricity resources capable of generating its current output of electricity many times over. Table 2 lists their generating potential. In the case of solar, wave and hot rock geothermal, it assumes only a small proportion of the total potential resource will be developed. Australia is generally thought to have developed nearly all its large hydro generating potential, although there is some potential for small hydro development (Needham 2009). Hot rock geothermal is a new type of renewable electricity that exploits the high temperatures of subterranean rock via wells drilled to several kilometres in depth. It is different to the geothermal renewable electricity, developed in places like New Zealand, that uses subterranean heated water that comes to the surface naturally. Australia's main hot rock geothermal resources are located a long way from transmission infrastructure which is likely to affect its future development. Wave generation is less developed than the other types of renewable electricity shown in Table 2. There is currently no grid-connected generation of wave or hot rock geothermal electricity in Australia.

**Table 2: Australia's Annual Renewable Electricity  
Generating Potential**

<b>Technology</b>	<b>Generating potential assumptions</b>	<b>Annual generation potential: TWh/yr</b>
Hydro*	Assume minor enhancement by small hydro	18
Wind	Assume small technological improvement and some transmission improvement	200
Wave*	Assume 1% of wave energy in waters of 50m depth, or less, along all of Australia's coastline is used	78
Biomass	Assume significant use of agricultural residues is used	92
Solar*	Assume 1% of energy falling on all of Australia's land surface is used	16,170
Hot rock geothermal*	Assume 1% of national resource is used	8,212,495
<b>Total</b>		<b>8,229,053</b>

*Sources:* CSIRO 2006, author calculations (\*).

According to the estimates in Table 2, renewable electricity could generate the 328 TWh/yr of electricity Australia is predicted to be generating by 2020 many times over. Also, solar and hot rock geothermal have a much higher generating potential than hydro, wind, wave and biomass. The combined generating potential of hydro, wind and biomass is 310 TWh/yr, which would not quite generate all of Australia's 2020 predicted level of grid generation, let alone later, possibly higher, levels of generation. But the solar generating potential shown in Table 2 could generate 49 times the predicted 2020 level of generation, while the hot rock geothermal resource could generate about 25,000 times Australia's predicted 2020 level of electricity generation.

Several scenarios suggest that Australia's solar and hot rock geothermal resources, in particular, will need to be central to any effort to significantly reduce electricity sector greenhouse gas emissions. This is particularly the case if such efforts are to be in line with an international

agreement to limit human induced global warming to 2°C (which is generally thought achievable by stabilising long-term global greenhouse gas concentrations at about 450 ppm CO<sub>2</sub>e, or less). Such scenarios assume that Australia will not come to use nuclear generation technology and, if it uses fossil fuel carbon capture and storage technology, it will not account for an overwhelming proportion of all electricity generation in the country. This is partly because the technology is not emissions free, and will still release 10% to 20% of the emissions that non-carbon capture and storage fossil fuel generation technology releases; and it is also at least a decade away from commercial use (Treasury Department 2008: 125). These scenarios include one by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Graham 2010) that projects that renewable electricity will need to generate three-quarters of Australia's electricity by 2050 – with 19% generated by wind and 31% generated by solar – if the country is to play a proportionate part in a global agreement to limit greenhouse gas concentrations to 450 ppm CO<sub>2</sub>e ppm. Another, similar, scenario developed by McLennan Magasanik Associates (2008a) for the federal Treasury department, projects that about half of the nation's electricity will be generated by renewable electricity by 2050 (with the balance generated by fossil fuel carbon capture and storage technology). This scenario assumes most of the renewable electricity will be generated by geothermal and wind.

A major problem with relying, for greenhouse gas reduction purposes, on solar or geothermal to eventually generate most of Australia's electricity is that they are currently more expensive than wind or biomass to generate, as shown in Table 1. This creates a major dilemma for Australian renewable electricity support policy, given that its Renewable Portfolio Standard is deliberately designed to support lowest-cost renewable electricity, like wind. No other continent receives higher average solar radiation than Australia (Lovegrove and Denniss 2006) but, so far, the country has made very modest use of its solar resource. In 2009, Australia had 105 MW of solar generation capacity (ABARE 2010b). By comparison, in 2009 alone, much less sunny Germany had 9,785 MW of solar photovoltaic capacity while Spain had 3,386 MW and Japan had 2,633 MW by the same year (European Photovoltaic Industry Association 2010).

Solar and hot rock geothermal electricity can be subsidised through mechanisms other than a Renewable Portfolio Standard. Small-scaled solar photovoltaic is already supported through state based Feed-in Tariffs in Australia and the Greens have called for a national Feed-in Tariff to subsidise more expensive types of renewable electricity. This would create a situation similar to that of Italy, which subsidises its solar photovoltaic generation through a Feed-in Tariff used alongside a Renewable Portfolio Standard that subsidises other types of renewable electricity. However, the current Australian federal government is not supportive of a national Feed-in Tariff and a 2008 Senate committee hearing rejected the Greens' call for a national Feed-in Tariff (Senate Standing Committee on Environment, Communications and the Arts 2008).

Assuming Australia will continue to mainly rely on its Renewable Portfolio Standard to subsidise its full range of renewable electricity, there are two types of refinement it can make to it to ensure it extends appropriate levels of subsidisation to the full range of renewable electricity. One is *banding*: this is the use of different levels of tradable certificate multipliers for different types of renewable electricity. Under banding, high-cost solar generation might receive four or five tradable certificates for each MWh of generation, compared to one for the same amount of output from low-cost wind, for instance. A second possible refinement is the use of *carve-outs*. These are parts of a Renewable Portfolio Standard that can only have particular types of renewable electricity used within them. They are, essentially, Renewable Portfolio Standard submarkets, with discrete tradable certificate prices, that (generally) can only have high-cost renewable electricity types used within them. Banding has been used in the United Kingdom and Italy, while carve-outs have been used in several US states that use a Renewable Portfolio Standard. Eleven Renewable Portfolio Standard states in the USA use carve-outs but none uses it in a way that fully exploits its potential (Union of Concerned Scientists 2009).

The price-based banding refinement, and the quantity-based carve-out refinement, have strengths and weaknesses similar to any price or quantity based mechanism. In the area of carbon pricing, these have been comprehensively explored by Weitzman (1974) and Hepburn (2006). On balance, banding is probably the better device, because changes to its

multiplier rates are easier to make than to the size of different carve-out markets and it retains the liquidity of a single tradable certificate market. If Renewable Portfolio Standard banding was combined with a device that put a floor under tradable certificate prices – as Belgium has in its Renewable Portfolio Standard – then a Renewable Portfolio Standard would operate much like a Feed-in Tariff and would have two of a Feed-in Tariff’s key strengths: different subsidies for different types of renewable electricity and enhanced renewable electricity investor certainty.

## **Reform to Enable Major Greenhouse Gas Reduction**

At 2009’s Copenhagen United Nations Framework on Climate Change Convention (UNFCCC) talks, Australia signed an accord that said it would join with other nations in making greenhouse gas emission reductions that would limit human induced global warming to 2°C. This was reaffirmed at the 2010 Cancun UNFCCC talks. There are several ways a government could achieve deep cuts in its greenhouse gas emissions to meet this goal, including through regulation or government ownership of electricity assets. Whilst these can be effective, this article assumes that Australia will retain a Renewable Portfolio Standard and that, eventually, it will be complemented by a greenhouse emissions trading scheme. The article also assumes that, together with enhanced electricity use efficiency measures, carbon pricing and the Renewable Portfolio Standard will be the main drivers of national efforts to achieve the country’s greenhouse gas target in the electricity sector.

There can be several advantages in having a Renewable Portfolio Standard operating alongside an emissions trading scheme. One is that a Renewable Portfolio Standard can lower the carbon price needed to achieve abatement outside of the electricity sector. This occurs, essentially, through the Renewable Portfolio Standard focusing some of the greenhouse gas emissions reduction work on the electricity sector that an emissions trading scheme (or carbon tax) would normally do across all sectors. Another advantage is that a Renewable Portfolio Standard can bring forward renewable electricity technology cost reductions thereby lowering the carbon price needed to bridge the generation cost gap between fossil fuels and renewable electricity.

**Table 3: Fossil Fuel And Renewable Electricity 2005 Generating Costs with Zero, US\$47 and US\$295 Carbon Prices**

Technology	Generating cost with zero carbon price: US\$/MWh (1)	Carbon intensity, current technology: CO <sub>2</sub> e t/MWh (2)	Generating cost with US\$47/t carbon price(3)	Generating cost with US\$295/t carbon price(4)
Black coal	\$20	0.9	\$62	\$286
Natural gas	\$37	0.6	\$65	\$214
Wind	\$65	0	\$65	\$65
Biomass	\$75	0.15	\$82	\$119
Geothermal	\$100	0	\$100	\$100
Concentrating solar thermal	\$285	0	\$285	\$285

Source: IPCC 2007:293 (col.1), CSIRO 2006: 32 (col.2), author calculations (cols 3 and 4).

Tables 3 and 4 show that the carbon price needed today, to make the most expensive form of large-scale renewable electricity (concentrating solar thermal) competitive with black coal generation, is much higher than that needed in 2030. This is because, over the next two decades, renewable electricity generating costs are projected to fall more rapidly than fossil fuel ones. Table 3 shows the case where a US\$295/tonne carbon price is needed to make concentrating solar thermal competitive with black coal, using current technology, while Table 4 shows the case where a US\$85/tonne carbon price is needed to achieve the same competitiveness, even after improvements in fossil fuel emission intensities (through development of new technology).

Evidently, it makes sense to use renewable electricity support mechanisms to bring forward reductions in renewable electricity generating costs so that carbon prices do not have to be as high to support the full range of large-scaled renewable electricity. This is a *dynamic efficiency* advantage of renewable electricity support mechanisms.



**Table 4: Fossil Fuel and Renewable Electricity 2030 Generating Costs with Zero and US\$85 Carbon Prices**

<b>Technology</b>	<b>2030 technology generating cost with zero carbon price: US\$/MWh (1)</b>	<b>Carbon intensity, 2030 technology: CO<sub>2</sub>e t/MWh (2)</b>	<b>Generating cost using 2030 technology with US\$85/t carbon price(3)</b>
Black coal	\$48	0.8	\$116
Natural gas	\$50	0.4	\$84
Wind	\$55	0	\$55
Biomass	\$65	0.15	\$78
Geothermal	\$80	0	\$80
Concentrating solar thermal	\$115	0	\$115

*Source:* IPCC 2007b: 293 (col. 1), CSIRO 2006: 32 (col. 2), author calculations (col. 3).

The Australian government has assumed that, after 2020, greenhouse gas emissions licence trading would begin to take over from the Renewable Portfolio Standard, in terms of supporting renewable electricity. However it has failed to explore, in detail, the connection that would exist between a Renewable Portfolio Standard and emissions trading by that time. Table 3 (column 3) shows that a carbon price of US\$47/tonne – the carbon price projected by Treasury (2008: 194) to be the starting carbon price of an Australian emissions trading scheme that aimed to achieve emission cuts associated with a maximum of 2°C warming (converted at US90c = \$1A) – would only make the lowest cost type of renewable electricity, wind, competitive with black coal and natural gas generation. Therefore, if carbon pricing were the only policy driving a switch to renewable electricity, all of the renewable electricity generated in Australia by 2020 would be generated by wind. This is despite the fact that, as shown in Table 2, solar and hot rock geothermal have the most generating potential in Australia, and would need to be relied upon to generate much of Australia’s electricity if renewable electricity were eventually to be used to generate most of it. If, as seems likely, Australia has a starting carbon price lower than US\$47/tonne, it will make no type

of renewable electricity competitive with either black coal or natural gas generation.

Significant reduction of Australia's electricity greenhouse gas emissions poses an enormous challenge for the electricity sector. As shown in Table 5, the 208 TWh/yr of electricity generated in 2000 in the country emitted 177 Mt CO<sub>2</sub>e greenhouse gas emissions. If Australia's grid and off-grid electricity generation were to increase by 1.8%/yr between 2008 and 2020, as predicted by ABARE (2010c: 31), then by 2020 the nation will be generating 328 TWh/yr which is 24% more than in 2008. In Scenario A of Table 5, this is generated by the same amount of coal and oil generation that the nation used in 2000 and 60 TWh/yr is being generated by renewable electricity because of the country's Renewable Portfolio Standard target (which was increased to this level by 2020 in 2009). All of the balance of the electricity predicted to be generated by 2020 comes from gas in scenario A. This is optimistic because, as shown in Table 3 and as reported in Bloomberg (2010: 7), natural gas generation is currently more expensive than black coal generation. Even under this scenario, total electricity greenhouse emissions increase to 227 Mt CO<sub>2</sub>e/yr: 28% more than the 2000 level of emissions.

Scenario B of Table 5 is even more optimistic. It assumes that, by 2020, only one-third of the 2000 level of brown coal electricity will be generated along with two-thirds of the 2000 level of black coal generation (with the same level of oil generation). Even under this very optimistic scenario, electricity generation greenhouse gas emissions are only reduced by 16% between 2000 and 2020, even though a global agreement to contain greenhouse gas concentrations to 450 ppm CO<sub>2</sub>e requires Australia to reduce its greenhouse gas emissions by 25%, across all sectors, between 2000 and 2020 (Garnaut 2008a: 296). A 16% reduction of the 2000 level of electricity generation greenhouse gas emission is, therefore, not consistent with this order of decrease. Nor is it consistent with the argument of an issues paper published for the Garnaut Climate Change Review (2008b: 3) that said 'the stationary energy sector is expected to provide the greatest and earliest reductions in emissions' (stationery energy embraces electricity and heat greenhouse gas emitters). Therefore, renewable electricity should be used to drive deeper cuts than even the optimistic projection of Scenario B if Australia is to play its part in limiting human induced global warming to 2°C.

**Table 5: 2000 and 2020 Generation and Greenhouse Emissions Scenarios for Australia's Electricity Sector**

<b>Electricity generation technology</b>	<b>Greenhouse gas emission intensity: tCO<sub>2</sub>e/MWh (1)</b>	<b>Australian generation in 2000: TWh/yr (2)</b>	<b>2000 greenhouse gas emissions: MtCO<sub>2</sub>e/yr (3)</b>
Brown coal	1.2	50.3	60.4
Black coal	0.9	110.2	99.2
Gas	0.6	26.2	15.7
Oil	0.75	2.7	2.0
Biomass	0.15	0.7	0.1
Non-biomass renewable electricity	0	17.3	0
<b>Total</b>		<b>207.5</b>	<b>177.4</b>

**Table 5 (cont.): 2000 and 2020 Generation and Greenhouse Emissions Scenarios for Australia's Electricity Sector**

<b>Electricity generation technology</b>	<i>Scenario A Australian generation in 2020: TWh/yr (4)</i>	<i>Scenario A greenhouse gas emissions in 2020: MtCO<sub>2</sub>e/yr (5)</i>	<i>Scenario B Australian generation in 2020: TWh/yr (6)</i>	<i>Scenario B greenhouse gas emissions in 2020: MtCO<sub>2</sub>e/yr (7)</i>
Brown coal	50.3	60.4	16.8	20.2
Black coal	110.2	99.2	73.5	66.2
Gas	104.8	62.9	100.0	60.0
Oil	2.7	2.0	2.7	2.0
Biomass	2.5	0.4	2.5	0.4
Non-biomass renewable electricity	57.5	0	132.5	0
<b>Total</b>	<b>328</b>	<b>224.9</b>	<b>328</b>	<b>148.8</b>

Source: CSIRO 2006 (col 1), ABARE 2010a (col 2), Australian Greenhouse Office 2006 (total of col 3), author calculations (cols 4, 5, 6 and 7).

Table 5 makes it clear that Australia's current renewable electricity target of 60 TWh/yr by 2020 is insufficient even to contain its electricity sector greenhouse gas emissions at 2000 levels. This is because the target will increase renewable electricity by 42 TWh/yr over the period, which is only 35% of the 120 TWh/yr increase in overall electricity generation predicted for the period. Table 5 also makes it clear, that for Australia's electricity sector greenhouse gas emissions to be reduced, either renewable electricity and/or gas will have to displace some electricity currently generated by brown and black coal.

At a minimum, then, Australia's renewable electricity target should be increased to a level where it absorbs *all* the increase in the nation's generation between 2000 and 2020. Using ABARE's (2010c) 1.8%/yr projected increase in electricity generation between 2008 and 2020, this would require it to be increased to about 138 TWh/yr by 2020, which is 42% of the projected 328 TWh/yr of electricity Australia is projected to be generating by 2020. This target is in line with the 40%-by-2020 advocated by the Australian Conservation Foundation (2010: 16). This order of renewable electricity target assumes that a politically acceptable carbon price will not reach high enough levels to drive major greenhouse gas emission reduction in the electricity sector, any time soon.

As shown earlier in Table 3, a carbon price of US\$47/t (A\$50/t) would be required to make the lowest cost type of renewable electricity, wind, competitive with natural gas. A slightly higher carbon price of US\$50/t (A\$53) would be needed to make it competitive with black coal. Once such carbon price thresholds are crossed, the renewable electricity target could be decreased to cover only those types of renewable electricity that are still uncompetitive with post carbon price fossil fuel generation.

The most cost-effective strategy for limiting the growth in Australia's electricity greenhouse gas emissions, however, is to use enhanced energy efficiency measures to contain the country's electricity generation growth to no more than about 1%/yr. If its growth was limited to this order of increase from 2008, the nation's electricity generation would increase by 44% between 2000 and 2020 instead of 58%. With this reduced level of increase, Australia's renewable electricity target would need to be 100 TWh/yr by 2020, or 33% of all generation by then, if renewable electricity was to absorb all electricity generation increase over the period. Greenhouse gas reduction cost curves, like the well

known one developed by McKinsey and Company (2008: 14), show enhanced energy efficiency measures – such as increased efficiency in residential and business lighting, heating and ventilation electricity use – to be more cost effective, in terms of the cost of each tonne of avoided greenhouse emission, than new renewable electricity generation.

Australia's rate of electricity generation growth is high by developed country standards. Between 2000 and 2007 grid-connected electricity generation in the country grew by 18%: over the same period, the electricity generation of the 27 members of the European Union grew by 11% and generation in the USA grew by 9% (Energy Information Administration 2010, European Commission 2010). To reduce Australia's electricity growth requires better articulation of Australia's renewable electricity, energy efficiency and greenhouse gas emission goals. The three need to be interconnected if the country is to make serious inroads into its electricity sector greenhouse gas emissions.

What is most concerning is that there is no plan for reducing emissions from Australia's electricity sector. Champions of emissions trading would argue the scheme, itself, is a sufficient plan. But if Australia ends up introducing emissions trading, it is likely to be compromised by compensation for coal generators and possible limits on early licence prices. An emissions trading scheme is a means, not an end. For this reason, in 2009 the United Kingdom government (which by then had had emissions trading for four years) released its 'Low Carbon Transition Plan' which maps out a route by which it plans to reduce its 2008 level of electricity emissions by 22% by 2020, in part by increasing the market share of renewable electricity from 6% to 30% (HM Government, 2009: 52, 54).

## **The Political Influences that Shape Renewable Electricity Targets and Support**

Powerful lobby groups oppose the type of large renewable electricity target suggested in the previous section. Surprisingly, in some ways, these include advocates of greenhouse gas emission licence trading. They often argue that a carbon pricing mechanism, alone, should drive all emission reduction. The Garnaut Climate Change Review (2008a: 354,

355), argued, for instance, that an 'aggressive' ramp-up in Australia's renewable electricity target would 'cannibalise' an emissions trading scheme that had a gentle trajectory. Less surprising is the opposition of large users of electricity, arguing for exemptions to renewable electricity support mechanisms. For instance, Rio Tinto, owner of most of Australia's aluminium smelters, in its submission to the Department of Climate Change's 2008-2009 consultation on the treatment of electricity-intensive trade-exposed industries (2008: 1, 2), argued the 2009 increase in Australia's renewable electricity target would impose an added extra annual expense for the company of about A\$130m (in current dollar terms) by 2020. It said that, since electricity accounts for 25% to 30% of the cost of aluminium, the Australian aluminium industry would have to reduce production if there was no exemption. In the end, intensive users of electricity, like Rio Tinto, were fully exempted from the 2009 target increase but this will increase the compliance cost of non-exempted electricity users.

Electricity retailers are another major lobby against significant renewable electricity targets. In Queensland, Victoria and South Australia (and soon in New South Wales) these are privately owned corporations. They fear that increased compliance costs will result in increased electricity prices that decrease the demand for their product. In its submission to a public consultation on draft legislation enacting the 2009 increase in Australia's Renewable Portfolio Standard target, the Energy Retailers Association of Australia (2008: 3) argued the new target was 'aggressive' and 'will take significant effort to achieve at potentially great cost'. The groups that attempt to put the opposite view to these interests generally include renewable electricity generators and environmental organisations. Neither is anywhere as near powerful as the major corporate users of electricity, or the electricity retailers. In its submission to the 2009 Senate inquiry into the new renewable electricity target the environment group, World Wildlife Fund Australia (2009: 4), advocated increasing the country's renewable electricity target to 25% by 2020.

More surprising are the lobbies that argue against differentiated support for high-cost types of renewable electricity, like solar and geothermal, of the sort that can be extended through banding and carve-outs. Renewable electricity companies, and groups aligned with low-cost types of renewable electricity, like wind, generally argue against such

differentiation. However, in countries like the United Kingdom, which has a significant quantity of the high-cost offshore wind resource, wind interests invariably argue for differentiated support. In Australia, the Clean Energy Council, whose members include a number of wind companies and coal generators that have interests in wind generators, argues against carve-outs. In a 2009 media release (p.1) it said ‘carve-outs in the proposed target for emerging technology sounds like a nice idea, but it doesn’t work’. Similarly, Vestas, a wind equipment supplier, argued in its submission to the 2009 Senate inquiry into the new 2009 renewable electricity target (2009: 3) that banding would add unnecessary complexity to the country’s Renewable Portfolio Standard. It also said that such an approach was generally advocated by renewable electricity interests that viewed support mechanisms as a ‘magic pudding’.

Probably the most influential obstacle to significantly increased renewable electricity targets is the political fear of a major consumer reaction against increased electricity prices. Although there are few developed countries with lower residential electricity prices than Australia’s (ABARE 2010b: 26), there is evidently political angst about the possible consequences of rising electricity bills. This was a significant contributor to the Rudd government postponing the reintroduction of emissions trading legislation into the Australian parliament in April 2010 and the New South Wales government’s decision to slash its state feed-in tariff by two-thirds in October 2010. Electricity prices in Australia have experienced rapid increases over the past five years: the electricity consumer price index rose by 50% between June 2005 and June 2010, whereas the ‘all-groups’ index rose by 16% (Australian Bureau of Statistics 2010). The main driver of this has been a catch-up in distribution infrastructure investment, not renewable electricity subsidisation. There is speculation that electricity prices will continue increasing, with a doubling predicted over the next five years (Bita 2010).

## **Conclusion**

Reduction of Australia’s high level of greenhouse gas emissions will require reduction of its electricity sector in particular. Renewable

electricity will play a central role. However, although Australia's renewable electricity support mechanism has made a start in diversifying the country's renewable electricity base, it is handicapped by a number of major weaknesses. These include a rapidly expanding electricity market, a volatile tradable certificate price, a lack of differentiation of subsidy levels for different types of renewable electricity, a large proportion of support directed to solar water heaters and a 2020 target that will not allow the country to even limit its electricity greenhouse gas emissions to 2000 levels. To make serious inroads into its electricity greenhouse gas emissions, Australia needs renewable electricity support that extends different subsidy levels to higher cost types of renewable electricity and a much higher 2020 renewable electricity generation target. All of this needs to be part of an overall electricity generation management strategy that significantly reduces the nation's high rate of electricity consumption growth. Australia has made a modest start to its renewable electricity development and its support policy design has a long way to go before it can play a major role in reducing the nation's high level of electricity sector greenhouse gas emissions.

*Greg Buckman is a PhD student at the Australian National University's Fenner School of Environment and Society.*

*greg.buckman@anu.edu.au*

*The author wishes to thank Dr Jack Pezzey and Dr Mark Diesendorf for their assistance in preparing this article as well as that of the unnamed reviewers.*

## **References**

- ABARE, 2010a. *Australian Electricity Generation by Fuel* (privately supplied statistics), Department of Resources, Energy and Tourism, Canberra.
- ABARE, 2010b. *Energy in Australia 2010*, Department of Resources, Energy and Tourism, Canberra.
- ABARE, 2010c. *Australian Energy Projections to 2029-30*, Australian Bureau of Agricultural and Resource Economics, Canberra.
- Australian Bureau of Statistics, 2010. *Consumer Price Index June 2010* (cat no. 6401.0), Australian Bureau of Statistics, Canberra.



- Australian Conservation Foundation, 2010. *Building Australia's Big Solar Industry*, Australian Conservation Foundation, Melbourne.
- Australian Greenhouse Office, 2006. *Stationary Energy Sector Greenhouse Gas Emissions Projections 2006*, Department of Environment and Heritage, Canberra.
- Bitá, N., 2010. 'Cost of Power to Double in Five Years' (newspaper article 23.9.10), *The Australian*, Sydney.
- Bloomberg New Energy Finance, 2010. *Renewable Energy Investment Opportunities and Abatement in Australia*, Bloomberg New Energy Finance, Sydney.
- Boyd, R., Sproule, A., Benyon, P., Grima, C., Naicker, K., Ward, P., and Feltrin, C., 2007. *NSW Power Generation and CO<sub>2</sub> Emissions Reduction Technology Options*, Connell Wagner, Sydney.
- Buckman, G., and Diesendorf, M., 2010. 'Design Limitations in Australian Renewable Electricity Policies', *Energy Policy*, vol. 38: 3365-3376.
- Clean Energy Council, 2009. *Emerging Technologies Need Investors Not a Carve Out* (media release 18.8.09), Clean Energy Council, Melbourne.
- CSIRO, 2006. *Heat is On: The Future of Energy in Australia*, CSIRO, Canberra.
- DCC, 2008. *National Greenhouse Gas Inventory 2006: Accounting for the Kyoto Target*, Department of Climate Change, Canberra.
- DCC, 2010. *Australia's National Greenhouse Accounts: National Greenhouse Gas Inventory, accounting for the Kyoto target May 2010*, Australian Government, Canberra.
- Department for Business Enterprise and Regulatory Reform, 2008a. *UK Renewable Energy Strategy Consultation: June 2008*, Department for Business Enterprise and Regulatory Reform, London.
- Diesendorf, M., 2007. *Paths to a Low Carbon Future: Reducing Australia's Greenhouse Gas Emissions by 30 per cent by 2020*, Sustainability Centre, Sydney.
- Energy Information Administration (United States), 2010. *Official Statistics from the US Government: Electricity*, Energy Information Administration, Washington DC.
- Energy Retailers Association of Australia, 2008. Submission to the Department of Climate Change 2008-2009 consultation on the Exposure Draft Legislation of the Renewable Energy Target Scheme, The Energy Retailers Association of Australia, Sydney.
- European Commission, 2010. *EU Energy in Figures 2010: Electricity Generation from Renewables*, Extended Time Series, European Commission Directorate-General for Energy and Transport, Brussels.
- European Photovoltaic Industry Association, 2010. *2014 Global Market Outlook for Photovoltaics until 2012: May 2010 update*, European Photovoltaic Industry Association, Brussels.
- Finon, D., 2006. 'The Social Efficiency of Instruments for the Promotion of Renewable Energies in the Liberalised Power Industry', *Annals of Public and Cooperative Economics*, vol. 77 no. 3: 309-343.
- Garnaut, R., 2008a. *The Garnaut Climate Change Review: Final Report*, Cambridge University Press, Melbourne.

- Garnaut R., 2008b. *Issue Paper 4, Research and Development: Low Emissions Energy Technologies*, Garnaut Climate Change Review secretariat, Canberra.
- Graham, Paul, Luke Reedman and Peter Coombes 2008. *Options for Electricity Generation in Australia – 2007 Update: Technology Assessment Report 72*. Cooperative Research Centre for Coal in Sustainable Development, Pullenvale.
- Graham, P., 2010. *Global and Local Learning Model of Electricity Generation Technology Futures*, CSIRO, Canberra.
- Green Energy Markets, 2010a. *The REC Report: October 2010*, Green Energy Markets, Melbourne.
- Green Energy Markets, 2010b. *Spot REC Prices (End Month)*(web information), Green Energy Markets, Melbourne.
- Hepburn, C., 2006. 'Regulation by Prices, Quantities or Both: a Review of Instrument Choice', *Oxford Review of Environmental Policy*, vol. 22: 226-247.
- HM Government, 2009. *The UK Low Carbon Transition Plan: National Strategy for Climate and Energy*, HM Government, London.
- IEA, 2009. *Statistics: Electricity/Heat* (on-line energy database), International Energy Agency, Paris.
- IPCC, 2007. *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policymakers*, Intergovernmental Panel on Climate Change, Geneva.
- Jakrawatana, N., Moore, S., and MacGill, I., 2009. 'Economic Assessment of Regional Bioenergy Systems in Australia: A Flow Analysis Application', *International Journal of Environment and Pollution*, vol. 39: 61-73.
- Kann, S., 2010. 'Overcoming Barriers to Wind Project Finance in Australia', *Energy Policy*, vol. 37: 3139-3148.
- Kent, A., and Mercer, D., 2006. 'Australia's Mandatory Renewable Energy Target: An Assessment'. *Energy Policy*, vol. 34: 1046-1062.
- Lovegrove, K., and Dennis, M., 2006. 'Solar Thermal Energy Systems in Australia', *International Journal of Environmental Studies*, vol. 63 no. 6: 791-802.
- MacGill, I., 2009. 'Electricity Market Design for Facilitating the Integration of Wind Energy: Experience and Prospects with the Australian National Energy Market', *Energy Policy*, vol 38 no. 7: 3180-3191.
- McLennan Magasanik Associates, 2008a. *Detailed Results of the Modelling of the Impacts of Emissions Trading on the Electricity Markets*, Treasury Department, Canberra.
- McKinsey and Company, 2008. *An Australian Cost Curve for Greenhouse Gas Reduction*. Sydney, McKinsey Australia.
- MRET Review Panel, 2003. *Renewable Opportunities: A Review of the Operation of the Renewable Energy (Electricity) Act 2000*. Canberra, Australian Greenhouse Office.
- Needham, S., 2009. *Renewable Energy Technologies Update*, Parliament of Australia Parliamentary Library, Canberra.

Renewables Target Working Group, 1999. *Final Report to the Greenhouse Energy Group: Implementation Planning for Mandatory Targets for the Uptake of Renewable Energy in Power Supplies*. Canberra, Australian Greenhouse Office.

Rio Tinto, 2008. Submission to the Department of Climate Change 2008-2009 consultation on the treatment of electricity-intensive, trade exposed industries under the Renewable Energy Target, Rio Tinto, Melbourne.

Saddler, H., Diesendorf, M., and Denniss, R., 2007. 'Clean Energy Scenarios for Australia', *Energy Policy*, vol. 35 no. 2: 1245-1256.

Senate Standing Committee on Environment, Communications and the Arts, 2008. *Renewable Energy (Electricity) Amendment (Feed-in-Tariff) Bill 2008*. Commonwealth of Australia, Canberra.

Treasury Department, 2008. *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, Commonwealth of Australia, Canberra.

Union of Concerned Scientists, 2009. *Renewable Electricity Standards Toolkit*, Union of Concerned Scientists, Cambridge, Massachusetts.

Valentine, S., 2010. 'Breaking Wind in Australia: A Critical Evaluation of the Renewable Energy Target', *Energy Policy*, vol. 38: 3668-3675.

Vestas, 2009. Submission to the 2009 Senate inquiry into the Renewable Energy (Electricity) Amendment Bill 2009 and a related bill, Vestas, Melbourne.

Weitzman, M., 1974. 'Prices vs. Quantities'. *Review of Economic Studies*, vol. 41 no. 4: 477-492.

World Resources Institute, 2009. *Climate Analysis Indicators Toolkit*, World Resources Institute, Washington.

World Wildlife Fund Australia, 2009. Submission to the 2009 Senate inquiry into the Renewable Energy (Electricity) Amendment Bill 2009 and a related bill, WWF, Sydney.

