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Design Limitations in Australian Renewable Electricity Policies

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ABSTRACT

Renewable electricity is pivotal to the medium and long-term reduction of Australia's greenhouse gas (GHG) emissions, if deep cuts in them are eventually implemented. This paper examines the effectiveness of the principal existing policies that could potentially promote the expansion of renewable electricity (RElec) in Australia: the expanded Renewable Energy Target (RET); the proposed emissions trading scheme (ETS); and the state and territory based feed-in tariffs. We find the effectiveness of RET is severely eroded by the inclusion of solar and heat pump hot water systems; by the inclusion of 'phantom' tradable certificates; and by high electricity consumption growth. We also find that the ETS will not produce a high enough carbon price to assist most RElec technologies before 2020; and that most of the feed-in tariffs exclude large-scale RElec and will give little assistance to small-scale RElec because they are mostly net tariffs. Unless there is a major revision of its RElec policy mechanisms, Australia will fail to reach its renewable electricity target and in particular will fail to build up its solar generation capacity which could be a major source of future deep cuts in the country's electricity generation emissions.

(192 words)

Keywords: Renewable energy target, emissions trading, renewable portfolio standard.

Abbreviated title: Australian Renewable Electricity Limitations

Table 1: Abbreviations

CCS	Carbon capture and storage
CPRS	Carbon Pollution Reduction Scheme (proposed Australian emissions trading scheme)
ETS	Emissions trading scheme
GHG	Greenhouse gas or gases
MRET	Mandatory Renewable Energy Target (Australian RPS until 2009)
PV	Photovoltaic
RElec	Renewable electricity
RECs	Renewable Energy Certificates (MRET or RET tradable certificates)
RET	Renewable Energy Target (Australian RPS from 2010)
RPS	Renewable Portfolio Standard

1. Introduction

Australia is the largest per capita greenhouse gas (GHG) emitter in the Organisation for Economic Cooperation and Development (OECD) (see Table 2). This is primarily due to the high percentage of coal (76%) in the fuel inputs to its electricity generation mix (IEA, website). Therefore, it could be argued that if Australia can achieve deep cuts in emissions from electricity generation, many other countries could emulate it. Electricity generated from renewable energy (RElec) is likely to be central to Australia's ability to make deep cuts in its GHG emissions. The current generating costs of RElec are higher than those of conventional fossil-fuel electricity and different types of RElec have different generation cost differences with fossil-fuel generated electricity. So it will largely be the success, or otherwise, of RElec support mechanisms and their effect on bridging these generation cost differences that will determine the future of RElec in Australia. Of course, if the price of fossil-fuel electricity included its external (environmental, health and social) costs support mechanisms for the lower-cost sources of RElec would be unnecessary (Rabl

and Spadaro, 2000). Carbon taxes and emissions trading can be seen as a means of internalising (at least to some degree) the external costs.

To date the major RElec support mechanism in Australia has been the modest Mandatory Renewable Energy Target (MRET): a Renewable Portfolio Standard (RPS) mechanism which sought to boost the country's RElec generation by 9.5 terawatt-hours per year (TWh/y) on 2001 levels by 2010. Sufficient RElec technology to reach the 2010 target was installed by 2006 and the boom in wind power, that had been driven by the target, ended. As a result, the new federal government implemented an expanded RPS – the Renewable Energy Target (RET) – comprising an additional 45 TWh/y of RElec by 2020 (including the original MRET). The MRET and RET RPS mechanisms have government mandated levels of RElec purchase by electricity retailers which can be met through contracted purchases of RElec or through the purchase of tradable renewable energy certificates (RECs).

Several commentators have examined the interaction of emissions trading and RPS mechanisms (Jensen and Skytte, 2003; Linares et al., 2008; Morthorst, 2001). Others have examined the extent of global RElec resources and its implications for long-run RElec marginal costs (de Vries et al., 2007; Hoogwijk et al., 2004). Linares et al (2008, pp. 380, 382, 383) argue that, because RPS tradable certificate prices represent the difference between the perceived long-run marginal cost of RElec and that of non-RElec electricity, an increase in non-RElec electricity costs through emissions trading should lower the RPS tradable certificate price. However, they also argue that, if the size of the RElec market is large compared to that of the emissions trading market, the relationship can work in reverse: an increase in the tradable certificate price can lower the ETS

carbon price. The examinations of global RElec resources broadly conclude that most regions of the world do not have an abundance of a full range of RElec types. This paper adds to this knowledge by considering a RPS mechanism that grows from being relatively small, compared to the proposed national emissions trading market, to being relatively large, in a country that is blessed with a wide range of significant RElec sources.

Specifically, this paper evaluates (1) the medium-term effectiveness of emissions trading in stimulating RElec in Australia and (2) the potential stimulatory contribution of the expanded RET with reference to Australia's availability of RElec resources and the unique design features of the mechanism. These aims are feasible, now that the shapes of the nation's ETS and expanded RET are clear. The paper uses modelled forecasts of Australia's emissions trading carbon price to predict what RElec stimulatory effect it will have in 2020 and projects the likely 2020 mix of the RElec stimulated by the expanded RET. Section 2 discusses the role of RElec in achieving deep cuts in Australia's GHG emissions; part of section 2 discusses a 'diversified portfolio' approach to RElec development in Australia. Section 3 considers the historical impact of the MRET on Australia's RElec generation; section 4 discusses the possible effect of emissions trading on Australia's RElec; section 5 examines the prospect of reaching the expanded RET target; and section 6 draws conclusions about the future of RElec in Australia.

Throughout this paper several references are made to the pursuit of a 'diversified portfolio' approach to RElec development. The portfolio approach to RElec development is similar to the portfolio approach to investment risk management: an investment theory pioneered by Markowitz (1959). Markowitz

argued the optimisation of investment return has to be balanced against the acceptance of risk to achieve a desired rate of return. He said a diversified portfolio will generally have a lower cost, compared to a narrow portfolio, because of its lower risk even if some components of it have a relatively high cost. In RElec planning terms, a diversified portfolio approach means stimulating a range of RElec types, not just the least-cost ones (hydro, wind and biomass) as RPS mechanisms are designed to do. Awerbuch (2006) argues energy planning needs to abandon its fixation with least-cost fuels through the development of diversified portfolios. In this paper the RElec concentration index is used as an indicator of whether a diversified portfolio approach is being pursued. The RElec concentration index is calculated using the Herfindahl concentration index: the sum of the squares of the market shares of the RElec types that make up a nation's RElec portfolio. The Herfindahl index is often used to measure energy market concentration, for instance by the European Commission (2007). The higher the index, the more concentrated is the RElec mix. The index is widely used in competition analysis to determine if there is monopolistic or oligarchic behaviour: it is similar to the Simpson diversity index used in ecology.

2. The role of renewable electricity in reducing Australia's greenhouse gas emissions

2.1 The need for deep cuts in Australia's electricity greenhouse gas emissions

Climate change is a high-profile issue in Australia. Eventually, Australia's response to climate change is likely to require long-term deep cuts in its GHG emission entitlements. There are several reasons for this. Firstly, although

Australia is a small global emitter responsible for about 1.4% of global GHG emissions, it is one of the world's highest per capita emitters and has the highest per capita emissions of any developed country (see Table 2). Its per capita emissions are about twice the OECD (unweighted) average and four times the global (unweighted) average (Garnaut, 2008 p.160). Secondly, the Intergovernmental Panel on Climate Change (IPCC, 2007 p. 23) calculates that, to contain human GHG emission-induced global temperature increases to no more than 2.4°C above pre-industrial levels, considered then to be a moderately safe level of warming, it will be necessary to reduce global emissions by between 50% and 85% on 2000 levels by 2050. The 2.4°C limit would require global GHG concentrations to stabilise at around 450 CO₂e ppm. An Australian government climate change inquiry conducted in 2008 found that if the country were to make a proportionate contribution to this GHG stabilisation scenario, consistent with eventual convergence of global per capita GHG emission entitlements, it would have to reduce its 2000-01 level of emissions by 90% by 2050 (Garnaut, 2008 p. 209). More recently, some leading climate scientists are recommending stabilisation at 350 ppm CO₂e (Hansen et al. 2008) and many support short-term targets of 25–40% below 1990 level by 2020.

Table 2: Per capita non land-use GHG emissions of selected OECD countries, 2005

<i>Country</i>	<i>2005 per capita emissions: CO₂e per person</i>
Australia	26.9
United States	23.5
Canada	22.6
New Zealand	19.1
Belgium	13.2
Germany	11.9
Greece	11.5
United Kingdom	10.6
Japan	10.5
France	9.0
Hungary	8.3
Sweden	7.4
Mexico	6.2

Source: World Resources Institute, 2009.

There are many areas where Australia could make major cuts in its GHG emissions, the most feasible are in electricity generation and use. Electricity is easier and less expensive to reform than other major sources of its emissions like agriculture and transport. It is also a prime target because electricity GHG emissions make up a larger proportion of Australia's national GHG emissions than they do for any other OECD country. Electricity generation accounted for 35.6% of Australia's net GHG emissions in 2000, nearly twice the OECD (unweighted) average that year of 18.3% (IEA, 2009b; WRI, 2009). A large part of the reason for the high contribution of electricity generation to Australia's GHG emissions is the high GHG intensity of its electricity supply. In 2000 each MWh of electricity emitted on average 0.863kg of CO₂ – this was 2.4 times the OECD (unweighted) average that year of 0.354kg (WRI, 2009).

The importance of major cuts in Australia's electricity GHG emissions is heightened by the fact that, as shown in Figure 1, they were the fastest growing source of emissions between 1990 and 2007 and, under business-as-usual

conditions, are forecast to grow a further 40% between 2006 and 2020 (DCC, 2008a p. 17). If a significant proportion of the nation's transport is eventually provided by electric vehicles, there will be even faster growth in electricity's emissions, unless all battery charging is restricted to RElec.

Figure 1: Australia's non-land clearing greenhouse gas emissions, 1990 and 2007

Source: DCC, (2009b).

The two main drivers of Australia's high, and increasing, electricity generation GHG emission intensity are its significant dependence on coal for electricity generation and its relatively low use of RElec. In 2007 Australia was the second-most coal dependent OECD country for electricity generation. In that year coal – both black and brown (lignite) – supplied 76% of the country's electricity generation compared to an OECD (unweighted) country average of 37.3% (IEA website). (Poland had highest percentage with 93%). In 2006 Australia's use of RElec was significantly lower than the country average for the OECD. In that year 7.6% of Australia's electricity generation was supplied by RElec compared to an OECD (unweighted) country average of 16.4% (IEA,

2009a). The disparity between the electricity share of RElec in Australia and other selected OECD countries is shown in Figure 2.

Figure 2: The percentage of electricity from RElec in select OECD countries, 2006.

Source: IEA (2009b).

2.2 The place of RElec in reducing Australia's electricity greenhouse gas emissions

There are two major ways in which the GHG emissions from Australia's electricity supply can be reduced: one is through using electricity more efficiently, the other is by switching all, or part, of its electricity supply to low or zero emission sources. 'Low emission electricity sources' means gas (both natural gas and coal seam methane), nuclear power, or coal with carbon capture and storage (CCS), if the latter two eventually become commercially available in Australia. 'Zero emission electricity' means RElec such as wind, biomass, solar or hot rock ('engineered') geothermal, if the latter becomes commercially available. Hot rock geothermal exploits subterranean heat via water pumped

through drilled holes. (Hydro has very little potential for expansion in Australia).

The attraction of using RElec for electricity generation is that it emits no GHG emissions during operation. By contrast, gas emits about half the emissions per unit of electricity generation that non-CCS coal does, and CCS technology, when and if it is ever commercially-ready, is likely to emit at least 20% of the emissions of non-CCS coal generation technology. A further advantage of RElec is that it can be used now: CCS is unlikely to be commercially available before 2025 (Treasury, 2008 p. 125). The big disadvantage of electricity generated from renewable sources is that it is currently significantly more expensive to generate than electricity generated from coal without CCS and generally more expensive than electricity generated from gas. As can be seen in Table 3, even the least expensive generation from the least expensive type of RElec – on-shore wind – has a generation cost twice that of electricity generated from black coal in Australia: the most widely used fossil fuel used to generate electricity in the country. It should be noted that Table 3 does not specify the discount rate used to calculate the costs of electricity generation. A table by Diesendorf (2007 p. 355), using an 8% discount rate, finds typically higher cost estimates for wind and solar than in Table 3. Also, it is likely that the low end of the biomass costs in Table 3 represents landfill gas, for which there is only small potential in Australia, and that the high end may be more typical. In November 2009, A\$1 $\approx$ US\$0.9.

Table 3: Comparison of generation costs of fossil fuel and RElec in 2006-07

<i>Fuel</i>	<i>Generation cost: A\$/MWh</i>
Brown coal ^a	35 – 40
Black coal ^a	30 – 35
Gas (combined cycle) ^a	38 – 54
Biomass ^a	46 – 80
Wind (on-shore) ^a	52 – 72
Geothermal ^b	70 – 110
Solar PV ^a	120+
Solar thermal ^c	120 – 150

Source:

^aPrime Ministerial Task Group on Emissions Trading (2007: 197) ,

^bMMA (2008 p. 18), ^cOwen (2007 p. 3-6).

The gap between what RElec and non-RElec can be sold for, with reasonable profitability, is larger in Australia than it is in most other developed countries. This is because Australia has relatively low retail electricity prices while having an RElec generation cost structure roughly similar to that of other developed economies. The country's low retail electricity prices have contributed to its economy being more electricity-intense than the OECD average since 1990 (IEA, 2009a). This has placed an upward pressure on its electricity generation GHG emissions.

As shown in Figure 3, in the first quarter of 2007, out of a large number of developed countries surveyed by the International Energy Agency (IEA, 2007 p. 43), Australia had one of the lowest retail industrial electricity prices. Assuming similar mark-ups between wholesale and retail electricity prices in each country, and a roughly equivalent cost of RElec in each, means RElec in Australia faces a larger price disadvantage and therefore requires a more generous mechanism than that needed in most other developed economies to overcome its generation cost gap with non-RElec electricity. Residential retail electricity prices, typically A\$120–170/MWh in 2009, are higher than industrial prices: this closes part of

the gap between the cost of residential retail electricity and the cost of residential photovoltaic electricity.

Figure 3: Electricity prices for industry in select OECD countries, first quarter 2007.

Source: IEA (2007: 43)

However, the generation cost disadvantage of RElec is likely to reduce over time because the cost of RElec is trending down while the cost of coal-fired electricity is trending up, though a small cost gap in Australia is not likely any time soon. According to researchers at the US Lawrence Berkeley National Laboratory, the weighted average price of on-shore wind-generated electricity in the United States has reduced from US\$63/MWh in 1999 (2007 dollars) to US\$40/MWh in 2007 (Wiser and Bollinger, 2008 p. 16). Meanwhile, electricity prices in Australia have recently risen in real terms and that trend is likely to continue. Between 1980 and 1990 the electricity consumer price index increased by 3% in real terms when compared to the all-groups Australian consumer price index. It then increased by 6% in real terms between 1990 and 2000 then increased by 16% in real terms between 2000 and 2009 (Australian Bureau of Statistics, 2009). After 2011, when emissions trading is proposed to commence

in the country, electricity prices will probably further increase because of their carbon cost component.

In Australia, there are two major types of mechanism that are either currently, or soon will be, available to help overcome the generation cost gap between RElec and fossil fuel-fired electricity: MRET/RET and GHG emissions trading. The original MRET mechanism operated in the country from 2001 until mid-2009, when it was rolled over into the new, expanded RET. There is now enough historic performance data about MRET to draw some conclusions about where RET can take RElec in Australia. Emissions trading, under Australia's so-called Carbon Pollution Reduction Scheme (CPRS), is not due to commence in the country until July 2011, assuming its legislation is eventually passed (it was rejected by the country's upper house of parliament in 2009). Treasury (2008) modelling of its impact, released in October 2008, gives an idea of the likely carbon price it will induce under different emission reduction scenarios. The federal government's emissions trading White Paper, released in December 2008, indicated what the short to medium term determinants of the scheme's carbon price will be (DCC 2008b). Together they give some guidance about the part emissions trading can be expected to play in overcoming the RElec/coal-fired generation cost gap. So we now have sufficient knowledge to discover approximately where RET and emissions trading are likely to take RElec in Australia in the short to medium term.

2.3 Advantages of a diversified ‘portfolio’ approach to RElec stimulation in Australia

To date Australia’s market has developed a narrow non-hydro RElec base, mostly comprising on-shore wind and some biomass (see section 3), that does not constitute a diversified RElec portfolio. There are two major disadvantages to the persistence of a narrow RElec base in the country: the first is that the number and amount of premium, low-cost wind and biomass sites and resource is limited and, eventually, their marginal costs will rise as these sites and resources are exhausted. In Germany, where high levels of RElec support have exhausted most good sites, higher marginal costs of wind generation are already being experienced (Junginger et al., 2005 p.142). The second disadvantage is that a narrow RElec base exposes Australia to greater insecurity of energy price and supply than a more diversified base would; a portfolio approach to RElec generation in Australia would reduce this exposure (Albrecht, 2007; Awerbuch, 2006). It could also reduce the risk of Australian RElec being exposed to cost increases during a rapid scaling-up of capacity which was experienced in the US wind industry in 2007 (Bolinger and Wiser, 2008).

In Australia, estimates of the national long term low-to-medium cost on-shore wind resource range from 8 GW, with existing transmission capacity (Outhred, 2003 p. 3), which would supply about 5% of Australia’s predicted 2030 electricity consumption, to 20% of its electrical energy in 2040 if the country’s transmission capacity is expanded (Diesendorf, 2007 p. 127).

Australia’s off-shore wind potential is limited, based on current (non-floating) technology, because most of its coastal waters are deep and its population is concentrated in several cities located in areas of low to medium wind speed.

Nevertheless, there are a few potential sites of interest (Messali and Diesendorf,

2009). In general, to achieve a wind energy penetration of 20% while maintaining generation reliability, some limited back-up from additional peak-load power plant may be required. In the unrealistic limiting case when all wind power is concentrated at a single site, required back-up capacity would be about half wind capacity (Martin and Diesendorf, 1982). However, with geographic dispersion of wind farms and an extended transmission system, additional back-up would in general be a small fraction of wind capacity and in some cases may be unnecessary (USDoE, 2008).

The extent of the country's long-term biomass resource depends largely on the success, or otherwise, of the utilisation of agricultural waste, particularly stubble. It also depends on how significant transport is to its use. If significant amounts of agricultural waste can be utilised, the national long-term biomass generation could reach 72 TWh/y, equal to 18% of Australia's projected 2030 electricity generation (Clean Energy Council, 2008 p. 5), or even as much as 30% during non-drought periods (Diesendorf, 2007 p. 151).

It is theoretically possible, then, for wind and biomass together to supply about 25% to 40% of Australia's 2030 electricity consumption, but the upper end of that supply would inevitably have a higher marginal cost than the premium resource supplied when both are first exploited. If a significant majority of Australia's electricity is eventually generated by RElec, wind and biomass will not be able to supply all of the RElec generation. In contrast to this, the marginal cost of solar RElec, particularly solar-thermal electricity, is likely to decline as generation capacity expands (Neij, 2007 p. 2205) and solar thermal electricity has nowhere near the same resource constraints in Australia that wind and biomass have. There are huge areas of marginal land in inland Australia that

could be devoted to solar power, provided grid extensions are made. A 2006 report published by the Cooperative Research Centre for Coal in Sustainable Development, estimated that an area measuring 35 km by 35 km located in a region of Australia with high solar radiance and low cloud cover could generate enough electricity to meet all of the country's current electricity generation, if covered with a solar thermal electricity generation system (Wibberley et al., 2006 appendix 1 p. 24). Australia's projected 2030 electricity generation could be produced from this sized solar generator if 15% solar-to-electric efficiency was achieved and a 70% capacity factor was employed (requiring storage). Despite this potential, there is less than 150 MW of solar power capacity installed in the country (Clean Energy Council, 2009) compared to 3,000 MW in Spain and 5,000 MW in much less sunny Germany (Fouquet, 2009).

On a similar scale of potential capacity, Geoscience Australia estimates one per cent of Australia's hot rock geothermal resource could supply energy equivalent to 26,000 times the country's annual consumption (Ferguson, 2008). The largest area of this resource extends from north-east South Australia to south-west Queensland. Once again, grid extensions will be needed to tap it.

Unlike Europe (MacKay, 2009), Australia has a potential RElec resource well in excess of its current annual electricity consumption needs. It could even export renewable energy stored, for instance, in the form of hydrogen or methanol. If Australia's RElec remains focused on wind and biomass alone, it risks both missing out on the long-term marginal cost reductions of solar and geothermal electricity and being increasingly exposed to the long-term marginal cost increases of wind and biomass. This will particularly be the case if very

deep cuts in Australia's GHG emissions are eventually sourced from electricity generation.

One scenario for sourcing deep GHG emission cuts from Australia's electricity generation consistent with a 450 ppm regime is shown in Figure 4. It shows about three-quarters of Australia's electricity sourced from RElec by 2050 with the balance sourced from coal generation using CCS (if it is commercially available). The RElec generation is mainly sourced from wind, solar thermal, solar photovoltaics and hot rock geothermal with minor contributions from biomass, hydro and wave.

Figure 4: Australian electricity generation mix scenario consistent with a 450 CO₂e ppm regime

Source: Graham and Wright (2009).

3. The success and failure of the MRET in stimulating RElec

3.1 Origins of the Renewable Portfolio Standard

Australia was one of the first countries in the world to adopt the RPS mechanism which was originally developed in the United States. The mechanism's big strengths are that, in theory, it delivers a pre-determined and

certain level of RElec generation and has an in-built incentive for electricity suppliers to source least-cost RElec. Its big disadvantages are that it has no in-built incentive to purchase electricity from a wide range of RElec types and has no in-built structure that necessarily decreases the support given to RElec over time.

3.2 The performance of the MRET mechanism

3.2.1 Quantity of RElec generation in Australia under MRET

Australia's MRET was designed to increase the country's level of RElec generation by 9.5 TWh/y between 2001 and 2010. When the mechanism commenced it was thought that, when combined with pre-existing RElec generation, it would lift the RElec share of the grid-connected electricity generation (which accounts for about 90% of all electricity generation in the country) from 10.5% to 12.5% by 2010. However, because of several factors including electricity consumption rising at a faster rate than anticipated, recent drought induced reductions in hydro-electric generation and the issuing of a significant number of RECs for technologies that do not generate RElec such as solar hot water heaters (see s5.3), it is unlikely RElec generation in Australia will have any greater a percentage share of national electricity generation in 2010 than it had in 2001, despite MRET. However, MRET has been successful at arresting a long term decline in the proportion of Australia's electricity generated by RElec. In the early 1960s nearly a quarter of the country's electricity was generated by RElec; by the commencement of MRET only 8% was (Tambling, 2003 p. 11).

As shown in Figure 5, from 2001 to 2006, the hydro and non-hydro RElec share of Australia's electricity generation (both grid and off-grid) remained at its

MRET commencement level of about 8%. The only change over the period was a slight reduction in the proportion of RElec generated by hydro and a slight increase in the proportion generated by non-hydro RElec.

Figure 5: Hydro and non-hydro RElec market shares of Australia's annual electricity generation: 2001 to 2006

Source: ABARE (2004 to 2007 and 2009a).

As shown in Table 4, RElec accounts for a smaller share of electricity generation in Australia than it does in Europe or the United States. However, the growth in Australia's RElec generation between 2001 and 2006 was higher than for the European Union but lower than for the United States. Like the European Union, Australia's RElec growth was adversely affected by a decline in hydro generation during between 2001 and 2006. However, Australia's non-hydro RElec grew more rapidly during the period than it did in either the US or the EU but the growth occurred off a low non-hydro base. In 2001 non-hydro RElec only accounted for 0.5% of all electricity generation in Australia compared to 1.9% in the US and 2.4% in the EU. Australia's high RElec concentration index reflects the fact that its RElec is more dependent on hydro generation than RElec is in either the US or the EU.

Table 4: RElec indices for the United States, all EU countries and Australia, 2001 and 2006.

	2001	2006	2001/2006 change
United States			
Electricity generation: TWh/y	3,737	4,064	+8.8%
RElec generation: TWh/y	288	379	+31.6%
RElec market share	7.7%	9.3%	+20.8%
Hydro generation: TWh/y	217	283	+30.4%
Non-hydro RElec generation	71	96	+35.2%
Non-hydro RElec market share	1.9%	2.4%	+26.3%
RElec concentration index	0.589	0.583	-1.0%
European Union 27			
Electricity generation: TWh/y	3,113	3,357	+7.8%
RElec generation: TWh/y	447	489	+9.4%
RElec market share	14.4%	14.6%	+1.4%
Hydro generation: TWh/y	373	309	-17.2%
Non-hydro RElec generation	74	180	+143.2%
Non-hydro RElec market share	2.4%	5.4%	+125%
RElec concentration index	0.709	0.461	-35.0%
Australia			
Electricity generation: TWh/y	218	247	+13.3%
RElec generation: TWh/y	18	20	+11.1%
RElec market share	8.2%	8.0%	-2.4%
Hydro generation: TWh/y	17	16	-5.9%
Non-hydro RElec generation	1	4	+300%
Non-hydro RElec market share	0.5%	1.5%	+200%
RElec concentration index	0.884	0.671	-24.1%

Source: Energy Information Administration (2009), European Commission (2009) and ABARE (2004 to 2007 and 2009a).

3.2.2 RECs issued in Australia under MRET

At first sight it seems MRET has been successful at stimulating a broad range of RElec types. As indicated in Figure 6, solar hot water, in addition to wind and biomass (mostly made up of landfill gas and sugar cane waste), are the non-hydro RElec sources that have been the major beneficiaries of the mechanism. But the significant level of solar hot water generation is not a product of MRET alone. It has also been stimulated by a range of federal, state and local government installation subsidies. Once this is factored in, Australia's MRET has not performed that differently from RPS mechanisms in other countries that use it. In general, the mechanism has only succeeded in stimulating the least-cost RElec types of wind and biomass. The big losers from

MRET have been solar photovoltaic (PV) and solar thermal electricity. Under MRET, tradable certificates – Renewable Energy Certificates (RECs: 1 MWh = 1 REC) – are created by RElec generators which are purchased by electricity retailers to discharge their MRET obligation. Solar hot water heaters, in reducing demand for electricity, are also allowed to create RECs. Of the 35,484,013 RECs created by the end of December 2008, only 1.4% had been created by solar energy other than solar hot water heaters (Office of the Renewable Energy Regulator, 2009b p. 19).

Figure 6: Valid RECs created under MRET, 1 April 2001 to 23 May 2009

Source: Office of the Renewable Energy Regulator (2009a)

Two ways of pursuing a diversified portfolio approach to RElec development, whilst using a RPS, are:

- to use a high-volume feed-in tariff (a mechanism that guarantees above-market RElec prices) for more expensive RElec types (modern feed-in tariffs were originally developed in Germany, Denmark and Spain – see Meyer 2003, Meyer 2007); or
- to introduce long-term higher weights, or ‘bands’, within an RPS for the more expensive types (as commenced in the UK in April 2009) or to create special

sub-markets, or ‘carve outs’, for them within the RPS (as done in several US states).

3.3 The contribution of the expanded RET to RElec in Australia

During the 2007 national election, the Australian Labor Party promised to replace MRET with the expanded RET. The latter is a more ambitious RPS than MRET: it aims to lift the RElec contribution to about 20% of the country’s grid-connected electricity by 2020 by generating an additional 45 TWh/y of RElec (including the MRET target) by 2020. After a delay of 18 months from the 2007 federal election, the legislation for the expanded RET was passed and took force from 1 July 2009. In addition to the pre-MRET RElec generation, the RET and MRET will in theory bring total RElec generation in Australia to 60 TWh/y by 2020, as detailed in Table 5. In addition to the Table 5 targets, RET will also include 0.85 TWh/y coal seam gas generation by 2020 but this is not a type of RElec.

Table 5: Pre MRET, MRET and RET 2020 RElec target generation levels

<i>RElec mechanism</i>	<i>RElec generation at 2020: TWh/y</i>
No mechanism: pre-MRET	15
MRET	9.5
RET	35.5
Total	60

As shown in Table 6, the increase in the intended amount of RElec generation, to be driven by both MRET and the expanded RET between 2005 and 2020, is predicted to be equal to about 45% of the projected electricity generation increase over the period. The current Australian government plans to phase out the expanded RET after 2030 by which time it claims its proposed

ETS – the CPRS – will be performing the same function in terms of bridging the cost gap between RElec and conventional coal-fired electricity generation.

According to the CPRS White Paper: ‘The Government’s emissions reduction strategy has four foundation elements: the Carbon Pollution Reduction Scheme, the Renewable Energy Target, carbon capture and storage, and energy efficiency’ (DCC, 2008b p. 19-4). So the obvious question is: will the CPRS and expanded RET make a significant contribution to GHG emissions reduction by stimulating Australia’s RElec?

Table 6: Contribution of MRET and expanded RET generation to projected increase in total Australian electricity generation between 2005 and 2020

<i>Period</i>	<i>Pre-MRET RElec generation with added MRET and expanded RET generation: TWh/y</i>	<i>Actual and projected total Australian electricity generation: TWh/y</i>
2005	19.4	252
2020	60	342
Difference: 2005 to 2020	40.6	90

Source: ABARE (2006: 29).

4. The potential effectiveness of the CPRS in stimulating Australia’s RElec

4.1 Treasury’s modelling of GHG reduction carbon prices

The Australian Treasury department’s modelling of the economic impact of national GHG reduction focused on four different national GHG reduction scenarios where, compared to the country’s 2000 level of GHG emissions, reductions of 5%, 10%, 15% and 25% were made by 2020. However, the CPRS White Paper, published in December 2008, stipulated the maximum GHG emissions cut that would be made by Australia would be 15% by 2020, subject to major international actions, and that the ‘unconditional’ reduction would be 5%. Subsequently, in May 2009, the Australian government increased the upper

limit of the cuts to 25%, subject to conditions that, so far, have not been met (Wong, 2009a). When announcing the possible 25% cut, the Australian Prime Minister said it would only be enacted if ‘the world agrees to stabilise levels of CO₂-e in the atmosphere at 450ppm or less by 2050’ (Wong 2009). Since the December 2009 Copenhagen climate change meeting did not agree on measures that would necessarily limit GHG concentrations in this way, it is thought Australia is ultimately likely to commit to a 10% to 15% GHG emissions cut on 2000 levels by 2020. In late January 2010, the Australian government submitted a 5% to 25% range of possible reductions as its commitment to the Copenhagen accord saying it would not pledge to cut by more than 5% until ‘the level of global ambition becomes sufficiently clear’ (Wong 2010). The commencement and 2020 emissions trading scheme carbon prices that Treasury’s modelling found would be associated with the 5%, 15% and 25% scenarios are given in Table 7. (Treasury quoted its 2020 carbon prices in 2005 prices while its commencement carbon prices were quoted in nominal prices.)

Table 7: Emissions trading carbon prices modelled by Australian Treasury.

<i>Year</i>	<i>5% GHG emission reduction by 2020 carbon price: A\$/tCO₂e</i>	<i>15% GHG emission reduction by 2020 carbon price: A\$/tCO₂e</i>	<i>25% GHG emission reduction by 2020 carbon price: A\$/tCO₂e</i>
2010	A\$23	A\$32	A\$52
2020	A\$35	A\$50	A\$60

Source: Treasury (2008 p. 139).

4.2 The impact of CPRS carbon prices on RElec stimulation

Figure 7 takes the current RElec and non-RElec generation costs quoted in Table 3 then adds in Treasury’s 5%, 15% and 25% 2020 GHG reduction carbon prices, taking account of the carbon intensities of the non-RElec sources, to get an approximate idea of 2020 post carbon pricing generation cost relativities (though future generation costs will be subject to the different cost forces

mentioned in section 2.2). In Figure 7, the generation cost gap between the five different types of RElec, and that of electricity generated from black coal, remains significant except for wind and biomass. However, if Table 3 underestimates the prices of wind and biomass, as Diesendorf's (2007) Table B.2 suggests, then even most wind and biomass may be unable to benefit from the CPRS's carbon prices. Furthermore, a carbon price of A\$120/tCO₂e, that is likely to be politically unacceptable, would be needed to stimulate the full cost range of all the RElec types (Treasury, 2008). Diesendorf (2007) estimates that even higher carbon prices would be needed to stimulate solar electricity, at least in the short-term. This suggests RElec in Australia is likely to be only marginally expanded by emissions trading by 2020, beyond that planned by MRET and the expanded RET. This is especially the case if RET reduces carbon prices in the short term. It also suggests that, unless carbon prices rise significantly after 2020 and remain consistently at high levels, they will not have the RElec stimulatory effect the government is anticipating they will have after that time. Carbon spot prices in the European ETS have fluctuated between €30 and €0 per tonne CO₂ over the period 2005–2007 (Alberola et al., 2008 fig.1), giving little confidence to potential investors in RElec.

Figure 7: 2020 electricity generation costs including Treasury CPRS 2020 carbon prices

On a the broader front of the CPRS’s general impact on the electricity sector, modelling quoted in the Australian government’s White Paper, which incorporated the CPRS and expanded RET, suggested their main combined impact would be on new electricity generation investment rather than existing investment (DCC, 2008b p. 13-16).

4.3 Criticisms of the combined effect of emissions trading and the RET on RElec in Australia

There has been criticism of the situation that emissions trading and the expanded RET may work side-by-side from 2011 until 2030 in Australia. Some argue that, together, the two mechanisms will concentrate too much of the country’s GHG reduction burden on the electricity sector, resulting in higher electricity prices than would exist under the CPRS alone (CRA International, 2007 p. 18; Productivity Commission, 2008 p. 72). They also argue this concentration on electricity will have other undesirable outcomes including lower carbon prices than would exist if the expanded RET did not exist (CRA International, 2007 p. 13). Several large electricity users, most notably

aluminium smelters, have succeeded in obtaining exemptions from the electricity price increases resulting from the expanded RET.

Whilst these criticisms have some validity in the short term, they ignore the longer term benefits of having a significant RElec base in Australia, especially its role in reducing its GHG emissions. It also needs to be remembered that the lower carbon prices generated by the two mechanisms working together will compensate for some of the higher cost of RElec. The expanded RET should help reduce the long-term generation costs of RElec by making economies of scale cost reductions available and by bringing forward other learning-by-doing cost reductions (that come through better approval processes, better finance practices, reductions in equipment costs etc) (MMA, 2007 p. 5).

5. The prospects of reaching the RElec generation target of the RET

5.1 An optimistic scenario for Australia's 2020 RElec

In reaching the RElec goal of 60 TWh/y of RElec by 2020, the conventional view is that wind generation will increase to take up at least half of the 35.5 TWh/y difference between the MRET target (including pre-MRET RElec generation) and the 2020 expanded RET target (MMA, 2007 p. 6). To generate half the difference, the installed wind generating capacity in Australia will need to increase five-fold from the 2008 level of 1,306 MW to about 8,600 MW (assuming a 30% capacity factor, which is typical for on-shore wind farms in Australia). Reaching this capacity will require a 17% compound rate of annual growth between 2008 and 2020. As can be seen from Table 8, this is below the rate of growth that wind generation achieved under MRET between

2001 and 2005 (from a very low base), and between 2007 and 2008, but is above what it achieved between 2006 and 2007.

Table 8: Australian wind energy generation capacity 2001 to 2008

<i>Year</i>	<i>Australian wind generating capacity: MW</i>	<i>% capacity increase from previous year</i>
2001	73	
2002	105	44%
2003	198	89%
2004	380	92%
2005	708	86%
2006	817	15%
2007	824	1%
2008	1,306	58%

Source: Global Wind Energy Council (2008: 21 p. 2009).

Beyond wind, most of the balance to reach the 2020 expanded RET target is expected to come from biomass and hot rock geothermal generation (Ernst and Young, 2008 p. 5). At this stage, both the biomass and geothermal industries think they can deliver this balance. The biomass sector states it can generate 10.6 TWh/y of electricity by 2020, which would be about 9.2 TWh/y more than it currently generates. It expects to generate most of its 2020 electricity from bagasse (sugarcane waste), wood waste and landfill gas from 1,845 MW of installed capacity: about 1,200 MW more capacity than it currently has (Clean Energy Council, 2008 p. 20). The geothermal sector currently generates no electricity for the Australian National Electricity Market, but believes it can have 1,000–2,200 MW of installed capacity by 2020 generating 7.7–17 TWh/y of electricity (assuming a 90% capacity factor) (MMA, 2008a p. 1). However, modelling done for the federal government’s Treasury department, which assumed a 25% cut in Australia’s GHG emissions by 2020 and continuation of MRET, considered that there would only be about 1,000 MW of geothermal capacity by 2020 (MMA, 2008b p. 17). A recent report compiled for the Australian geothermal industry also conceded it may only have 1,000 MW capacity ready by 2020 (MMA, 2008a p.

20). So if wind capacity scales up by about 7,300 MW, biomass capacity increases by about 1,200 MW and geothermal by about 1,000 MW of capacity, the 2020 60 TWh/y target will be reached, roughly along the lines summarised in Table 9. However, Table 9 does not take account of RECs created by solar hot water heaters. Although they are currently a major creator of RECs, one prediction is that by 2020 they will only be responsible for about 8% of the RECs market (MMA, 2009 p. 36). However, their future RECs creation strongly depends on non-RET subsidy levels and regulations (see s5.3) and so 8% may be an underestimate (see section 5.3).

Table 9: Scenario of increased RElec generation to reach 2020 RET target of 60 TWh/y of RElec generation

<i>RElec source</i>	<i>Yearly generation by 2020: TWh/y</i>
Pre-MRET RElec generation	15
MRET generation	9.5
Increased wind generation (from extra 7,300 MW capacity)	19.2
Increased biomass generation (from extra 1,200 MW capacity)	8.4
Geothermal generation (from an extra 1,000 MW capacity)	7.9
Total generation	60

5.2 Australian RElec resource and technology limitations

However, significant problems may be encountered in reaching the RElec generation levels in Table 9. Apart from the possible limitation of the inability of wind capacity to expand at the required rate, the expansion of biomass generation from sugarcane waste may be constrained by fluctuating global sugar prices as well as concerns about the ongoing viability of the sugar industry (Ernst and Young, 2008 p. 12). There are also concerns about the amount of transport fuel needed to collect biomass. The ability to source biomass electricity from wood waste is restricted by the fact that if it comes from native forest logging it cannot be used as an RElec source in most Australian states and

there is limited capacity to expand landfill gas generation in the country. In addition, drought could constrain the use of biomass residues from the wheat industry.

The generation of geothermal electricity in Australia from hot rock technology has its own set of constraints: although there is a huge resource, the technology is in its infancy, is very capital intensive and therefore subject to the vagaries of the equity and debt markets, and will require the construction of long transmission lines to be able to feed into Australia's National Electricity Market grid.

5.3 Design limitations of the RET

The resource and technology limitations mentioned in the previous subsection are not insurmountable barriers to significantly increased RElec generation in Australia. For instance, given appropriate government policies, a shortfall in generation from biomass or wind could be offset by an increase in geothermal and solar thermal generation. A far greater barrier to reaching the target of 20% RElec by 2020 is set up by some of the design features of the RET, which could exclude the lowest cost sources of RElec: wind and biomass.

Under RET, solar and electric heat pump hot water technologies can produce RECs. Based on 'conservative' modelling, Saddler (2009) reports that 25% of all RECs could be received by water heaters over the period from 2009–2020. Based on trends in the former MRET mechanism, a government department finds that it is possible that 30%–35% of the medium-term increase in the target could be taken up by these water heating technologies, which already receive federal and state/territory subsidies (DEWHA, 2009). Between 1 January 2009 and 13 November 2009, solar and electric heat pump hot water

technologies were responsible for 45% of all RECs created in Australia (Office of the Renewable Energy Regulator, 2009a). Their high level of RECs creation was prompted by a significant increase in February 2009 in the national government subsidy solar hot water heaters receive. Their RECs creation may fall after the subsidy reduces (by 2012), but the possible future phase-out of off-peak electric water heating may keep the demand for solar and electric heat pump hot water heaters high. Unlike most versions of the RPS, both MRET and RET allow unlimited banking of RECs so the effect of a high volume of hot water heater and heat pump RECs coming to market may be felt long after the demand for them subsides. Arguably, the principal barrier to the rapid diffusion of solar hot water is the requirement of many local governments in Australia for planning permission for these systems, a process that can take weeks. This has the effect that, when an existing electric hot water system breaks down at the end of its life, householders tend to install another electric hot water system, since this can be done within one day. The solution is for state governments to ban the required planning permission for accredited solar water heaters (Diesendorf, 2007 p.155). Potentially an even worse RET design flaw is that more than half the increase in RET's target, at least over the next five years, could be taken up by 'phantom' residential solar, wind or hydro systems. The flaw arises under the federal government's Solar Credits scheme, which is a RECs multiplier scheme that initially awards five RECs per MWh to each small residential solar photovoltaic, wind or hydro system instead of the usual one REC/MWh (DCC, 2009a). The scheme's level of RECs creation will fall after 2015 when it finishes, although, like hot water heaters, RET's allowance of unlimited banking of RECs may ensure the effect of the phantom RECs is felt

long after this date. The problem with the scheme's RECs multiplier is that it counts all five RECs as contributing towards RET's target, even though four of them do not represent real RElec generation. Because RET's target is expressed as a number of generation hours, and not as a future market share (see below), the extra RECs created under the scheme erode its target. The federal government has given no justification for this extraordinary design feature. It means that, if residential solar electric systems contribute (say) 15% of the increase in target, they will actually be counted as fulfilling 75% of the target. When combined with the RECs earned by solar and heat pump hot water heaters, it is possible there will be little room in the expanded RET for extra wind or biomass generation, at least until 2015.

The increase in the supply of solar and heat pump hot water RECs, together with the Solar Credits phantom RECs, puts a downward pressure on RECs prices. This thwarts wind generation, and the lower-cost forms of biomass generation, from competing with coal-fired electricity in Australia. Indeed, as shown in Figure 8, this has been the RECs price experience since early 2009 when the solar hot water subsidy was increased. This resulted in major concern being expressed about the fall in RECs prices (Environment Victoria et al., 2009; Parkinson, 2009; Wong, 2009b).

Figure 8: Australian RECs prices: June 2003 to September 2009

Source: Green Energy Markets (2009).

Another influence that may work against RET producing RElec generation equal to 20% of Australia's grid-connected electricity generation by 2020 is the rate of electricity generation growth in the country. Unlike RPS targets in other countries, the RET's target is specified in TWh per year (see Table 5) and not an electricity percentage market share. In 2006-07, Australia's grid-connected electricity generation was 227 TWh/y (ABARE,, 2009b p. 20). RET's 60 TWh/y-by-2020 target assumes annual generation will reach 300 TWh/y by 2020. This projection implies an average compound rate of generation growth of 2.1%/y between 2007 and 2020. Although this is in line with projections by ABARE, there is good reason to think actual growth may end up higher than this. Table 10 shows that the predicted 2.1% annual growth between 2007 and 2020 is well below the average annual rate of growth since 1997-98 (3.3%). It is not inconceivable that the average annual rate of generation growth will fall to the predicted rate, but much will depend on the price of electricity (including

carbon pricing) and the effect it has on increasing electricity usage efficiency and decreasing demand growth. At the very least, RET's TWh target needs periodic revision to ensure it remains consistent with RET's 20%-by-2020 target.

Table 10: Grid-connected electricity generation in Australia, 1997-98 to 2006-07.

<i>Year</i>	<i>Grid-connected generation: TWh/y</i>	<i>Increase on previous year</i>
1997-98	170	
1998-99	186	9.4%
1999-2000	193	3.7%
2000-01	199	3.1%
2001-02	201	1.0%
2002-03	206	2.5%
2003-04	213	3.4%
2004-05	217	1.9%
2005-06	220	1.4%
2006-07	227	3.2%

Source: ABARE (2005 p. 39 and 2009b p. 20).

Another design problem with RET is its reliance on high ongoing hydro generation in Australia. A quarter of RET's TWh target is made up of hydro generation which the target assumes will remain at 15 TWh/y. However, because of recent drought conditions, hydro generation may fall below this level. If this happens, RET's ability to reach 20% of Australia's grid-connected electricity generation by 2020 will be further eroded. As shown in Table 11, although hydro generation in Australia was above 15 TWh/y between 2001 and 2006 but below it in 2007, the forecast for future generation is not optimistic. The International Energy Agency (IEA, 2009a part III p. 103) reports that in 2008 total hydro generation in Australia was only 12.4 TWh/y.

Table 11: Hydro electricity generation in Australia, 2001 to 2007.

<i>Year</i>	<i>Hydro generation: TWh/y</i>
2001	16.8
2002	16.0
2003	16.5
2004	16.3
2005	15.6
2006	16.0
2007	14.5

Source: ABARE (2009a p. 33).

On top of the aforementioned potential hurdles, the feed-in tariffs so far announced by Australia's state and territory governments are unlikely to significantly augment the amount of RElec induced by the RET. This is because all the feed-in tariffs schemes, with the exception of the Australian Capital Territory's (ACT) one, are only aimed at small generators of solar photovoltaic electricity. Also, they only create a modest incentive because they are generally based on the net amount RElec generators feed into the grid, not the gross amount (with the exception of ones in New South Wales and the ACT).

Even if the above mentioned design flaws are removed from the expanded RET – with the result that wind, biomass and hot rock geothermal manage to deliver the extra RElec generation required to reach the 20% target – solar electricity will remain a marginal player in Australia's RElec generation because of its current high generation cost. Without a mechanism to stimulate large solar power stations, the country will still have a narrow spectrum of RElec sources from which major cuts in its GHG emissions might one day be delivered. Either a relaxation of the restrictions on the feed-in tariffs, specific bands in the expanded RET, large government capital subsidies or tax deductions are needed for large-scale solar generation to significantly expand in Australia. In addition,

a strengthening and expansion of the country's transmission network is required for RElec generated in remote locations to expand.

6. Conclusions about the future of renewable energy electricity in Australia

This paper leads to two broad conclusions about the future of RElec in Australia. The first is that the 45 TWh/y MRET/RET 2020 target is unlikely to be reached, for two reasons. Firstly, wind, biomass and hot rock geothermal generation may not be able to expand fast enough to reach it. This is unlikely to be a problem if effective government policies are enacted to bridge the price gaps between these sources and conventional coal-fired electricity. Secondly, a substantial barrier is that most of the increase in the target is likely to be taken up by RECs created by solar and heat pump hot water as well as by 'phantom' residential RElec systems, with the result that their prices will remain low, at least until 2015. The negative effect of these design flaws will have on the attainment of RET's target may be made worse by low hydro generation and by higher-than-predicted growth in grid-connected electricity generation. Also, it is very unlikely that either the CPRS, or state and territory feed-in tariffs, will stimulate much RElec in addition to that stimulated by MRET and the expanded RET, before 2020 at the earliest.

The second broad conclusion is that, with continued use of the MRET/RET mechanisms to stimulate most of the nation's RElec, it is unlikely Australia will develop a broad enough RElec base from which it could one day make deep cuts in its GHG emissions. In their present forms, the expanded RET, and the CPRS cannot be relied upon to push the RElec industry into large

quantities of generation sufficient be able to deliver deep cuts in Australia's GHG emissions at least until 2020.

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