ISSN 1835-9728

Environmental Economics Research Hub Research Reports

The Future of Renewable Electricity in Australia

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Research Report No. 30

May 15 2009

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Environmental Economics Research Hub Research Reports are published by The Crawford School of Economics and Government, Australian National University, Canberra 0200 Australia.

These Reports present work in progress being undertaken by project teams within the Environmental Economics Research Hub (EERH). The EERH is funded by the Department of Environment and Water Heritage and the Arts under the Commonwealth Environment Research Facility.

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Abstract

Renewable electricity is likely to be pivotal to the long-term reduction of Australia's greenhouse gas emissions, particularly if deep cuts are eventually implemented. However, if current renewable electricity policies continue, Australia's renewable electricity base will remain narrow with little contribution from solar technologies before 2020. This will not provide an adequate basis for delivering long-term deep cuts to its greenhouse emissions nor for achieving major greenhouse gas emission reductions at least cost. Emissions trading, the state and territory based feed-in tariffs announced in 2008, and other policies of the Federal Government are likely to have only modest impacts on renewable electricity generation in Australia at least until 2020. The future of Australia's renewable electricity rests mainly with the success, or otherwise, of its Mandatory Renewable Energy Target and expanded Renewable Energy Target whose effectiveness may be eroded by the long-term banking of tradable certificates used with both mechanisms. Unless there is a change of policy mechanisms, Australia will probably fail to reach its renewable electricity target of 20% of electricity by 2020 and will also fail to build up its solar and hot rock geothermal electricity to make large generation contributions beyond 2020.

Keywords: Renewable electricity, energy, greenhouse emissions, emissions trading, renewable portfolio standard, feed-in tariff.

1. Introduction

Electricity generated from renewable energy (RElec) is likely to be central to Australia's ability to make deep cuts in its greenhouse gas emissions (GHG). The current generating costs of renewable electricity are higher than those of conventional fossil-fuel electricity and different types of RElec have different levels of long-run marginal costs. So it will largely be the success, or otherwise, of RElec support mechanisms, including emissions trading, and their effect on RElec marginal costs, that will determine the future of RElec in Australia.

One of these support mechanisms is the modest Mandatory Renewable Energy Target (MRET) which sought to boost Australian RElec generation by 9,500 GWh/yr on 2001 levels by 2010. Sufficient renewable energy 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 Rudd government is in the process of implementing an expanded Renewable Energy Target (expanded RET) comprising an additional 45,000 GWh/yr by 2020 (including the original MRET).

Several commentators have examined the overseas country interaction of emissions trading and renewable portfolio standard (RPS) mechanisms, like Australia's MRET (Linares *et al.* 2008; Morthorst 2001; Jensen and Skytte 2003). There has also been examination of the extent of global RElec resources and its implications for long-run RElec marginal costs (Hoogwijk *et al*. 2004; de Vries *et al.* 2007). The examinations of the interaction between emissions trading and RPS mechanisms broadly concluded their net effect depends on the relative size of the reach of each while the examinations of global RElec resources broadly concluded 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 an RPS mechanism that grows from being relatively small, compared to the national emissions trading market, to being relatively large in a country that is blessed with a full range of RElec sources.

The contribution of this article is to evaluate the medium term RElec stimulatory power of carbon pricing and the expanded RET with reference to Australia's availability of RElec resources now that the shapes of the nation's emissions trading scheme and expanded RET are clear. It uses modelled forecasts of Australia's emissions trading carbon price to forecast 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 greenhouse gas emissions, section 3 considers the impact of the MRET on Australia's RElec generation, section 4 discusses the 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.

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

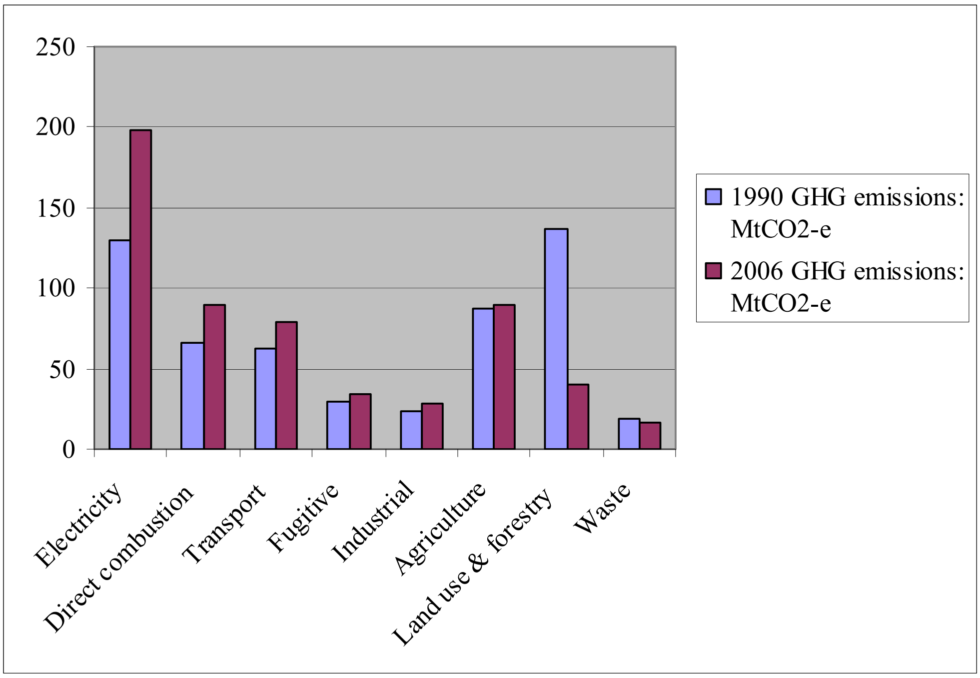
2.1 The need for deep cuts in Australia's electricity greenhouse gas emissions

Climate change is a high-profile issue in Australia. Eventually, Australia's climate change response is likely to require long-term deep cuts to its GHG emission entitlements. There are at least three reasons for this. The first is that the Intergovernmental Panel on Climate Change (2007: 23) believes 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 second is that at the G8 meeting held in July 2008 developing countries like China and India made it clear they were not willing to make cuts in their GHG emissions, of the order of the 50% cut on 2000 emissions by 2050 proposed at the summit, making it likely that eventually developed countries like Australia will have to make deeper cuts than developing ones. Thirdly, 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. Its per capita emissions are about twice the OECD average and four times the global average (Garnaut 2008a: 160).

There are many areas where Australia could make major cuts in its GHG emissions; the most feasible is through reducing the GHG emissions from its generation of electricity. Electricity is a prime target because it is easier, and less expensive, to reform than other major sources of Australia's emissions like agriculture and transport. A 2008 Garnaut Climate Change Review issues paper (2008b: 3) said: 'the stationary energy sector is expected to provide the greatest and earliest reductions in emissions'. As shown in Figure 1, in 2006 electricity generation was the largest source of Australia's GHG emissions. It was responsible for 34.4% of Australia's net emissions that year (Department of Climate Change (DCC) 2008a: 7). The importance of major cuts in electricity emissions is heightened by the fact that its emissions were the fastest growing source between 1990 and 2006 and, under business-as-usual conditions, are forecast to grow a further 40% between 2006 and 2020 (DCC 2008b: 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.

Electricity's share of Australia's GHG emissions is higher than most other developed countries' because few other countries are more dependent on coal for their electricity generation (Diesendorf 2007: 215). This has resulted in a very high GHG emissions intensity of Australia's electricity supply.

Figure 1: Australia's net greenhouse gas emissions, 1990 and 2006



Source: Department of Climate Change 2008a: 1,7

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 Australia's electricity supply to low or zero emission sources. Switching to low emission electricity sources means switching to gas, to nuclear power, or to coal using carbon-capture-and-storage (CCS) if the latter two become commercially available in Australia. Switching to zero emission electricity means switching to RElec such as wind, biomass, geothermal and solar (hydro has virtually no capacity for expansion in Australia).

The attraction of using renewable sources is they emit no GHG emissions. 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 is renewables can be used now: CCS is unlikely to be commercially available before the 2020s. 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 1, even the least expensive generation from the least expensive type of RElec – 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 1, sourced from McLennan Magasanik (2008), does not specify the discount rate used to calculate the costs of electricity generation. A table by Diesendorf (2007: 355) using an 8% discount rate, finds typically higher cost estimates for wind and solar than in Table 1. Also, it is likely that the low end of the biomass costs in Table 1 represents landfill gas, for which there is only small potential, and that the high end may be more typical.

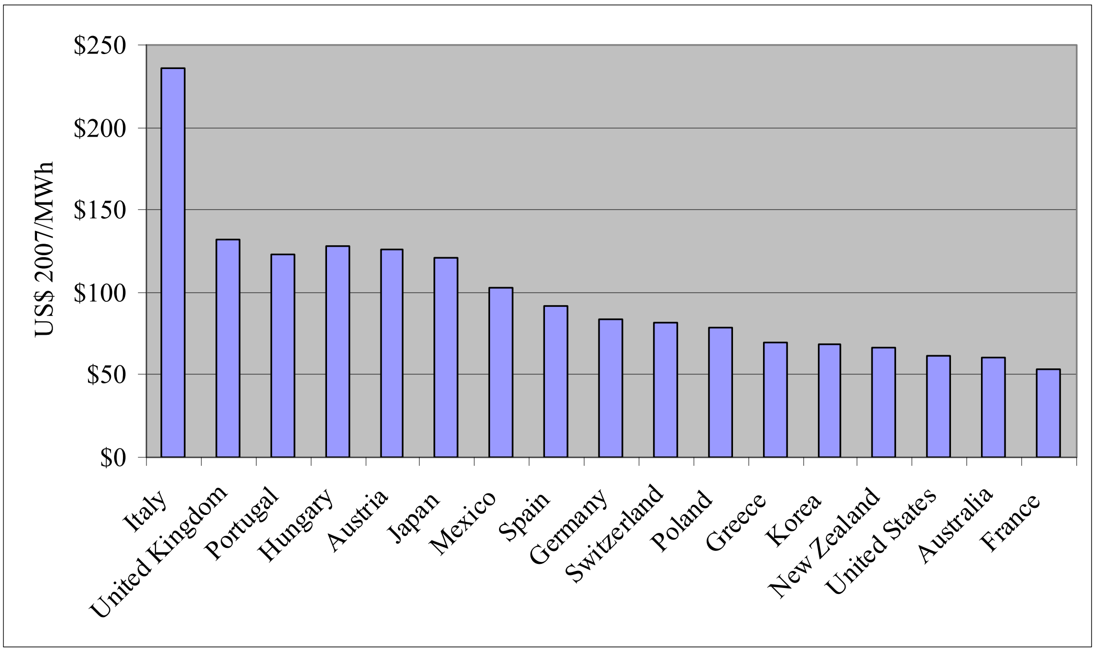
Table 1: Comparison of current generation costs of fossil fuel and RElec

Fuel	*Generation cost: A$/MWh*
Brown coal	35 – 40 *
Black coal	30 – 35 *
Gas (combined cycle)	38 – 54 *
Biomass	46 – 80 *
Wind	52 – 72 *
Geothermal	70 – 110 **
Solar PV	120+ *
Solar thermal	120 – 150 ***

Sources:
*Prime Ministerial Task Group on Emissions Trading 2007: 184 ,
**McLennan Magasanik 2008: 18,
***Owen 2007: 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, because Australia has low retail electricity prices but has a RElec generation cost structure roughly similar to that of other developed countries. As shown in Figure 2, in the first quarter of 2007, out of 27 developed countries surveyed by the International Energy Agency (2007: 43), Australia had the sixth-lowest retail industrial electricity price. Assuming similar mark-ups between wholesale and retail electricity prices in each country, and a roughly equivalent cost of RElec in each, this means RElec in Australia faces a larger price disadvantage and therefore requires a more generous mechanism to overcome its generation cost gap with non-RElec electricity. Residential retail prices, typically $120–150/MWh, are higher than industrial prices: this helps to close part of the gap between the cost of residential retail electricity and the cost of residential photovoltaic electricity.

Figure 2: Electricity prices for industry by country, first quarter 2007.



Source: International Energy Agency 2007: 43

However, the price 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 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: 16). Meanwhile, electricity prices in Australia have recently risen in real terms and that trend is likely to continue. The real price of Australia's electricity fell by 2.4% between March 1988 and March 2003 but rose by 6.1% between March 2003 and March 2008.

There are two major types of mechanism that are either currently, or soon will be, available to help overcome the price gap between RElec and coal-fired electricity in Australia: the MRET and GHG emissions trading. The MRET mechanism has been operating in Australia since 2001. There is now enough historic performance data about it to draw some conclusions about where it can take RElec in Australia. Emissions trading is not due to commence in Australia until July 2010, assuming legislation is passed in 2009, but 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 Carbon Pollution Reduction Scheme White Paper, released in December 2008, indicated what the short to medium term determinants of the scheme's carbon price will be (DCC 2008c). 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 MRET, the expanded RET, and emissions trading are likely to take RElec in Australia in the short to medium term.

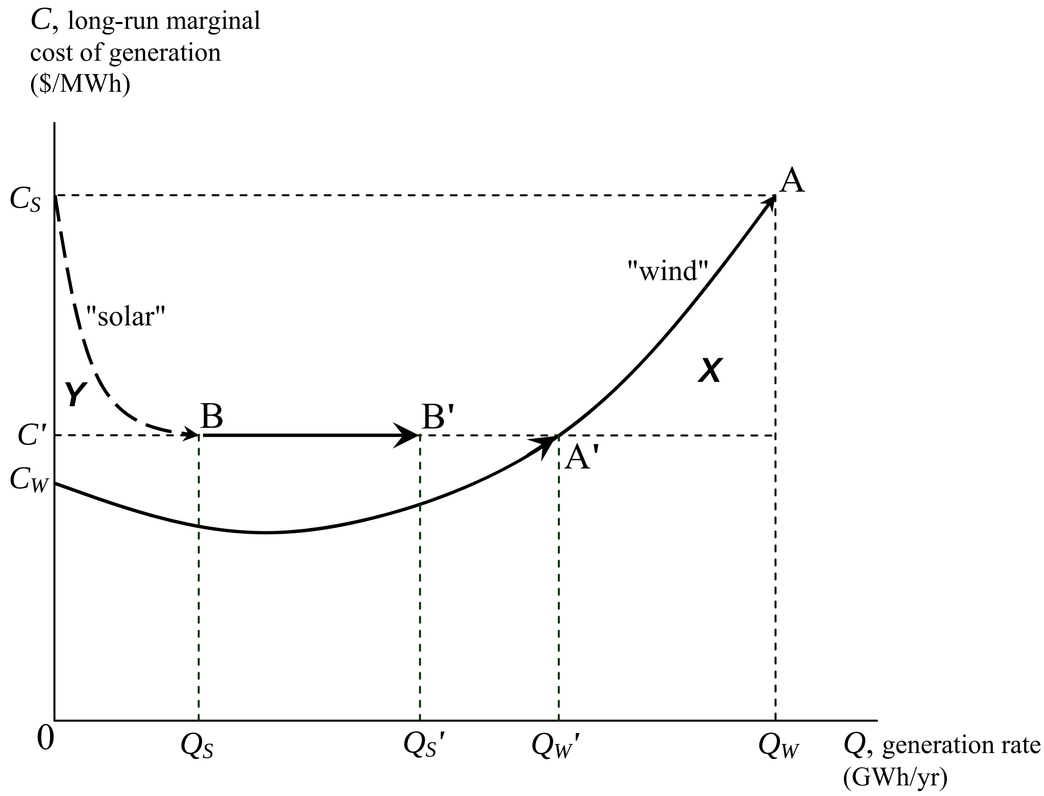
2.3 Advantages of a diversified 'portfolio' approach to RElec stimulation in Australia

The ability to use RElec to deliver cuts in GHG emissions, particularly deep cuts, is significantly enhanced by the pursuit of a diversified 'portfolio' approach to REE development. The portfolio approach to energy development is similar to the portfolio approach to investment risk management: it holds that price and supply risks are minimised through creating a diversified portfolio of energy supply. It argues that, like investment management, the optimisation of return has to be balanced against the acceptance of risk and that that risk is generally lower with a wide range of holdings.

To date, however, Australia's market has developed a narrow non-hydro RElec base comprising wind and some biomass (see section 3). There are two major disadvantages to the persistence of a narrow RElec base: 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: 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 (Awerbuch 2006; Albrecht 2007). It could also reduce the risk of Australian RElec being exposed to cost increases during a rapid scaling-up of capacity which is already being experienced in the US wind industry (Bolinger and Wiser 2008).

In Australia, estimates of the national long term low-to-medium cost wind resource range from 8,000 MW, with existing transmission capacity (Outhred 2003: 3), which would supply about 5% of Australia's predicted 2030 electricity consumption, to enough to be able to supply as much as 20% of its demand in 2040 if the country's transmission capacity is expanded (Diesendorf 2007: 127). 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. If significant amounts of the waste can be utilised, the national long-term biomass generation could reach 72,000GWh/yr, equal to 18% of Australia's projected 2030 electricity generation, and could go higher if supplemented with purpose-grown crops (Clean Energy Council 2008: 5; Diesendorf 2007: 151). This means it is theoretically possible for wind and biomass together to supply about 40% to 50% of Australia's 2030 electricity consumption, but the upper end of that supply will 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 won't be able to supply all of the 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: 2205) and solar thermal electricity has nowhere near the same resource constraints in Australia that wind and biomass have. A 2006 report published by the Cooperative Research Centre for Coal in Sustainable Development, for instance, estimate that an area measuring 35 km by 35 km located in a region with high solar radiance and low cloud cover could generate enough electricity to meet all of Australia'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 used (requiring storage). This means if Australia's RElec remains focused on wind and biomass, it risks both missing out on the long-term marginal cost reductions of solar 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. This assertion is proved by the following economic case, which describes Figure 3.

Figure 3: Long-run RElec marginal cost performance with and without mechanisms that force the use of greater quantities of solar and geothermal sources



The two curves, C_WA'A and C_SBB', show two different, general, ways of how the long-run marginal cost of RElec may change as Q, the total national rate at which electricity is generated, expands to generate major amounts of RElec. C_WA'A is labelled 'wind' but represents both wind and biomass generation. These are technologies which, on the scale of generation relevant to major amounts of RElec generation, start out with falling costs thanks to economies of scale and knowledge spillovers; but beyond a certain point, such falling costs are outweighed by diminishing returns from the increasing scarcity of prime wind sites and increasing costs of biomass feedstock (de Vries *et al.* 2007). C_SBB' is labelled 'solar' but represents both solar and geothermal REE technologies, where generation costs are initially much higher than 'wind' (at C_S rather than C_W). Because of knowledge spillovers, significant falls in costs (to C') will occur once generation reaches level Q_S; but returns beyond that are roughly *constant* shown as exactly constant for simplicity, but all that is really required is for cost at B' to be significantly lower than cost at A rather than increasing, thanks to the very large amount of quality sunshine and geothermal resource available in Australia, resulting in the constant cost curve BB' shown beyond generation level Q_S.

With such cost curves, we can then compare two alternate policy paths which each achieve a total generation amount of $Q_W + Q_S$ over a certain period of time (note $Q_W' + Q_S' = Q_W + Q_S$).In Path 1 (unprimed), the RElec stimulation policy maintains neutrality between technologies. An ever-expanding demand therefore expands RElec in order of cost, first expanding wind generation through A' up to A, at which point the generation cost has increased to C_S, so that solar starts expanding, reducing the LRMC to C' as generation expands to Q_S. In Path 2, before wind generation reaches A', specific policies start forcing solar generation to expand from C_S down towards B, so that wind generation expands no further than A' (generation amount Q_W'), and solar generation expands instead to Q_S' at B'. In either case, the economy must pay the 'solar development cost' of area Y; but Path 2 *avoids the extra cost X of installing high-cost, marginal wind capacity* that is first needed in Path 1 to trigger the onset of solar development.

Of course, Figure 3 omits several further features that need to be considered. On Path 2, the solar development cost must be borne earlier, which increases its present value, because it is less discounted. Also, the diagram shows the solar development cost, area Y, as the same on either path. However, on Path 2 the solar development cost must be borne mainly by the public sector (via direct spending on research and development or taxpayer spending on solar-specific market support mechanisms), while on Path 1 it will be borne by the private sector: it is not obvious which cost will be lower.

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

3.1 Origins of the Renewable Portfolio Standard

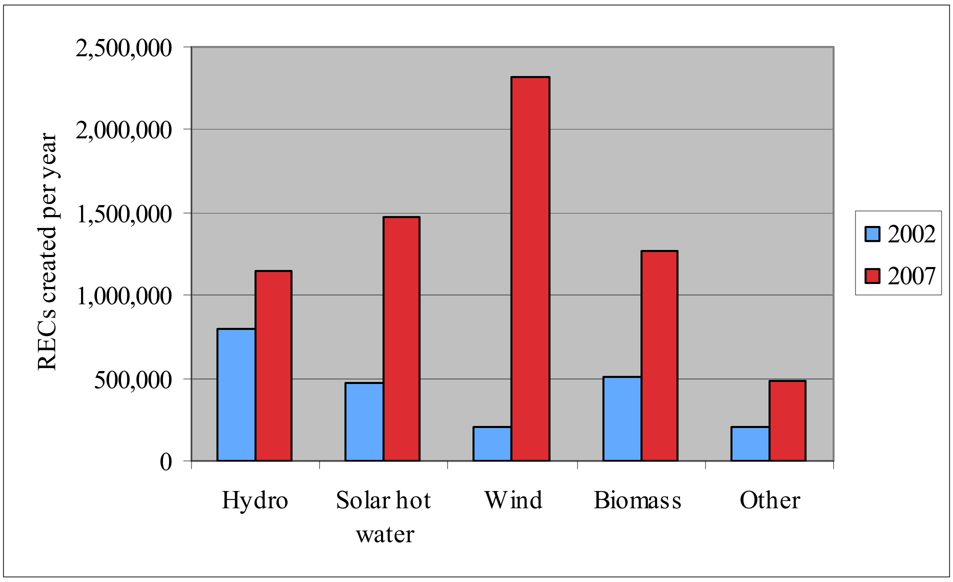
MRET is an Australian adaptation of the Renewable Portfolio Standard (RPS) mechanism originally developed in the United States. It is an RElec support mechanism that mandates that electricity retailers purchase a minimum proportion of their electricity from RElec sources. Its big strengths are that it 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

Australia’s MRET was designed to increase the country’s level of RElec generation by 9,500 GWh/yr 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 electricity from 10.5% to 12.5% by 2010. However, because electricity consumption has increased at a faster rate than anticipated, and because the recent drought has reduced hydro-electric generation, it is generally thought RElec will have no greater a percentage share of the national electricity market in 2010 than it had in 2001, despite MRET.

At first sight it seems MRET has been successful at stimulating a broad range of RElec types. As indicated in Figure 4, 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 as well as the availability of off-peak electricity tariffs for overnight boosting. Once this is factored in, Australia's MRET has not performed that differently from other countries that have used the RPS mechanism, which have 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, Renewable Energy Certificates (RECs: 1 MWh=1 REC) are created by RElec generators which are purchased by electricity retailers to discharge their MRET obligation. Of the 6,693,908 RECs created by the end of December 2007 only 0.12% had been created by solar PV and none had been created by solar thermal RElec (Office of the Renewable Energy Regulator 2008: 14).

Figure 4: RECs created under MRET, 2002 and 2007



Source: Office of the Renewable Energy Regulator 2002 to 2008

Three ways of pursuing a portfolio approach to RElec development, whilst using a RPS (ie achieving a Path 2 outcome as described in s2.3), are to use a high-volume feed-in tariff (a mechanism that guarantees above-market RElec prices) for more expensive RElec types (as done in Italy); to introduce long-term higher weights, or 'bands', within an RPS for the more expensive types (as is about to be done in the UK), or to create special sub-markets for them within an RPS (as done in some US states).

3.3 The contribution of the expanded RET to RElec in Australia

During the 2007 federal election the Labor Party promised to boost MRET by replacing it with the expanded RET. The latter is a more ambitious RPS than MRET: it aims to generate approximately 20% of the country's electricity from renewable sources by 2020 by generating an additional 45,000 GWh/yr of RElec (including MRET generation) by 2020. The legislation for the expanded RET is due to take force from 1st July 2009. In addition to the pre-MRET RElec generation, the RET and

MRET will bring total RElec generation in Australia to 60,000 GWh/yr by 2020, as detailed in Table 2.

Table 2: Pre MRET, MRET and RET RElec generation levels/targets

RElec mechanism	*RElec generation at end of mechanism: GWh/yr*
No mechanism: pre-MRET	15,000
MRET	9,500
RET	35,500
Total	60,000

During the 2007 election the Australian Labor Party (2007: 2) said the expanded RET 'will bring Australia into line with other developed nations including Europe, China and many American states' but this is not necessarily so. Both the EU and the state of California aim to produce at least 30% of their electricity from RElec by 2020 rather than the approximately 20% Australia is planning.

As shown in Table 3, the increase in the intended amount of RElec generation, to be driven by both MRET and the expanded RET between 2005 and 2020, is equal to 45% of the projected electricity generation increase over the period. The Rudd government plans to phase out the expanded RET after 2024 by which time it claims its proposed emissions trading scheme, the Carbon Pollution Reduction Scheme (CPRS), will be performing the same function, in terms of bridging the cost gap between RElec and conventional coal-fired electricity generation.

The CPRS White Paper said: '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 2008c: 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 REIec?

Table 3: Contribution of MRET and expanded RET generation to projected increase in total Australian electricity generation between 2005 and 2020

	Pre-MRET RElec generation with added MRET and expanded RET generation: GWh/yr	*Actual and projected total Australian electricity generation: GWh/yr**
2005	19,400	252,000
2020	60,000	342,000
Difference: 2005 to 2020	40,600	90,000

*Source: Cuevas-Cubria et al, 2006: 29.

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

4.1 Treasury's modelling of GHG reduction carbon prices

Treasury's modelling of the economic impact of national GHG reduction focused on four different Australian 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 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%. The commencement and 2020 emissions trading scheme carbon prices that Treasury's modelling found would be associated with the 5% and 15% scenarios are given in Table 4 (the 2020 carbon prices were quoted in 2005 prices while the commencement carbon prices were quoted in nominal prices).

Table 4: Emissions trading carbon prices modelled by Australian Treasury.

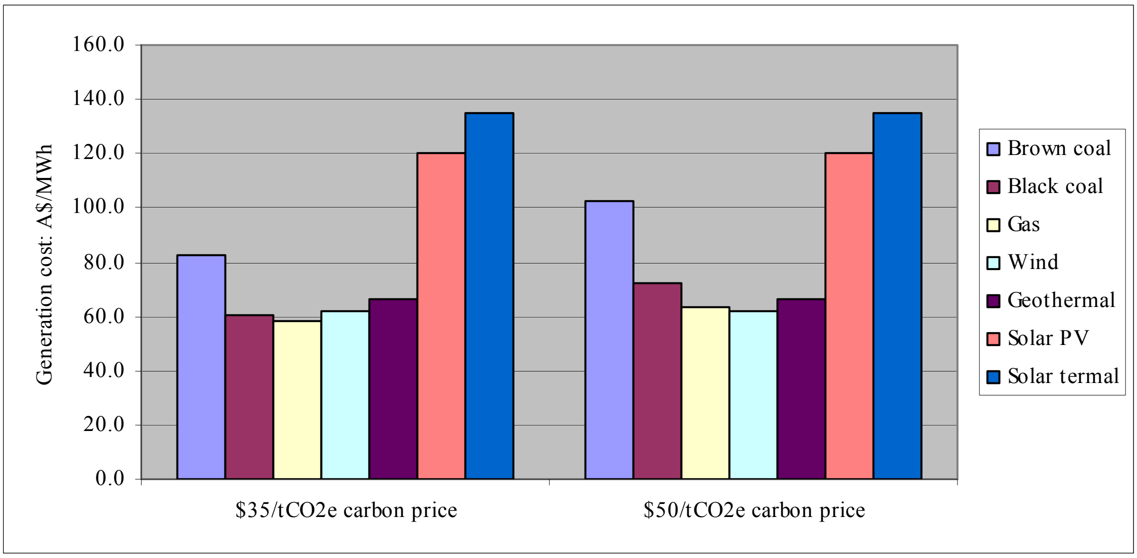
Date	*5% GHG emission reduction by 2020 carbon price: A$/tCO2e*	*15% GHG emission reduction by 2020 carbon price: A$/tCO2e*
2010	$23	$32
2020	$35	$50

Source: Treasury 2008: 139

4.2 The impact of CPRS carbon prices on RElec stimulation

Figure 5 takes the current RElec and non-RElec generation costs quoted in Table 1 then adds in Treasury's 5% and 15% 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 2.2). In Figure 5 the generation cost gap between the five different types of RElec and that of electricity generated from black coal remains significant – except for wind under the $35/tCO2e 2020 carbon price, the lower end of the wind cost range under the $35/tCO2e 2020 carbon price and the lower end of the biomass cost range under both the $35/tCO2e and $50/tCO2e 2020 carbon prices. However, if Table 1 underestimates the prices of wind and bioenergy, 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, according to McLennan Magasanik (2008), a carbon price of $120/tCO2e, that would likely be politically unacceptable, would be needed to stimulate the full cost range of all the RElec types. 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, beyond that planned by MRET and the expanded RET, by emissions trading by 2020. It also suggests that, unless carbon prices significantly rise after 2020, they won't have the RElec stimulatory effect the government is anticipating they will have after that time.

Figure 5: 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 by the White Paper, which incorporated the CPRS and the expanded RET, suggested their main combined impact would be on new electricity generation investment rather than existing investment (DCC 2008c: 13-16).

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

There has been significant criticism of the fact that emissions trading and the expanded RET will work side-by-side from 2010 until 2030. Some argue that, together, the two mechanisms will concentrate too much of Australia's GHG reduction burden on the electricity sector, resulting in higher electricity prices than would exist under the CPRS alone (CRA International 2007: 18; Productivity Commission 2008: 72). Critics also argue this concentration on electricity will have other undesirable outcomes including, it is argued, lower carbon prices than would exist if the expanded RET did not exist (CRA International 2007: 13). Several large electricity users, most notably aluminium smelters, are even pushing for 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. It also needs to be remembered 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) (McLennan Magasanik Associates (MMA) 2007: 5).

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

5.1 The likely mix of Australia's 2020 RElec

In reaching the RElec goal of 60,000 GWh/yr of RElec by 2020, the conventional wisdom is that wind generation will increase to take up at least half of the 35,500 GWh/yr difference between the 2010 level of RElec generation and the 2020 expanded RET target (MMA 2007: 6). To generate half the difference the amount of installed wind generating capacity in Australia will need to increase five-fold from a 2008 level of 1,306 MW to about 7,000 MW (assuming a 30% capacity factor). Reaching this capacity will require a 15% compound rate of annual growth between 2008 and 2020. As can be seen from Table 5, 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 5: Australian wind energy generation capacity 2001 to 2008

Year	*Australian wind generating capacity: MW*	*% capacity increase from previous year*
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, 2009

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: 5). At this stage, both the biomass and geothermal industries are confident they can deliver this balance. The biomass sector believes it can generate 10,624 GWh/yr of electricity by 2020, which would be about 9,200 GWh/yr 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: 20). The geothermal sector currently generates no electricity for the Australian National Electricity Market, but believes it can have up to 2,200 MW of installed capacity by 2020 generating about 17,000 GWh/yr of electricity (assuming a 90% capacity factor) (MMA 2008: 1). So if wind capacity scales up to 7,000 MW, biomass capacity increases to 1,845MW and geothermal can build 2,200 MW of capacity, the 2020 60,000 GWh/yr target will be reached, roughly along the lines summarised in Table 6.

Table 6: Scenario of increased RElec generation to reach 2020 RET target of 60,000 GWh/yr of RElec **generation**

RElec *source*	*Yearly generation by 2020: GWh/yr*
Pre-MRET RElec generation	15,000
MRET generation	9,500
Increased wind generation (from extra 6,200 MW capacity)	16,000
Increased biomass generation (from extra 1,200 MW capacity)	9,200
Geothermal generation (from extra 2,200 MW capacity)	17,000
Total generation	66,700

However, significant problems may be encountered in reaching the RElec generation levels in Table 6. Apart from the possible constraint 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: 12). Also, the ability to source biomass electricity from wood waste is constrained by the fact that wood waste from native forest logging cannot be used as an RElec source in most states and there is restricted capacity to expand landfill gas generation. Drought could limit 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: it 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. The sector concedes it may only have 1,000 MW capacity ready by 2020 (MMA 2008: 20).

Another influence that may thwart the attainment of the Table 6 RElec generation levels is the perverse interaction of the ability to 'bank' an unlimited amount of the RECs created under the expanded RET with the fact that the target will be reduced from 45,000 GWh/yr in 2024 to 23,000 GWh/yr in 2030 before being abolished (with emissions trading expected to do all the RElec stimulation afterwards). This could result in an early peak in RElec development, which will never reach the 45,000 GWh/yr target: similar to the 2006 peak under MRET. The Clean Energy Council (2009: 5) identified this possible flaw arguing it could result in post-2001 MRET/expanded RET RElec development never rising above about 31,000 GWh/yr: just 69% of the expanded RET target. The Council argued this could be avoided by maintaining the full 45,000 GWh/yr target through to 2030. One significant influence that could stop this happening, however, might be the inability of RElec generation to grow quickly enough to enable such major banking of RECs to occur.

On top of the aforementioned potential hurdles, the state and territory based feed-in tariffs so far announced are unlikely to significantly augment the amount of RElec induced by the expanded RET. This is because of the feed-in tariffs schemes so far announced, from the ACT scheme, are only aimed at small generators and only create a modest incentive because they are based on the net amount RElec generators feed into the grid, not the gross amount.

Even if wind, biomass and hot rock geothermal manage to deliver the extra RElec generation required to reach the RET target, solar electricity will remain a marginal player in Australia's RElec generation. 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. This is particularly the case if hot rock geothermal fails to generate significant amounts of electricity by 2020. Either a relaxation of the restrictions on the feed-in tariffs, or specific bands in the expanded RET, or tax deductions are needed for large-scale solar and geothermal power. In addition, a strengthening and expansion of the transmission network is required.

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 involves the likelihood of reaching the 45,000 GWh/yr MRET/RET 2020 target. There is a good chance it will not be reached, either because wind, biomass and hot rock geothermal power will not be able to expand fast enough to reach it and/or because long-term RECs banking will interact with the proposed phaseout of the expanded RET from 2025 to make RElec development plateau below the target. Also, it is 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 least.

The second conclusion involves the probability that Australia will eventually be able to make deep cuts in its electricity GHG emissions through the use of a significant amount of RElec. 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 particular, it is unlikely Australia will be able to exploit the long-run marginal cost reductions of solar RElec if it continues to rely on the mechanisms. Neither the market-based MRET, nor the expanded RET, can be relied upon to push the RElec industry into large quantities of solar generation sufficient be able to deliver deep cuts in Australia's GHG emissions.

The authors acknowledge the generous assistance of Dr Jack Pezzey, Senior Fellow at the Australian National University's Fenner School of Environment and Society, in the preparation of this article. This research received support from the Australian Government's Environment Research Facilities Program.

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