Policy interactions of an Australian ETS and expanded MRET

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Declaration

Except where I have indicated, the work in this dissertation is my own, and has not been submitted for assessment in another unit or course, or at another institution.

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Abstract

This dissertation examines the simultaneous operation of an emissions trading scheme (ETS) and the expanded Mandatory Renewable Energy Target (MRET) in Australia. Focussing on the electricity generation sector, I seek to answer the question as to whether MRET can be regarded as complementary or in conflict with an ETS. A brief overview of the expanded MRET and the likely form of an ETS is given, the latter comparing the two key climate change mitigation policy initiatives: *The Garnaut Climate Change Review* and the Commonwealth's *Carbon Pollution Reduction Scheme* Green Paper. The pervasive normative bias in favour of *coal* in both documents is highlighted.

A range of key economic interactions between the two policy instruments are evaluated. An important conclusion is that electricity prices are subject to three complex counteracting influences: MRET's downwards pressure on ETS permit prices while ETS permits simultaneously exert upwards pressure on fossil fuel generation costs, and MRET's additional cost impost on electricity retailers.

The importance of systemic interactions in technological innovation is examined, highlighting the barriers to entry for renewable energy represented by incumbent fossil fuel dominance. A crucial and perhaps surprising finding is that a carbon price signal alone is insufficient to stimulate structural change in energy technologies due to the 'locked-in' nature of existing fossil fuel generation technologies and their enabling social and institutional context. Other complementary policy mechanisms are needed throughout the 'innovation chain'.

I further discuss the political nature of policy instruments such as the ETS and MRET, and examine the implications of a full rendering of the Precautionary Principle. A key argument is that an over-reliance on coal and the promise of geosequestration can be tempered by policies such as MRET.

On balance, I conclude that MRET is indeed necessary and is complementary to an ETS.

Acknowledgements

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1 Introduction

1.1 Scope

The work to follow is focussed on electricity generation within the domestic Australian stationary energy sector. While of great importance to the eventual outcomes in this sector, many complexities of ETS operation cannot be considered in the space afforded. To highlight but two, the role of international scheme linkages and of domestic offsets, and their respective eligibility criteria, may radically alter the form and evolution of Australia's transition to a carbon-constrained economy. A basic knowledge of the function of emissions trading is also assumed.

1.2 Research Objectives

This dissertation examines the interactions and policy implications arising from the simultaneous operation of an ETS and an expanded MRET. The objective of this research is to address the following questions:

- Should the expanded MRET be regarded as complementary or in conflict with the ETS, and on what basis?
- What are the major interactions between these two policy instruments? In particular:
    - Impact on abatement costs
    - Electricity price effects
    - Effect on ETS permit price and the abatement effort
    - Facilitation of long term structural change
- What are the combined political implications of these instruments and their enabling policy frameworks?

1.3 Methodology

This dissertation is based on a critical analysis of relevant documents from Government and regulatory authority sources, industry reports and analysis, and the general policy literature. Of particular importance are the Garnaut Review (Garnaut 2008b) and the CPRS Green Paper (Department of Climate Change 2008a) (see section 4).

The information collected from these sources has been assessed to determine the form and context of an ETS and an expanded MRET, as well as an understanding of the principles and lessons from empirical evaluation contained in relevant policy literature. Independent reasoning has been applied to this combined knowledge to arrive at the perspectives and conclusions presented throughout this dissertation.

1.4 A note regarding ontology

This is not an economic assessment. Although economic perspectives play a key role and are evaluated in detail in certain sections, this is an assessment of public policy, its instruments, and their implementation. Policy-making must involve more than economic considerations alone, despite the importance of issues such as least cost and efficiency.

What's more, where relevant I write in the first person. This is a deliberate choice so as to make clear that, *like any policy document*, my perspectives are informed by political and cultural positions, both explicit and unconscious. Policy instruments are not politically 'neutral'; they express sociopolitical choices and this function must be recognised in any policy analysis. While I strive to be as objective as possible, there are three fundamental normative positions that form the ontological basis of my perspective and hence inherently influence my work:

1. Climate change is the greatest threat to human civilisation, and to the ecosphere on which that depends, that humanity has ever faced.
2. Fossil fuel consumption is the root cause of the significant majority of anthropogenic greenhouse gas emissions and those emissions must be curtailed radically and urgently.
3. Advanced renewable energy systems are the most viable long-term sustainable option for humanity's energy requirements, as non-renewable fossil fuels inherently produce greenhouse gases in their energy-release function *and are subject to physical depletion*.

2 Background and context

2.1 Emissions trading

The collective task of our times is to mitigate and adapt to anthropogenic climate change; in economic terms, to internalise the negative externalities of greenhouse gas emissions (GHGs). A carbon price[1] is now clearly regarded as the preeminent policy mechanism in service of that aim. By facilitating a price on carbon, an emissions trading scheme (ETS) will finally redress 'the greatest and widest-ranging market failure ever seen' (Stern 2006, i). The conceptual foundation for tradeable property rights of this form was laid out by Pigou in 1920, then developed further by Coase in the 1960s — 'the basic theory ... has been established for almost four decades' (Hepburn 2007, 376).

The primary advantages of a *cap-and-trade* ETS policy instrument over carbon tax regimes or strict command-and-control regulation are twofold: under conditions of uncertainty, an ETS sets the emissions cap directly, allowing the market to determine how that cap is reached; and the trading of emission permits in this manner is regarded by economists as being the 'least cost' economy-wide abatement mechanism. Further, the carbon price signal, rising as the emissions cap tightens, progressively changes the profitability of certain production processes, inducing shifts towards low-emission alternatives. In the electricity sector, renewable energy and carbon capture and storage (CCS) systems are expected to become increasingly competitive with conventional fossil fuel technologies, ultimately replacing them.

Yet emissions trading is not without its flaws. Its complexity leaves it vulnerable to gaming and rent-seeking behaviour by polluting interests, co-opting and manipulating the regulatory process. An ETS is likely to involve substantial administrative and transaction costs. And it remains unproven in practice. Indeed, the world's largest ETS to date in the European Union has driven little real abatement, and the free allocation of permits delivered windfall profits to existing polluters with no substantive benefit (Garnaut 2008a, 32-3; Hepburn 2007, 381-3). Moreover, the US sulphur dioxide (SO_2)

[1] As carbon dioxide (and other carbon-based gases) is the principal contributor to climate change, and GHGs are by convention represented in terms of their 'carbon dioxide equivalence', internalisation of the negative social costs of climate change is commonly referred to as a *carbon* price.

ETS, created to combat acid rain caused by coal-fired electricity generation and vaunted as the archetypal example of a successful scheme, has been sharply criticised for allegedly reducing emissions at *greater* cost than regulation would have, and that the changes that did occur were likely the result of unrelated structural shifts (such as fuel-switching[2]) that had begun *prior* to scheme introduction (Lohmann 2006; Driesen 2009 (forthcoming)).

The ontological and normative implications of emissions trading must also be recognised. Driesen (2009 (forthcoming)) argues that an ETS is the policy instrument of choice of the neoliberal political worldview and free market ideology, because it submits the vitally important policy goal of mitigation to the forces of the market. Moreover, ETS proponents implicitly assume that such markets are 'perfectible entities' that necessarily produce the required abatement outcomes (Healy and Kuch 2008, 6). Indeed, Driesen points out that the rejection of command-and-control measures, which are aimed *directly* at desired structural changes, fails to appreciate that regulation *also* puts an effective price on emissions (because failure to comply incurs a financial cost) and produces markets in the requisite technologies (pp. 30, 32).

2.2 The Mandatory Renewable Energy Target

The existing Mandatory Renewable Energy Target (MRET) — established by the *Renewable Energy (Electricity) Act 2000* — obliges liable parties to obtain a set proportion of annual electricity purchases from credited renewable sources, such that an additional 9500 GWh/yr is collectively sourced from renewables by 2010 (Tambling 2003, 2-3). The annual proportion is set by the Renewable Power Percentage (RPP) — as defined in the *Renewable Energy (Electricity) Regulations 2001* — such that each liable party must obtain RPP% of its total electricity purchases from renewables. RRPs increased annually from scheme commencement. RRPs are specified to 2008 only with a final value of 3.14% (§ 23 part 4, Commonwealth of Australia 2007). MRET is national in scope, applying to electricity grids greater than 100 MW capacity, where liable parties are

[2] Fuel switching to low-sulphur coal had already begun because new sources coming online were actually *cheaper*.

in general large wholesale purchasers of electricity such as electricity retailers and certain industrial entities (ORER 2008a, 1).

In order to demonstrate compliance, liable parties must annually obtain and surrender Renewable Energy Certificates (REC). Each REC represents 1 MWh of renewable generation, created by generators accredited by the Office of the Renewable Energy Regulator (ORER). RECs are bankable, tradeable, have no expiration date, and are terminated upon surrender (Tambling 2003, 3). Failure to comply incurs a *shortfall charge* of $40/MWh (subject to a 10% leeway), which is redeemable up to 3 years if shortfalls are made up (Tambling 2003, 4; ORER 2008a, 3). Importantly, the shortfall charge is *not indexed to inflation*, hence declining in real terms over time. Further, it is not tax deductible, which effectively means that liable parties would normally be willing to pay closer to $57/REC (Sonneborn 2004, 1803).

RECs are sold on both spot and bilateral contract markets. The bilateral market is the main game however, comprising some 80% of total volume, while the spot market is commonly regarded as a residual compliance market, supplying liabilities not covered by contracts and generally at lower prices (McLennan Magasanik Associates 2007b, 18, 31).

2.2.1 REC sources

The relative proportion of RECs generated from the various eligible renewable sources has varied significantly over the scheme's course. As of 2006, wind was the largest source at 46% (up from 6% in 2001), followed by solar water heaters (SWH) at 27% (up from 13%), with lesser contributions from bagasse, landfill gas, and wood waste (McLennan Magasanik Associates 2007b, 17). Hydroelectric's contribution has fluctuated dramatically from a high of some 60% in 2003 dropping to only 3% in 2006, reflecting variability in the water resource.

The eligibility of SWH, the only non electricity generating source, is something of an anomaly. SWH are deemed eligible due to their displacement of electric water heaters, thereby reducing emissions from fossil fuel generation (ORER 2008b). This is something of a distortion of MRET's primary purpose of encouraging renewable energy, and each

SWH installation certainly cannot be guaranteed to displace electric water heaters nor guarantee that any displaced electricity necessarily came from fossil fuels.

2.2.2 REC prices

REC prices logically reflect the relative scarcity of RECs subject to market supply and demand. In the principal context of renewable electricity, REC prices represent the difference between the *marginal* renewable generator's costs and the wholesale electricity price received (Garnaut 2008b, 354; Outhred and MacGill 2003, 4). The REC 'provides the subsidy, in addition to the electricity price, that is required to recover all costs including investment costs of the last installed (marginal) renewable energy generator required to meet the REC target' (McLennan Magasanik Associates 2007b, 21). However, the eligibility of SWH means that the long term REC price (within the shortfall cap constraint) is set by the marginal renewable generator *or* by the price required to increase SWH sales, *whichever is lowest* (pg. 28).

It could therefore be argued that SWH prices tend to act as an entry cost threshold for new renewable generators, because if their costs exceed SWH prices they may not receive REC revenues to cover them.

An industry participant advised in late October 2008 that the current REC spot price is $44.

2.3 Electricity sector

Estimates vary, but in 2005-06, total Australian electricity generation was around 220 TWh, of which about 7.6% was from renewable energy sources (6.4% from hydroelectric alone) (Commonwealth of Australia 2008, 39-40).

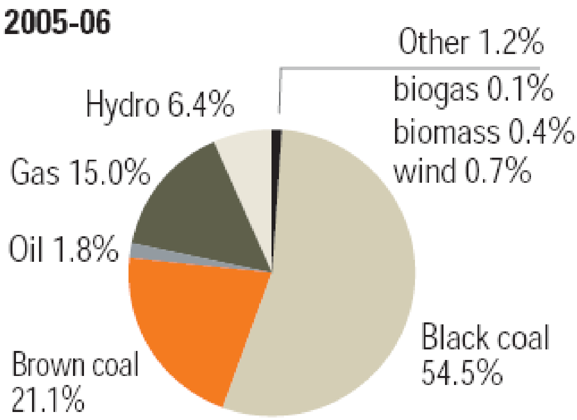

Figure 1 - 2005-06 Australian electricity generation by fuel (Commonwealth of Australia 2008, 40)

In 2005-06, Australian GHG emissions totalled 576 Mt CO_2-eq, 50% of this from the stationary energy sector; another 6% is from fugitive emissions, the bulk being in coal mining (Department of Climate Change 2008c, 3, 8). 68.9% of stationary energy emissions are produced in electricity generation — at 34.5%, the largest single contributor to the Australian total under the rules employed by Department of Climate Change (2008a) — with the sector increasing from 1990 by 53% (pg. 7).

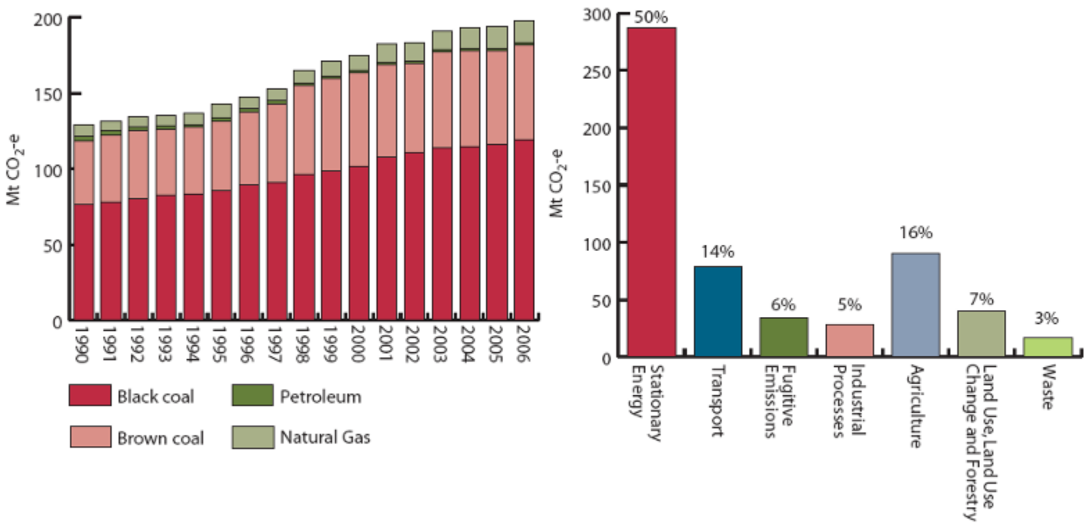

Figure 2 - Historical emissions from electricity generation, 1990-2006; total Australian emissions 2006 (Fig 6 & Fig 1,Department of Climate Change 2008c, 7, 3)

2.4 Wholesale electricity markets

Wholesale electricity markets are a particularly important focal point for both the ETS and MRET's impacts on the electricity sector. It is in these markets that key price effects from both schemes first manifest. An appreciation of the wholesale market's price-setting function is required for a full understanding of these schemes' implications and this is outlined below. The National Electricity Market (NEM), covering Queensland, NSW, Victoria, SA, and Tasmania, operates a wholesale electricity 'spot market' broadly as described (NEMMCO 2008). The Wholesale Electricity Market of Western Australia (WEM) does employ a market trading mechanism, but the bulk of energy and capacity trades occur via bilateral contracts, so price effects are likely to vary from this description.

In 'liberalised' wholesale electricity markets the system operator dynamically dispatches generators to meet demand using a 'merit order' determined by each generator's offer price, such that lowest cost generators are dispatched first. That offer price is based on individual generators' short run marginal cost (SRMC), which incorporates all variable costs of operation as well as avoidable fixed plant startup and shutdown costs (McHugh 2008, 10-1). The spot price for the half-hour period is then the offer price of the most expensive generator dispatched, and all dispatched generators receive this price; this marginal profit may be well in excess of their offer price. In this way, the most marginal generator serves as the *price maker*, and is commonly peaking gas-fired plant (Foxon et al. 2007, 47-8; Department of Climate Change 2008a, 348-50). Baseload in Australia is predominantly supplied by coal-fired generators.

Price formation in a wholesale market is illustrated below.

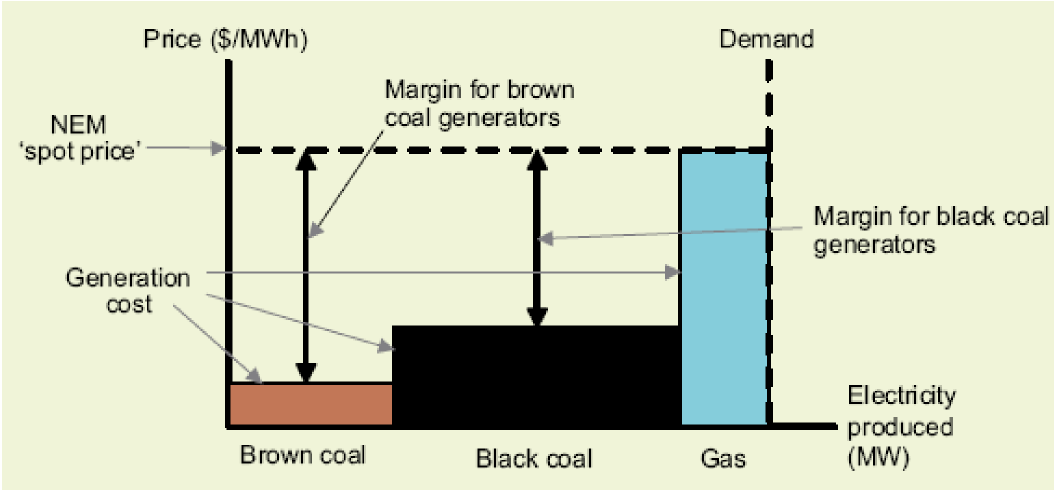

Figure 3 - Margins earned by coal generators when spot price set by gas plant (Fig 10.1, Department of Climate Change 2008a, 349)

Crucially, under these conditions, renewable generators — due to their largely non-schedulable[3] nature and near zero SRMC — are highly unlikely to be the marginal dispatched plant and hence are almost always price *takers* (Foxon et al. 2007, 47-8).

[3] Although, geothermal, biomass, and, to a lesser extent, solar thermal and hydroelectric plants can reasonably be regarded as schedulable.

3 The expanded Mandatory Renewable Energy Target

The expanded Renewable Energy Target (RET)[4] is being designed by the Council of Australian Government's (COAG) Working Group on Climate Change and Water. An options paper was released on 2nd July 2008, with a submission period extending to July 31st (Department of Climate Change 2008b). The final expanded RET design was due to be tabled at COAG's October 2008 meeting; however the meeting's formal communiqué and website make no mention of it whatsoever, and requests to the COAG unit to determine the RET design's status remain unanswered at time of writing.

The specific form of the RET is therefore not yet known. However, the two design options proposed by COAG are outlined below. For the purposes of the current analysis both options would have largely similar effects, although final treatment of the shortfall charge (especially any phase-out mechanism) would alter the price effect dynamics discussed in section 5.4.

The federal Government has committed to an expanded RET that (COAG 2008, 4):

- Would commence from 2010
- Ensures 'at least' (pg. 4) 20% of national electricity supply will be sourced from renewables by 2020 through an increased RET of 45 TWh per year, in combination with existing supply of around 15 TWh per year
- Consolidates the existing MRET and all State-based targets
- Retains the same eligibility criteria as MRET
- Will be phased out between 2020-2030 as the ETS matures and electricity prices reflect the carbon cost

An important and apparently unanswered question in the design is whether the expanded RET would be enacted as a *percentage* target as the MRET is (annual RPP) or in terms of specified *aggregate* generation. If a percentage target is used then, under the influence of

[4] While not stated explicitly, the implication is that the expanded MRET scheme will be renamed to simply RET. For the purposes of this dissertation, RET and MRET are used interchangeably.

an ETS, 20% of total electricity generated in 2020 may be significantly less than the combined 60 TWh.

3.1 Two design options

COAG is considering two design approaches (COAG 2008, 13-18). Both approaches incorporate a review in 2015 with possible target adjustments, and generators accredited before Jan 2008 would be unable to generate RECs after 2020, allegedly so as to prevent windfall gains to incumbents.

Approach 1 is closely based on the existing MRET; has a least-cost renewable uptake goal; provides strong investment incentive early in the scheme and encourages early creation of RECs to help minimise REC prices (through banking). Specific features of Approach 1:

- Lowers cost through REC market liquidity, in part due to continued eligibility of SWH
- Has high initial annual targets from 2010 but would increase at a lower rate in the early years before increasing pace to 2020
- Shortfall charge would be set above the projected maximum REC price and is not indexed to inflation
- Two options for scheme phase-out:
    - Option 1: reducing shortfall charge from 2025 to 2030, allegedly enabling the 45 TWh/yr target to be maintained from 2020-2030
    - Option 2: fixed shortfall charge for scheme duration but annual targets are reduced; this may lead to generation less than 45 TWh/yr by 2020

Approach 1 is illustrated below.

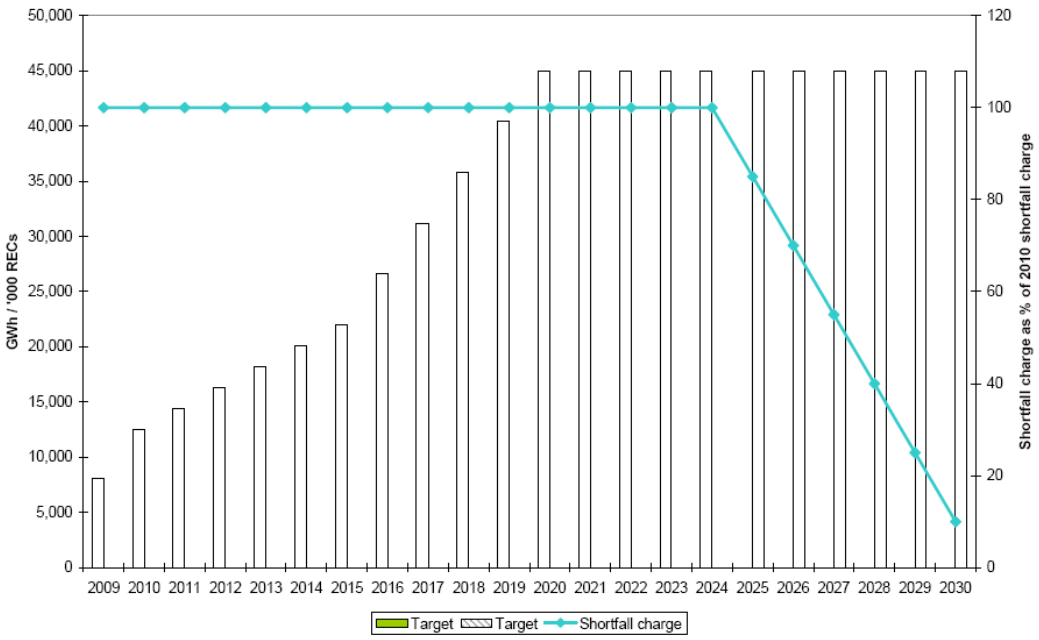

Figure 4 - RET Approach 1, showing phase-out Option 1 (Fig 3.1, COAG 2008, 14)

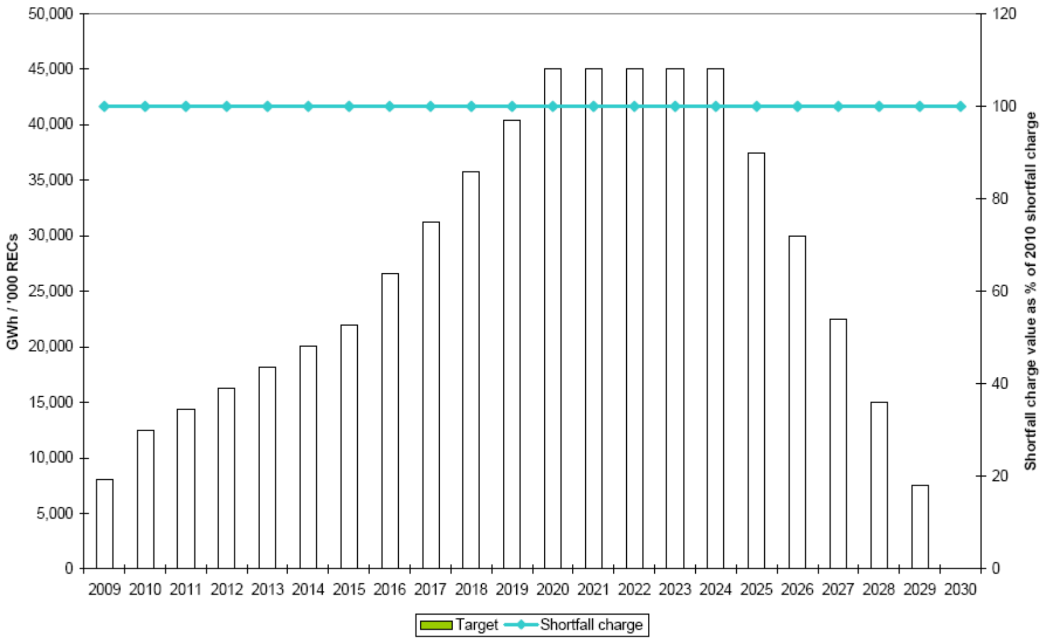

Figure 5 - RET Approach 1, showing phase-out Option 2 (Fig 3.2, COAG 2008, 15)

Approach 2 balances the objective of least-cost with the risk that 45 TWh is not actually being generated in 2020 (due to banking); it 'seeks to encourage a smoother investment profile to help bring forward new technologies in the latter part of the scheme' (pg. 13). Specific features of Approach 1:

- REC market liquidity is achieved through allowing long participation times; however, time periods for REC generation and banking are limited
- The annual target profile rises from 2010 to 45 TWh/yr by 2020, then declines from 2025 at the same rate as the rise from 2010 — this reflects the proposed 15 yr project eligibility period
- SWH would be phased out as eligible generators to 2020 and then excluded
- Shortfall charges would be similar to Approach 1 (but are not stated), seeking to 'encourage the relevant liability every year to be met through surrendering RECs rather than paying the shortfall charge' (pg. 17)

Approach 2 is illustrated below.

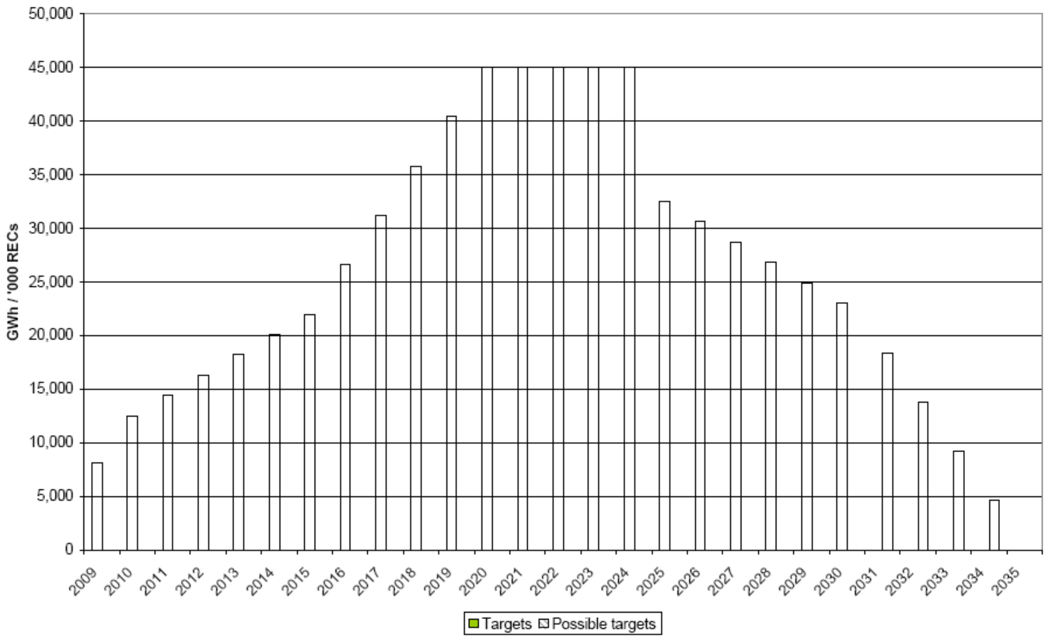

Figure 6 - RET Approach 2 (Fig 3.3, COAG 2008, 16)

4 An Australian ETS and policy framework

Two initiatives are central to the definition and design of an ETS and accompanying policy framework in Australia: *The Garnaut Climate Change Review* and the Commonwealth Government's *Carbon Pollution Reduction Scheme* (CPRS), currently as a Green Paper. Of the two, it is reasonable to conclude that the Green Paper indicates the probable direction of Government policy as it is directly produced by the Department of Climate Change, and because Minister Wong has publicly stated that Garnaut is now just one 'input' into the design process.

Garnaut's Final Report and the Green Paper each exceed 500 pages, so only a summary of the major relevant points can be provided here.

4.1 Common recommendations

In general terms both Garnaut and the Green Paper contain the following recommendations:

- A cap-and-trade ETS to begin in 2010, with some form of price limit for the initial 'transitional' period to 2014/15, the end of the Kyoto Protocol (Green Paper via price caps, Garnaut via fixed prices)
- Emission permits representing 1 tonne CO_2-eq covering 6 GHGs (see GLOSSARY)
- Initial scheme coverage to include stationary energy, transport, industrial processes, fugitive emissions, and waste sectors; forestry sector would be opt-in under CPRS but initially excluded by Garnaut
- A primary permit allocation mechanism with secondary trading market
- Annual surrender[5] of permits to cover emission liability
- Direct obligation on point of emission (hence fossil fuel electricity generators are directly liable)

[5] Garnaut did not specify *annual* compliance periods but this is within the range suggested.

- Domestic offsets from non-covered sectors and linkage to similar international markets (including international offset credits)
- Intertemporality measures, including permit banking (potentially unlimited)
- Redistribution of permit revenues to households and businesses in order to assist in the adjustment process
- Assistance to Emissions-Intensive Trade-Exposed industries (EITEs)
- Complementary policy efforts to address other market failures
- Transitional assistance measures, particularly R&D and development funding for low emission technologies

4.2 Points of departure

There are some stark differences between the two initiatives however, essentially related to impacts on the worst polluting industries. In this the Green Paper makes so many concessions, accommodations, and dispensations that realisation of the ETS's goals of least-cost abatement or environmental effectiveness may be seriously compromised.

Where Garnaut makes clear that the only fair, effective, and non-distortionary method for allocating emission permits is 100% auctioning, the Green Paper argues for free allocation to EITEs and 'Strongly Affected Industries' (SAIs), at least initially. Garnaut points out that free allocation undermines the policy objective of abatement, encourages rent-seeking and lobbying behaviour, and 'safeguards the profits of the fortunate recipients while imposing even greater adjustment costs on other emitters and on the community' (2008b, pp. 314-5). It also has no effect whatever on consumer prices as firms simply pass on the *opportunity cost* of not on-selling any freely allocated permits, giving them windfall profits as demonstrated by the EU ETS (2008a, pp. 32-3).

But the most fundamental difference from Garnaut is the Green Paper's largesse toward SAIs — those emissions-intensive industries with significant sunk costs that 'face a reduction in their profitability' and consequent 'large reduction in their asset values', because production cost increases cannot fully be passed on to consumers (pp. 341-5).

Electricity generation, and especially coal, are listed as the prime instance of an SAI. Astoundingly, coal-generators' lack of 'significant economically viable abatement opportunities' and resultant loss of market share to less emission-intensive competitiveness is given as a further reason for assistance (pp. 348-51). This is without doubt *compensation* to the worst polluters.

The Green Paper goes yet farther still. On top of general SAI assistance measures, coal generators in particular are to receive *direct financial assistance* and specific programmes dedicated to developing CCS (pp. 355-70). This direct assistance is allegedly justified on grounds of energy security and supply reliability, 'fairness', and especially the negative effect on the investment climate caused by the ETS.

Garnaut (2008b) repeatedly and unambiguously rejects any such compensatory measures, specifically labelling the very arguments employed by the Green Paper[6] as 'false' (pp. 396-7). Garnaut points out that there is neither tradition nor precedent for compensating firms for losses or gains resulting from economic reform (pp. 315-6); any similar payments to EITEs are about the lack of international carbon constraints, not compensating a loss in profit or asset value (pp. 344-5). What's more, the concept of a negative effect on investment climate is unjustifiable. Garnaut highlights that policy risk is not 'sovereign risk' and is hence a normal fact of life for market participants, and policy changes that affect asset values 'are not unusual'; the industry has been aware of a pending carbon price 'for some time'; the 'Government does not, as a matter of course, compensate asset owners when environmental or social externalities are internalised'; and where some investors may be deterred, a clear climate change mitigation response will attract others (pp. 396-7).

It should be noted that *compensation* is distinct from structural adjustment assistance for affected workers, communities, and regions, which are supported in varying ways by both Garnaut and the Green Paper.

[6] Yet Garnaut does not actually make any link *to* the Green Paper.

Box 1: Countering perverse arguments for compensation

The Green Paper's compensation measures are largely sophistry, a thinly veiled political argument for acceding to lobbying pressure. As many commentators have noted, the coal industry can now look forward to both free permits *and* direct 'assistance', making the CPRS 'as much a handout bonanza for our biggest polluters as it is an emissions trading scheme' (Kean 2008). The painful lessons of the EU ETS first Phases have not been learned. In their submission to Garnaut's ETS discussion paper, University of NSW researchers bluntly state that arguments for compensation due to negative impact on investor confidence 'have the matter *the wrong way around*', effectively penalising investors who assumed good governance would be forthcoming and changed their investment portfolios accordingly (emphasis added, MacGill and Betz 2008, 15). After all, investors have known the carbon price was coming since at least 1992 when Australia signed the UN Rio Declaration (pg. 14). Other researchers have shown in general terms that the implications of political actions such as these have a strong influence on the strategic investment climate (as policy risk) (Foxon et al. 2007, 53). And loss of market share for the worst polluting sources in Australia ***should be the whole point of an effective ETS.***

4.3 All about coal

If one theme stands out in both documents it is that our energy future and national interest lies with coal, and carbon capture and storage (CCS) will be the saviour of the industry. The Green Paper is especially redolent in this regard, for example stating that '[c]oal is the most plentiful and broadly distributed energy source on the planet' (pg. 29) — evidently the immensely greater abundance of solar energy does not factor into this perspective.

Despite recognising that an ETS should rightfully result in 'winners and losers' (pg. 80), the Green Paper makes much of Australia's role as the 4th largest coal producer and largest exporter, and that maintaining this is firmly in the national interest (eg, pg. 356). Time and again the Green Paper extols the virtues for CCS and proposes yet more funding[7], where it could instead have pushed for renewable energy alternatives with at least equal force.

Garnaut's (2008b) discussion of technology innovation refers far more to CCS and its value for coal exports than renewables. Again and again the opportunity to at least balance the picture with recognition of the national interest inherent in the great energy and export potential for renewable technologies goes begging (for example, pp. 31-2). Chapter 20 on energy transformation again focuses on coal and CCS, with only minor mention of renewables, and even then marginalising them as but 'intermittent'. Quite amazingly, Garnaut sees not only a continuing future for brown coal — the dirtiest of all fossil fuels — but even an expansion of it for domestic consumption and for export (pp. 392, 474). All in all this is a rather glaring case of picking winners, given Garnaut's exhortations to avoid doing so, discussed below.

The normative position deeply embedded in both policy documents is as unambiguous as it is unable to vision alternative realities. This position is examined in section 6.3.

4.4 Positions regarding MRET

The Green Paper says little about the expanded MRET other than to note its existence. There is no discussion of its role as a complementary policy mechanism nor of any conflict with the ETS. A minor reference is made to the Ministerial Council on Energy commissioning a review of 'energy market frameworks' in light of the introduction of the ETS and expanded MRET. No position statement is presented. However, as the expanded MRET is current Government policy, the implication is that it *will* be implemented.

Garnaut *does* discuss the expanded MRET and takes the explicit position — initially under the heading 'Pandering to pet solutions' — that it 'will not address any additional market failures' because, in his view, it functions only as an 'additional emissions

[7] Estimates of existing direct and indirect State and Commonwealth subsidies to the fossil fuel industries total at least \$6b/yr and may be greater than \$9b/yr (Diesendorf 2007, 289-91).

reduction measure', and that its 'potentially distorting effects can be phased out' (pg. 317). Seemingly without any intended sense of irony, Garnaut then counsels governments to not 'pick winners' and instead 'fix market failures', avoiding 'policies that skew investment decisions towards technologies that are currently in favour' (pp. 317-8). Such statements are rather strangely at odds with the predilection for the continued use of coal and the explicit support for CCS that pepper the review. Most importantly, Garnaut appears to have failed to appreciate the vital function that a mechanism like MRET plays in fostering technological innovation, detailed in section 6.

4.4.1 Garnaut's analysis of MRET

At slightly under 3 pages, Garnaut's (2008b) analysis of MRET is not overly detailed (pp. 353-6). The main points are itemised in Table 1 below; these are addressed directly in section 8.

Table 1 - Garnaut's analysis of MRET implications for ETS

Item	Description
GR01.	The expanded MRET would drive increasingly expensive technology deployments, both those 'currently favoured' and emerging. REC prices would rise as a result, causing higher electricity prices.
GR02.	The ETS and MRET reflect different policy objectives and operational characteristics. The ETS focuses on emission constraints and is technology neutral, operating as a competitive market to abate at least cost. MRET is technology prescriptive and set by Government.
GR03.	Simultaneous operation of the two policy instruments 'will potentially be detrimental' to electricity producers and consumers alike due to their 'clash of objectives'.
GR04.	Reasonable assumptions of the effects of interaction indicate that by 2020 some 8000 MW of additional renewable capacity (largely wind) would displace gas plant, costing an extra $750m-$1.1b per year.
GR05.	MRET 'could' cause the 'perverse consequence' of *additional* coal

	generation in excess of 2000 MW as gas plants are 'crowded out' by renewables. A situation that would not occur under the ETS alone.
GR06.	If MRET's ramp-up rate was 'aggressive'[8] while the ETS trajectory was 'gentle', MRET would cause very low permit prices, high REC prices, high electricity prices, and little other abatement activity. If the ETS trajectory was also 'aggressive', prices become more variable. In both situation's, MRET is regarded as 'cannibalising' the ETS.

Garnaut (2008b) further argues that if the expanded MRET is to proceed, the existing non-indexed $40/MWh shortfall charge should be retained as it provides the 'best opportunity for a smooth transition' into the broader ETS (pg. 355). The shortfall charge is effectively an upper limit on MRET's higher costs relative to the ETS. It approximates a permit price of $40/t CO_2-eq, and as permits rise beyond $40-45 the ETS would 'come to dominate investment decisions and the economic effects of MRET would be subsumed' within it[9] (pg. 355).

Remarkably, the *only* external source cited in Garnaut's 3 page analysis is a report on the implications of a 20% target from CRA International to the Australian Petroleum Production & Exploration Association. Obviously such industry perspectives have a right to be heard. But CRA International is notorious for its role in the fossil fuel industries' lobbying activities and intense efforts to prevent Australian climate change mitigation policies (Pearse 2007). The lack of balance here is then greatly concerning, not the least of which for the omission of clear advice in MRET's favour found in reports actually *commissioned by* the review (see section 6.2).

[8] The term's 'aggressive' and 'gentle' are vague and not defined. However, it seems reasonable to conclude that the COAG design options would be regarded by Garnaut as 'aggressive'.

[9] This approximation is under current conditions and average emission intensity ratio of 1.0-0.9t CO_2-eq/MWh for electricity supplied outside of MRET.

5 ETS & MRET: key economic interactions

This section examines the key economic interactions expected to occur between the ETS and expanded MRET over the short to medium term from scheme commencement in 2010. It is a distillation of analysis and insights from a range of sources, in combination with my own interpretation and reasoning.

5.1 The ETS carbon price signal

The principal effect of an ETS in the electricity sector is to increase the operational costs for fossil fuel generators: each unit of electricity generated now incurs the additional cost of the previously unpriced negative externality of GHG emissions, as determined by the ETS permit price. This cost can be modelled as a function of the emissions intensity of the specific fossil fuel plant (∆ indicates increasing change). That is:

> ∆ *operating cost* ($) = *emissions intensity* (t CO_2-eq/MWh) x *electricity generated* (MWh) x *permit price* ($/t CO_2-eq)

However, this cost could be calculated at any point during the liability period; ie, the relevant permit price is that determined at the time of permit surrender[10].

This additional cost is incorporated into each generator's short run marginal costs (SRMC), which therefore drives up the wholesale electricity price (see original description in section 2.4). Different fossil fuel generation technologies, and specific plants, have significant variation in emissions intensity, with combined cycle gas turbines (CCGT) being the least intensive of existing generation technologies. Hence, SRMC will increase by different relative proportions for different fossil fuel generators, with brown coal being the greatest and gas the least. The ETS will therefore induce both changes in the dispatch merit order and fuel switching among fossil fuel generators as costs rise asymmetrically, with gas becoming progressively favoured over coal. Figure 7 below shows average operational emissions intensity by generation technology (CCS is of course predicted only).

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[10] Subject to firms' usual risk management strategies such as permit banking, derivatives markets, etc.

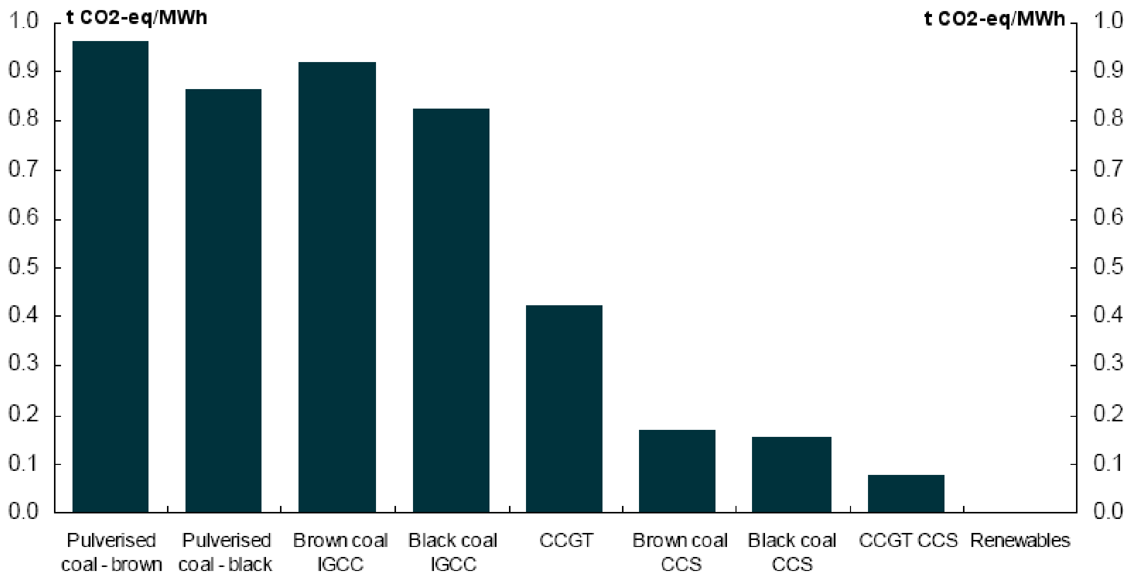

Figure 7 - Emissions intensity of electricity technologies (units changed from kg CO_2-eq/kWh, in Chart 6.24, Australian Federal Treasury 2008, 173)[11]

The effect on the wholesale electricity market is therefore to increase the market price by the relative increase in SRMC of the marginal dispatched generator, again commonly gas. As the Green Paper highlights, this SRMC differential will tend to reduce the profits earned by coal generators, as illustrated below: the spot price increases by $Z, the carbon cost for the marginal generator, where coal generator's carbon costs ($X and $Y) are significantly greater than $Z. However, it should be noted that even in this case the additional revenue received by *all* generators with SRMC (and hence offer prices) below that of the marginal dispatched generator is economic 'rent' — or supernormal profit — that would not occur if any such entity was themselves the price setting marginal generator.

[11] See GLOSSARY for definition of acronyms.

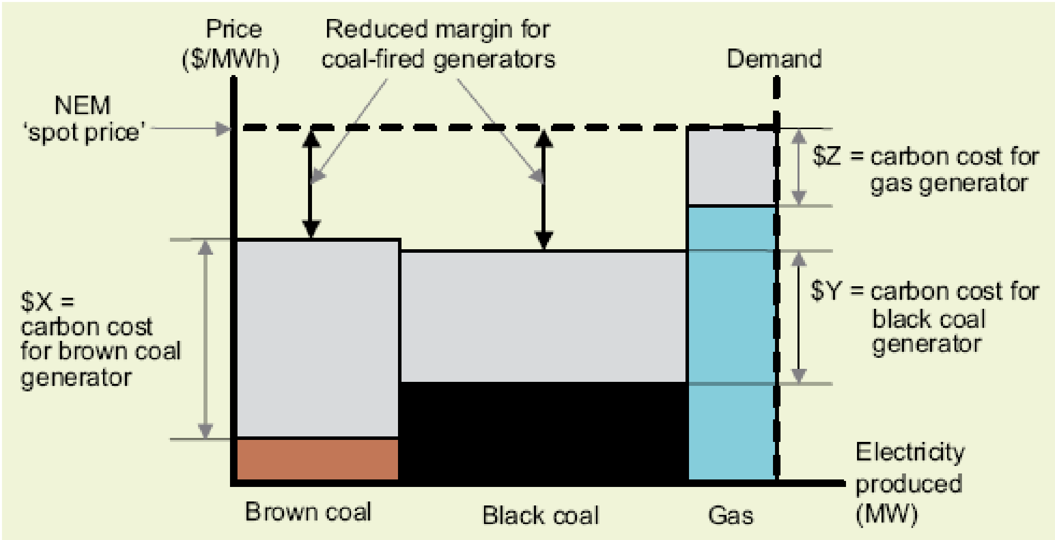

Figure 8 - ETS price effect on wholesale electricity market (Fig 10.2, Department of Climate Change 2008a, 350)

5.2 Fungibility

No scheme design proposals include any form of fungibility or interchangeability between RECs and emission permits: RECs cannot be exchanged for permits nor directly surrendered to meet obligations under the ETS, and vice versa. Further, liable parties under each scheme are separate and discrete entities: MRET applies to wholesale electricity *purchasers* whereas the ETS applies to emitters, which in the electricity context means fossil fuel *generators*. Simultaneous operation therefore avoids the situation of double counting (eg, if a REC was also considered a unit of abatement) and double coverage (the same party liable twice), which are a risk under policy interaction (Oikonomou and Jepma 2008, 147).

The primary implication of non-fungibility is that the ETS is not compromised by the allowance of permits derived from non-abatement activities[12]. That is, while a REC represents renewable energy generation which is of course emission free (at point of use), that generation is *not* abatement as such. However, for a given level of electricity generated from a portfolio of plants, increased renewable generation will result in reduced emissions. This reduction has value within the ETS as a decreased emission

[12] Notwithstanding the presence of domestic and international offsets in the scheme.

liability for that displaced fossil fuel generator. The abatement is thus 'real' in that emissions are measurably decreased, whereas if a REC could be surrendered directly under the ETS it would only represent abatement *potential*.

5.3 MRET effect on abatement

To reiterate: MRET and expanding renewable generation — both absolute and as a relative proportion of total electricity generation — *does not* ***directly*** *result in GHG emission abatement*. This is because renewable generation plants are separate from existing fossil fuel plants: they are not an incremental or marginal technology addition or component replacement within a fossil plant that allows that plant to continue operation at reduced emissions intensity. A renewable generator coming online does not in and of itself cause emissions to reduce directly because that generator has no immediate effect on emission sources. Only when any mandated increase in renewable generation *displaces* existing and potential fossil plants, causing them to reduce or cease output, does abatement occur, and I classify that effect as *indirect*. Further, only by displacing *existing* fossil plant does MRET induce indirect abatement: if renewable generation comes online to meet some *increase* in electricity demand, displacing fossil plant that may otherwise have provided that capacity, then renewable energy has increased while emissions have remained *static*.

Moreover, it should not be assumed that even a 20% RET necessarily results in displacement of existing fossil plant. As Garnaut (2008b) observes, total electricity demand over time is sensitive to the emissions trajectory, other policy influences, and the degree of fuel switching towards electricity (pp. 355, 468). Some analysts suggest that the 20% target would equate to only 60% of forecast demand increase in the NEM (Riesz 2008)[13]. Whatever the eventual proportion, it is at least plausible that increased renewable generation induced by MRET causes only minor displacement of existing fossil plant, and could potentially displace none at all.

[13] It is not clear if this projection included the impact of an ETS however.

So while MRET serves to stimulate structural change away from fossil fuels, reducing costs and supporting innovation (see section 6), it is *not* a direct abatement instrument.

5.3.1 Marginal abatement costs

MRET also has no direct effect on fossil fuel generators' marginal abatement costs (MAC) under the ETS. This is because, as outlined above, the technology deployments mandated by MRET do not affect the emissions intensity of existing fossil plants. Increased renewable generation has no bearing on the ability or cost for an existing fossil fuel generator to reduce their emissions intensity at the margin (reduced emissions for same electricity output). Incremental technology change such as fuel washing, boiler efficiency improvements, ultracritical coal combustion techniques, etc., are simply unrelated to renewable energy technologies and their level of deployment.

However, this analysis principally applies to particular fossil fuel generation *plants* and not to the firms that own and operate them per se. If such a firm adopts a portfolio approach to its generation assets, diversifying generation technologies, then the MAC for that firm's total output *as a whole* may be affected by MRET. In this scenario, the cost reductions for renewable technologies induced by MRET, in combination with the additional REC revenue stream (up to the shortfall cap), may result in a levelised cost for equivalent renewable generation that is less than the additional cost for improvements at the margin of existing fossil fuel assets. But of course deploying new renewable generation assets is a long run investment decision for the firm, where the MAC for existing assets (as sunk costs) is in the short run.

5.3.2 Displacement

A number of analysts have noted that additional renewable generation, such as that induced by MRET, will tend to displace existing marginal fossil fuel plants within wholesale electricity markets (del Río González 2007; McLennan Magasanik Associates 2007a; Australian Federal Treasury 2008). Predominantly this will be peaking gas plant in Australia, because of their role as the marginal generator, especially at peak demand. This occurs because, as explained in section 2.4, renewable generators are almost always price takers. Further, they are likely to 'shadow bid' the highest-cost dispatched generator during the trading interval when renewable energy is available, so as to maximise revenue (extending analysis in McLennan Magasanik Associates 2007a, 30). Hence, once sufficient renewable energy is available, the net result is that renewable generators are dispatched to meet the dynamic demand requirements, thereby displacing more expensive marginal gas producers that would otherwise have met supply. The situation is illustrated below.

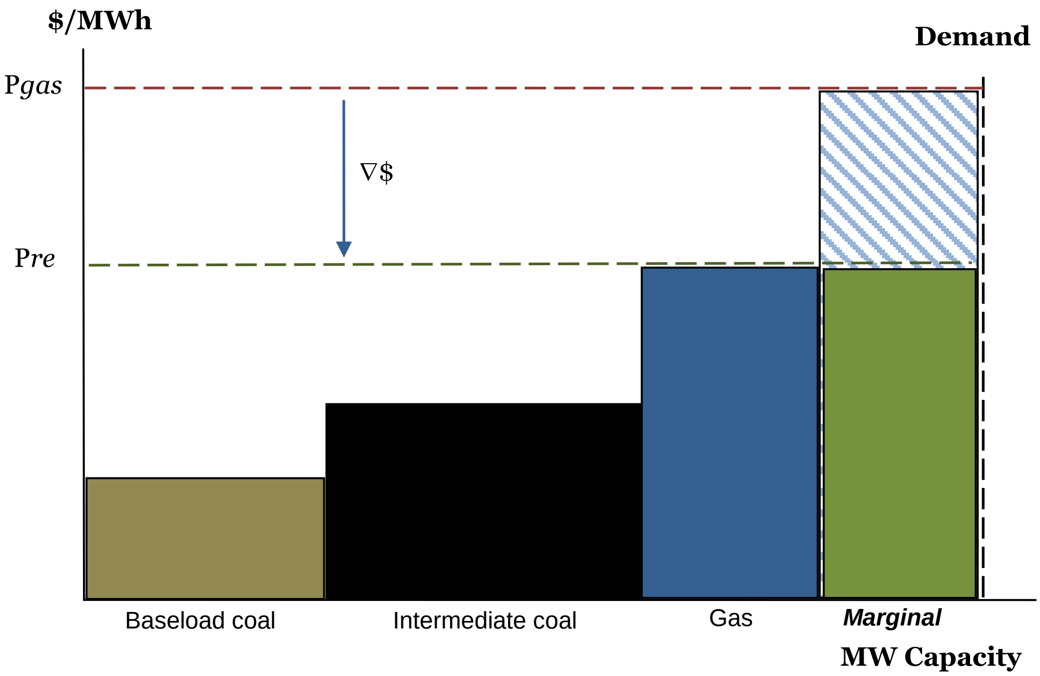

Figure 9 - Renewable generator displaces marginal gas generator

In Figure 9, the marginal peaking gas generator (blue hatched) is displaced by a renewable generator (solid green) in satisfying the higher demand. This renewable generator has shadow bid the previous highest-cost dispatched generator (solid blue), so sells at the same price, P*re*. This is of course only one illustrative scenario. Renewable generators would offer into the market at a range of price points, not only at the margin — all else being equal, a renewable generator must sell electricity when it can be generated and will simply take the spot price available at that time. Displacement of peaking gas would then occur because, for example, renewable generation was available at base or intermediate demand levels, changing the dispatch order of plants other than just peaking gas generators.

5.4 Price effects

A number of important price effects occur in the electricity sector under the ETS, MRET, and their interaction.

5.4.1 MRET effect on ETS permit price

If MRET induces sufficient renewable generation to displace existing fossil fuel generators, then the emissions avoided by that displacement serve to reduce the relative scarcity of emissions under the ETS. That is, for a given emissions cap, emissions avoided due to MRET's displacement effect are available to be 'used' by other actors covered by the scheme. The volume of emissions 'available' are then higher than would otherwise be the case, and so are relatively *less scarce*. Reduced scarcity is reflected in the ETS by dampened permit demand, and hence a reduced permit price. MRET can therefore be expected to put downwards pressure on the ETS permit price, at least during the short to medium term of scheme operation. After a certain point the emissions cap would be such that generators displaced by MRET would not have been able to continue operation in their original configuration in any case.

5.4.2 Effects on electricity prices

By displacing marginal generators, increased renewable generation would tend to put downwards pressure on the wholesale electricity spot price. As can be seen in Figure 9, displacement of a marginal gas generator caused the spot price to fall from P_{gas} to P_{re}. Revenue for all generators operating during that trading interval is then reduced by the amount ∇$. Importantly, this effect occurs when renewable generators enter the market (they are able to make a normal profit) and is not a function particular to MRET *per se*.

Conversely, the ETS price signal *increases* the wholesale electricity price because fossil fuel generators — who dominate the market — pass on their additional operational costs, as described in section 5.1.

Electricity *retailers* are of course affected by these wholesale price effects. In the absence of regulatory price controls, changes in electricity costs would be passed on to consumers.

However, retailers also have the additional cost impost of purchasing RECs to satisfy their MRET liability; this REC revenue is of course the parallel mechanism by which renewable generators cover operational costs, thereby passing MRET's costs on to consumers (del Río González 2007, 1374). Retail electricity prices are therefore subject to three interrelated but broadly opposing influences: upwards pressure on wholesale prices from the ETS, in part counteracted by downwards pressure from MRET on the ETS permit price itself, combined with the REC price cost impost for retailers.

In his survey of the policy literature, del Río González (2007) notes that the end result for retail electricity prices of the latter two MRET-related influences is 'ambiguous', and that the interaction between policies like MRET and an ETS, as described above, 'is a complex one' (pp. 1373-4). These complexities are illustrated below.

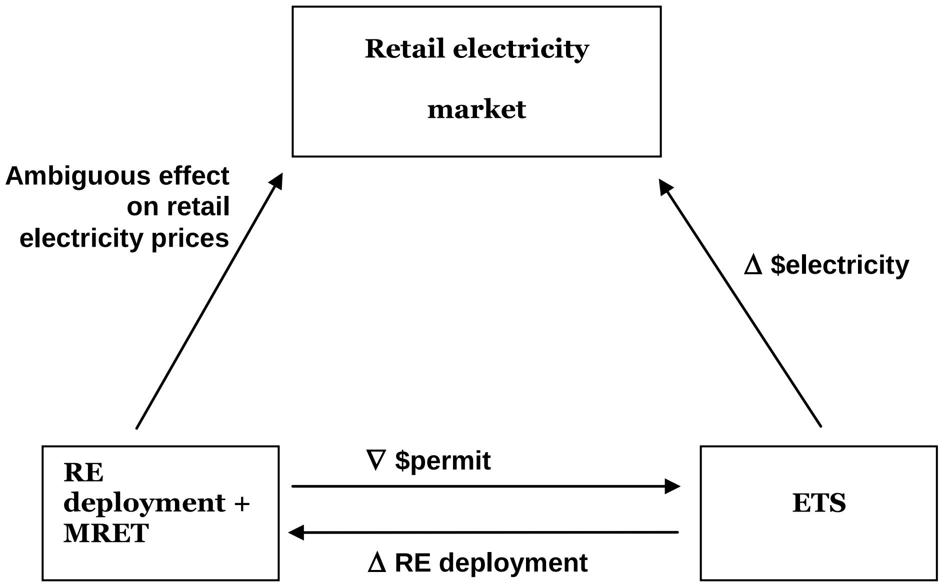

Figure 10 - Interactions between electricity market and policy instruments (reproduced with minor modification from del Río González 2007, 1373)

5.4.3 Long run investment decisions

Electricity prices received by generators should 'in principle' cover long run marginal costs (LRMC) (McLennan Magasanik Associates 2006a, 2). New entrants are then only viable if the average wholesale electricity price received is greater than LRMC over the expected plant life, taking into account capacity factors and the prices received at various times of operation (peak, shoulder, etc.). In evaluating whether to invest in a new generation plant, firms will make use of techniques such as the *levelised cost* of each unit of electricity generated (ie, $/MWh) (Foxon et al. 2007, 45). Levelised cost considers total generation over the plant lifetime (revenue) divided by the total costs of construction, investment, and operational and maintenance costs, incorporating an assessment of the interest rate, all expressed in net present value terms (Alonso et al. 2006). The long run average cost (LRAC) curve of a new technology is also a key input to the investment decision, representing the total costs of production over cumulative output; LRAC is discussed in section 6.

Clearly, for all firms the trajectory of ETS permit prices over time is a key influence on levelised cost, the decision to continue operation, and the form of future capital investment. In the electricity sector, fossil fuel generators will face declining profitability and increasing costs as the permit price rises, while renewable generators will experience much the reverse. Fossil fuel generators may well be forced to cease operation of existing plants that cannot accommodate progressively more severe emission constraints substantially before end of plant life.

Renewable generators of course receive the additional REC revenue stream under MRET, and this will be taken into account for any decision to enter the market. On balance a firm would invest in renewable energy technology if the combined revenue from wholesale electricity market sales and REC prices meet or exceed projected LRMC for the plant lifetime.

$$\textit{revenue}\ (\$) = \textit{wholesale electricity receipts}\ (\$_{EL}/\text{MWh}) + \textit{REC price}\ (\$_{REC}/\text{MWh})$$

Investment decisions would also have to take into account that such projects can be expected to continue operation once the expanded MRET begins to wind down from 2020 and REC revenue is hence removed. Secondly, as REC prices are subject to demand and supply interactions, REC revenue is potentially volatile if the expanded MRET induced some form of overbuild in renewable generation. And crucially, any investment decision must also take into account the effective REC price cap represented by the

$40/MWh shortfall charge: as this is not indexed, the cap is in effect progressively falling in real terms, making REC revenue increasingly marginal and a declining factor in the investment decision.

The decision to invest in new renewable energy projects therefore depends on the net effect of complex interactions between declining technology costs, wholesale electricity prices, and the REC revenue stream, all operating within the overarching ETS.

5.5 Least cost

A key objection to the simultaneous operation of MRET and an ETS is that abatement no longer occurs at economic 'least cost'. This is implicit in Garnaut's (2008b) criticisms, and the entire purpose of the CRA International report (2007) mentioned in section 4.4.1. Yet modelling of a complementary measure very similar to MRET[14] by McLennan Magasanik Associates (2007a) actually found that under certain conditions the outcome could be a net *benefit* to the economy, especially over the long term.

The question of least cost is highly sensitive to the timeframe. A policy environment that may cause higher costs in the short term may result in greatly reduced costs in the long term. Incremental improvements to existing fossil fuel technologies may well turn out to be good money after bad once the emissions cap inevitably tightens. Stimulating structural change to renewable energy alternatives through MRET causes the necessary investments to begin earlier, which in turn leads to faster declines in capital costs (McLennan Magasanik Associates 2007a, 38, 44). It also tempers an overly narrow focus on short term abatement at least cost that 'may be suboptimal in the long term if these reductions result in locked-in use of carbon-intensive technologies for the next decade' (Hepburn 2007, 384); see section 6.3.

Moreover, least cost of *abatement* is not the only factor to consider. Renewable energy technologies also engender a range of other benefits beyond those recognised within the ETS. Displacing coal, for example, has benefits from reduced local pollutants;

[14] The complementary measure is based on a strict emissions intensity of 0.2t CO_2-eq/MWh, which would make effective CCS eligible.

socioeconomic gains in development, employment, and investment; reduced fossil fuel dependency and energy security risks (del Río González 2007, 1372). Many studies have highlighted the net benefits in health and environmental integrity in a shift to renewables, including dramatically less water consumption in both coal mining and thermal plant operation — a positive that should not be overlooked in the context of an Australia adapting to now-unavoidable climate change impacts. Analysis of renewable energy's benefits in Australia show significantly greater job hours per unit of electricity generated (see for example Diesendorf 2005; MacGill et al. 2002), and 'vast' export potential for indigenous technologies and services that would be developed in any serious effort to harness Australia's abundant renewable energy resources (McLennan Magasanik Associates 2006b). Overall net job *gains* are even projected from an assisted transition away from coal in areas such as the Hunter Valley (Bill et al. 2008). The policy objectives underlying both the ETS and MRET, and the sociopolitical context of which they are a part, are then greater than somewhat reductionist assessments of economic least cost.

6 Structural change toward decarbonised electricity generation

6.1 Can the ETS alone stimulate structural change?

The 2006 Stern Review explicitly states that '**[c]arbon pricing alone will not be sufficient to reduce emissions on the scale and pace required…**' (emphasis added, Stern 2006, 346): support for R&D and early stage commercialisation investments for new technologies is also necessary, as well as addressing other barriers to entry. The ETS — a price on carbon — is necessary but *not sufficient* to stimulate the structural change toward decarbonisation urgently required, especially in the energy sector. As well as addressing specific market failures such as the positive externality of research or the first-mover disadvantage and natural monopoly characteristics of electricity infrastructure, *other complementary policies are called for*. This view is echoed in various ways by a range of other authors (such as Healy and Kuch 2008; Foxon et al. 2007; Outhred and MacGill 2003; Sonneborn 2004; del Río González 2007).

In essence, the ETS will not operate under conditions of *ceteris paribus*. All else is *not* equal because renewable energy technologies are not competing against fossil fuels from the same starting point: fossil fuel technologies are the incumbent *dominant design*, and a carbon price alone does not address the power and the inertia of this incumbency.

To understand why this is so, we need to appreciate the *innovation chain* of technology development and progression to market competitiveness.

6.2 The Innovation Chain

In one of three reports commissioned by the Garnaut Review on the subject of innovation, Foxon et al. (2007) provide a compelling overview of innovation systems theory and the role of complementary policy instruments in stimulating structural change in the energy sector. Central to this work is the articulation of the innovation chain, a realisation of the non-linear progression of technology development, incorporating systemic feedbacks and the roles of different interacting actors. Crucially, this construction recognises the complementary forces of 'market pull', once commercialisation is achieved, and 'technology push' from policy instruments while technology is still immature. The innovation chain is illustrated below.

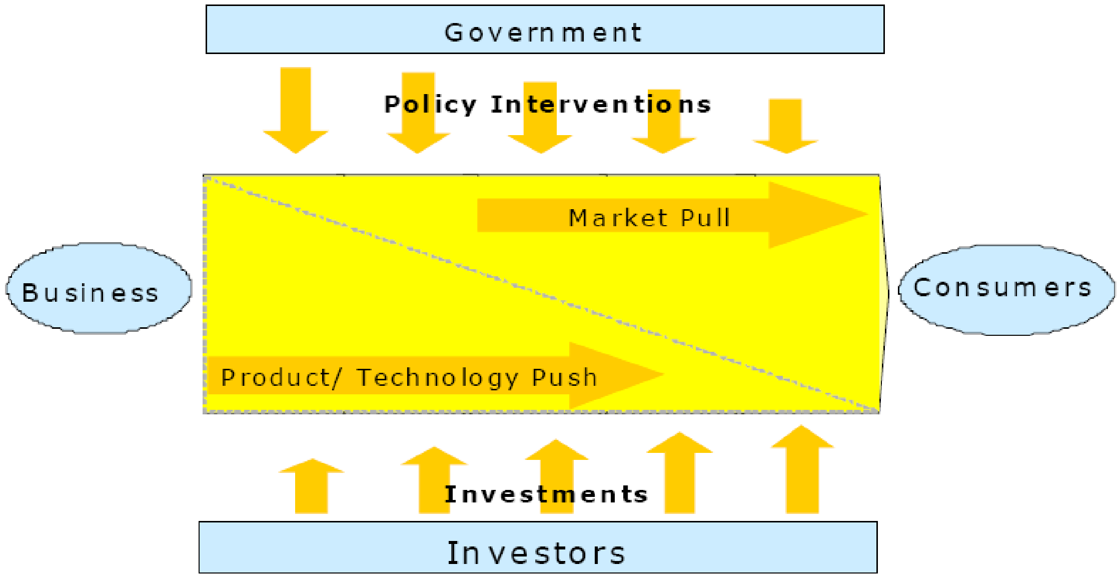

Figure 11 - The Innovation Chain (Fig 2.2, from Foxon 2003, in Foxon et al. 2007, 28)

Foxon et al. (2007) identify three key themes within innovation systems approaches (pp. 19-21): the importance of recognising *systemic interactions* affecting innovation, including "*systems failures*" that extend beyond economic market failures into realms such as institutional biases; the fact that firms always operate within the constraints of *uncertainty and "bounded rationality"*, where innovation often results from 'learning-by-doing, learning-by-using and learning-by-interacting' and innovation is 'necessarily characterised by uncertainty' about markets, technology potential, and the regulatory environment; and the key role played by the *institutional set-up* in affecting the direction and pace of technological innovation, as institutions, and social norms and expectations (especially regulations and regulatory authorities) dictate the "rules of the game".

These insights, which critically stem not only from theory but a range of empirical studies and observations, indicate that 'a mix of policies is needed to promote successful innovation, which goes beyond just support for R&D and pricing carbon emissions'

(Foxon et al. 2007, 28). Specifically, and as also described in the Stern Review, three distinct types of policy measure are necessary (pp. 29-30):

1. A carbon price
2. Direct support for innovation at the various stages of the innovation chain, including *price support mechanisms*, particularly for renewable technologies, such as feed-in tariffs (FiT) which have proven so effective in Europe, and market obligation systems like the UK's Renewable Obligation and Australia's MRET
3. Addressing other barriers to technology adoption

The application of these measures to the innovation chain is illustrated in Figure 12 below.

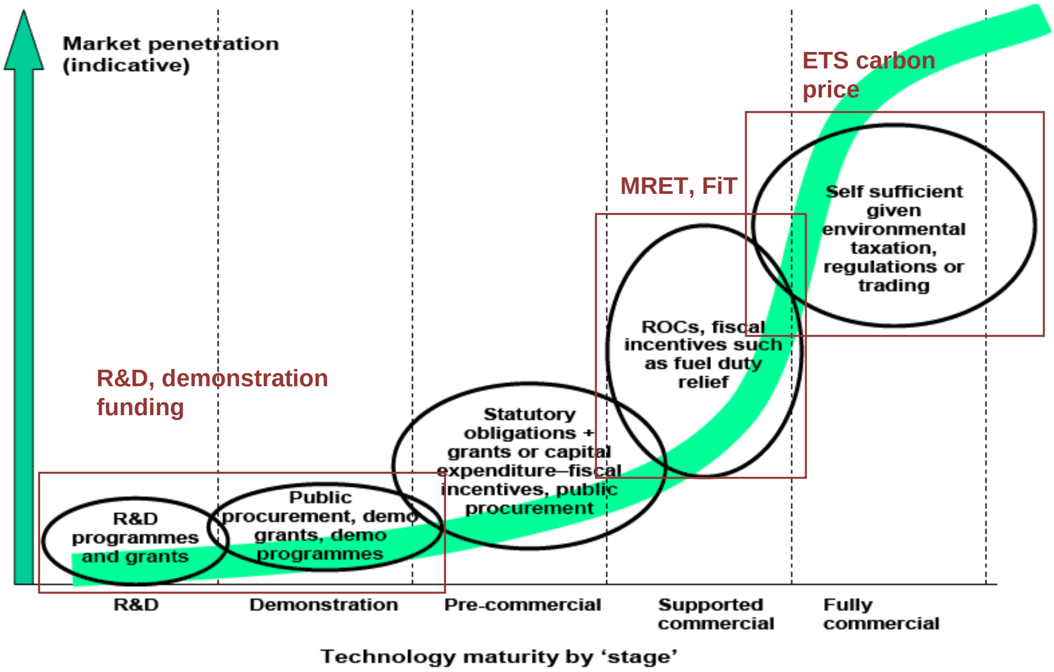

Figure 12 - Policy support of the innovation chain (modified from Fig 3.1, Foxon et al. 2007, 41); note: ROCs is Renewable Obligation Certificates, analogous to MRET RECs

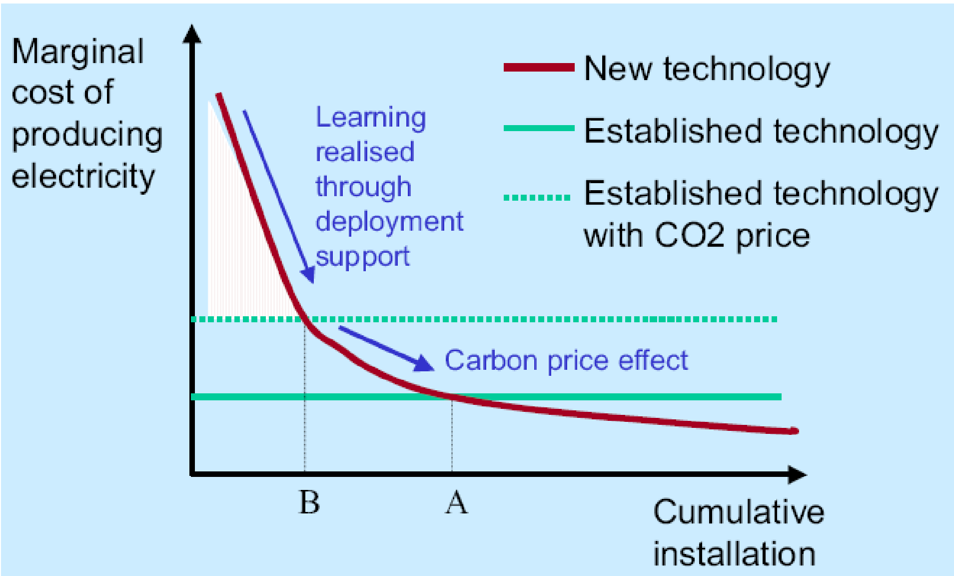

Figure 13 - Interaction between carbon price and deployment support (Fig 16.6, Stern 2006, 359)

Similarly, the Stern Review previously highlighted the crucial role that 'deployment support' mechanisms play in complementing a carbon price signal in stimulating technology innovation[15] in the electricity sector, such as for renewables. Stern (2006) makes clear that these policy mechanisms come *after* the initial support given to R&D and demonstration, assisting development of the technology and reducing costs 'to the point that deployment can begin' (pg. 359). Price support mechanisms are clearly an effective instance of this deployment support. The complementarity of these two policy instruments for innovation is illustrated in Figure 13 above — under a carbon price the degree of cost reduction needed to compete with incumbent technology moves from point A to point B.

Of the three necessary policy types above, both Garnaut (2008b) and the Green Paper clearly recognise the need for a carbon price. Garnaut broadly recognises the innovation chain and the need to address commonly understood market failures and barriers to entry such as those related to electricity network infrastructure; the Green Paper is relatively weak in this regard and defers much assessment to COAG's working group and the Wilkins Review of complementary policy measures[16]. The second measure, direct innovation support, is addressed in both Garnaut and the Green Paper but only in the initial stages of the innovation chain through funding for R&D and demonstration projects. The seminal role of *deployment support* — like MRET — has in effect been overlooked in the Green Paper in its deference to the Wilkins Review, and implicitly *rejected* by Garnaut, as highlighted in section 4.4. Garnaut's rejection is all the more remarkable considering the clear advice presented to the review by Foxon et al. (2007) in the paper commissioned specifically for that purpose.

[15] Stern is highlighting the function of learning-by-doing in this instance.
[16] Questioning in the federal Senate indicates that the Wilkins Review has been received by Government, but its contents have not been tabled, despite multiple requests by The Greens, and its findings are certainly not publicly available at time of writing.

6.2.1 MRET's price support function

McHugh (2006) has noted the barrier to entry for new technology represented by the market dominance of incumbent technology operating with unpriced external costs. Incumbent producers have already realised reductions along their long run average cost (LRAC) curve through economies of scale and economies of learning achieved by cumulative production. However, new technologies must enter the market with cumulative production of *zero*, at the highest point of their LRAC curve — their entry price may be well above the current production price of incumbents and they cannot compete (McHugh 2006, 368-9). By policy action to internalise negative externalities, incumbent technologies' LRAC curves are moved upwards. This may result in the current production price rising to a level that new technologies are able enter the market competitively (pg. 370).

However, this insight can be applied in the context of the ETS carbon price acting on the electricity generation sector where the increased production cost for incumbent fossil fuel generators is *not* sufficient to allow new renewable technologies to enter the market. This may well occur in the short to medium term of ETS operation, dependant on the particular emissions trajectory, regulatory and institutional context, and the specific LRAC characteristics of various fossil and renewable generators. The function of a price support mechanism like MRET in this scenario is then to guarantee a degree of production from renewable generators[17] such that they are *able to move along the LRAC curve to achieve price parity with fossil fuel generators* and then compete without further assistance.

This scenario is illustrated using the stylised example of coal and a non-specific renewable technology in Figure 14 & Figure 15 below, derived from McHugh (2006).

[17] Provided of course that the additional revenue available from RECs is sufficient under the effective shortfall price cap.

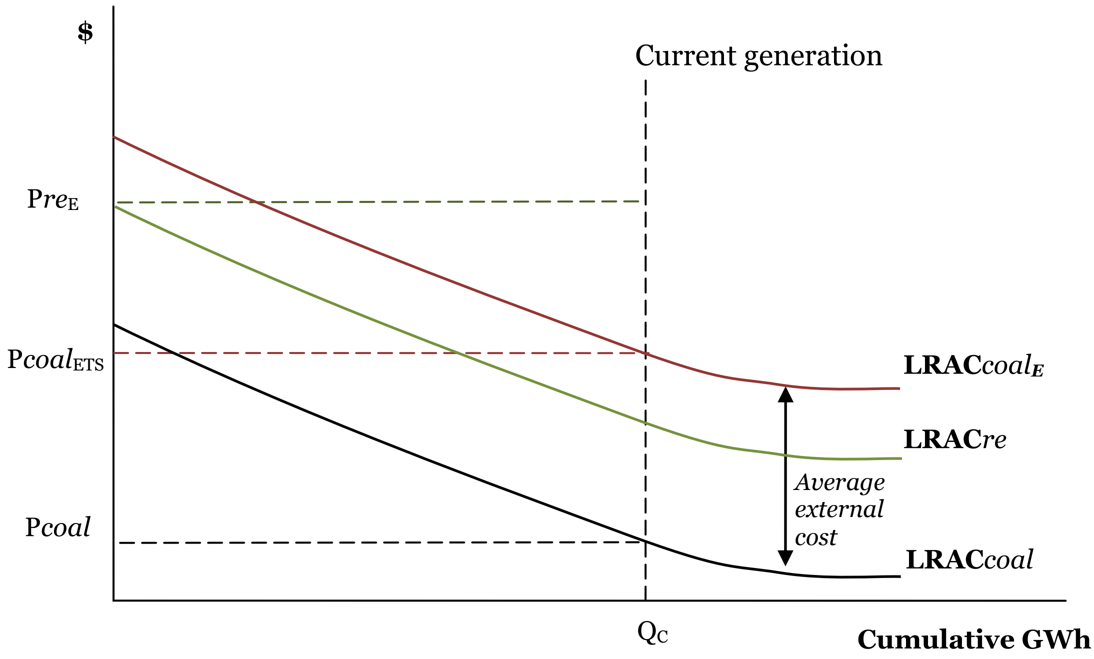

Figure 14 - The market dominance barrier to entry even under carbon price

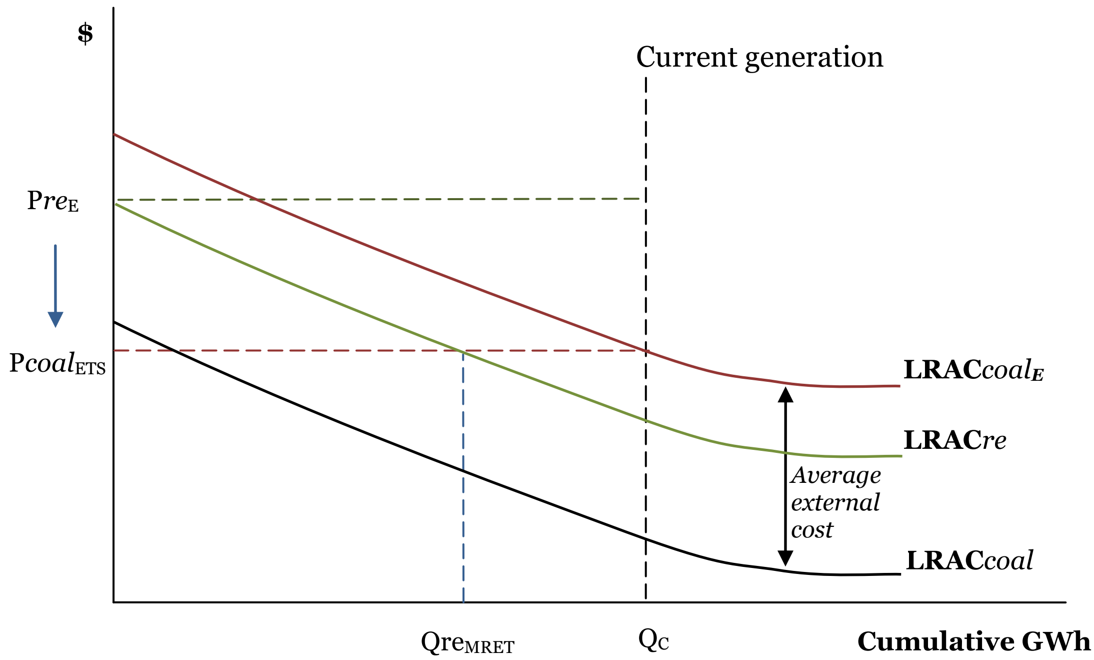

Figure 15 - The role of MRET in addressing the market dominance barrier to entry

Figure 14: Initially, at the current cumulative production level Q_C, the incumbent coal generation technology produces at price P*coal*. The LRAC curve for the renewable technology is above that of coal for all levels of production, and further must enter the market at zero cumulative production with price P*re*$_E$. The introduction of an ETS carbon price shifts the coal LRAC curve upwards such that LRAC*coal*$_E$ is now above LRAC*re* for all levels of production. However, at Q_C coal is able to produce at price P*coal*$_{ETS}$, which *remains* below P*re*$_E$, and the barrier to entry persists.

Figure 15: MRET's price support allows the renewable technology to achieve economies of scale and learning through cumulative production, moving down the LRAC*re* curve to level Qre$_{MRET}$. At this point in the curve, the renewable technology is at price parity with coal under the ETS (P*coal*$_{ETS}$) and can now compete unassisted. MRET has then in effect lowered the entry price P*re*$_E$ to the same point as P*coal*$_{ETS}$.

6.3 Recognising carbon lock-in

> ... [I]ndustrial economies have become locked into fossil fuel-based technological systems through a path-dependent process driven by technological and institutional increasing returns to scale. This condition, termed *carbon lock-in*, arises through a combination of systematic forces that perpetuate fossil fuel-based infrastructures in spite of their known environmental externalities and the apparent existence of cost-neutral, or even cost-effective, remedies.
>
> (Unruh 2000, 817)

Recognition of the carbon lock-in afflicting Australian energy supply systems, and especially electricity generation, must inform policy making if climate change mitigation efforts are to be effective. Put bluntly, Australia is enthralled by coal, oil, and gas, at the same time as our abundant renewable energy resources are too-often ignored or marginalised. This situation of carbon lock-in is the product of more than a century of deliberate and accidental, intended and incidental, government policies and government-built infrastructure and the sociocultural norms and institutions of which they are a part. Complex technological systems — indeed, *systems of systems* — such as electricity generation cannot be understood in isolation but rather as 'embedded in a powerful conditioning social context of public and private institutions' (Unruh 2000, 818). Unruh (2000) describes this state as the *techno-industrial complex* (TIC), developing 'through a path-dependent, co-evolutionary process involving positive feedbacks among technological infrastructures and the organizations and institutions that create, diffuse and employ them' (pg. 818). The interlinked and self-referential TIC serves to *lock-out* alternative technologies and, more importantly, alternative visions for the possible forms of society and technological infrastructure, often manifesting through a myriad of market and policy failures that remain 'systematically uncorrected', and even exacerbate carbon lock-in (pp. 818, 825).

Box 2: Increasing returns to scale

The innovation literature identifies four major classes of the increasing returns to scale referred to above (Unruh 2000, 820-1, citing Arthur 1994; Foxon et al. 2007, 13,19-21; del Río González 2007, 1372):

- Scale economies, wherein production costs decline by spreading fixed costs over increasing output volumes
- Learning economies, involving learning-by-doing (experience gained in the production process), learning-by-using (experience gained by subsequent use of a product), and learning-by-interacting (interaction between producers and consumers in a communicative context)
- Adaptive expectations, reducing uncertainty and gaining confidence through increasing adoption of a technology (applying to producers and consumers alike)
- Network economies, where interaction among technology systems and their users generates effects greater than the sum of individual parts

In this way, dominant technologies such as coal-fired electricity generation and its attendant centralised, monolithic network infrastructure, attained and retain dominance not through superior function but through a path-dependent process reliant on increasing returns to scale, based as much on historical circumstance as any sense of optimality (Unruh 2000, 820). Path-dependence expresses the realisation that dominant technologies' success depends on the path taken in their development and diffusion, including the character of initial markets, institutional and regulatory context, and social expectations (Foxon et al. 2007, 11). Sonneborn (2004) observes the lock-in of fossil fuel electricity generation can in part be ascribed to its cost reductions from a 'long production history' and 'extensive infrastructure of fuel supply', noting that this dominance was established while negative social costs were not recognised (pg. 1800). Further, dominant technologies (dominant *designs*) become embedded within social norms and expectations — and government institutions — co-evolving in ways that entrench their dominance progressively over time (Unruh 2000, 824). A key instance of technological dominance is the hegemony of contemporary centralised AC electricity infrastructure. This dominance arose only after hard-fought battles against competing DC systems in the late 19th century, where AC's success had little to do with its technical merits but rather circumstance and concerted political action; what's more, AC actually facilitated the emergence of centralised infrastructure and monopolies where DC would have created more decentralised and localised systems (Lohmann 2006, 111; Unruh 2000, 821).

It must be understood that the fossil fuel techno-industrial complex persists as much due to the sociocultural norms and institutional structures that have co-evolved with it, as to technology. In fact, I argue these non-technical forces are now preeminent. The TIC construct expresses the hegemony of a discourse in Australia that perceives fossil fuels, and the technologies that extract and exploit them, as the natural order of things, unassailable and inviolate.

A key manifestation of these forces is the political power and influence of the fossil lobby. The asymmetries of power in comparison to the renewable energy industry and allied environmental and social change organisations cannot be overstated. Guy Pearse (2007) in his book *High & Dry*, and Clive Hamilton (2007) in *Scorcher*, make clear the extent to which the fossil lobby has co-opted, manipulated, and ultimately prevented Australian attempts to begin meaningful action toward climate change mitigation; a recent closed door 'crisis meeting' with the largest polluters, instigated by the federal Minister for

Energy seeking to generate more 'industry friendly' alternatives to the CPRS, further highlights the power of these groups (Milne 2008b).

These same perspectives are rife within the Green Paper and the Garnaut Review, as highlighted in sections 4.3 and 5.5. The massive bias in favour of 'technofixes' such as CCS in the contemporary Australian political discourse is fundamentally an expression of the carbon lock-in worldview that, as Lohmann (2006) observes in his critique of carbon trading, seeks to 'allow continued exploitation of coal, oil and gas' , anything to avoid actually reducing and finally ceasing their use (pp. 43-4).

6.4 The policy approaches needed to overcome carbon lock-in

In recognising the existence of carbon lock-in and the imposing barrier to effective structural transition toward a decarbonised energy system represented by its techno-industrial complex, policy makers also open the possibility for overcoming it. As Unruh (2002) notes in a subsequent paper, we must not conclude that the 'current quasi-stable equilibrium is a permanent feature' — changes can and do occur, and the limiting factors are predominantly institutional and organisational, not of science or technology itself (pg. 318).

Following from the innovation chain discussion in section 6.2 above, Foxon et al. (2007) distil three guiding principles for fostering structural change (pp. 58-9):

1. The fundamental need for a stable, long-term *strategic framework* for the transition to a low-carbon economy, including incentives for a diverse range of technologies
2. The key role of the *innovation chain* approach to identify policy instruments suited for different stages of technology development
3. Policy instrument *flexibility* over time, within the overarching strategic framework

Within this framework, the ETS carbon price signal *underpins* all other policies applied at the various stages of the innovation chain, such as MRET's price support. When designed properly these are *complementary*, not conflictual. The ETS becomes the primary policy mechanism once technologies are suitably mature and can compete against dominant fossil fuel technologies without further assistance (Foxon et al. 2007, pp. 3, 30, 55).

Unruh (2002) identifies that attempts to induce structural change broadly follow two policy approaches: *continuity*, replacing certain components within the underlying system; and *discontinuity*, replacing the entire system through 'radical change' (pp. 318-20). Individual technology options can be applied in both continuous and discontinuous ways. Renewable energy technologies could, for example, be applied in a continuous fashion where they replace fossil fuel plant but remain within the centralised infrastructure paradigm; or they could form the basis for a new and discontinuous decentralised, localised energy infrastructure, where 'learning and mass production economies would substitute for the brute scale economies of large generation plants' (pg. 320). This underscores the fact that it is not only technology but rather the TIC that maintains carbon lock-in. Further, whether a change is continuous or discontinuous depends on the scale of the system level being examined. An overall continuous change can at the same time be *discontinuous* for powerful subsectors, who may attempt to block policy action. Importantly, attempts to maximise continuity so as to avoid or reduce resistance to change, risk delivering lower *short term* costs through solutions that are sub-optimal in the long term, resulting in greater overall costs (pp. 319-20).

Effective policy to achieve discontinuous solutions to climate change can therefore only be realised once the fossil fuel TIC lock-in has been overcome: this becomes the 'major precondition' for such structural change (Unruh 2002, 320). Unruh (2002) notes that this is a little explored area, but that evidence suggests some form of major crisis within the existing institutional configuration is needed, likely stemming from exogenous forces. The problem is 'really one of overcoming *collective action* challenges, which are exacerbated by techno-institutional lock-in…, and establishing a countervailing consensus for policy action' (emphasis added, Unruh 2002, 321). Two important potential sources of exogenous influence are the *technological* (where new technologies are able to exploit sheltering 'niche' markets) and the *social* or *institutional* (slow-changing institutions may need to be compelled by social movements, and perhaps a triggering environmental event) (pp. 320-3).

These insights give new perspective to the role of the ETS and the MRET. The ETS itself can reasonably be regarded as neutral with respect to fostering discontinuous structural change — its principal function is to price the negative externality of GHG emissions, it does not *directly* entrench nor challenge locked-in technologies. However, the TIC context within which the ETS is implemented is crucial to its ultimate outcome. MRET serves to directly challenge carbon lock-in by forcing the diffusion of renewable energy technologies in the energy system. But this challenge will not necessarily cause discontinuous change, as it is entirely possible, even likely, that 20% of electricity supply from renewables will be accommodated within the existing centralised infrastructure paradigm; that is, an overall *continuous* technological change may result. The eventual outcome then, depends on the galaxy of policies and sociocultural norms that surround and suffuse our energy systems — it is as much a question of political choice of the future form of those systems as the outcome of individual instruments such as the ETS or MRET.

7 Policy-making is a political decision

7.1 Policy under precaution

There is insufficient attention paid to the uncertainty and risk in achieving necessary environmental outcomes in the current Australian political discourse surrounding emissions trading. This applies to both the limited vision of alternative technological paths from within the blinkered carbon lock-in worldview, and to faith in the efficacy of an ETS, which remains a largely unproven market solution. As Healy and Kuch (2008) observe, the current discourse 'reproduces the naïve and apparently unshakable confidence in technological and market "solutions" that brought about climate change and other, similarly "diabolical", policy problems in the first place' (pg. 3)[18].

This lack of attention to uncertainty is especially prevalent in discussion of the potential of CCS, most poignantly in the Green Paper. The uncertainties and risks inherent in CCS technologies are not properly recognised. In particular, continued use of coal and gas within a CCS regime is implicitly assumed to be equivalent to the use of genuinely low-to-zero emissions technology such as renewable energy. Conflating the absence of emissions with their 'capture' and permanent 'storage' is an artifice. To do so simply ignores the risk that storage may fail and conveniently equates emissions' *uncertain* confinement with *quite-certain* non-existence.

7.1.1 The uncertainty and risk of CCS

CCS is technologically complex, unproven, and highly uncertain; it may never work at all on sufficient scale, let alone at acceptable cost or in the timeframes required (see for example Saddler et al. 2004; Diesendorf 2006; Wilkenfeld et al. 2007; Rochon 2008). Even recent Treasury modelling does not project CCS deployment before 2026 at the absolute earliest (Australian Federal Treasury 2008, 179). The over-reliance on the mere *possibility* of CCS becoming viable is seriously unwise climate change mitigation policy.

Yet the most insidious feature of CCS is the act of geosequestration itself. The storing of CO_2 in geological structures and aquifers imposes a *permanent liability* on future

[18] This is a reference to Garnaut's famous characterisation of climate change as a 'diabolical policy problem'.

generations in the form of a *permanent risk of storage failure*. Even if the probability of such a failure is very low, the impacts may be very large indeed. In a future world of internationally agreed severe emission constraints, the failure of a geosequestration site and consequent CO_2 pulse release could have grave environmental and cost implications. This liability is largely an unrecognised and unpriced cost in the current political discourse. Indeed, attempts to create ostensibly 'world first' Australian legislation facilitating CCS have failed to address the core question of liability in the event of storage failure — the implication is that the tax payer assumes this burden (Milne 2008a).

The unavoidable fact is that the continued use of fossil fuels categorically involves the production of GHGs in some form, and no amount of investment or subsidy in CCS technologies can ever completely neutralise this reality nor remove the risk of failure. Conversely, renewable technologies produce no GHGs at point of use and very little in their life cycles; no GHGs are *inherently* produced in life cycle.

Sound policy should properly incorporate these risks through a full rendering of the Precautionary Principle.

7.1.2 The Precautionary Principle

The Australian *Intergovernmental Agreement on the Environment*, made in 1992 between the Commonwealth and all States and Territories, obliges parties to be guided by a range of principles in the formation of policy. One of these is the Precautionary Principle:

> § 3.5.1 precautionary principle -
>
> Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:
>
> > i. careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
> >
> > ii. an assessment of the risk-weighted consequences of various options.
>
> (Australian Government 2007)

The Principle is commonly understood as the imperative 'to remove uncertainty as an obstacle to addressing potential environmental and health hazards' (Weier and Loke 2007, 1). In the context of climate change the imperative was to act to mitigate potential damage despite significant scientific uncertainties. However, the Principle also articulates a more nuanced need to carefully evaluate the implications of potential options for action. That is, we must weigh 'the potential costs and benefits to society of each alternative course of action' (Weier and Loke 2007, 5). Precaution should inform the selection of particular actions as much as providing the impetus to act in the first place.

7.1.3 MRET balances the risk and enhances certainty

MRET serves to balance the risk inherent in CCS and the continued use of fossil fuels by forcing diversification of electricity supply, creating and maintaining other options. Furthermore, in mandating inherently low-to-zero emission technologies MRET ensures a significant degree of structural change toward sustainable alternatives, thereby *enhancing the certainty of achieving necessary abatement outcomes*. Should these changes ultimately result in greater net social costs than would otherwise have been the case under an ETS alone — and that outcome is far from certain — the additional cost can be regarded as *the price society pays for this enhanced certainty of outcome*.

This perspective is illustrated in the following figures depicting stylised scenarios of net social costs over time[19] from an ETS alone (red curve) and a simultaneous MRET and ETS (blue curve).

It is important to note that none of these scenarios represent the currently-unpriced permanent liability of geosequestration discussed above.

[19] I have not specified any timeframe but these would be well into the 21st century.

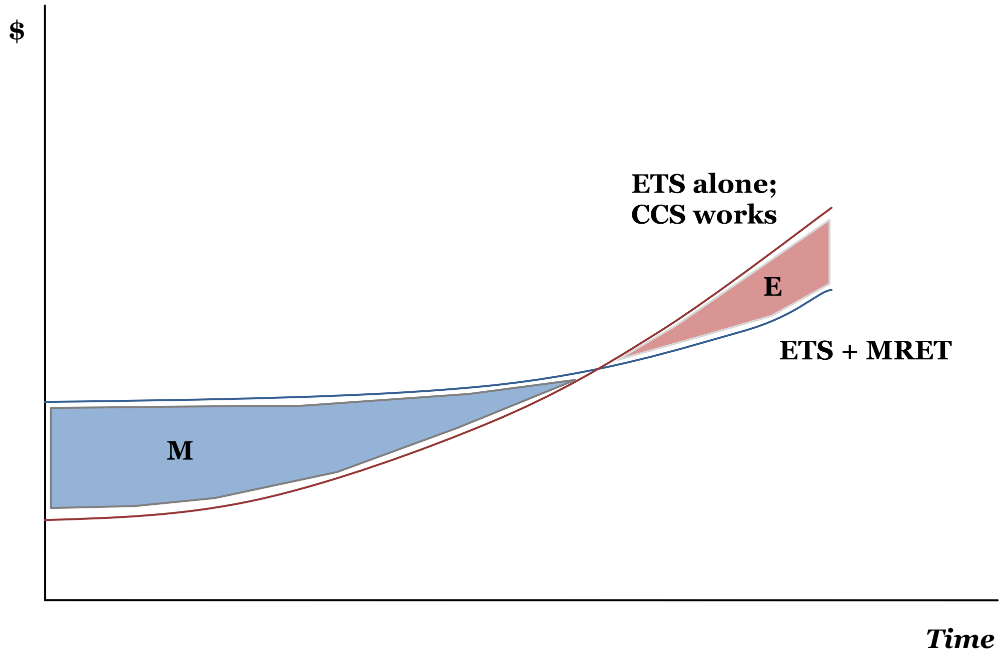

Figure 16 - Social costs over time – CCS works

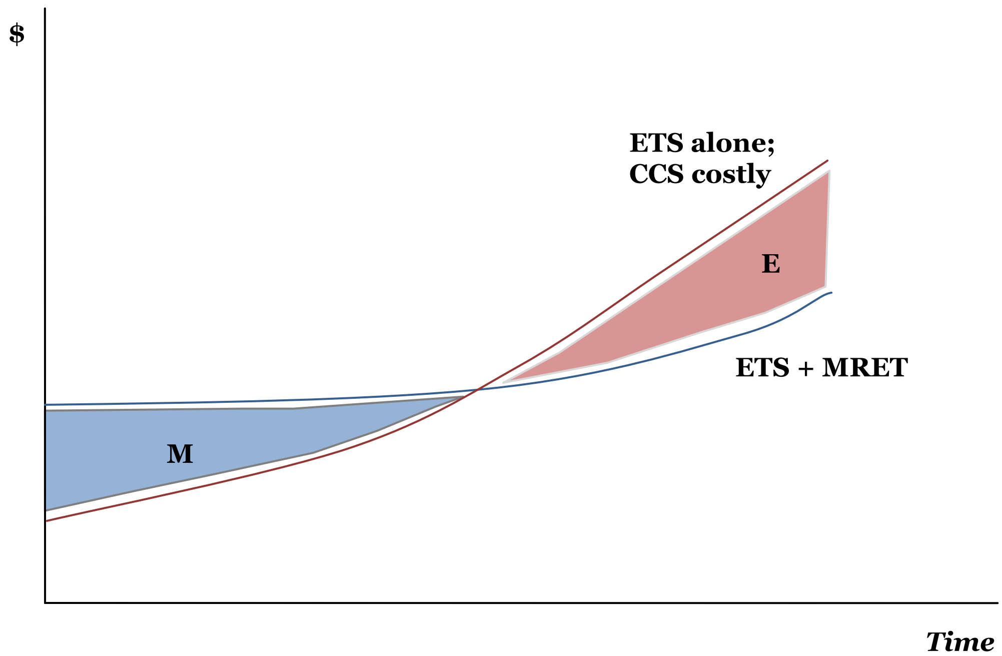

Figure 17 - Social costs over time – CCS is costlier than expected

Figure 16: In this scenario CCS technology is found to work effectively and at acceptable cost. With full hindsight the social costs of MRET (area *M*) are substantially higher than an ETS alone (area *E*). However, the additional cost to society is politically acceptable as the price of enhanced certainty of abatement outcomes.

Figure 17: In this scenario CCS technology is found to work but with more complexity and at greater costs than anticipated. It is unclear if the social costs of MRET (area *M*) are higher or lower than an ETS alone (area *E*). Again, any additional cost to society from MRET is politically acceptable as the price of enhanced certainty of abatement outcomes, and that cost may well be lower in the long run.

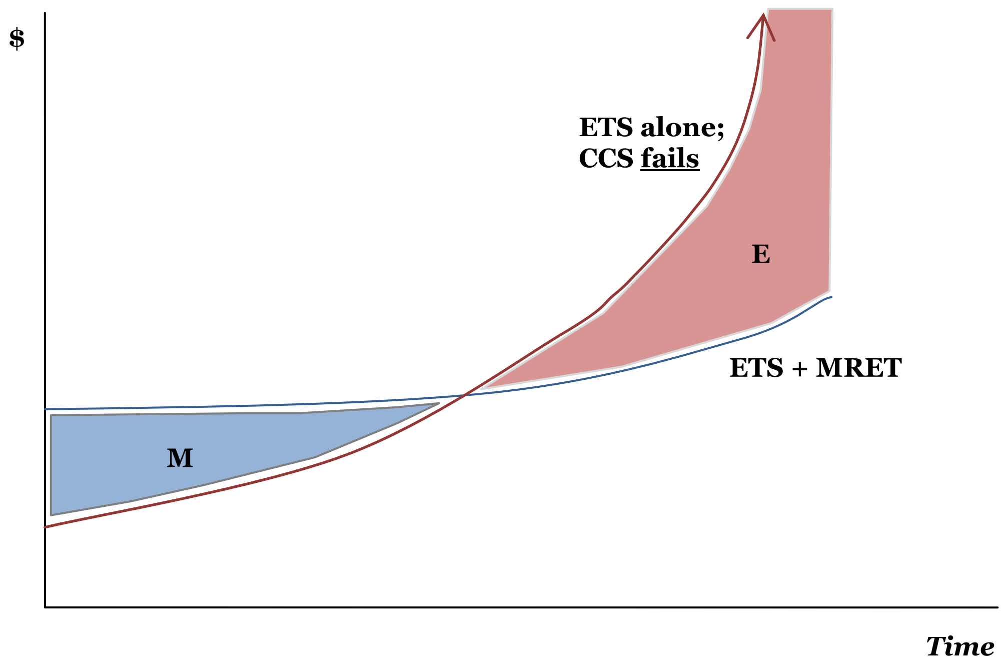

Figure 18 - Social costs over time – CCS fails

Figure 18: In this scenario CCS technology has *failed* either technically or from prohibitive costs; the arrow indicates that CCS costs may even increase asymptotically. The social costs of MRET (area *M*) are markedly lower than an ETS alone (area *E*). So MRET would achieve the desired abatement outcomes where the uncertain CCS does not, and at much lower cost to society.

7.2 Reframing policy objectives

In finally facing up to climate change, the ETS presents an opportunity to escape from our state of carbon lock-in. Rather than the normative political vision articulated by Garnaut (2008b) and the Green Paper, why should Australia not seize this opportunity, framing the mitigation and adaptation objectives in terms of a future energy system based on annual solar energy budget and Australia's abundant renewable energy resources? Instead of relying on CCS — the ultimate end-of-pipe technofix solution — why not move to genuinely address the root cause of GHG emissions from our energy use, to move away from fossil fuels? An alternative future broadly based on renewable energy could be *truly* sustainable where fossil fuels can never be. With renewable energy's benefits in jobs, health, energy security, and environmental impact, it is folly to be so narrowly focussed on coal and CCS. Our national interest can lie just as much in renewable energy and technology services as it does in mining and exporting coal.

Only by assuming that coal use must be maintained can MRET be seen as a policy objective in conflict with the ETS. If our objectives are defined in terms of emissions abatement and a structural transition toward renewables — or at the very least an effort in that direction equal with CCS — then MRET is clearly complementary to the ETS.

Moreover, we forget the uncertainties and risks of CCS at our peril; climate change does not permit us the time to fail in that pursuit. Garnaut (2008b) states: 'In determining the preferred approach for Australia's mitigation effort, the primary policy objective must be to meet a specified trajectory of emissions reductions at the lowest possible cost (pg. 310).' But this could be modified to recognise the need for greater certainty of the abatement outcome, to set the primary policy objective as meeting the specified trajectory of emissions reductions *with the necessary degree of certainty* at the lowest possible cost this allows.

8 Conclusions

In light of the above discussion it is instructive to return now to Garnaut's criticisms of MRET in section 4.4.1, addressing each in turn: each Criticism identifier below refers to the original summarised in Table 1, pg. 19.

Table 2 - Analysis of Garnaut's MRET criticisms

Criticism	Analysis
GR01	MRET is unlikely to drive increasingly expensive technology deployments simply because the non-indexed shortfall charge is an effective REC price cap, which places an upper bound on this additional revenue stream. Any renewable generation investment must cover its costs (section 5.4.3), and as the shortfall charge declines in real terms, new investment will on balance closely track the trends in wholesale electricity markets.
GR02	The ETS is technology neutral but the political-economic context it operates within is certainly not. An understanding of the innovation chain and the presence of carbon lock-in makes the need for price support mechanisms such as MRET — in addition to the ETS price signal — clear and unequivocal for stimulating structural change toward decarbonisation. Moreover, under conditions of carbon lock-in, the statement that fostering renewable energy and emissions abatement are *conflicting* policy objectives belies a normative bias in favour of fossil fuels. There is no reason why government should not take an explicit position that recognises the benefits and ultimate sustainability of renewable energy, enacting policies that at least 'level the playing field' with the fossil economy.
GR03	Further, it is at least possible that MRET's induced expansion of renewable energy may lead to less cost and net benefit in the long term. Any short term excess costs may well be balanced by markedly reduced costs overall.

GR04	Even if the assumptions underlying such modelling prove broadly accurate, a range of parallel benefits to society and the economy are not reflected in such cost estimates. These include additional jobs and development in the Australian renewable industries, as well as benefits to health and the environment. And again, any such costs in the short term may result in net savings in the long term.
GR05	No evidence or explanation for this perverse consequence (*more* coal generation) is given. The assertion seems fanciful and illogical. Even if displacement of gas by renewables was somehow able to allow new coal generation to occur — presumably through coal taking up the emissions 'freed up' by gas — such investment would be remarkably ill-advised, and likely short-lived, within a tightening emissions trajectory. Given their relative emission intensities (Figure 7), it is far more likely that more intermediate-level gas (eg, CCGT) would come onstream to displace *coal*, even while peaking gas plant was displaced by renewables.
GR06	The price effects of the two policy instruments' interactions are complex and extremely difficult to determine *ex ante* (see section 5.4). With a low cap, MRET could cause strong downward pressure on permit prices. But as above, the shortfall charge sets an upper bound on REC prices, so they cannot realistically rise much farther than currently. What's more, due to the marginal generator displacement effect of substantial renewable generation, wholesale electricity prices could well *fall* in this scenario. The lack of other abatement activity is debatable, but even if true, why should this necessarily be a problem? When viewed over the long term, earlier structural changes in the electricity sector are to be welcomed. The ETS is a means to an end, not the objective in and of itself. And the question could be inverted to ask why an ETS trajectory should be 'gentle' in the first place, given the manifest urgency and magnitude of the abatement task.

An expanded MRET clearly serves the crucial innovation price support function necessary to allow renewable energy technologies to realise cost reductions through diffusion, becoming competitive with incumbent fossil fuel generators under the ETS carbon price signal. In this way MRET will play a key role in stimulating structural change toward a decarbonised energy system, ensuring GHG abatement is for the long term. The simultaneous operation of the two instruments will generate some complex and dynamic effects on electricity prices, the outcome of which is far from certain. Higher costs may be experienced in the short to medium term but may result in overall reduced costs and even net benefits in the long term. A range of other benefits are also driven by greater renewable energy deployments, including gains in employment, health, and environmental impact.

Beyond cost comparisons, MRET further provides an essential signal of intent as part of the long-term strategic framework needed to overcome carbon lock-in and the hegemonic fossil fuel techno-industrial complex. In its support for emission-free energy innovation, MRET helps to level the playing field against the vested and powerful interests of the fossil fuel industry and their lobbyists.

And where the prime climate change mitigation policy initiatives in Australia — the Garnaut Review and especially the CPRS Green Paper — remain so enthralled by coal and the distant promise of CCS, MRET forces an early diversification of our energy supply. What's more, by fostering renewables MRET balances the inherent and overlooked risks in an over-reliance on geosequestration and enhances the certainty that true abatement will be realised.

Perhaps most of all, the presence of MRET keeps open the possibility for more fully articulating an alternative, genuinely sustainable vision of a future Australian society, sited in a world that finally comes to grips with the dire and immediate threat of anthropogenic climate change.

An expanded MRET is then a necessary policy instrument and **is complementary** ***to the overarching ETS carbon price signal.***

9 GLOSSARY

Term / Abbreviation	Definition
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage, the various technologies to capture and then store CO_2 using some form of geosequestration
CO_2-eq	Carbon dioxide equivalent, the standard measure of greenhouse gases (see below) stated in terms of the equivalent emission of carbon dioxide reflecting the actual gas' global warming potential
COAG	Council of Australian Governments
CPRS	*Carbon Pollution Reduction Scheme*, the ETS and accompanying policies outlined by the *Green Paper*
Emissions intensity	The volume of GHGs produced per unit of electricity generation, expressed in tonne CO_2-eq/MWh of electricity
EITE	Emissions-Intensive Trade-Exposed industries
ETS	Emissions Trading Scheme
FiT	Electricity Feed-in Tariffs for renewable energy systems
Garnaut	*The Garnaut Climate Change Review* – Final Report, unless otherwise stated (Garnaut 2008b)
Gas	Unless stated otherwise or implied by context, 'gas' will refer to *natural gas* as a fossil fuel
GHG(s)	Greenhouse gas(es); unless otherwise stated these are the six gases covered under the United Nations' Framework Convention on Climate Change *Kyoto Protocol* (and to be covered under an Australian ETS): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NOx), sulphur hexafluoride (SF_6), perfluorocarbons

	(PFCs), and hydrofluorocarbons (HFCs)
Green Paper	*Carbon Pollution Reduction Scheme Green Paper* (Department of Climate Change 2008a)
IGCC	Integrated gasification [of coal], combusted using combined cycle gas turbines
Levelised cost	Total generation over the plant lifetime divided by total costs expressed in net present value; see section 5.4.3
LRAC	Long run average cost
LRMC	Long run marginal cost
MRET	Mandatory Renewable Energy Target
NEM	National Electricity Market, covering Queensland, NSW, Victoria, SA, and Tasmania
ORER	Office of the Renewable Energy Regulator, statutory authority administering MRET
Permit	An emissions reduction permit within the ETS, equivalent to 1 tonne of CO_2-eq abatement
RE	Renewable energy
REC	MRET's Renewable Energy Certificate instrument, equivalent to 1 MWh of renewable electricity
RET	Renewable Energy Target, the expanded MRET
RPP	MRET's annual Renewable Power Percentage
SAI	Strong Affected Industry under the *Green Paper's* classification
SRMC	Short run marginal cost
SWH	Solar water heating
TIC	Techno-industrial complex; see section 6.3
WEM	Wholesale Electricity Market of Western Australia

10 REFERENCES

Alonso, Gustavo, Javier C. Palacios, and J. Ramon Ramirez. 2006. Economic Analysis of the Levelized Cost of Electricity Generation. In *2006 International Congress on Advances in Nuclear Power Plants*. Reno, NV.

Australian Federal Treasury. 2008. *Australia's Low Pollution Future - The Economics of Climate Change Mitigation*. Commonwealth of Australia.

Australian Government. 2007. *Intergovernmental Agreement on the Environment*. Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/esd/national/igae/index.html (accessed 27 October, 2008)

Bill, Anthea, William Mitchell, and Riccardo Welters. 2008. *A Just Transition to a Renewable Energy Economy in the Hunter Region, Australia*. Policy report to Greenpeace Australia Pacific by Center of Full Employment and Equity, June 2008.

COAG, Working Group on Climate Change and Water. 2008. *Design Options for the Expanded National Renewable Energy Target Scheme*. http://www.climatechange.gov.au/renewabletarget/consultation/pubs/ret-designoptions.pdf

Commonwealth of Australia. 2007. *Renewable Energy (Electricity) Regulations 2001*, Statutory Rules 2001 No. 2, amended 5 November 2007.

Commonwealth of Australia. 2008. *Energy in Australia 2008*. Department of Resources, Energy and Tourism, ABARE.

CRA International. 2007. *Implications of a 20 per cent renewable energy target for electricity generation*. Final report prepared for Australian Petroleum Production and Exploration Association., November 2007.

del Río González, Pablo. 2007. The interaction between emissions trading and renewable electricity support schemes. An overview of the literature. *Mitigation and Adaptation Strategies for Global Change* 12 (8): 1363-1390.

Department of Climate Change. 2008a. *Carbon Pollution Reduction Scheme Green Paper*. Commonwealth of Australia, July 2008.

Department of Climate Change. 2008b. *COAG Working Group on Climate Change and Water consultation paper*. http://www.climatechange.gov.au/renewabletarget/consultation/index.html (accessed 15 October, 2008).

Department of Climate Change. 2008c. *National Greenhouse Gas Inventory 2006*. Commonwealth of Australia.

Diesendorf, Mark. 2005. *Towards Western Australia's Clean Energy Future*. WWF Australia. http://wwf.org.au/publications/CEFWA2005Report2ndEd.pdf

Diesendorf, Mark. 2006. Can geosequestration save the coal industry? In *Transforming Power: Energy as a Social Project*, edited by J. Byrne, L. Glover and N. Toly: Vol. 9, Energy and Environmental Policy Series: 223-248.

Diesendorf, Mark. 2007. *Greenhouse Solutions with Sustainable Energy*. Sydney: UNSW Press.

Driesen, David. 2009 (forthcoming). Neoliberal Instrument Choice. In *Economic Thought and U.S. Climate Change Policy*, edited by D. Driesen: MIT Press.

Foxon, Tim, Robert Gross, Philip Heptonstall, Peter Pearson, and Dennis Anderson. 2007. *Energy Technology Innovation: A Systems Perspective*. Report for the Garnaut Climate Change Review, December 2007.

Garnaut, Ross. 2008a. *Emissions Trading Scheme Discussion Paper*. The Garnaut Climate Change Review, March 2008.

Garnaut, Ross. 2008b. *The Garnaut Climate Change Review - Final Report*. Commonwealth of Australia.

Healy, Stephen, and Declan Kuch. 2008. Emissions trading: 'Grip on reality' or just 'trust in numbers'? *Australian Review of Public Affairs* (August 2008).

Hepburn, Cameron. 2007. Carbon Trading: A Review of the Kyoto Mechanisms. *Annu. Rev. Environ. Resour.* 32: 375-93.

Kean, Bernard. 2008. Wong's Green paper: what it means. *Crikey*, 16 July, 2008. http://www.crikey.com.au/Garnaut-Report/20080716-Wongs-Green-paper-what-it-means.html (accessed 26 October, 2008).

Lohmann, Larry. 2006. Carbon Trading: A Critical Conversation on Climate Change, Privatisation and Power. *Development Dialogue* September 2006 (48).

MacGill, Iain, and Regina Betz. 2008. *CEEM Submission to the Garnaut Review Emissions Trading Scheme Discussion Paper*. UNSW Centre for Energy and Environmental Markets, April 2008.

MacGill, Iain, Muriel Watt, and Rob Passey. 2002. *Jobs and Investment Potential of Renewable Energy: Australian case studies*. The Australian CRC for Renewable Energy Policy Group, March 2002.

McHugh, Adam. 2008. *Portfolio Short Run Marginal Cost of Electricity Supply in Half Hour Trading Intervals*. Technical Paper, Economic Regulation Authority of Western Australia.

McHugh, Adam Robert. 2006. Chapter 39: Oil and Substitution: Reviewing the Possibility of Failure in the Technology Market. In *Sharing wisdom for our future. Environmental education in action: Proceedings of the 2006 Conference of the Australian Association of Environmental Education*. Sydney.

McLennan Magasanik Associates. 2006a. Explanation of results on electricity market impacts of emission trading: Email to National Emission Trading Taskforce, November 2006.

McLennan Magasanik Associates. 2006b. *Renewable Energy – A Contribution to Australia's Environmental and Economic Sustainability: Executive Summary*. Final Report to Renewable Energy Generators Australia, June 2006.

McLennan Magasanik Associates. 2007a. *Increasing Australia's Low Emission Electricity Generation – An Analysis of Emissions Trading and a Complementary Measure*. Report to Renewable Energy Generators Australia, October 2007.

McLennan Magasanik Associates. 2007b. *Review of REC Markets*. Report to Office of the Renewable Energy Regulator, October 2007.

Milne, Christine. 2008a. *Carbon capture laws dodge biggest question: Who carries liability?* Australian Greens media release. http://greensmps.org.au/content/media-release/carbon-capture-laws-dodge-biggest-question-who-carries-liability (accessed 21 October, 2008).

Milne, Christine. 2008b. *Taking note: Ferguson's big polluters "crisis meeting" undermining Wong*. Australian Greens, transcript of Senate Hansard, 26 August, 2008. http://christine-milne.greensmps.org.au/content/speech/taking-note-fergusons-big-polluters-crisis-meeting-undermining-wong (accessed 26 August, 2008).

NEMMCO. 2008. *An Introduction to Australia's National Electricity Market*. National Electricity Market Management Company Ltd, June 2008. http://www.nemmco.com.au/about/000-0286.pdf (accessed 12 November, 2008)

Oikonomou, V., and C. J. Jepma. 2008. A framework on interactions of climate and energy policy instruments. *Mitigation and Adaptation Strategies for Global Change* 13: 131-156.

ORER. 2008a. *Fact Sheet - Mandatory Renewable Energy Target Overview*, Version 2. http://www.orer.gov.au/publications/pubs/mret-overview-feb08.pdf (accessed 16 October, 2008)

ORER. 2008b. *Solar water heaters*. http://www.orer.gov.au/swh/index.html (accessed 16 October, 2008).

Outhred, Hugh, and Iain MacGill. 2003. *Submission to the Review of the Renewable Energy (Electricity) Act 2000*. UNSW Sustainable Energy Research Group.

Pearse, Guy. 2007. *High & Dry*. Camberwell, Victoria: Viking.

Riesz, Jenny. 2008. *What will be the impact of the expanded MRET on the NEM?* In *CEEM seminar*. UNSW, February 2008.

Rochon, Emily. 2008. *False Hope: Why carbon capture and storage won't save the climate*. Greenpeace International, May 2008.

Saddler, Hugh, Chris Riedy, and Robert Passey. 2004. *Geosequestration: What is it and how much can it contribute to a sustainable energy policy for Australia?* Discussion Paper No. 72. The Australia Institute, September 2004.

Sonneborn, Carrie L. 2004. Renewable energy and market-based approaches to greenhouse gas reduction—opportunity or obstacle? *Energy Policy* 32 (16): 1799-1805.

Stern, Nicholas. 2006. *The Stern Review: The Economics of Climate Change*. UK: HM Treasury.

Tambling, Grant. 2003. *Renewable Opportunities, A Review of the Operation of the Renewable Energy (Electricity) Act 2000*. MRET Review Panel.

Unruh, Gregory C. 2000. Understanding carbon lock-in. *Energy Policy* 28: 817-839.

Unruh, Gregory C. 2002. Escaping carbon lock-in. *Energy Policy* 30: 317-325.

Weier, Annette, and Paul Loke. 2007. *Precaution and the Precautionary Principle: two Australian case studies*. In *Staff Working Paper*. Australian Government, Productivity Commission.

Wilkenfeld, George, Clive Hamilton, and Hugh Saddler. 2007. *'Clean coal' and other greenhouse myths*. Research Paper No. 49. The Australia Institute, August 2007.