

concept economics

REPORT

**A PEER REVIEW OF THE
TREASURY MODELLING OF
THE ECONOMIC IMPACTS OF
REDUCING EMISSIONS**

Prepared for:
Senate Select Committee
on Fuel & Energy

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INTRODUCTION

This report was commissioned by the Senate Select Committee on Fuel and Energy as a peer review of Treasury modelling of the impacts on Australia's economy of reducing greenhouse gas (GHG) emissions. The terms of reference for this review is set out in Appendix A. Released on 30 October 2008, the Treasury report, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, has provided important input into policy decision-making on an emissions trading scheme (ETS) due to commence in 2010 and on a medium-term (2020) national emissions target range.

Releasing the Carbon Pollution Reduction Scheme (CPRS) White Paper on 15 December 2008, the Government announced a commitment to reduce Australia's emissions by between 5 per cent and 15 per cent below 2000 levels by the end of 2020. The 5 per cent figure represents a minimal (unconditional) commitment to reduce emissions by 2020, irrespective of the actions by other nations. The 15 per cent figure represents a commitment to reduce emissions in the context of a global agreement where all major economies commit to substantially restrain emissions and all developed countries take on comparable reductions to that of Australia. This is in addition to the Government's long-term policy commitment to reduce Australian emissions by 60 per cent below 2000 levels by 2050.

The Treasury modelling report examined the potential economic impacts of reducing Australia's emissions over the medium and long term. This is done via an examination of four alternative scenarios 'in which Australia and the world follow pathways to a low-pollution future' (Treasury 2008a, p. x). The stabilisation level of GHG concentrations, the global framework for action, Australian targets and Australian policy settings are key variables determining the impact on the Australian economy.

Two Treasury scenarios – CPRS -5 and CPRS -15 – model the Australian Government's policy settings, including ETS design features proposed in the CPRS Green Paper. The CPRS scenarios begin in 2010 and centre on two trajectories:

- 5 per cent below 2000 levels by 2020 and 60 per cent below by 2050, assuming stabilisation of the concentration of greenhouse gases in the atmosphere at 550 ppm CO₂-e around 2100 (CPRS -5); and
- 15 per cent below 2000 levels by 2020 and 60 per cent below by 2050, with stabilisation at 510 ppm CO₂-e around 2100 (CPRS -15).

It is sensible to focus on these scenarios given the national target range subsequently announced by the Government and because of their 'multi-stage' global framework. Two additional scenarios – Garnaut -10 and Garnaut -25 – were included in the Treasury modelling report. Australia's emission reduction targets in these scenarios are:

- 10 per cent below 2000 levels by 2020 and 80 per cent below by 2050, consistent with stabilisation at around 550 ppm CO₂-e in 2100 (Garnaut -10); and
- 25 per cent below 2000 levels by 2020 and 90 per cent below by 2050, consistent with stabilisation at around 450 ppm CO₂-e shortly after 2100, after an initial overshoot during which concentrations exceed 450 ppm CO₂-e (Garnaut -25).

The Garnaut scenarios assume an optimal international emissions trading scheme covering all emissions sources and all economies from 2013. The Garnaut scenarios are not discussed in any detail further in this review.

Although the public report on the Treasury modelling is voluminous there remain aspects of the modelling that are not transparent. To assist in this review the Chair of the Senate Select Committee wrote to the Treasurer requesting, 'the government's complete documentation of the government's models together with the model codes and databases and any other model simulations undertaken relevant to the policy scenarios, but not publicly released'. To this reviewer's knowledge no response was received. As a consequence, it has been necessary to undertake this review without access to a complete set of information about model documentation, databases, implementation and many of the underlying technical model parameters. Given the major long-term structural changes to the Australian economy implied by the introduction of an ETS and the fact that the development of the key model employed to determine the international effects on the Australian economy of the scheme was fully taxpayer funded, it seems reasonable that full model datasets, codes and comprehensive documentation be released.

The Treasury modelling paints a benign picture of Australia's transformation to a low-emissions economy. Among the key Treasury results are the following:

- Mitigation policies impose relatively small costs on Australia as even ambitious reduction goals have limited impact on national and global economic growth;
- From 2010 to 2050, Australia's real GNP per person grows at an average annual rate of 1.1 per cent in all policy scenarios, compared with 1.2 per cent in the reference scenario;
- Early action by Australia is less costly than later action: economies that defer action face higher long-term costs, as global investment is redirected to 'early movers';
- Almost all sectors of the Australian economy grow, and key low-emission sectors grow strongly;
- Many of Australia's emissions-intensive sectors (such as iron and steel, coal and livestock) are likely to maintain or improve their international competitiveness under global emission pricing;
- Slower world demand for Australia's mineral and energy commodities will lower Australia's terms of trade. In response, the exchange rate depreciates, helping to maintain the competitiveness of various export-oriented and import-competing industries (including manufacturing);
- Allocation of some free permits to EITE sectors eases their transition to a low-emissions economy in the initial years;
- Australia's competitiveness is likely to decline in sectors (including aluminium and petroleum refining) where Australian production is relatively more emission-intensive than its competitors but at least initially, output is projected to grow compared with 2008 levels in the medium term;

- The issue of carbon leakage is down played, with little evidence found of leakage at emission prices corresponding to all but the most stringent stabilisation goal;
- Pricing emissions will not compromise Australia's future energy security and the electricity sector should achieve large emission reductions in the long run, even if some technologies being explored do not prove commercially viable;
- Australia's emissions fall significantly once new low-emission electricity generation technologies become cost-effective;
- Australia's coal industry and coal producing regions will be affected by the future cost, performance and timing of carbon capture and storage (CCS);
- Real household incomes continue to rise strongly despite increases in electricity and gas prices;
- After a one-off rise in the Consumer Price Index there are likely to be minimal implications for ongoing inflation.

A central finding of the Treasury modelling relates to Australia's heavy reliance on the purchase of lower cost global permits to meet its emission targets and to lower the costs of mitigation. Australia's emissions plateau until the emission price facilitates large-scale commercial deployment of CCS in the electricity sector. In the key CPRS -5 scenario, Australia's emissions remain at around 2005 levels until the mid 2030s.

The Treasury report was the result of an extensive modelling exercise conducted over 18 months. As well as drawing on the significant resources of the Commonwealth, it made use of eight external consultants and a suite of global, national, sectoral and distributional models to estimate the macroeconomic, sectoral and distributional impacts of various emission reduction scenarios. Government officials have described it as 'the most extensive modelling exercise ever undertaken by the Australian Treasury' (Gruen 2008, p. 1).

This review is the product of a much more time- and resource-constrained examination of the key issues raised by the Treasury modelling.

It begins from a premise that, notwithstanding exercises such as the Stern Review, the Garnaut Review and the Treasury modelling, considerable uncertainty pervades the economics of climate change mitigation. This is a view shared by other Australian economists and policy institutions that have examined the economics of climate change over many years (McKibbin and Wilcoxon 2002, 2008; Productivity Commission 2007).

Uncertainty in no sense justifies inaction on climate change. An economy wide signal of the social costs of emitting GHGs is an important part of a responsible long-term policy approach. However, careful analysis must accompany the design of an ETS and the setting of emissions targets in the absence of a comprehensive global response. Policy frameworks must be durable yet flexible so as to take account of changes in international circumstances, changes in our knowledge about climate change and serious economic shocks.

Uncertainty also cautions against uncritical acceptance of statements such as the following: 'If we don't act now, we will be hit hard and fast. We will lose key industries and Australian jobs. ... Countries that delay acting on climate change will face 15 per cent higher costs' (Australian Government 2008a).

A second premise of this review relates to the strengths and weaknesses of computable general equilibrium (CGE) modelling. High-quality CGE modelling is a powerful tool that can assist policy makers and stakeholders in understanding the effects of mitigation action, especially at an economy-wide level. However, the results obtained will only ever be indicative. Models can never be perfect representations of reality and it is important that there be 'common sense' post-modelling checks on results.

Among the factors that determine the integrity of any modelling exercise include the quality of the data, the credibility of assumptions and scenarios, the model closure framework and the ease with which the model(s) results can be reproduced. In other words, a rigorous approach to modelling demands a high level of transparency.

As already stated this review regards the transparency surrounding the Treasury modelling process as unsatisfactory, notwithstanding the efforts of the Committee to gain access to models, documentation, codes and databases developed with public funding. This lack of transparency is regrettable given Treasury's traditional advocacy of openness and competition when it comes to others.

It is true, as some commentators have noted, that differences in aggregate national mitigation costs under different models and scenarios can appear relatively minor. This is especially the case where results are reported for time periods well into the future. Almost inevitably, it is at the sectoral level where different CGE modelling exercises yield the greatest variation.

It is important, nonetheless, that Australia not be complacent about the scale of economic transformation in prospect under an ETS, either at an economy-wide or sectoral level. Those who suggest that the Treasury modelling confirms that Australia's economy could accommodate easily much larger emission targets than those proposed by the Government seem willing to overlook the limitations that surround even the most careful of modelling exercises.

For example, it is commonly the case in CGE models that capital is assumed to be 'fungible' so that assets are retired without cost. This can yield results where large capital investments are made in one period, only to be removed a few years later. These models are especially problematic when dealing with large, lumpy investments such as power stations, smelters, oil refineries and LNG facilities especially in the presence of uncertainty about future carbon permit prices. Some models also embody very optimistic technology assumptions that can provide a false sense of security about the ease of the abatement task. In addition, CGE models are not well equipped to assess the transitional costs of adjustment faced by real firms and individuals.

The Treasury itself identifies various ways in which its own modelling results may underestimate the costs of mitigation, noting that: (1) the models used in the report 'are not well suited to examining short-term adjustment paths, so may underestimate costs from changing capital and retraining workers'; and (2) the models 'do not capture the effects of uncertainty, or non-market factors which can significantly affect economic behaviour' (Treasury 2008b, p. 13).

An emissions trading scheme and associated medium and long-term targets will have profound economic implications for every Australian business and household. That Australia's economy may be on the brink of the greatest economic slump in more than half a

century only reinforces the need for prudent decision-making, notwithstanding the results of the Treasury modelling about Australia's smooth transition to a low carbon future.

A number of recommendations are made based on the analysis that follows. They include:

- that given indications of the worst global economic crisis in more than half a century, Treasury provide stakeholders with updated GDP forecasts from the IMF, OECD and Consensus Economics so that these can be compared with those used in the climate change modelling;
- that full model documentation and databases together with any additional scenario implementation code be released so that stakeholders can better understand the full implications of the Treasury modelling;
- that ETS governance arrangements incorporate a review process to confirm that the Treasury modelling results were reasonably accurate. This process should specify the way that any unintended consequences in ETS performance can be quickly corrected;
- that further analysis be done on the short- and medium-term impact of an ETS on the electricity generation sector and other emissions intensive industries that may be subject to significant structural adjustment particularly as it affects regional Australia and that such modelling be done using tools that take into account the lumpy nature of investment and the likely timing of the retirement of large capital assets;
- that additional sensitivity analysis be conducted around at least one policy scenario involving slow, fragmented and partial global action in the medium to long term;
- that additional sensitivity analysis also be conducted around less optimal international permit trading assumptions and the availability of Clean Development Mechanism (CDM) certificates;
- that a formal review follow the UN Conference of the Parties in Copenhagen in late 2009 to take stock of the likely configuration of global climate action in the next decade and Australia's actions in that context (this would mirror the review mechanism agreed by European Union leaders at their summit in December 2008);
- that Australia undertake a significant, pre-emptive diplomatic effort in Europe and the United States in order to counter the possible imposition of border barriers in the likely event that global action on climate change is slow, partial and fragmented;
- that the Productivity Commission formally review the Government's proposed ETS against its Best Practice Regulation Guidelines.

1. TERMS OF REFERENCE: ONE

Sensitivity analysis of the assumptions on which the modelling has been undertaken;

Treasury estimates the costs of reducing emissions by modelling a reference case scenario and four policy scenarios. The reference scenario projects the future path of the world and Australian economies if new policies to reduce emissions are not introduced. The comparison of outcomes between the reference scenario and the policy scenarios shows the impact of emissions reduction policies on the Australian and global economies relative to what otherwise would have occurred.

The Treasury report notes correctly that scenario modelling does not predict what *will* happen in the future. Rather, it is an assessment of what *could* happen in the future, given the structure of the models and input assumptions. Hence the input and policy assumptions are critical with the report stating that:

Treasury developed these assumptions through research, through consultation with stakeholders and domestic and international experts, and on the basis of expert consultancies. While they intend to be plausible central estimates within a range of uncertainty, other analysts could well form different judgments (Treasury 2008a, p. 16).

Taking account of assumptions in both the reference scenario and the policy scenarios in the Treasury modelling, this review concludes that the most problematic elements surround:

1. sectoral marginal abatement cost curves that in a number of emissions-intensive industries appear to admit very significant mitigation at relatively low cost;
2. electricity sector transformation assumptions that appear to underestimate significantly the cost and structural adjustment challenge of moving to a decarbonised electricity generation sector;
3. long-term commodity price assumptions that in some cases depart significantly from industry estimates;
4. international action assumptions that are highly optimistic given the intrinsic nature of the climate change problem and the institutional framework in which international negotiations take place; and
5. emission pricing and permit trading assumptions that bias the results toward artificially low costs of mitigation.

Of necessity, any sensitivity analysis around these factors is essentially qualitative, given limits on the information available to this review and other constraints. It also is safe to conclude that the relative importance of each factor to the overall results of the Treasury modelling will vary. Collectively, however, the interaction of these assumptions is likely to result in the Treasury modelling seriously underestimating the economy-wide and sectoral challenges associated with particular emissions reduction targets, particularly in the short to medium term. The implications are especially important for Australia's emission-intensive, trade-exposed (EITE) industries and for the electricity generation sector.

The Treasury reference scenario assumes current trends in economic activity into the future. It does not include the impact of climate change on the economy. The assumptions underpinning the reference scenario determine the level of baseline emissions. Treasury identifies the baseline as 'a major (and perhaps the single biggest) determinant of the estimated costs of mitigation because the emissions level in the reference scenario defines the amount of mitigation required to reach the environmental goals of the policy scenarios' (Treasury 2008a, p. 28).

The reference scenario is described as a 'plausible future path for economic growth, population levels, energy consumption and greenhouse gas emissions in a world without climate change' (Treasury 2008a, p. 27). Important global trends in the reference scenario include strong global economic growth, rising per person incomes, slowing population growth over the century, continuing reliance on fossil fuels for energy and falling emissions intensity of the global economy.

Under the reference scenario, Australian and world emissions continue to grow strongly. By 2050, world GHG emissions increase by over 140 per cent from current levels and Australia's greenhouse gas emissions nearly double. The concentration of greenhouse gases in the atmosphere rises to over 1,500 parts per million (ppm) CO₂-e by 2100.

Reference case emissions in GTEM (the main international model used by Treasury) tend to be high in comparison with the reference cases of other comparable models. For example, according to the Energy Modelling Forum EMF 22 database the reference case atmospheric concentration of CO₂ in 2100 in GTEM is 1030ppmv. The corresponding figures for other comparable models are: MERGE, 955ppmv; IMAGE, 772ppmv; miniCAM, 775ppmv; and ETSAP-TIAM, 820ppmv.

Reference case assumptions are important because they condition the economic path against which the costs associated with the policy scenarios and shocks are assessed. Treasury has relied on various forecasts from international organisations and Consensus Economics for variables such as economic growth, population/participation and productivity.

In many cases, such long-term assumptions are relatively uncontroversial. Nonetheless, with the global economy now confronting the worst economic crisis in half a century, it would be appropriate for Treasury to provide regular updated GDP forecasts from the IMF, OECD and Consensus Economics (on a rolling five year basis) so that stakeholders can compare them with those used in the climate change modelling.

Reference scenario assumptions at the sectoral level, including key technology assumptions, are more open to question. Treasury assumptions in some areas diverge sharply from industry estimates. Areas of particular concern include the capital costs of new power plants, the assumed deployment cost of carbon capture and storage (CCS) technology, price projections for key commodities and assumed rates of energy efficiency improvement in various sectors.

Sectoral marginal abatement costs

One of the most problematic elements in the Treasury modelling assumptions concerns the embedded marginal abatement cost (MAC) curves in the models. A marginal abatement cost

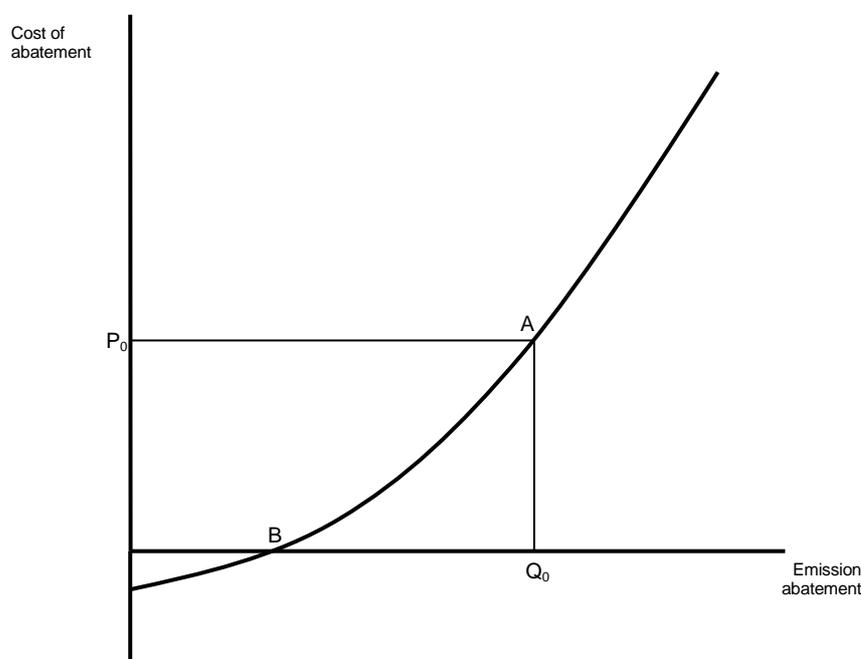
curve shows the cost (say in dollars per tonne) of reducing emissions for a particular sector in a given economy. Marginal abatement cost curves can be constructed for whole economies but such curves would have no applicability in CGE models.

The stylised curve in Figure 1 shows that at low levels of abatement, emission abatement may provide benefits (so-call 'no regrets' policies). However, as the abatement task increases, the cost of abatement rises at a faster rate. Emission abatement is brought about through a variety of mechanisms: fuel switching, substituting away from energy toward other factors of production such as labour and capital, changing consumer behaviour, structural change in the economy and, ultimately, reducing economic output.

The MAC curve can be thought of as a schedule of abatement options (or opportunities) organised by cost. Under a market-based mechanism, such as an ETS, in response to the price signals the market determines the scheduling of the emission abatement options based on their cost effectiveness. Subject to transactions costs and uncertainty this characteristic of an ETS makes it the policy instrument of choice among many economists.

While many of the relevant MAC curves may be said to be embedded in models such as GTEM, without the release of full model documentation it is not clear that consistency has been maintained between GTEM and MMRF, the model used to derive the sectoral impacts of the ETS. In the case where these curves are documented (see Treasury 2008a , Appendix B, pp. 256-8) it is obvious that no attempt has been made to enforce consistency on the model assumptions.

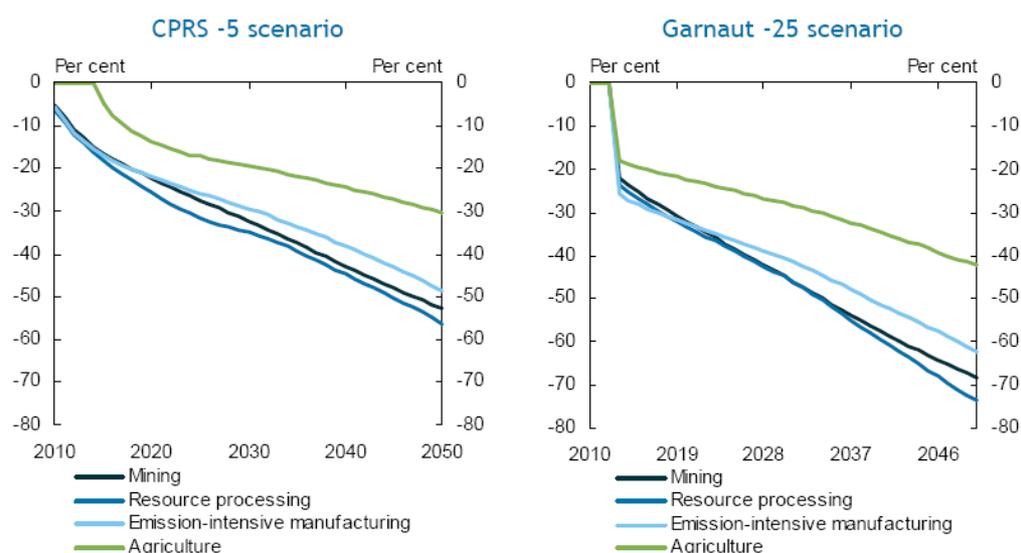
Figure 1: Stylised marginal abatement cost curve



The Treasury modelling report acknowledges that Australia faces relatively high mitigation costs compared with other developed countries due to the substantial contribution of emission- and energy-intensive industries to the Australian economy. It also acknowledges that Australia has less mitigation potential at low emission prices than many other developed countries (Treasury 2008a, p. xiii).

Against this backdrop, the steep declines in EITE industry emissions reported in the modelling, and the marginal abatement curves on which they are premised, appear extremely optimistic. As shown in Figure 2, all EITE sectors reduce emissions relative to the reference scenario despite the fact that output for many of them appears to grow against the level achieved in 2008 in the medium term (Treasury 2008a, pp. 164-5).

Figure 2: EITE industry emissions (change from reference scenario)



Source: Treasury estimates from MMRF.

Source: Treasury 2008a, p. 168.

Differences in mitigation across sectors largely reflect assumed differences in marginal costs of mitigation. Mitigation in mining and resource processing is largest, though the fall in emissions in these sectors also reflects falls in output due to lower world demand, especially after 2025. It is smallest in agriculture, 'but still significant, with around a 30 per cent reduction relative to the reference scenario in 2050' (Treasury 2008a, p. 167).

The Treasury report notes that the Garnaut -25 scenario (the most ambitious of the policy scenarios in terms of GHG stabilisation) employs 'very flexible marginal abatement curves', while the CPRS -5 scenario adopts 'a smoother transition' yet still one that admits very significant mitigation at relatively low cost (Treasury 2008a, p. 167).

An interesting example of these emission intensity reduction curves is the one for aluminium assumed in MMRF. This curve implies that around 80 per cent of all process emissions in the aluminium sector can be removed at a permit price of \$80/t CO₂e (see Figure B10). In the case of agriculture, it is unclear how the large emission reductions would be achieved in the face of substantial increases in output relative to the level in 2008 as suggested by the sectoral results of the Treasury modelling. In a country where competitiveness will continue to depend on extensive rangeland agricultural production of sheep and cattle it is difficult to imagine that technology will become available in the near future to enable major reductions in methane output from rangeland agriculture.

It is important also to scrutinise the industry-level MAC curves for fugitive emissions, especially for sectors such as coal where it is well known that achieving significant emissions reductions is becoming increasingly difficult. In order for stakeholders to better understand

the marginal abatement cost curves in the Treasury modelling, it is important that, subject to any commercial confidentiality considerations, full model documentation be released.

Electricity sector transformation assumptions

Both globally and in Australia, the Treasury modelling foresees an essentially seamless transformation to a decarbonised electricity generation sector. In the long run, large emission reductions are achieved in all scenarios, even if some technologies being explored do not prove commercially viable. The report states that there is no evidence that pricing emissions will compromise Australia's energy security.

Significant long-run changes in the mix of technologies and fuels used in the electricity sector are reported in all policy scenarios (Figure 3). However, in the short- to medium-term electricity generation sector emissions do not fall significantly. Indeed, under both the CPRS scenarios electricity sector emissions increase between 2010 and 2020, a period in which Australia theoretically meets its emission reduction targets by purchasing lower cost global permits. Demand reduction and the Government's expanded Renewable Energy Target (RET) account for most of the abatement relative to the reference case by 2020, with relatively little shift toward gas-fired generation. Emissions in the electricity sector do not fall significantly, relative to current levels until the mid-2030s, when expanded technology options become available.

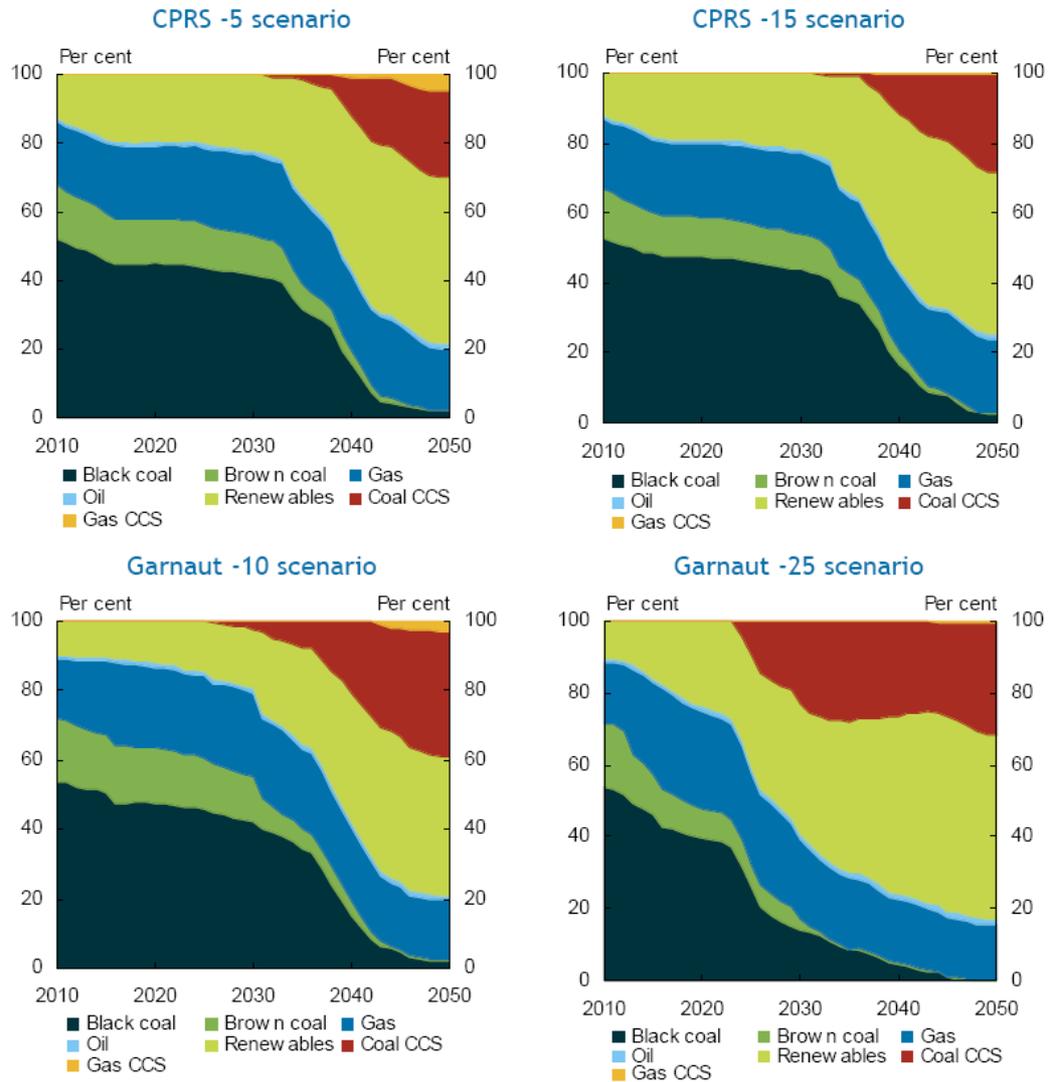
According to the Treasury modelling, carbon capture and storage technology starts to develop during the 2020s and 2030s, while the share of renewables continues to rise strongly. By 2050, the electricity generation sector is almost decarbonised with the share of renewables ranging from 40-51 per cent in the policy scenarios compared with just over 5 per cent in the reference scenario.

Across the economy, electricity demand falls relative to the reference scenario after an emission price is introduced. The reduction in demand leads to immediate emissions mitigation. Over time, however, most emission reductions are achieved through reduced emission intensity.

Electricity prices rise as a result of emission pricing and the adoption of low-emission technologies. In the short term, Australian wholesale electricity prices increase by around 50-130 per cent in real terms compared with the reference scenario. As a result of the continued deployment of more expensive technologies average wholesale prices are 80-150 per cent higher by 2020 and 120-190 per cent higher by 2050.

A key result from the Treasury modelling is that while several existing plants retire earlier than in the reference scenario, most continue to operate. Treasury confidently asserts that: 'The retirement of several existing fossil fuel power plants, either fully or partially, owing to reduced profitability, does not lead to power shortages. The reduced demand for electricity and new investment in lower-emission sources ensures demand for electricity is met' (Treasury 2008a, p. 178).

Figure 3: Electricity generation technology shares

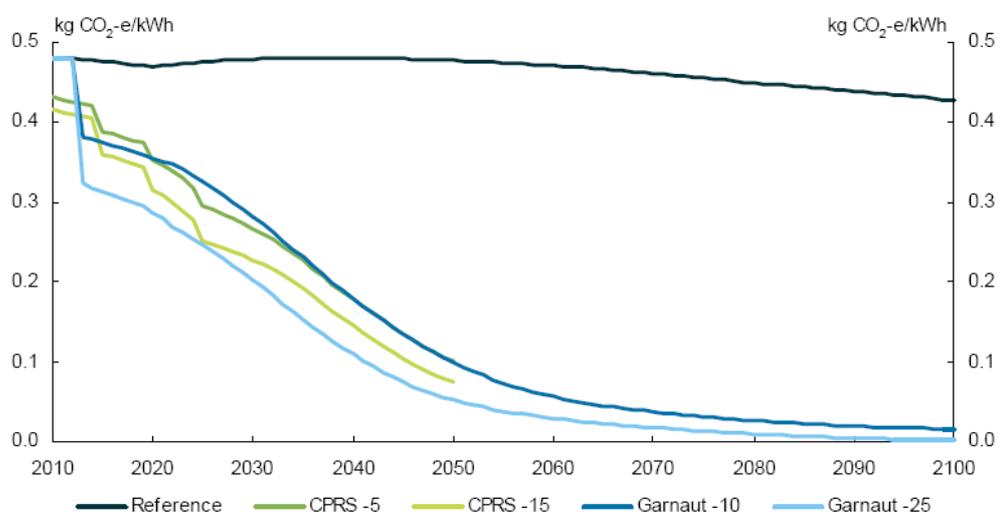


Source: MMA.

Source: Treasury 2008a, p. 174.

The Treasury modelling relies on a set of assumptions that together are likely to mean that the structural adjustment challenge of moving to a decarbonised electricity generation sector has been significantly underestimated.

First, the modelling relies on uncertain international action, emission pricing and permit trading assumptions. While these will be discussed in more detail below, their importance can be adduced from Figure 4 which shows the path toward decarbonisation of global electricity generation reported by the Treasury. By 2050, the emission intensity of electricity generation is around 0.05-0.1 kg of CO₂-e kWh, compared with just under 0.5 kg in the reference scenario.

Figure 4: Emission intensity of world electricity generation

Source: Treasury estimates from GTEM.

Source: Treasury 2008a, p. 124.

In the case of the Garnaut scenarios, an instantaneous drop occurs in emission intensity the moment a global ETS comes into force. This is not well explained in the Treasury report, nor is there any basis in reality for what appears in the Garnaut -25 scenario as a 30 per cent instant drop in the emissions intensity of the electricity generation sector.

The reason that the instantaneous drop in intensity is not so obvious in the case of the CPRS-5 and CPRS-15 scenarios is that for developed countries (Annex B countries under the Kyoto Protocol) the scheme is assumed to commence in 2010 so the divergence from the reference case occurs in the first year. The implication is that the moment the scheme comes into effect in the case of the CPRS scenarios there is an instantaneous drop in the emissions intensity of world electricity generation of about 13 per cent.

These results arise because the modelling does not appear to take proper account of fixed capital and lumpy investment. At the beginning of the scheme it is assumed that the price does not start smoothly from a low level but will jump immediately to \$20-30/t CO₂e. This appears to induce the model to instantaneously retire emissions intensive capital stock and replace it with low emissions generation capacity. Clearly this cannot happen in the real world.

In the Treasury modelling, emission permit prices are exogenous to the electricity sector models of McLennan Magasanik Associates (MMA). Permit prices appear to have been determined through an undocumented iterative process using GTEM and a Hotelling pricing rule (Treasury 2008a, pp. 93-4). While such an approach may have some theoretical merit it is unclear from the Treasury report how this projection process was undertaken or whether it leads to reliable projections of permit prices. Given the central role of permit prices in determining both the success and the cost of the scheme it remains unclear to this reviewer why this aspect of the modelling has not been more fully publicly documented.

The permit prices were input into MMA's electricity market models (MMA 2008). The credibility of the emission permit prices postulated by the Treasury modelling is of vital importance to the electricity generation sector given it accounts for in excess of 35 per cent of

Australia's total emissions and around 50 per cent of covered emissions under the proposed ETS.

Access to a high level of lower cost international permits, as assumed by Treasury modelling scenarios, is especially critical in the first decade of the ETS when Australia continues to rely heavily on traditional coal-fired generation. Any major departure from the optimal international permit trading assumptions in the Treasury modelling will likely have negative consequences for Australia's major electricity generators.

Even with the sort of permit prices assumed by the Treasury/MMA modelling, the potential exists for more wrenching structural adjustment in the sector. Modelling work undertaken by Concept Economics, as well as work undertaken by ACIL Tasman for the Energy Supply Association of Australia, points to very different outcomes for the electricity sector notwithstanding broadly similar emission permit prices.

The Treasury/MMA modelling outcomes rely, for example, on a very high rate of pass through of permit prices into wholesale electricity prices. In the National Electricity Market (NEM), prices in the CPRS -5 scenario are projected to increase by about 76 per cent by 2020 compared with the reference case and by about 120 per cent by 2030. Given the permit price path assumed, this implies a pass through rate of permit prices into electricity prices of about 120 per cent by 2020 and 110 per cent by 2030.

The key driver of this result is a change in the nature of the NEM whereby Victorian brown coal generators (traditionally price takers in the market) become price setters. Because of their high emissions intensity, electricity prices increase by the full amount of the increase in brown coal generators' short run marginal costs. This is aided by rising gas prices which prevent gas-fired plant from taking advantage of high permit prices to displace brown coal plant (MMA 2008, p. 7).

Nothing in the experience of the NEM would suggest that the likely result of an ETS would be the emergence of brown coal generators as strategic price setters. With a fall in electricity demand and no immediate retirement of coal fired generators, the opposite is more likely to be the case with excess base load capacity over demand and prices lower than suggested by the Treasury/MMA modelling followed by the potential financial failure of some major emissions intensive generators

Moreover, were such high prices to eventuate it is highly likely that the result would be new entry from gas fired generation. Based on the data in the MMA report, the long-run marginal cost of gas-fired generation (including the emission permit price) is well below the prices projected for all of the NEM regions between 2010 and 2030. The small role played by gas-fired generation in Australia's abatement task is therefore an implausible feature of the Treasury/MMA modelling.

Together these factors help ensure that while brown and black coal generators are forced to reduce output, none appear forced to retire in the first decade of an ETS. In the CPRS -5 scenario, for example, Queensland black coal generation in 2020 is 101 per cent of the 2008 level, NSW black coal generation is 97 per cent of the 2008 level and Victorian brown coal generation is 80 per cent of the 2008 level. This outcome is not supported by other modelling work of the electricity supply industry (ACIL Tasman 2008).

Significant concerns also surround the technology assumptions in the Treasury/MMA modelling. Key MMA electricity technology assumptions are reproduced in Table 1. In addition to the original data in the table the implied capital costs of each type of power plant in 2050 have been added as the final column.

Table 1: Assumed technology characteristics

Fuel/technology	Thermal efficiency		Capital costs	Capital cost de-escalator		Capital costs
	2010	2011 – 2050	2010	2010 – 2020	2021 – 2050	2050
	%	% p.a.	\$/kW s.o.	% p.a.	% p.a.	\$/kW s.o.
Black Coal						
Supercritical coal (dry-cooling)	38	0.48	1879	0.5	0.5	1538
Ultrasupercritical coal (US)	41	0.48	2255	0.5	0.5	1845
Integrated gasification combined cycle (IGCC)	39	1.20	2673	1.5	1.0	1700
IGCC with carbon capture (CC)	32	1.30	3688	1.5	1.0	2345
Ultrasupercritical with CC and oxyfiring	30	0.58	2997	1.0	0.5	2332
USC with post-combustion capture	28	0.58	2482	1.5	0.5	1836
Brown Coal						
Supercritical coal with drying	35	0.48	1972	0.5	0.5	1614
Supercritical coal	33	0.48	2289	0.5	0.5	1873
Ultra supercritical coal with drying	37	0.48	2366	1.0	0.5	1841
IGCC with drying	37	1.20	2788	1.0	1.0	1865
Integ. drying gasification combined cycle (IDGCC)	37	1.20	2732	1.5	0.5	2021
IGCC with CC and drying	30	1.30	3886	1.5	0.5	2874
IDGCC with CC	32	1.30	3026	1.5	0.5	2238
Co-firing with biomass or gas in supercritical plant	35	0.48	2169	0.5	0.5	1775
Post-combustion capture without drying	28	0.58	2761	1.5	0.5	2042
Post-combustion capture with drying	26	0.58	2575	1.5	0.5	1905
Natural Gas						
Combined cycle gas turbine (CCGT) - small	49	0.60	1467	0.5	0.5	1200
CCGT - large	53	0.60	1334	0.5	0.5	1092
Cogeneration	72	0.60	1740	0.5	0.5	1424
CCGT with CC	46	0.70	2001	1.0	0.5	1557
Renewables						
Wind			2134	0.5	0.5	1746
Biomass- Steam			2598	0.5	0.5	2126
Biomass - Gasification			2784	1.5	1.0	1770
Concentrated solar thermal plant			4176	1.5	1.0	2656
Geothermal - Hydrothermal			2227	1.0	1.0	1490
Geothermal - Hot Dry Rocks			2413	1.5	0.5	1785
Concentrating PV			4640	1.0	1.0	3104
Hydro			2320	1.0	0.5	1805

Source: Treasury, MMA, Concept Economics

In relying on these technology assumptions for plant capital costs and capital cost de-escalators, Treasury appear to have dramatically underestimated the cost of transforming Australia's current electricity generation capacity to one based on near-zero emissions technologies. In some cases, capital costs for new plant appear to be roughly half current industry estimates given the rapid escalation in capital costs over recent years.

Significantly, the Final Report of the Garnaut Climate Change Review drew attention to the fact that:

Capital costs have risen markedly with particular impact on capital-intensive industries. Industry advice to the Review indicates that there have been increases of up to 60 per cent in construction costs per installed kilowatt of power plants since 2004, across all technologies (Garnaut 2008a, p. 472).

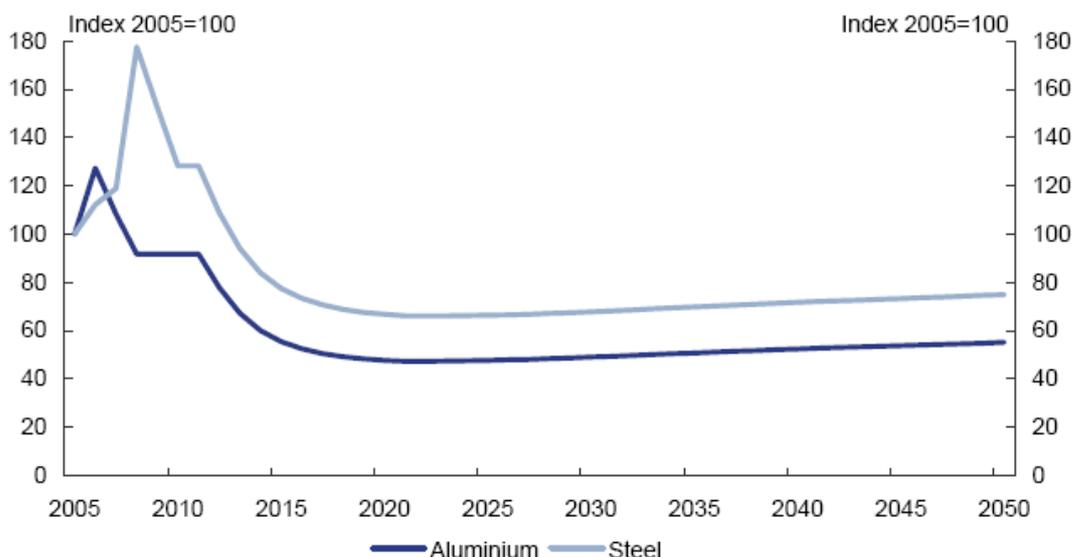
Some of the increase in construction costs of conventional power plants experienced in recent years is likely to be unwound in the coming two years. However, the problem of artificially low capital cost assumptions is especially acute in the case of carbon capture and storage related technologies. Issues surrounding CCS are examined in more detail under TOR 4.6.

MMA assumptions have also come under scrutiny for appearing to overstate the benefits from learning-by-doing in low-emissions energy sources. Wind power plays an important role in increasing electricity capacity in the near-term within the Treasury modelling, yet wind is a relatively mature technology (Productivity Commission 2008, p. 33).

Commodity price assumptions

An area of related concern surrounds reference case assumptions for commodity prices. These are important both in their own right and because they are one of two factors (along with technological progress) driving capital costs over time in the MMA analysis. With MMA assuming that 25 per cent of capital costs reflect commodity costs, Treasury's reference case assumptions for aluminium and steel provide critical input for build costs on new power plants and electricity transmission lines. The relevant metal price indices are reproduced in Figure 5 (see the Treasury Summary of Assumptions and Data Sources book released on 3 October 2008).

Figure 5: Index of metal prices in reference case (2006 \$AUD)

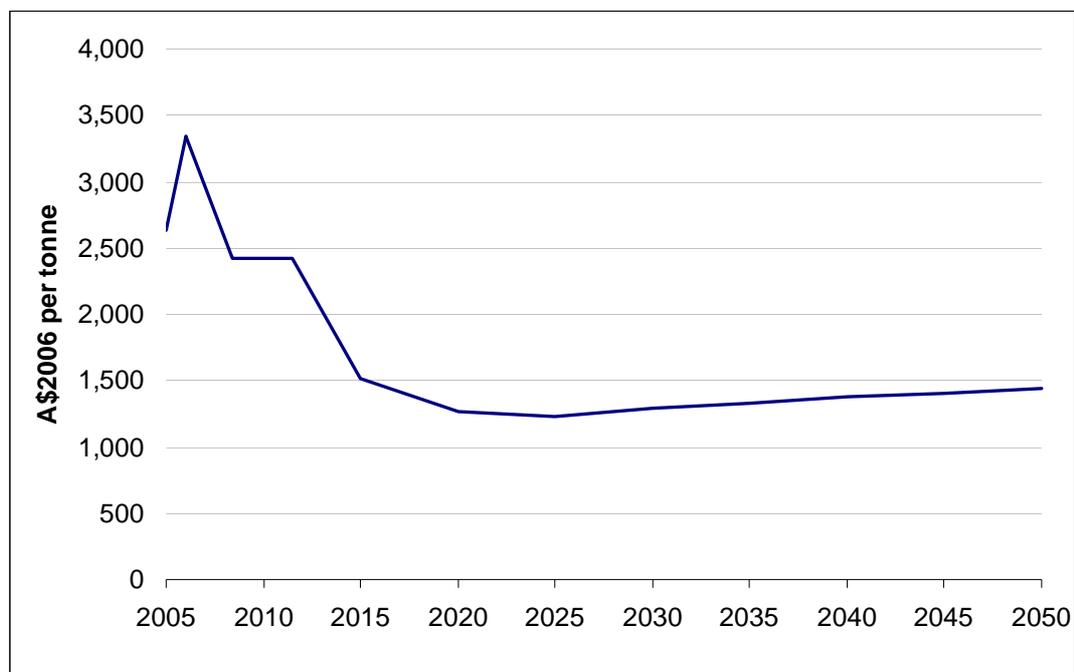


Source: Treasury.

Focusing on aluminium, the projected prices appear to fall well below estimates of long-run marginal cost. When converted into prices (Figure 6), the projected price indices are at odds

with both future global demand projections and independent assessments of the long-run marginal cost of production by groups such as CRU Strategies. If such prices were to materialise, all aluminium producers globally would be losing money by 2015. This simply cannot happen for sustained periods.

Figure 6: Implied Treasury aluminium price projection



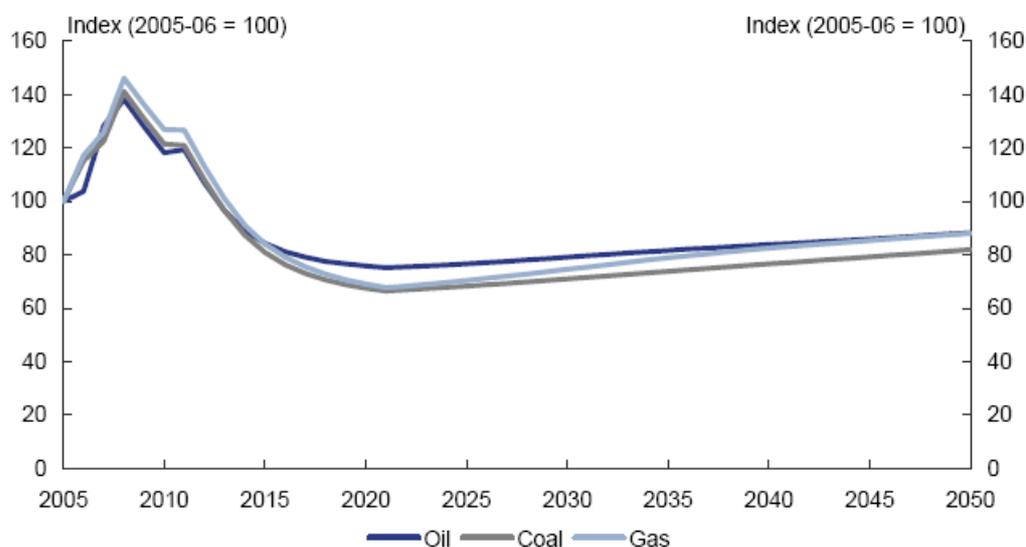
Source: Calculated by Concept Economics

The risk of a significant underestimation of metal prices in the reference case appears heightened by the fact that steel prices are projected to follow a similar price to the aluminium price, helping also to drive low capital costs of new power generation.

In addition to low projected metals prices, long-run energy price assumptions also appear questionable. While Treasury is able to point to International Energy Agency projections as the basis for gradually rising global energy prices, a key question is at what level prices will rise in real terms.

As can be seen from Figure 7, Treasury projects that real energy prices will fall between now and around 2022 with West Texas Intermediate prices falling over that period to a little under \$US50/bbl. At the same time coal and gas prices are also assumed to fall in real terms at similar rates. While energy prices on global markets have fallen sharply in recent months the longer term projections do not seem to be in line with the strong world growth assumptions adopted by Treasury. Among the implications of relatively low oil and gas prices are fuel switching between coal and gas at carbon prices lower than those that appear realistic.

In addition, the assumed divergence between oil and gas prices in the reference case (with gas becoming relatively cheaper between 2015 and 2020) also appears problematic in light of likely future growth in demand for LNG, particularly as China's demand for cleaner energy rises in response to greater demand for reductions in air pollution.

Figure 7: Energy commodity price assumptions (Foreign currency – 2005-06 dollars)

Source: Treasury and IEA.

International action assumptions

The Treasury has modelled the impacts of four policy scenarios that assume that Australia and the world implement emission trading schemes to reduce global emissions and stabilise atmospheric concentrations of GHG. The stabilisation level, the global framework for action, Australian targets and Australian policy settings are key variables determining the impact on the Australian economy.

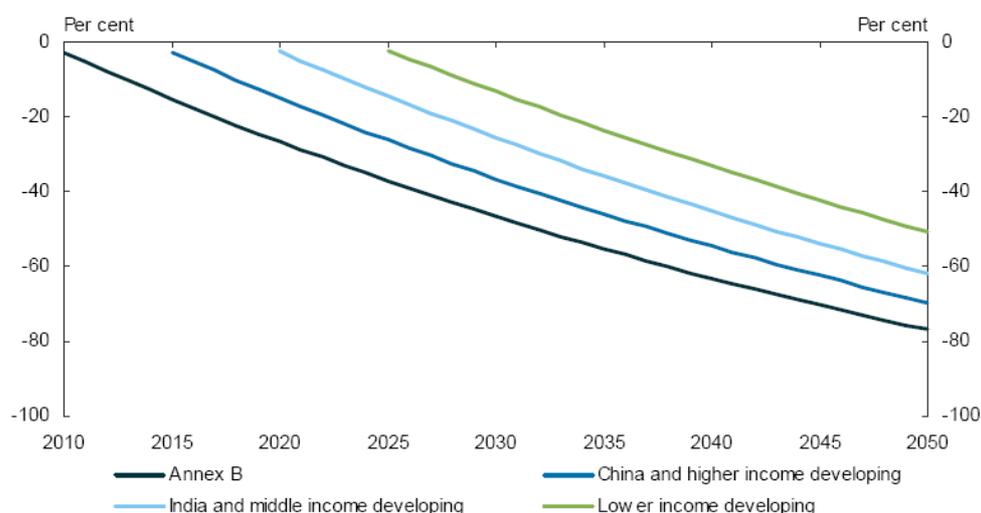
The results of the Treasury modelling rely crucially on the assumption that the world implements emissions reduction arrangements through a global emissions trading scheme with 'strong coordinated global action' (Treasury 2008a, p. ix). This is fundamental to results that yield relatively modest emission prices and aggregate economic costs of mitigation policies in Australia. It also helps to determine core conclusions about Australia's 'early mover' benefits, posited improvements in the competitiveness of many EITE sectors and the ease with which Australia's economy (including the electricity sector) transforms to a low-emissions future.

The starting point for the modelling is the statement that: 'Because responding to climate change is a global challenge, this report evaluates the impacts on Australia in the context of global action to reduce emissions' (Treasury 2008a, p. 3). From this premise, Treasury's analytical framework yields a self-reinforcing, virtuous circle of domestic and international benefits. Hence: 'Strong global coordinated action accelerates cost reductions in low-emission technologies, prevents lock-in of more emission-intensive industry and infrastructure, and minimises distortions in trade-exposed sectors' (Treasury 2008a, p. 89).

The international action assumptions of the two Garnaut scenarios in the Treasury modelling are particularly optimistic based as they are on a global emissions trading scheme covering all economies and sources of emissions from 2013. The Treasury report itself describes the global framework assumed by the two CPRS scenarios as 'more realistic' than the Garnaut framework (Treasury 2008a, p. xi).

The CPRS scenarios assume a 'multi-stage' approach to international emissions trading with developed countries acting first and developing countries joining over time. National targets are based on an allocation of mitigation effort, with each country gradually diverging from its reference scenario emissions. This multi-stage global framework is illustrated for CPRS -5 in Figure 8.

Figure 8: Emissions allocations relative to reference scenario (CPRS-5 scenario)



Note: Allocations applied in the modelling diverge slightly from this chart owing to assumptions about the creation of offset credits in developing economies.
Source: Treasury.

Source: Treasury 2008a, p. 83.

Australia's level of mitigation effort is taken as the starting point. Developed economies (Annex B countries under the Kyoto Protocol) are assumed to act in concert with Australia from 2010 and to take comparable action, diverging from their reference scenario emissions at the same rate. Under the CPRS scenarios, Australia's allocation is 60 per cent below 2000 levels by 2050, equal to about an 80 per cent reduction relative to the reference case.

Developing economies join the scheme over the period 2015 to 2025. China and higher income developing countries take on targets in 2015. India and middle income developing economies take on targets in 2020, and lower income economies take on targets in 2025.

These targets gradually reduce emission rights, and diverge strongly from reference scenario levels by 2050. In the CPRS policy scenarios, China's allocation of emissions continues to rise until around 2030, and India's until around 2040. China's allocation is roughly treble 2000 levels in 2030, but falls to less than double 2000 levels by 2050. This is equal to a 70 per cent reduction in China's reference scenario emission levels. Before taking on emission reduction targets, non-Annex B economies are assumed to generate a modest volume of offset credits for sale to Annex B economies.

A serious gap in the released Treasury modelling results is the failure to publish the results from any policy scenario where 'strong coordinated global action' on climate change is not forthcoming. This deficiency is all the more notable given:

- the intrinsic nature of the collective action problem surrounding climate change;

- the manifest failings of the existing international climate change architecture; and
- the explicit adoption by the Government of a medium-term national target range that includes an unconditional commitment to reduce Australia's emissions irrespective of the actions of other countries.

Only global action, or at least coordinated action by the countries that contribute the lion's share of global emissions, can reduce greenhouse gas emissions to a level that significantly reduces the risks of climate change. Climate change is a classic free rider problem in that it is virtually never in the economic interests of individual nations to undertake unilateral emission reductions. A further dimension of the problem is that GHG reductions would cost some nations much more than others, and benefit some nations far less than others, creating different incentives for different countries that can be expected to bargain in their own national interests.

For these reasons, coordinated international action on climate change has been described as 'much the most complex collective action problem in human history' (Wolf 2008). The Garnaut Climate Change Review similarly concluded that: 'Any effective remedies lie beyond any act of national will, requiring international cooperation of unprecedented dimension and complexity' (Garnaut 2008a, p. xvii). Garnaut (2008b, p. 3) has described the process of escaping what he calls the 'prisoners' dilemma' surrounding global action as 'perhaps the most formidable of international relations challenges; more formidable than the multilateral trade negotiations which have recently collapsed'.

Reflecting this reality, the 2007 Prime Ministerial Task Group on Emissions Trading (the so-called Shergold Report) concluded correctly that the road to a workable global emissions trading regime 'will be lengthy, and progress will be patchy' (PMTGET 2007, chapter 5).

The experience with the Kyoto Protocol reinforces a picture of global action as being slow, fragmented and partial. Kyoto has shown itself to be neither an effective, nor efficient, nor especially equitable instrument for global action on climate change.

Too many countries have not restrained emissions and too many of those who have are well behind their targets. Kyoto does not place binding emissions constraints on many of the world's largest emitters, including the most rapidly growing economies in the developing world. Three of the world's five largest emitters – the United States, China and India – do not face binding emission constraints under the Kyoto Protocol. A fourth – Russia – has a Kyoto commitment so lax that it will require no abatement to ensure compliance (Aldy and Stavins 2008). But the reality is that the negotiated articles of the Protocol and the Marrakesh Accords adopted at the 7th United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties reflect what was practically possible after years of intense diplomatic effort.

The rigid distinction between developed nations and developing countries in the UNFCCC remains an enormous stumbling block to concerted action to restrain global emissions, with developing countries set to contribute 75 per cent of the growth in GHG emissions by 2030 (IEA 2007). Already, developing countries account for 50 per cent of energy-related emissions and their share is expected to rise to 70 per cent by 2030 in the absence of appropriate policies (IEA 2006).

At the same time, it is clear that many developed countries with constraints under the protocol will not achieve their Kyoto targets by the end of the first commitment period in 2012. A recent UN reported stated that of the 37 developed nations with Kyoto targets, 20 are set to miss their emissions goals.

This includes many nations in the European Union, often seen as a global leader on climate change action. A 2007 report by the European Environment Agency (2007) noted that: 'Spain, Austria, Italy, Portugal, Greece and Denmark are currently not on track to meet their individual [Kyoto] targets based on past trends, even when the planned use of carbon sinks and Kyoto mechanisms is taken into account'.

Even on equity grounds, Kyoto represents a flawed basis for global action given the changed nature of the global economy since the Framework Convention divided countries into the two categories in 1992. Approximately 50 non-Annex I countries (developing countries and some others under the UNFCCC) now have higher per person incomes than the poorest of the Annex I countries with commitments under the Kyoto Protocol (Aldy and Stavins 2008, p. 4).

The singular weaknesses of the Kyoto Protocol based on efficiency, effectiveness and equity remain no less relevant by virtue of Australia's ratification of the agreement in late 2007. Yet it is likely that any post-2012 climate change agreement will embody the same key structural features as the Kyoto Protocol.

Given the nature of the collective action problem and the historical record of slow, partial and fragmented action, it is difficult to conceive why Treasury did not model and publicly release at least one policy scenario where comprehensive and coordinated global action fails to develop in the next decade. This is the most realistic scenario facing Australia so the implementation of the policy should be undertaken with full information about the likely costs to the Australian economy and particularly the costs to Australia's key export industries.

This omission is all the more remarkable given the Government's confirmed commitment in the White Paper to an unconditional 5 per cent emissions reduction target in 2020 regardless of the actions of other nations. Stakeholders had long recognised that this sort of unconditional commitment would likely form one element of the Government's approach on a medium-term target.

The most obvious scenario would have been one where Annex B countries under the Kyoto Protocol reach a new agreement on emission targets at the Copenhagen climate change meeting in late 2009 (recognising the role of the United States remains highly uncertain), but developing countries as a group continue to reject binding emissions restraints in the medium term – at least until 2020, but more realistically until 2025.

Stern (2008) has argued that among the conditions required for developing countries to adopt binding national targets by 2020 are: (i) agreement by developed countries in 2009 to reduce emissions from 1990 levels by 20-40 per cent by 2020 and at least 80 per cent by 2050; and (ii) the development of mechanisms and institutions to allow 'substantial' financial flows and technology transfer to developing countries. By implication, in the absence of these factors the chances of developing countries taking on binding emissions restraints in the next decade diminish dramatically.

Treasury officials have advised the Committee that 'the scenarios that were modelled by Treasury were done at the direction of the government'. It appears difficult to reconcile this

statement with the assurances by Treasury concerning extensive consultation with experts to ascertain assumptions intended to be 'plausible central estimates within a range of uncertainty' (Treasury 2008a, p. 16).

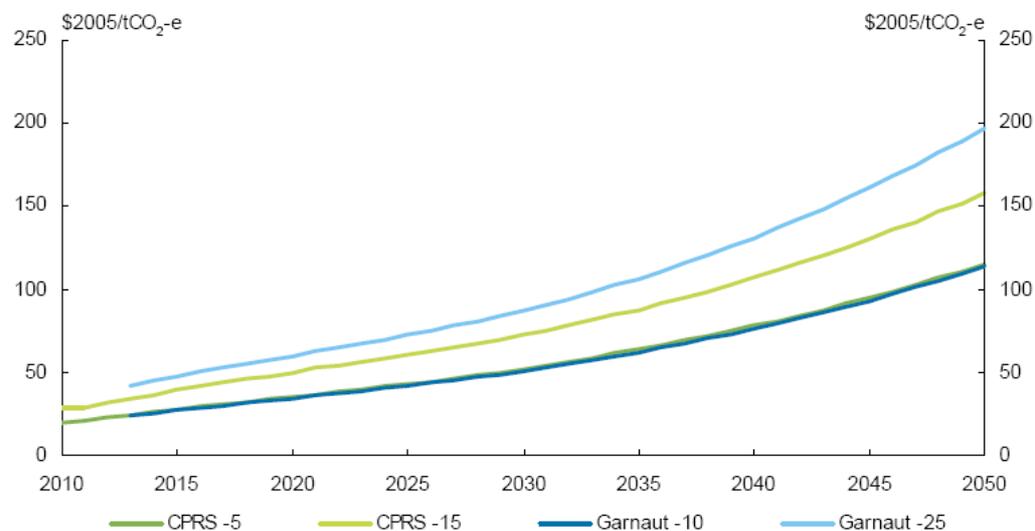
Elsewhere, Treasury officials have defended the policy assumptions arguing: (1) that the assumptions about global action are consistent with current international trends regarding the introduction of emissions trading schemes; and (2) that given the majority scientific opinion and the risks of climate change, the only sensible presumption is one of meaningful global action to slow and then reverse the increase in greenhouse gas emissions. Any other scenario, it is suggested, is not a presumption with which any of us should feel comfortable' (Gruen 2008, p. 5). The degree of 'comfort' or otherwise felt by Treasury officials is not relevant here. What is required is an impartial assessment of the likely outcomes (and timing of those outcomes), of the international negotiations and a transparent discussion of the consequences.

Ideally, Treasury's scenarios should have taken account of global, group and independent action by Australia, a view shared not only by a range of stakeholders but also, it would appear, by the Government's premier advisory body on structural reform (Productivity Commission 2007, p. 11).

Emission pricing and permit trading assumptions

The Treasury modelling assumes that the global emission price drives the emission price in Australia (adjusted for exchange rate changes) and that the global price is set efficiently. As mentioned above, Treasury has used a 'Hotelling rule' to construct a global emissions pathway for each scenario for the global models (GTEM and G-Cubed).

It is stated that this approach 'mimics the expected behaviour of an efficient global emission market that allows banking and borrowing of permits over time, and draws on similarities between mitigation policy and management of finite resources' (p. 78). Banking and borrowing encourages the efficient intertemporal allocation of mitigation effort by allowing use of a permit at any time. Under the Treasury approach, emission prices (in global currency terms) rise exponentially at a real rate of 4 per cent per year on different emission price paths consistent with the stabilisation goal (see Figure 9).

Figure 9: Australian emission price

Note: Prices are in 2005 Australian dollars.

Source: Treasury estimates from MMRF.

Source: Treasury 2008a, p. 140.

More generally, Treasury assumptions virtually guarantee that the permit prices from the modelling are unrealistically low. In addition to the assumption of coordinated global action, the results appear reliant on international climate negotiations delivering 'optimal' institutional and permit trading arrangements.

A global emissions trading scheme with complete coverage of regions, gases and emissions sources (either from 2013 in the case of the Garnaut scenarios or in a multi-stage CPRS framework) provides maximum access to low-cost abatement and thus lower cost estimates than a less efficient global arrangement. The Treasury (2008a, pp. 16-17) itself acknowledges that its assumption of complete global coverage of regions, gases and emissions sources works to minimise the costs of mitigation action in all scenarios:

While the international emissions trading scheme is an analytical proxy for the mix of policy instruments that are likely to be deployed, such an 'optimal' policy mechanism, with complete coverage of regions, gases and emissions sources, tends to give lower cost estimates than a less efficient global arrangement.

It is clear that full confidence in an international emissions trading scheme depends on the strength of the compliance regime and the ability to verify emission reduction certificates. If it is not possible to guarantee that a tonne of carbon purchased from country A is legally equivalent to a tonne purchased from country B then confidence in the scheme will break down. It is not even clear that the institutional arrangements are in place in all Annex B countries to ensure the necessary verification regime could be put in place for a full trading regime in the next decade let alone building the necessary institutions in developing countries. In addition, legal international enforcement of compliance with the any agreed scheme remains problematic.

The scale of international trade in permits under GTEM is shown in Table 2.

Table 2: GTEM international trade in permits

	2020				2050			
	CPRS	CPRS	Garnaut	Garnaut	CPRS	CPRS	Garnaut	Garnaut
	-5	-15	-10	-25	-5	-15	-10	-25
	Mt CO ₂ -e				Mt CO ₂ -e			
United States	795	930	1698	1568	324	-187	1080	288
European Union	882	1011	406	539	1206	932	854	731
China	-691	-782	94	66	-598	689	3848	3930
Russia + CIS(a)	399	478	309	271	-27	-507	468	-127
Japan	330	386	297	365	413	347	299	272
India	-576	-701	-369	-205	-524	-275	-2373	-1297
Canada	121	140	263	245	176	93	309	170
Australia	64	60	103	77	85	-47	209	49
Indonesia	-84	-148	-183	-234	-157	-218	-345	-333
South Africa	-36	-38	34	26	-53	-78	130	28
Other South and East Asia	-304	-468	-566	-768	-1266	-1735	-1536	-2021
OPEC	252	281	204	309	1445	1164	1645	687
Rest of world	0	0	-2290	-2258	-1023	-178	-4589	-2378

Note: Note: (a) Commonwealth of Independent States. Positive values represent purchases of permits; negative values represent sales of permits.

Source: Treasury estimates from GTEM.

Source: Treasury 2008a, p. 116.

International emission reductions are primarily determined by the emission price and the coverage of the emission trading scheme. A crucial dimension of the modelling in this context would seem to be the degree to which emission prices dramatically reduce deforestation and stimulate large scale reforestation (Treasury 2008a, p. 131).

The largest forest sinks across the range of scenarios are in Indonesia and Other South and East Asia. As a consequence of the assumption that the international regime accepts forest sink credits it is further assumed that the region Other South and East Asia undertake major reductions in emissions in the short term and that credits arising from this activity enter the international permit market. Although some recent progress has been made in discussions of forest sinks previous experience with the negotiations on the formal rules regarding land use, land use change and forestry suggest that many years of negotiations would be required before much formal progress could be expected in the field.

The current architecture for the global carbon market remains a long way short of that envisaged for an effective and efficient international emissions trading regime with developing countries participating actively in the global abatement effort. Major hurdles need to be overcome if Australia is to secure the cost reductions from expanded access to international mitigation through market-based mechanisms such as international emissions trading and the Clean Development Mechanism (CDM).

The Kyoto Protocol's existing baseline-and-credit scheme, the CDM provides for emission offsets created in developing countries to help meet the compliance obligations of firms in Annex I countries. It currently operates on a narrow project-by-project basis, with a capacity of about 400 projects a year resulting in new financial flows annually of around US\$6 billion at current carbon prices. Estimates suggest that an effective global mechanism would imply annual carbon flows of up to US\$75 billion by 2020 (Stern 2008).

Major weaknesses in the existing CDM framework still need to be overcome for it to be a credible mechanism for lowering international mitigation costs prior to any global emissions trading scheme. The lack of a simple, timely and transparent CDM project approval process

means that substantial transaction costs in terms of validation, verification and independent scrutiny currently act as the barrier to CDM development (Ellis and Kamel 2007, Stern 2008).

There are concerns about the environmental integrity of CDM projects, including whether many projects are really providing emission reductions that are 'additional' to what would have happened in any case (Aldy and Stavins 2008).

The Kyoto mechanisms do not include deforestation and carbon effects of forestry projects are difficult to measure. There are fears that the Kyoto Protocol may actually accelerate deforestation by shifting timber harvesting from Annex I to non-Annex I countries.

In light of the importance the Government has placed on the Treasury modelling and the risks that surround various assumptions used, this review proposes:

- that ETS governance arrangements incorporate a review process to confirm that the Treasury modelling results were reasonably accurate. This process should specify the way that any unintended consequences in ETS performance can be quickly corrected;
- that further analysis be done on the short- and medium-term impact of an ETS on the electricity generation sector and other emissions intensive industries that may be subject to significant structural adjustment particularly as it affects regional Australia;
- that additional sensitivity analysis be conducted around at least one policy scenario involving slow, fragmented and partial global action in the medium to long term; and
- that additional sensitivity analysis also be conducted around less optimal international permit trading assumptions and the availability of Clean Development Mechanism (CDM) certificates.

2. TERMS OF REFERENCE: TWO

The impact on global emissions of the Government's proposed emissions trading scheme and the potential leakage of Australian jobs and industry in;

2.1. EMISSION INTENSIVE TRADE EXPOSED INDUSTRIES SUCH AS ALUMINIUM, LNG, CEMENT AND AGRICULTURE;

The first issue is relatively straightforward and relates to the impact on global emissions of Australia's efforts to reduce its own emissions under an ETS. Few dispute the simple reality that Australian emission reductions will have negligible impact on global emissions.

Australia currently accounts for around 1.4 per cent of global emissions and on current projections this will shrink to around 1 per cent by 2050. If Australia were to eliminate entirely its emissions it would make no dent in the problem in a world where Australia's annual emissions constitute less than either the United States or China emits in a month.

In other words, Australia's actions alone have no discernable impact on the environmental objective. The only effective response to climate change is a global one that engages all major emitters. As the Productivity Commission (2007, p. viii) has stated:

Independent action by Australia to substantially reduce GHG emissions, in itself, would deliver barely discernible climate benefits, but could be nationally very costly. Such action would therefore need to rest on other rationales. Facilitating transition to an impending lower emissions economy is the strongest rationale for independent action, but it is contingent on the imminent emergence of an extensive international response.

In the absence of such a response, many Australian industries, particularly in the traded-good sector, face a major competitive challenge under a domestic ETS. Just as Australia is a climate taker, not a climate maker, it is also the case that Australia is a price taker in global markets, not a price maker for the very large majority of the commodities that we produce.

An ETS could impose significant costs on Australian operations and bias investment decisions toward countries with lesser constraints on emissions. Hence the competitive impact on Australia's emission-intensive, trade-exposed industries – including aluminium, LNG, cement and agriculture – is likely to be substantial in an environment where international action on mitigation is likely to be slow, fragmented and partial.

On the basis of recent data, EITE industries account for 16 per cent of Australian business investment, 51 per cent of exports, 15 per cent of gross value added and employ nearly one in 10 working Australians (BCA 2008). The imposition of additional costs not faced by competitors is likely to constrain employment, investment and growth in these industries, with the potential for economic activity to shift to locations without a carbon price.

Alongside these competitiveness concerns is the problem of 'carbon leakage' – the extent to which global emissions could rise as EITE industries relocate to other jurisdictions not yet pricing emissions, thus partially negating any environmental benefit. It has been argued by one noted international economist that: 'Of all the daunting obstacles faced by the effort to combat global climate change, the problem of leakage is perhaps easiest to underestimate' (Frankel 2008, p. 3).

The most common description of carbon leakage concerns the relocation of energy intensive industries from countries with emissions constraints to countries with no such constraints. This could happen either via physical plant relocation or if firms in emission-constrained countries shrink while competitors in non-constrained countries expand. Global emissions might actually rise, compared to what otherwise would have occurred, if firms in the non-constrained economy use more emission-intensive technologies.

Another channel by which leakage can occur is via global energy prices. Mitigation policies in carbon-constrained countries reduce demand for high carbon fossil fuels, leading to lower prices on world markets (other things equal). As a result, non-constrained countries would respond by increasing consumption above what it would otherwise be. Conversely, demand for cleaner fuels such as natural gas would increase in rich, participating countries, driving up the world price and reducing the reliance on such fuels in non-constrained countries (Frankel 2008, p. 4).

Attempts to estimate carbon leakage empirically show significant variation. These tend to be based on studies on effects of mitigation associated with the European ETS and the impact on energy-intensive industries such as steel, cement, newsprint and aluminium. The Fourth Assessment of Report of the Intergovernmental Panel on Climate Change (IPCCC 2007, p. 81) cites estimates of carbon leakage in a range of 5-20 per cent by 2010 – where carbon leakage is defined as the increase in CO₂ emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries.

Some studies report higher results, including leakage rates of over 100 per cent (where mitigation in the carbon-constrained economy leads to more rather than less global emissions). Others point to minimal carbon leakage occurring. Higher estimates tend to be associated with increasing returns to scale, strategic behaviour in energy-intensive industries and homogeneous products. Studies have also tended to confirm the degree to which projected leakage has been lower as a result of the free allocation of carbon permits (Sijm et al. 2004; Reinaud 2005).

Australia's EITE industries are price takers in world markets with key competitors in nations unlikely to be subject to a meaningful carbon constraint in the foreseeable future. In thermal coal, for example, major export competitors include Indonesia, South Africa, China and Colombia. In the case of iron ore, global competitors include Brazil, India and South Africa. Major players in global aluminium trade include the Russian Federation, South Africa and the United Arab Emirates. Producers from Peru, Chile and the Russian Federation are among the main competitors of Australian copper producers (ABARE 2007).

Over 80 per cent of Australia's exports go to countries that are unlikely to be subject to a carbon constraint in the near term. Around 75 per cent of Australia's imports come from similar countries. Notably, these figures are significantly higher than developed countries in Europe given high levels of intra-EU trade. For example, the relevant figures for the United Kingdom are roughly 40 per cent (PJP 2008, p. 17). This suggests, in turn, that competitiveness and carbon leakage problems may be more significant for Australia's EITE sector than for emissions-intensive industries in many other developed countries.

Notwithstanding modifications in the White Paper, the Government's proposed ETS looks set to impose greater competitiveness imposts on Australian EITE industries than will apply under any other current or proposed scheme, including the European ETS.

A critical factor is the overall balance between administrative allocation of permits to EITE industries and auctioning of permits. The European ETS will move to 20 per cent auctioning only in its ninth year (2013), with free allocation to be phased down over the period to 2020. In 2013, only the power sector will be subject to full auctioning, with 80 per cent of permits to the non-power sector allocated on an administrative basis. The conclusion of one study that 'the ambitions for an Australian ETS in 2010 are more akin to the ambitions of the European ETS in 2020, not as it currently is' appears little exaggeration (PJP 2008, p. 16).

Importantly, EU states have also left open the prospect of introducing new instruments to deal with carbon leakage and competitiveness concerns in the absence of a global carbon constraint. Possible measures include continued free permit allocation to emissions-intensive firms or some form of border measure, if this can be made compatible with World Trade Organization rules. The relevant EU (2008) Directive includes the provision that:

Energy-intensive industries which are determined to be exposed to significant risk of carbon leakage could receive a higher amount of free allocation or an effective carbon equalization system could be introduced with a view to putting EU and non-EU producers on a comparable footing. Such a system could apply to importers of goods requirements similar to those applicable to installations within the EU, by requiring the surrender of allowances.

Any prospective scheme that may emerge in the United States in coming years is also likely to have significantly more generous EITE assistance provisions than Australia's ETS. For example, the Lieberman-Warner bill (defeated in Congress in 2008) proposed a phase-in of 24.5 per cent auctioning in 2012, rising to 58.75 per cent by 2032 and then remaining at that level until 2050.

In addition, it is virtually assured that any politically viable bill to introduce a cap-and-trade scheme in the United States must include provisions for border measures against countries not subject to an emissions constraint. The Lieberman-Warner bill, for example, would have required the president to determine what countries had not taken comparable action to limit GHG emissions and for importers of covered goods from those countries to buy international reserve allowances. Some form of border measure was supported by both presidential candidates prior to the November 2008 election (Frankel 2008). This then would raise serious questions in the WTO and potential disruption to trade.

The Treasury modelling report adopts a notably sanguine view of competitiveness issues while arguing that fears of carbon leakage 'may be overplayed' (Treasury 2008a, p. 170). The analysis applies only to the CPRS scenarios as the Garnaut scenarios assume emission pricing is introduced in all economies at the same time. The domestic impact of transitional assistance for EITE sectors (termed 'shielding' in the report) was also examined based on the Green Paper EITE assistance regime.

With its international action assumptions, the Treasury modelling largely assumes away what Garnaut described as the 'truly dreadful problem' of Australia's EITE industries facing a carbon price while their international competitors take no action (Garnaut 2008a, chapter 13).

For EITE industries, impacts are determined by the global emission price, changes in global demand, changes in the exchange rate and the relative-emission intensity of global producers. Reflecting the assumption of 'strong coordinated global action', the latter is critical. Hence Treasury finds that where Australia's EITE industries are more emission-intensive than comparable sectors in competitor countries (e.g. aluminium and petroleum refining)

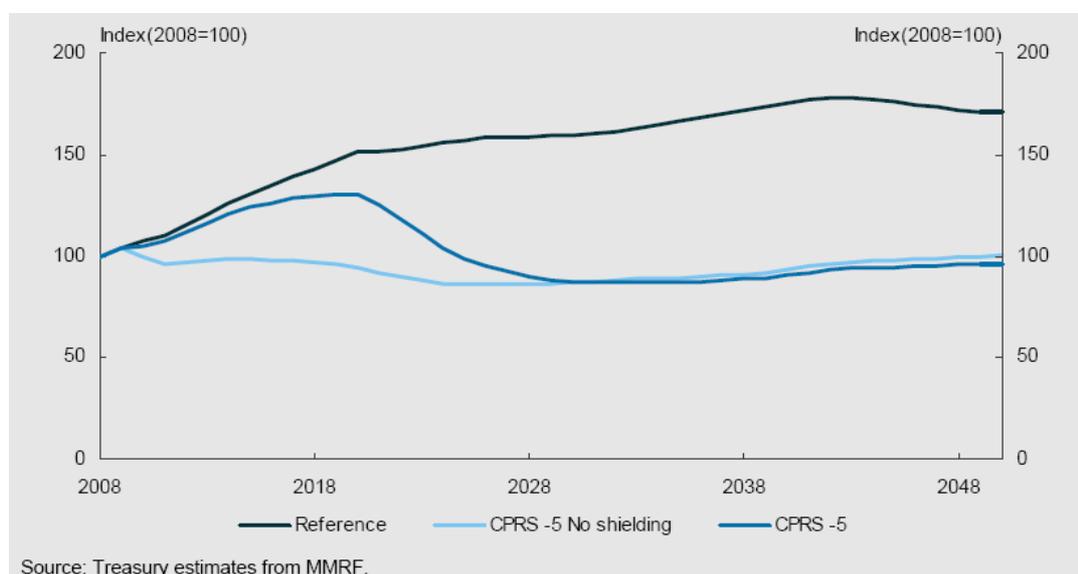
Australia is likely to lose competitiveness. Where Australia is seen as less emission-intensive than comparable sectors in competitor countries (e.g. coal, livestock, iron and steel) Australia is likely to maintain or improve competitiveness.

Many other traded low-emission sectors (e.g. wood products, textile, clothing and footwear, dairy and grains) benefit from a lower exchange driven by a forecast fall in Australia's terms of trade.

The Treasury report also concludes that there is 'little evidence of carbon leakage' at the relevant emission prices with noticeable impacts only occurring at higher emission prices, roughly double the price of the CPRS -5 scenario (Treasury 2008a, p. 169). Again, given the questions raised above about the international action assumptions this is not an especially credible result.

The report notes that without shielding there is a small change in emissions and output from EITE sectors in regions not participating in a global emissions trading scheme. The transitional assistance for EITE industries proposed in the Green Paper is seen as reducing the impact of the scheme on emission-intensive industries in the initial years. Benefits flow to sectors such as sheep and beef cattle once agriculture is included in the scheme. Aluminium is seen to benefit most from shielding, although output falls once the sector is no longer shielded (Figure 10). The phasing out of EITE assistance reflects the assumption that the rest of the world joins the international emissions trading scheme.

Figure 10: Aluminium output relative to current levels (With and without shielding)



Source: Treasury, p. 170.

As shown in Figure 10, there is a 45 per cent contraction in the aluminium sector relative to the reference case under the CPRS-5 scenario and a projected contraction from current output levels by 2050. Despite this overall result, the modelling suggests that aluminium output (assuming permit allocation) will grow substantially to about 2022, before contracting sharply once permit allocation is removed. Again, these results should be treated with some scepticism as they suggest the modelling is not able to deal well with large lumpy capital investments such as those required for smelting and alumina refining. As far as this reviewer is aware there are no plans for major expansions of the aluminium smelting sector in

Australia in the coming decade and modelling that suggests the contrary would on the surface appear to contain flawed parameter settings.

The impact of the Government's proposed ETS on EITE sector jobs and investment will be determined by broad parameters (e.g. the emissions trajectory and associated permit prices) and by specific design features (e.g. EITE assistance rates, allocation of permits for indirect emissions etc.) with each factor likely to have differential impacts on individual sectors.

In the case of aluminium, the impacts are likely to be substantial. Australia is a major exporter of aluminium and the world's largest producer of bauxite and alumina. A highly integrated industry across mining, refining, smelting and semi-fabrication, the aluminium industry comprises five bauxite mines, seven alumina refineries, six primary aluminium smelters, twelve extrusion and two rolled product (sheet, plate and foil) mills. The aluminium/alumina industry employs around 17,000 people, mostly in regional Australia.

The industry is both highly emissions-intensive and highly trade-exposed with aluminium prices determined by global supply and demand via the London Metals Exchange. It is estimated that over 50 per cent of global aluminium production is sourced from non-Annex B countries, with China alone accounting for around a third of global production.

Energy accounts for around a third of operating costs in the aluminium industry, hence the importance of scheme design issues such as the emissions factors used to allocate permits for indirect emissions. Another important issue for the aluminium industry is the interaction of the ETS and the expanded RET. With nearly all Australian smelters due to negotiate new contracts within the next decade, the additional cost imposts from the RET will be apparent in the near term.

The risk of carbon leakage and of perverse economic outcomes in the sector can be illustrated most clearly by the Bell Bay smelter in Tasmania, Australia's only predominantly hydro-based facility. Tasmania's electricity price will be linked via Basslink to electricity prices affected by Victoria's marginal brown-coal generators. If (as the Treasury/MMA modelling predicts) these generators are able to pass-through permit prices at more than 100 per cent, there is a real possibility of significant value loss at a 'clean green' facility like Bell Bay. This would be perverse in the extreme given most of China's aluminium production is supplied by coal-fired electricity.

Even with 90 per cent allocation of permits for aluminium and 60 per cent allocation of permits for alumina, it is highly unlikely that the sort of output growth estimated by the Treasury modelling will eventuate. The sectoral output figures for alumina (output growing by 73 per cent from current levels by 2050 under CPRS-5) appear just as, if not more, implausible than the results for aluminium shown in Figure 10.

The impact of an ETS on the LNG industry is likely to be significant for two reasons. First, both the production of gas and the processes required to transport LNG are emissions-intensive. In addition, LNG projects are highly capital intensive and changes in costs, such as those imposed by an ETS, are enough to make many projects unviable.

Modelling work by Concept Economics suggests that under plausible ETS scenarios LNG output is likely to be between a third and a half less than it otherwise would be by 2030. This is the case regardless of whether or not the government offers to shield the industry with assistance for a period of time. This is based on a study of trajectories which span the two

CPRS scenarios (0, 10 and 20 per cent reductions by 2020), but with more realistic international action and permit trading assumptions.

While 60 per cent permit allocation lessens the competitive impact on the industry, output would still be between 16 and 37 per cent below the reference case level in 2020, and between 39 and 54 per cent down on what it otherwise would be by 2030. Broadly similar results are reported for natural gas.

By contrast, the Treasury modelling reports a single set of results for 'gas mining' in 2050. This shows that while output is 17 below the reference case in the CPRS-5 scenario by 2050, it is 59 per cent above current output.

The cement industry is highly emissions-intensive (based on both direct and indirect emissions) and increasingly trade-exposed with Australia importing around 18 per cent of domestic consumption. There are few barriers to imports of cement in Australia and well-developed infrastructure exists for the import of cement and clinker. Domestic prices tend to reflect import parity prices.

Major sources of imports include Japan, Indonesia and Taiwan, while developing countries in the Asia-Pacific region that are unlikely to impose a carbon constraint in the medium term have accounted for most of the growth in global capacity in recent years. China is the world's largest exporter approaching 40 per cent of global exports of cement. Industry estimates put excess capacity in the Asia-Pacific at more than 200 Mt (equivalent to more than 20 times Australian consumption). This indicates a serious risk to jobs and investment under an ETS, especially given countries such as China, Indonesia, Thailand, Malaysia and Vietnam are unlikely to embrace emission pricing in the foreseeable future.

In this context, the reported results for cement in the Treasury modelling appear highly implausible. Under the CPRS-5 scenario, cement output is only 6 per cent below the reference scenario at 2050 and more than double 2008 output levels.

The Government proposes to include agriculture in the ETS from 2015 at the earliest, though this assumption should be viewed with considerable caution. To date, agriculture has not been included in any ETS except as a source of offsets. Complex and potentially costly issues surround the measurement and verification of emissions from agriculture, while significant uncertainty surrounds abatement potential (ABARE 2007b).

The nature of the agricultural sector offers little hope that the sorts of obstacles that currently prevent its inclusion in the ETS will be quickly overcome. The sector is comprised of about 130,000 geographically dispersed enterprises and emission sources vary widely in terms of size, time, location and nature (ABARE 2007b). The Treasury modelling makes no allowance for the difficulties surrounding the inclusion of agriculture in an ETS.

Just because agriculture is excluded from the scheme in the first five years does not mean that farm costs will not rise. Suppliers of inputs such as electricity and diesel will have to purchase permits and a large share of those costs will be passed on. In the cropping sector, almost 40 per cent of input costs come from emission-intensive inputs, while in livestock the share is about 17 per cent. Competitors in key developing countries will not be subject to such cost increases.

A final point worth noting is that the competitive impact on EITE industries of an ETS is likely to be felt most keenly in regional and remote Australia, often in locations with limited alternative sources of economic activity of such high value. The minerals industry, for example, is especially important to the economies of Western Australia, Queensland and the Northern Territory.

The industry directly employs around 127,000 Australians, with indirect employment estimated at around 200,000 (ABARE 2007a, MCA 2007). Since 2003-04, employment in the industry has grown by 38 per cent. Many of these jobs are in regional and remote Australia.

2.2. NON TRADE EXPOSED INDUSTRIES SUCH AS ELECTRICITY

In general, the term 'leakage' is not applied to the competitiveness and environmental implications of an ETS in the case of non trade exposed industries such as electricity generation. Even so, it is clear that the Government's proposed ETS will have profound competitive implications for many operators in Australia's electricity generation sector.

In the Treasury modelling, firms producing non-traded emission-intensive commodities, such as electricity, gas and transport services, are seen as able to pass on much of the increase in costs to consumers as higher prices. Over time, these sectors are projected to transform due to lower emission and energy-efficient technologies.

In line with the treatment of other sectors, most of the discussion of the electricity industry in the Treasury modelling report centres on a smooth, long-run transformation of the industry toward decarbonisation. There is relatively little that sheds light on the short- to medium term adjustment path of the sector and, as noted earlier, what analysis there is rests on assumptions about pass-through rates and strategic price setting behaviour. Also significant is the statement that the report projects retirement of electricity generators by modelling them as physical economic assets, with no account taken of 'the impact of financial considerations, such as debt-equity ratios or ownership structures' on retirement decisions' (Treasury 2008a, p. 178).

Modelling work by Concept Economics suggests that, coal-fired electricity operators in particular face a much more wrenching adjustment scenario, with a large part of the adjustment occurring before 2020. Output in the electricity sector as a whole was found to be more than 22 per cent lower than it otherwise would be by 2020 based on a scenario of a 10 per cent reduction in Australia's emissions below 2000 levels.

The largest impact was experienced in Victoria (a fall of almost 30 per cent compared with the reference case) given its heavy reliance on brown coal fired electricity. This has important implications for other industries and for regional employment.

3. TERMS OF REFERENCE: THREE

The economic and environmental consequences of the Government's proposed eligibility thresholds for emissions intensive, trade exposed (EITE) industry assistance;

The eligibility thresholds for EITE assistance in the proposed ETS will provide a degree of 'shielding' to certain EITE industries. At the same time, the configuration of the assistance regime creates the potential for market distortions and perverse economic and environmental outcomes.

Based on current data and the proposed design, the Government now estimates that there could be as many as 40 activities in the economy eligible for EITE assistance. Among the sectors identified as likely to be eligible for EITE assistance are: aluminium (90 per cent initial assistance); and alumina refining, some non-metallic mineral product manufacturing and some non-ferrous metals smelting (60 per cent initial assistance). Neither coal nor iron ore, Australia's two largest export industries, are viewed as eligible for any administrative permit allocation.

The Government's White Paper has sought to address some of the concerns of EITE industries expressed in relation to the Green Paper proposals. Refinements include:

- an extension of EITE assistance at the 60 per cent rate to activities at a lower level of emissions intensity;
- a choice of metric for assessing emissions intensity (either revenue or value-added based);
- a longer period of assessment for emissions intensity (now based on the period from 2004-05 to the first half of 2008-09);
- a new trade exposure test based on either a trade share of greater than 10 per cent in any year since 2004-05 or a demonstrated lack of capacity to pass through costs due to the potential for international competition;
- eligibility to include cost increases related to the upstream emissions associated with the production of natural gas and its components when they are used in feedstock;
- a modified (slower) rate of reduction in rates of EITE assistance based on a carbon productivity contribution of 1.3 per cent per annum; and
- a higher quantum of EITE assistance (around 30 per cent of permits – including agriculture) with an expectation that this could rise to around 45 per cent in 2020.

Among the key beneficiaries of the White Paper modifications to the EITE regime are oil refining and LNG production, both likely to be eligible for assistance at a 60 per cent rate.

The proposed EITE assistance regime still raises a number of potential problems relevant to the scheme's economic efficiency and environmental effectiveness.

First, the Government proposes a regime that, by design, delivers only partial assistance to EITE industries. This is explicit both in the Government's Green Paper and in the White

Paper, with the latter stating that the Government's aim is 'to reduce the risk of carbon leakage and provide them [emissions-intensive trade-posed industries] with some transitional assistance' (Department of Climate Change 2008c, p. 12-1). There is no detailed economic analysis underpinning the designated assistance thresholds which seek to identify Australian industries that would be viable and sustainable under a global carbon constraint.

In these circumstances, there remains a clear risk under the ETS that industries will move from Australia to elsewhere, with no benefit in terms of global emissions reductions. This would be contrary both to economic efficiency and to environmental effectiveness.

Second, there are major discontinuities in assistance rates, which in turn can lead to unintended consequences and distorted investment decisions.

While an activity with emissions intensity of 1000t CO₂-e per \$million of revenue receives 60 per cent compensation, an activity with 999t CO₂-e per \$million of revenue receives no compensation. With its arbitrary thresholds and administratively complex compliance arrangements, the proposed EITE assistance regime will likely remain a focal point for unintended economic consequences and hence industry lobbying.

Third, there are obvious anomalies such as the exclusion of the coal industry from the assistance regime that appear to reflect an element of politicisation of the scheme.

Fourth, there is uncertainty about the long-term credibility of the assistance regime given other demands on permit revenue. As one study based on the assistance regime proposed in the Green Paper has noted, once emission prices begin to exceed a certain level the 'permit arithmetic' begins to break down. In other words, there may be insufficient permit revenue to assist households, support low emissions technologies and prevent the export of business activity and emissions that would have remained in Australia under a global carbon price (PJP 2008, p. 11). Similar concerns about the White Paper regime have been expressed by Garnaut.

Fifth, there is continuing uncertainty over the phase-out of EITE permit allocation. The phase-out of EITE assistance ahead of comprehensive global action would likely have serious consequences for industries such as aluminium, as the Treasury report itself demonstrates.

4. TERMS OF REFERENCE: FOUR

The consequences of more realistic assumptions concerning:

4.1. THE LIKELIHOOD OF THE REST OF THE WORLD TAKING SIMILAR ACTIONS TO AUSTRALIA;

The likely consequences of what this review regards as a more realistic set of assumptions on global action include the following:

- estimated emission prices in Australia are likely to be higher for a given emissions reduction trajectory;
- the cost of emission reductions to the Australian economy are likely to be higher;
- the postulated gains from early action by Australia are likely to be less or non-existent;
- the degree of competitive disadvantage faced by Australia's EITE sector would be greater; and
- the risk of serious disruption surrounding the transformation of Australia's stationary energy sector would be greater.

A comprehensive and legally-binding international climate change agreement based on comparable efforts to restrain emissions remains an elusive prospect 17 years since the UN Framework Convention on Climate Change was agreed. The Convention itself contains legal language that makes it extremely difficult for such an agreement to be reached. The only realistic assumption, as noted by the 2007 Prime Ministerial Task Group on Emissions Trading, is that 'there will continue to be significant differences in the scale and type of commitments adopted by individual countries' (PMTGET 2007, p. 8).

The UN Framework Convention established the principle of 'common but differentiated responsibilities' and calls on developing countries to 'take the lead' in addressing climate change. As noted earlier, the explicit distinction between the roles and responsibilities of developed and developing countries remains a significant barrier to securing a comprehensive and effective agreement, with developing countries now producing a majority of annual global emissions.

Developing countries continue to maintain that they should not be forced to adopt binding international targets given their relatively low per person emissions, the historical responsibility of developed countries for GHG concentrations in the atmosphere and because of their need to prioritise growth and economic development. In these circumstances, the prospects of major developing country emitters such as China, India and Brazil taking on binding international commitments in the foreseeable future is very small. At a practical level also, very few, if any, developing countries have the capacity to reliably quantify their current (let alone project their future) emissions so as to credibly commit to binding targets (Diringer 2008a, p. 6)

There is little in the recent experience of international climate change negotiations that points the way to the Treasury scenario of 'strong coordinated global action' involving all major emitters. If anything, the position of rapidly growing developing countries in global climate

change forums has hardened since the Bali meeting at the end of 2007. In July 2008, on the fringes of the Group of Eight summit of industrialised countries in Japan, a group made up of India, Brazil, South Africa, Mexico and China released a statement calling on developed countries to commit to cutting emissions by between 80 and 95 per cent by the middle of the century, compared with 1990 levels.

In reality, there is almost no prospect of non-Annex B countries taking on binding emission restraints under a post-2012 international climate change agreement arising from the UN climate change summit in Copenhagen. Any new agreement will have to allow for different types of mitigation commitment. The best that could be hoped for in coming years is for developing countries to engage gradually in an international framework via policy-based commitments.

Table 3, which outlines the assumed national emission allocations under the various policy scenarios, illustrates the extreme implausibility of the Treasury assumptions about international action.

Table 3: National emission allocations

Region	2020				2050			
	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
	Per cent change from 2001 levels							
United States	-19	-28	-12	-28	-69	-69	-81	-89
EU-25	-23	-32	-14	-30	-75	-75	-69	-82
China	172	155	210	195	88	71	-4	-45
Russia + CIS(a)	14	2	13	-8	-58	-58	-73	-85
Japan	-29	-37	-27	-41	-81	-81	-75	-86
India	99	97	98	97	152	119	230	90
Canada	-9	-19	-33	-45	-63	-63	-80	-89
Australia	-5	-15	-10	-25	-60	-60	-80	-90
Indonesia	0	-2	0	-1	-14	-26	6	-39
South Africa	56	46	79	45	2	-7	-48	-70
Other South and East Asia	-15	-16	10	9	-34	-43	-11	-49
OPEC	50	40	67	67	11	1	-19	-54
Rest of world	47	47	40	39	48	26	94	11
World	32	24	40	29	-9	-18	-13	-50

Note: (a) Commonwealth of Independent States
Source: Treasury estimates from GTEM.

Source: Treasury, p. 93.

Leaving to one side the timing of US introduction of an ETS (discussed below), there is very little prospect of the United States (with or without international permit trading) accepting a national emissions allocation almost 20 per cent below 2001 levels by 2020 while China is permitted to increase emissions by more than 170 per cent. One observer crystallised the issue aptly just prior to the presidential election last November:

Does anyone think (regardless of who wins the election next Tuesday), that the US Senate will ratify a treaty that commits a recession-plagued US to a treaty where it must undertake real GHG reduction limits, while a growing economic power house like China (associated now in US public perception with a spectacular and lavish Olympics and a Shenzhou space program complete with vanity space walks) gets to continue to increase its GHG emissions and gets lots of money and free technology to boot? (McElwee 2008)

In fact, this is precisely the policy assumption on which Treasury is operating and on which it is providing advice to the Australian Government.

Table 3 also shows that Treasury has assumed that Japan will take on the most onerous reduction allocation (relative to 2001 emissions) by 2020 of the listed countries in Annex B. Given Japan's starting point as one of the least emissions intensive countries in Annex B, such a target is again diplomatically implausible.

In both these cases, therefore, the Treasury modelling presumption that major developed country emitters will take on comparable medium-term commitments to Australia appears optimistic.

Further, the region Other South and East Asia is assumed to reduce emissions against the 2001 level by around 15 per cent by 2020 mainly from the production of forest sink credits. Leaving aside the developing country status of this group, the extent of this reduction appears both infeasible in terms of its dimensions in the time period and also unlikely given the length of time needed to negotiate the necessary forest sink rules.

4.2. THE PARTICIPATION OF CHINA IN A GLOBAL EMISSIONS TRADING SCHEME BY 2015;

China's role is critical to any global climate change response. Already the world's largest carbon emitter by some estimates, China accounted for 58 per cent of the global increase in energy-related CO₂ emissions over the six years to 2006 (IEA 2007). By 2030, based on current projections, China will account for 27 per cent of global emissions.

Coal-fired electricity will account for much of this projected growth. In 2006, China installed over 90 gigawatts of new coal capacity – the equivalent of about two large coal power plants per week (Pew Center on Global Climate Change 2007).

China released a new National Climate Change Program in 2007, outlining activities both to mitigate GHG emissions and to adapt to the consequences of potential climate change. It includes a number of elements including targets to reduce energy consumption per unit of GDP, efficiency targets for energy-intensive enterprises, renewable energy goals, fuel efficiency standards and expanded forest coverage (Leggett et al. 2008). There is little doubt that the Chinese government has adopted an ambitious climate change related domestic policy program but this should not be taken as an indication that China is prepared to adopt binding targets in an international regime.

In the Treasury's multi-stage framework, China is scheduled to begin economy-wide pricing of emissions from 2015. China's current climate change negotiating stance underlines the optimistic nature of this assumption. China's recent submission to the Ad Hoc Working Group on Long-Term Cooperative Action under the UNFCCC provides that:

- All developed country Parties to the Convention shall commit to a reduction in GHG emissions by at least 25-40 per cent below 1990 levels in 2020 and by approximately 80-95 per cent in 2050;
- Nationally appropriate mitigation actions by developing Parties shall be taken in the context of their sustainable development and, supported and enabled by technology transfer, financial assistance and capacity building to be provided by the developed country Parties; and

- The principle of 'common but differentiated responsibilities' between developed and developing countries is the keystone of the Convention and the Bali Action Plan. Any further sub-categorization of developing countries runs against the Convention itself and is not in conformity with consensus reached in the Bali Action Plan.

In other words, China's position in global climate change negotiations revolves around: 1) demands that industrialised countries first commit to massive reductions in emissions; 2) demands for large-scale technology transfers and financial support; and 3) using the legal framework of the UNFCCC to avoid any attempt to see it take on commitments sooner than other developing economies.

The Treasury modelling assumptions appears to regard China's position in international climate change negotiations as a giant bluff.

4.3. THE PARTICIPATION OF INDIA IN A GLOBAL EMISSION TRADING SCHEME BY 2020;

While not of the same scale as China, India also has a major role to play in any coordinated global effort on climate change. India is the world's fifth largest GHG emitter accounting for about 5 per cent of global emissions. At the same time, India's emissions are 70 per cent below the world average on a per person basis.

India released a National Action Plan on Climate Change in 2008 outlining existing and future plans addressing climate change mitigation and adaptation through to 2017. Similar to China, India has a number of policies that, while not driven by climate concerns, contribute to avoiding GHG emissions. India's overriding priority is to maintain high economic growth, with the climate plan geared around measures to promote development objectives 'while also yielding co-benefits for addressing climate change effectively' (Government of India 2008).

Among the 'national missions' advanced as part of India's National Action Plan on Climate Change are the promotion of solar energy for power generation and other uses, enhanced energy efficiency, support for climate adaptation in agriculture and goals for afforestation and expanded forest cover.

In general, India's stance in international climate change negotiations is viewed as less accommodating than that of China. India has maintained a firm position that developed nations must first commit to very large emissions reductions (in the order of 80 per cent by 2050) before developing countries take on commitments to constrain emissions. At this stage, India has pledged only that its per person GHG emissions 'will at no point exceed that of developed countries even as we pursue our development objectives' (Government of India 2008).

On this basis, the prospects of India pricing emissions by 2020 appear slim.

4.4. THE IMMEDIATE PARTICIPATION OF THE UNITED STATES IN A GLOBAL EMISSIONS TRADING SCHEME;

There are high expectations in some quarters that the election of President Obama will lead to the imminent introduction of an ETS in the United States. This view is at least implicit in Australian Government statements that have repeatedly highlighted declaratory statements by President Obama about a 'cap and trade' scheme as supportive evidence of why Australia

would be introducing an ETS in 2010 consistent with international trends (Department of Climate Change 2008a, 2008b).

This review believes that expectations of early US action on an internationally-binding emissions target should be tempered for a number of reasons.

First, there are a range of practical hurdles that surround organising a new administration and developing a politically viable climate policy in the face of competing economic, social and national security priorities. In reality, the prospects of Congress passing mandatory climate legislation in 2009 are slim with some analysts suggesting that 'any near term action may come in the form of energy legislation that, while helping to reduce US emissions, will not achieve the levels of reduction envisioned under a cap-and-trade scenario' (Diringer 2008b, pp. 2-3). As such, the United States would be hampered in making a credible commitment to an emissions target at Copenhagen.

Second, with the US economy facing a deep and protracted economic downturn, the political environment for climate change action in the form of an ETS or a carbon tax is very adverse in the near term. President Obama has already responded to questions about a higher federal tax on gasoline by saying that 'putting additional burdens on American families right now, I think, is a mistake' (NYT 2008).

Third, there is no appetite in US government circles for the sort of 'multi-stage' framework for global action as modelled by the Treasury. Policy makers in the United States (both Republican and Democrat) have consistently argued that at least the most important developing countries must make binding commitments in a new international climate change framework to ensure the environmental effectiveness of the response and so that undue costs are not placed on economies making commitments.

At the Poznan Conference of the Parties meeting in December 2008, President Obama's envoy, Senator John Kerry, made it clear that large developing countries such as China and India would have to take on some kind of target before US ratification of an international agreement (ICTDS 2008). This is consistent with US policy over many years, both at the executive and legislative levels. It is not consistent with the Treasury modelling assumptions.

In 1997, the US Senate unanimously passed the Byrd-Hagel resolution (S. Res. 98) which states that 'the United States should not be a signatory to any protocol ... [which mandates] commitments to limit or reduce greenhouse gas emissions for the Annex I parties, unless the protocol ... also mandates new specific scheduled commitments ... for Developing Country parties within the same compliance period ...'. It appears naïve to expect any future US climate change action to depart materially from this position (Sunstein 2006, p. 20).

The legislative fate of the 2008 Lieberman-Warner Bill (defeated in the US Senate by 48 votes to 36) cautions against an assumption of rapid movement on climate change in the United States. Expectations should be further tempered by the fact that the most recent major price of energy legislation in the United States involved five years of legislative activity.

Fourth, both the Framework Convention and the Kyoto Protocol rely on 1990 as the base year. Under most proposals considered by the Congress, US emissions would still be above 1990 levels by 2020. By contrast, the European Union has a goal of reducing emissions 20 per cent below 1990 levels by 2020. Some mechanism to bridge this gap would need to be devised in order to secure a new climate change agreement.

Fifth, there remains an important body of opinion in the United States, including among key advisers within the Obama Administration, supportive of a carbon tax in preference to a cap and trade emissions scheme. These include the new head of the National Economic Council, Lawrence Summers, and the director of the White House budget office, Peter Orszag. Mr Summers has also been a strong critic of the Kyoto Protocol, describing it as 'idealistic and visionary yet impractical, ultimately ineffective and perhaps even counterproductive because of the valuable political capital it consumes' (Summers 2007).

In short, there is little prospect of the United States agreeing in the near term to anything approaching the national emissions allocation framework modelled by the Treasury. The modelling relies on especially heroic assumptions in terms of the timing and nature of future US commitments to emissions reduction targets within an international agreement.

4.5. THE LIKELIHOOD OF A GLOBAL AGREEMENT BEING SUSTAINED THROUGH THE YEAR 2050;

No less formidable than the task of reaching a comprehensive global agreement on climate change will be sustaining one, especially if it is based on Kyoto-type architecture. McKibbin et al. (2008) have highlighted the high risks in trying to maintain a rigid framework of targets and timetables in the face of uncertainty surrounding the costs of mitigation action and other economic shocks. Conversely they note: 'A well-designed global climate regime and the attendant domestic implementation policies undertaken by participating countries need to be resilient to large and unexpected changes in economic growth, technology, energy prices, demographic trends, and other factors that drive costs of abatement and emissions' (McKibbin et al. 2008, p. 1).

Areas of likely institutional stress include:

- Global economic shocks such as the current financial crisis;
- The highly differential impact of climate change, with some countries possibly perceiving national benefits;
- The inability of developed countries to commit credibly to the sorts of emissions reductions (80-90 per cent) regarded as essential by developing countries for them to accept emission restraints;
- The inability of developing countries to meet any targets over a sustained period of time;
- The inability of national governments to provide anything like the necessary low-emissions technology funding;
- The possibility that a sufficient number of major emitters may decide to focus scarce resources on adaptation rather than mitigation; and
- The practical difficulties associated with establishing the necessary monitoring and compliance regime to ensure that legally binding targets are enforced.

Recognising that it is impossible to predict with any precision the specific course of international developments, it would have been useful if the Australian Government had

explored likely areas of institutional stress in formulating the parameters of the Green Paper, the White Paper and the Treasury modelling.

This would have assisted policy makers in gaining a better understanding of the likely dynamics of future global cooperation. At the moment, the dominant approach seems based on willing all national governments to act without a clear understanding of the incentives of particular groups of countries. Australia has put its faith squarely behind a Kyoto-based approach which has demonstrated its incapacity to engender comprehensive engagement.

From a game theory perspective, a well-known result points to a tit-for-tat strategy as the most likely basis for engendering cooperative behaviour in repeated games (Axelrod 1984). The Australian Government needs to develop a more realistic understanding of the strategies likely to elicit sustained global cooperation on climate change.

4.6. COMMERCIAL SCALE AVAILABILITY AND USE OF CARBON CAPTURE AND STORAGE TECHNOLOGY, PARTICULARLY IN THE LIGHT OF ASSUMPTIONS REGARDING THE PATH OF THE CARBON PERMIT PRICE;

A key aspect of the modelling surrounds the assumptions and results relating to carbon capture and storage and its role in lowering the costs of mitigation, both globally and in Australia. The Treasury report states that: 'Carbon capture and storage plays a significant role in global electricity generation in the policy scenarios. ... Carbon capture and storage begins to be commercially adopted between 2020 and 2025 in all policy scenarios (Treasury 2008a, p. 125). As Figure 3 suggests, CCS plays an important role from the 2030s before declining as a share of global electricity generation from around 2050.

Treasury assumes that: 'Coal CCS technology is generally deployed at a carbon price of \$45 per tonne of CO₂-e while gas CCS technology is generally deployed at a carbon price of around \$100 per tonne of CO₂-e'. This in turn rests on a range of other assumptions about technology capital costs and CCS capture efficiency.

Analysis by Concept Economics of those electricity technology assumptions suggests that in the critical cases of conventional coal and CCS-related technologies capital costs for new plants appear to have been underestimated by up to 50 per cent. In turn, Treasury appears to have underestimated the price at which CCS technology will be viable, with work by Concept Economics suggesting a more realistic carbon price spectrum of \$60-90 per tonne of CO₂-e.

The Treasury report also appears somewhat inconsistent on the implications for Australia if CCS technologies fail to materialise at the sorts of emission prices postulated by the modelling. It implies, for example, that the commercial viability of CCS is a key determinant of Australia's emissions falling significantly from around 2035. It also states that the 'global adoption of carbon capture and storage technology will affect significantly the long-term viability of Australia's coal industry', the nation's largest export industry by a considerable margin (Treasury 2008a, p. 144). It nonetheless concludes that whether or not CCS technologies become a commercial alternative for electricity generation 'is not crucial for the aggregate mitigation cost results' for Australia (Treasury 2008a, p. 144).

This depends on one's definition of crucial'. Elsewhere in the report when examining the global role of carbon capture and storage it is stated that: 'Australian mitigation costs are

more than the global average. Without carbon capture and storage, Australian mitigation costs rise by 23 per cent in 2050' (p. 127). A figure of 23 per cent may or may not be considered 'crucial', but it is surely significant.

4.7. LOW OR NON-EXISTANT BARRIERS TO INTERNATIONAL TRADE IN CARBON PERMITS;

In the efficient global emissions trading scheme assumed by Treasury, there are no barriers to permit trading. In the world as it is likely to unfold the Australian government will be faced with decisions about whether permits or credits generated in particular countries are verifiable and represent a genuine emissions reduction and whether to allow the import of such permits. This may have important implications for both the domestic permit price and the international credibility of the Australian scheme. There appears to have been no analysis of this issue.

4.8. THE TAXATION TREATMENT OF PERMITS, BOTH IN AUSTRALIA AND OVERSEAS;

The issue of whether permits are taxed or whether they are taxed consistently across countries is not addressed in the Treasury modelling.

It is important that the Australian Government continue to monitor developments around international permit trading. It is possible that the taxation of international permit trading could be viewed as a means of funding other climate change policy commitments. Some advocates, for example, have suggested that a levy on international emissions trading could be used to fund more ambitious technology transfer arrangements with developing countries (Diringer 2008a, p. 8).

The legal aspects of the domestic taxation treatment of permits requires specialised legal advice that this reviewer presumes is being sought by individual firms directly subject to the proposed scheme.

5. TERMS OF REFERENCE: FIVE

The failure to include the impact of the global financial crisis on:

5.1. AUSTRALIA'S CAPACITY TO BEAR THE COSTS OF PARTICIPATION IN A GLOBAL EMISSIONS TRADING SCHEME;

The global financial crisis and its flow-on to the real economy has altered dramatically the context in which Australia will be introducing an ETS and taking, in all likelihood, unconditional action to reduce emissions. By contrast, the Treasury modelling exercise and much of the decision-making on scheme design has assumed, often explicitly, a continuation of strong global and domestic growth, both in the implementation phase of the ETS and in the longer term.

More broadly, the financial crisis has highlighted the extent to which sharp economic discontinuities of a sort that modelling exercises are ill-equipped to handle remain a feature of the modern globalised economy. While it may be the case that the full scale of a looming economic downturn could not be foreseen through 2008, what is striking is the failure of both the Treasury modelling report (released end October 2008) and the White Paper documents (released mid December 2008) to make any plausible attempt to grapple with the macroeconomic and microeconomic implications of financial crisis or more particularly the uncertainty that surrounds the future trajectory of the global economy.

The simple fact is that an ETS imposes a new cost on Australian producers and consumers. A critical concern surrounds the impact of the imposition of this additional cost of production on Australian firms at a time when company balance sheets have deteriorated dramatically, investment plans have been shelved and workers are being dismissed.

Other concerns relate to the impact of the financial crisis on the effective cost of capital. With the Treasury modelling already underpinned by very optimistic cost of capital assumptions relating to new electricity generation plant, it seems naïve to expect new low-emissions technology suppliers to seamlessly replace any short-fall in capacity due to the closure of fossil-fuel based plants.

The global financial crisis should also puncture the air of complacency that has surrounded the financial burden an ETS places on Australian businesses competing in the global marketplace. Against a backdrop of high commodity prices, there was a widely-shared presumption in official circles that the imposition of a carbon price in advance of other competitor nations would have only a minor adverse impact on key Australian export industries.

With commodity prices in some cases down 50 per cent from their peak and export-oriented companies looking to reduce costs wherever possible, measures that cannot be recovered through increased prices establish a significant disincentive to investment in Australia, both in existing operations and in future development as the time of the introduction of the scheme approaches.

5.2. THE RATE AT WHICH OTHER COUNTRIES WILL COMMENCE PARTICIPATION IN A GLOBAL EMISSIONS TRADING SCHEME;

In many countries, including Australia, the global financial crisis has reinforced the primacy of economic growth and jobs in national policy debates. While the full economic implications of the crisis remain unclear, there is a strong probability that policy-makers in many jurisdictions will regard global emissions trading based on an internationally binding carbon constraint as a distinctly weak priority until strong economic growth has been restored.

Given (a) their respective shares of global emissions, (b) their assumed early participation in global emissions trading in the Treasury CPRS scenarios (2010 for the US and 2015 for China), and (c) the close strategic link between their likely actions, particular significance surrounds the implications of the current economic crisis for the United States and China in the short to medium term.

6. TERMS OF REFERENCE: SIX

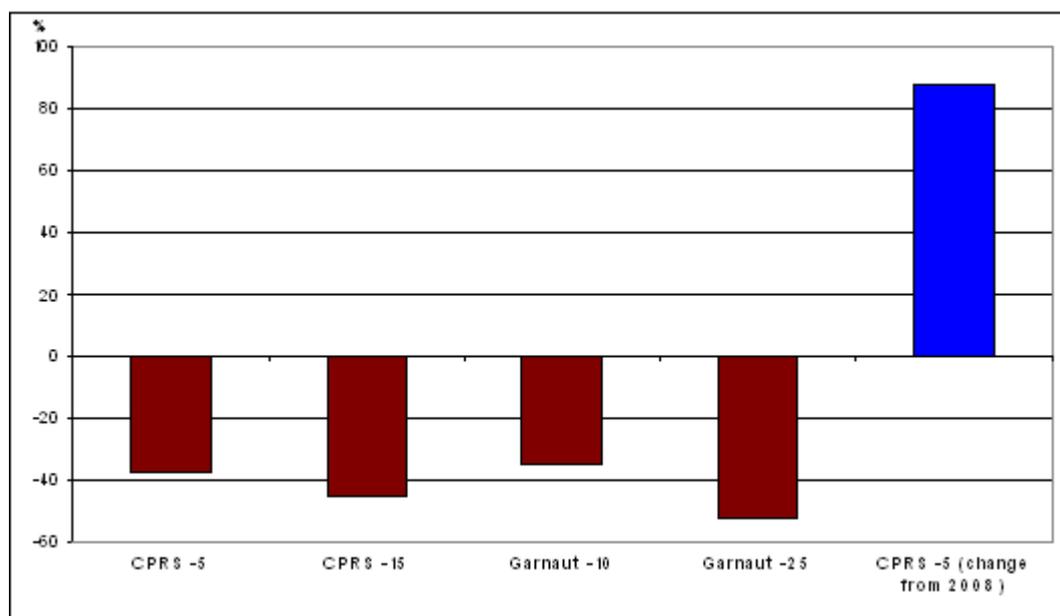
The impact of the Government’s emissions trading scheme on issues of national security including fuel resources and refining, construction resources and energy security;

The Treasury modelling report asserts that there is no evidence that pricing emissions will compromise Australia’s energy security. This is in keeping with the postulated smooth transition of the economy to a low carbon future with ready access to lower cost international permits.

Traditionally, the country’s energy resource base (especially access to low cost fossil fuels) has afforded Australia a high level of energy security compared with other nations. The two areas where this may be tested under an ETS are electricity sector transformation (dealt with elsewhere) and oil refining capacity.

Figure 11 shows sectoral results of the Treasury modelling for the refinery sector. The Treasury modelling projects a significant decline relative the reference case under all four scenarios (ranging from -38 per cent to -52 per cent). Even so, refinery output at 2050 is projected to be 88 per cent above current output under the key CPRS -5 scenario. This is despite the fact that petroleum refining is one of the sectors which the Treasury report notes may contract under a comprehensive global agreement because of its relatively high emissions intensity.

Figure 11: Refinery output at 2050 under Treasury policy scenarios



Source: Treasury

The impacts on oil refining will depend on two key factors:

- The production effect: an ETS will raise the price of key inputs into oil refining, such as energy, which will reduce the international competitiveness of Australian production compared with overseas production (particularly in Asia).

- The consumption effect: an ETS, by design, will raise the price of petroleum products which will discourage their use. Lower demand will lead to a reduction in the output of the domestic refining industry.

Work by Concept Economics suggests that even under 60 per cent permit allocation (in line with the White Paper) the production in the refining sector is likely to decline by around a third relative to what it otherwise would be by 2020. This fall relative to the reference case does not change significantly across a range of policy scenarios.

A 60 per cent administrative allocation of permits has very little impact on the projected reduction in production. Higher carbon prices lead to a considerable reduction in the use of petroleum products (through a combination of reduced transport output and fuel switching). The results for the sector exhibit the same pattern under a spectrum of trajectories spanning the CPRS scenarios, although the projected effects on output are smaller with a less ambitious trajectory because the projected carbon prices are lower.

The modelling work by Concept Economics suggests only minor expenditure on expansion in the oil refining sector. This result occurs for two reasons. First, the size of the Australian market does not economically justify major expansions in the sector. Second, under realistic international policy settings with non-Annex B countries only restraining emissions from 2030 it is more economic to locate facilities elsewhere in the world.

In general, modelling exercises assume that the petroleum industry can make continuous and fine adjustments to capacity. In reality, this is not feasible because new plant must be installed in units of a particular size and shutdowns are likely to be done at the whole plant level rather than in small increments.

Refineries typically undergo complete or partial shutdowns ('turnarounds') every four to six years so that critical maintenance, repair and overhaul operations can be undertaken. Depending on the activities required, the refinery may be shutdown for months, particularly if the catalytic cracking unit and crude distillation unit need attention.

There were a number of planned and unplanned refinery shutdowns in 2008. In January 2008, Shell announced that it was going to keep a catalytic cracking unit shut for several months at its Clyde refinery after an unplanned stoppage. The closure overlapped with a partial shutdown of the company's Geelong refinery, and followed a three-week closure of Caltex's Lytton refinery (Reuters 2008a). In July, BP's Bulwer Island plant was returned to production after a two-month turnaround. It was the third major turnaround for the refinery in three years (Reuters 2008b). In October, BP announced that its other Australian plant (at Kwinana) would be shutdown until December for planned maintenance work (Business Spectator 2008).

Given the large number of shutdowns in 2008 and assuming a six-year gap between turnarounds, it is projected that a large number of shutdowns will occur in 2014, including refineries at Clyde, Geelong, Bulwer Island, Kwinana and Kurnell. Caltex has indicated that its Lytton plant will undergo maintenance in the third quarter of 2009 (Reuters 2008c).

The time at which major maintenance expenditure is required for a refinery would be a logical point to close capacity if a firm decided to reduce its exposure to the Australian refinery sector because of external cost pressures such as those associated with the emissions trading

scheme. The likelihood that such an adjustment, if it were to occur, would take place in 2014 appears high.

7. TERMS OF REFERENCE: SEVEN

The impact of the Government's emissions trading scheme on government revenue and spending, and the total revenue that the government can expect to collect from the scheme through the year 2050;

The Government's proposed ETS will generate substantial government revenues.

Treasury's modelling publishes estimates of the emissions allocations under each scenario in Chart 6.2, and the emissions pathways under each scenario in Chart 6.4. The difference between the pathways and the allocations is in effect the volume of permits that must be obtained internationally.

The White Paper (p lxvi) states that:

Allocations will, over the longer term, progressively move towards 100 per cent auctioning as the Scheme matures, subject to the provision of transitional assistance for emissions-intensive trade-exposed industries and strongly affected industries.

The total value of domestically issued emissions permits therefore provides an estimate of the upper bound for the amount of revenue that the government could expect to collect from the scheme if all permits were auctioned, noting that the government's stated goal is to move toward a 100 per cent auction system.

Treasury also provides estimates of the path of permit prices under each scenario in Chart 6.3. It is therefore possible to obtain an estimate of the upper bound for permit revenue in each year (and therefore an estimate of the upper bound of the total amount of revenue that will be collected out to 2050) by multiplying the emissions allocation under each scenario by these projected permit prices.

For example, in the CPRS-5 scenario in 2010, the permit price is estimated at \$20.40, while the emissions allocation is 601.8 Mt. Thus, if the government were to auction 100 per cent of the allocation in 2010, revenue would be \$12.28 billion (in 2005 dollars).

Proceeding in this fashion, it is also possible to estimate the upper bound for revenue in each year of the scheme. For example, for the CPRS-5 scenario in 2050, 221.1 Mt of permits are allocated at a price of \$115.30 per permit. Thus, Treasury's modelling implies that an estimate of the upper bound of revenue in 2050 is \$25.5 billion (in 2005 dollars).

Because Australia imports permits under all scenarios, the amount of money actually spent by the private sector on permits would of course exceed these amounts in a setting in which 100 per cent of domestically issued permits were auctioned.

On the spending side of the Budget, the government's current commitment is to spend all revenue that is collected. Should this commitment be honoured, the above figures would apply to spending as well, and there would be no (first round) effects on the Budget bottom line.

8. TERMS OF REFERENCE: EIGHT

The economic cost of the Government's expanded renewable energy target compared to the costs of alternative policy approaches;

The Government's expanded Renewable Energy Target (RET) sets a designated target of 20 per cent of Australia's electricity supply from renewable sources by 2020 (an additional 45,000 GWh of renewables capacity). It excludes other low-emissions technologies such as carbon capture and storage and nuclear power.

The RET policy places an unnecessary burden on Australian consumers of stationary energy. With an effective ETS in place, it merely imposes additional costs but without any additional abatement. Electricity prices would be higher than otherwise. It also distorts economic decision-making by favouring certain low emission technologies over others, directing investment toward higher cost abatement options and reducing incentives to abate emissions or innovate in ways that do not meet the eligible technology criteria. This is directly contrary to the intended purpose of an ETS based on least-cost, market-driven abatement.

Contrary to the view that a policy such as the RET generates jobs, the overall effect on the economy is less job creation than would otherwise have occurred and a loss of economy-wide output compared with a well-designed ETS alone.

A number of studies have highlighted the economic costs of the RET and its adverse interaction with an ETS (Garnaut 2008a, Productivity Commission 2008). The electricity sector has identified a range of specific concerns about the policy, including the need for significant transmission sector augmentation, the need for additional reserve to address the intermittency of renewables and the fact that the measure is a form of 'picking winners' likely in the short-term to simply be a subsidy to wind-based power. The combined impact of the RET and the ETS will have an early and serious impact on key industries. For example, industry estimates put the impact of the RET alone on the cost of aluminium production at more than 3 per cent.

The expanded RET is included in the CPRS scenarios, though the Treasury has also assessed its impact via a sensitivity analysis excluding the RET in the case of the CPRS -5 scenario. This puts the cost to GNP of the expanded RET at \$5.0-5.5 billion, when estimated as a net present value using real discount rates of 4-8 per cent.

It is found that by 2020 GDP costs could be around 0.1 per cent higher than from an emission price alone. The average cost of the mitigation (per tonne of CO₂-e) from expanding the RET is around three times the average permit price from 2010 to 2020 (Treasury 2008a, p. 181).

This is broadly consistent with modelling work by the author of this review. This found that the interaction of the ETS and the 20 per cent renewable target:

- costs Australia \$1.8 billion more in 2020 than a pure ETS policy in terms of GNP losses;
- costs Australia \$1.5 billion more in 2020 than the ETS in output (GDP) losses;
- results in the loss of an additional 3,600 full time equivalent jobs in 2020;

- causes substantial switching away from gas fired generation compared with an ETS in the order of 12,620GWh per year by 2020;
- results in electricity prices rising at least 6 per cent more than would be the case under an ETS alone - the price of electricity rises 24 per cent under the combined policy approach, and by 18 per cent under an ETS that delivers equivalent emissions abatement.

These results confirm that an ETS alone is preferable to an ETS and a renewables target that results in higher costs and no additional mitigation. If a case could be made for supplementary policies based on persistent market failures in the presence of an ETS, any low emissions policy should be inclusive of all technologies, including clean coal technologies such as CCS.

9. TERMS OF REFERENCE: NINE

Testing the veracity of the conclusions that under the Government's emissions trading scheme by 2050 electricity prices in Australia would rise five times as much as in the US, Canada, Japan and the EU and three times as much as in China over the same period;

Questions have been raised above regarding the electricity modelling undertaken in conjunction with the Treasury modelling. The uncertainty in electricity price paths out to 2050 is very large and the structure of the electricity sector in each country will depend crucially on policy settings and local conditions that are unlikely to have been studied in any detail by the Treasury. This reviewer concludes that little useful can be said about relative electricity prices between the selected countries that will apply 40 years hence.

10. TERMS OF REFERENCE: TEN

The impact of the Government's emissions trading scheme and a rising carbon price in all years that the scheme is in place on:

10.1. UNEMPLOYMENT;

As far as the reviewer is aware the general equilibrium models employed by the Treasury assume that real wages adjust downwards following the introduction of the ETS to ensure that the long run equilibrium rate of unemployment is maintained. This is a common closure for such models. It follows that estimates of possible additions to unemployment have not been made as far as the reviewer is aware.

Real wages decline steadily over time, relative to the reference scenario. This assumes that individuals will willingly accept ongoing downward real wage adjustments below what they otherwise would have received, without any adverse impacts on labour market outcomes at the sectoral or aggregate level. Labour inputs are assumed to costlessly shift between sectors. These assumptions ignore some of the key existing institutional realities of the Australian labour market, as well as any impact that the introduction of new regulatory arrangements on labour markets might have. These appear to be major oversights.

10.2. COST OF LIVING PRESSURES FOR HOUSEHOLDS, PENSIONERS AND INDIVIDUALS MORE GENERALLY;

As the Treasury notes (Treasury 2008a, p. 199) the 'initial impact on households will be through increases in electricity and gas prices'. The Treasury further notes (p. 199) that 'While the price impact of the scheme is estimated to be relatively larger for low-income households, these impacts will be offset by the Government's commitment to help households adjust'. The burden of the scheme on households depends crucially on the actual permit prices that result under the scheme and the way other policies (such as the commitment to a fuel tax offset) interact with the scheme. As mentioned above there is considerable uncertainty about the level of the projected permit prices as there is about future government policy.

10.3. INFLATIONARY PRESSURES;

The Treasury (2008a, p.192) notes that the G-Cubed model was used to make estimates of the impact of the scheme on inflation and the possible monetary policy response. The Treasury (2008a, p.192) notes that 'In Australia, the CPI rises by 0.7 per cent in 2010 in the CPRS -5 scenario and by around 1.1 per cent in the CPRS -15 scenario' and that 'After the initial spike, inflation continues to be slightly higher than the reference scenario'. This result appears to arise from the way in which future permit prices have been constructed.

What needs to be considered is the way in which permit prices will unfold in the real world – in a real permit market prices will not follow a smooth path with no variability at the Treasury's assumed real rate of interest. The ongoing increases in permit prices (and therefore the price of energy) will have implications for the conduct of monetary policy. Ongoing relative price changes (which require no monetary policy response) may be mistaken for ongoing changes

in the general price level (inflation), and vice versa. This complicates the task of monetary policy.

As Reserve Bank Governor Glenn Stevens (2008) noted in his testimony before the House Economics Committee on April 4, 2008:

... let us suppose, for the sake of argument, that there is at some point a set of policies which increase the price of energy. At a first pass, I would expect that the way we would think about that from the point of view of the inflation target would be roughly the same as the way we thought about the GST when it came in. In that episode, there was a quite large one-time rise in the price level. Some prices rose, others fell, but the net effect was positive and the CPI inflation rate went to six per cent. But it was a one-time level shift; it was not an ongoing inflation effect, provided there were no second rounds—which, of course, we have to watch for. But, on that proviso, then what we do is we look through that, and that is what we did on that occasion. If it were the case that policies to address climate change had an impact of that type, even if the quantity were different, at the moment I cannot see why we would not treat that in the same fashion. The harder thing, I suppose, would be if there were smaller increases over a whole run of years, little bit by little bit. It gets harder to distil that out.

10.4. NOMINAL INTEREST RATES, AND RETAIL INTEREST RATES;

See 10.3 above.

10.5. AGGREGATE PRODUCTIVITY;

Resources are shifted into sectors with low productivity (Treasury 2008a, p. 151); but no results for aggregate productivity growth are reported for each scenario, although they are published for the reference case.

11. TERMS OF REFERENCE: ELEVEN

The economic impact of Australia introducing a poorly designed scheme in 2010, rather than a better designed scheme in 2011 or 2012, taking into account the decisions of major emitters;

Treasury's modelling of the costs of delay is inadequate.

Treasury does not model or analyse the economic cost of Australia introducing a poorly designed emissions trading scheme in 2010, as opposed to introducing a more appropriately designed scheme in 2011 or 2012.

A sensitivity analysis is conducted to determine the costs of delaying a global ETS by seven years (Treasury 2008a, p. 102). The analysis involves the following thought experiment: the entire world (not just Australia) delays an ETS by seven years (beginning in 2020 instead of 2013) and then implements an ETS that tries to achieve the same targets by the same dates. It is unclear as to exactly why this thought experiment is chosen, as it does not appear to correspond with any likely real-world scenario.

In any case, Treasury's analysis shows that delaying mitigation is economically beneficial under a wide range of reasonable assumptions. In particular, Treasury's modelling shows that delaying a global agreement produces a net benefit if the discount rate is assumed to be higher than three per cent.

There is no analysis or modelling of the consequences to Australia of either the rest of the world delaying its ETS (whilst Australia introduces one), or of Australia delaying its ETS (whilst the rest of the world introduces one). There is no analysis or modelling of the consequences of implementing a poorly designed ETS earlier, versus a better designed ETS later.

Thus, the key economic and policy issues relating to delay and timing appear not to have been considered. This is a major oversight.

The world will only tackle climate change effectively by collectively tightening restraints on global carbon emissions over many decades. This simple reality needs to be borne in mind when assessing the merits of claims about the nature and timing of action by a single country that accounts for a very small share of global emissions.

If the only action likely to make a difference is global action, it is important above all that any emissions trading scheme is durable yet sufficiently flexible to take account of changes in international circumstances, changes in our knowledge about climate change and economic shocks such as the serious world-wide recession now in prospect.

The introduction of an ETS has been labelled Australia's 'most difficult ever regulatory challenge' (Productivity Commission 2008, p. xiii). Identifying the need for careful analysis to underpin action by Australia in advance of a global arrangements involving major emitters, the Productivity Commission (2007, pp. 9-10) highlighted approvingly the warning expressed by the United Kingdom's Better Regulation Commission based on a review of the regulatory implications of the Stern Report:

... make haste in creating law and repent with the resultant poor regulatory outcome at your leisure. A good policy outcome depends on the quality of the regulatory framework crafted to implement it. The issue is too important to get wrong; it deserves the most sophisticated response possible. We must not let climate change become a victim to 'quick fix' legislation. Failing to live up to expectations and consequently losing public support is a real possibility, and one that must be avoided.

This review also endorses this sentiment.

That major decisions on scheme design and medium-term emissions targets have been taken without any clear knowledge of the post-2012 international climate change architecture suggests the need for further consideration of policy and governance arrangements to ensure the ETS works as intended. In December 2008, EU members agreed to a review of the current EU climate package in March 2010 to reflect the outcome of the Copenhagen conference. A similar review process to take stock of Australia's policy settings should be implemented to ensure the domestic scheme maintains community confidence and credibility.

More generally, it remains a major gap in the national climate change policy approach that Australia's premier, independent structural reform advisory body has not been asked to report formally on the nation's 'most difficult ever regulatory challenge'. The Productivity Commission should be given a brief to assess formally the Government's White Paper proposals against the Government's own Best Practice Regulation Guidelines.

This would doubtless shed light on improvements to ensure that the ETS is both durable and flexible, able to meet its core objective of supporting least-cost emissions abatement and soundly based in a way that is likely to maintain community support for climate change action over many decades. It would, for example, expose the full costs to businesses and households of the interaction of the ETS and the expanded RET.

The reality is that there is nothing sacrosanct about 2010. If the scheme is rushed or implemented alongside measures that simply add to the costs of mitigation there is a genuine risk that public support for long-term action on climate change will be eroded.

12. TERMS OF REFERENCE: TWELVE

The discounted present value of the economic costs and benefits of the government's proposed emissions trading scheme;

For the purposes of this section the Treasury's results from each scenario are taken as given. However, it should be kept in mind that these costs are not a full accounting of the costs of any ETS. As Professor Garnaut has noted, any climate change policy could also involve other costs:

- Type 2 costs, which comprise 'standard economic impacts for which data are not available in a form that is sufficiently precise for modelling.'
- Type 3 costs, which 'comprise the special and additional costs of extreme outcomes'
- Type 4 costs, which relate to 'non-market benefits'.

Professor Garnaut notes that these costs should be taken into account when estimating the costs of climate change (and the benefits of mitigation). But standard cost-benefit considerations dictate that if these costs are taken into account on the benefits side of the equation, they should also be taken into account when estimating the costs of any policy response. Treasury's modelling ignores these issues.

For the CPRS scenarios, Australia's GDP growth is, on average, projected to be reduced by 0.1 percentage points on average, for every year for the next 40 years, from an average of 2.4 to 2.3 percentage points.

How should this reduction in GDP be assessed? Page 62 of the Department of Finance's *Handbook of Cost-Benefit Analysis* states that: *a project should be accepted if the sum of its discounted benefits exceeds the sum of its discounted costs; that is, where its net present value exceeds zero.*

Treasury supplies projections of GDP out to 2050 in chart 3.29. It also supplies (chart 6.10) estimates of foregone GDP in percentage terms for each policy scenario out to 2050. Thus it is straightforward to compute the levels of foregone GDP under each policy scenario.

Unfortunately Treasury does not supply projections of the benefits of an ETS under each scenario, and so there is insufficient information in Treasury's modelling results to estimate the net benefits of mitigation. In particular, this means that it is impossible to use the standard Department of Finance Handbook methodology to assess the merits of the proposed policy. This is a significant oversight.

Nevertheless, since GDP estimates have been supplied it is possible to compute the cost of the projected reduction in GDP growth in present value terms. The analysis is by necessity limited, because Treasury does not publish estimates of the full costs of the ETS - it only publishes estimates of these GDP costs out to 2050. Thus, the full GDP costs cannot be computed from Treasury's modelling because GDP estimates are only provided out to 2050, whereas any ETS will presumably be designed to extend beyond that date and will continue to reduce GDP below the reference scenario in all years after 2050.

The main conclusion of the analysis below is that growth reductions of the magnitude projected by Treasury appear small, but in present value terms they are not.

The Treasury modelling assumes that GDP will be \$1.19 trillion (expressed in 2005 dollars) in 2010. Treasury also publishes tables of GDP projections under the reference scenario and each policy scenario. The difference between GDP for each year under the mitigation and no mitigation cases can be computed. Aggregate GDP is lower in the presence of mitigation, each and every year into the future.

So how much will the ETS cost Australia in today's dollars? Put another way, what is the net present value of the permanent and rising reduction in GDP that is brought about by mitigation? To answer these questions, an assumption must be made about how much a dollar received tomorrow is worth today. In other words, a discount rate needs to be assumed. It is straightforward to compute the present value of foregone GDP using a range of discount rates. The results under each mitigation scenario are reported in Table 4.

The results show that in present value terms (which is the method for selecting projects that the Department of Finance Handbook recommends), the costs of mitigation can easily exceed the entire value of Australia's current GDP.

For example, using a discount rate of 1.4 per cent (used by Professor Garnaut on page 270 of his final report), in present value terms, the cost of mitigation under each scenario is:

- CPRS -5: \$1.264 trillion
- CPRS -15: \$1.661 trillion

Table 4: The net present value of GDP loss for each mitigation scenario

Discount Rate	CPRS-5	CPRS-15
0.0%	1,881	2,472
0.5%	1,627	2,139
1.0%	1,412	1,857
1.4%	1,264	1,661
1.5%	1,230	1,616
2.0%	1,074	1,412
2.5%	941	1,237
2.7%	893	1,174
3.0%	827	1,087
3.5%	729	958
4.0%	644	847
4.5%	572	751
5.0%	509	669

13. TERMS OF REFERENCE: THIRTEEN

The adaptation opportunities that could be foregone as a result of implementing a poorly designed emissions trading scheme, and the economic costs of not implementing those opportunities;

Broadly speaking the net benefits of any climate change policy can be captured in the economic value of damage that is avoided.

Conceptually, there are two ways of reducing the damages that might occur as a result of climate change. The first – mitigation – focuses on opportunities for reducing the probability of climate change itself by reducing the flow of emissions, thereby stabilising the stock of CO₂-e in the atmosphere. The second – adaptation - focuses directly on the probability and economic extent of damages. Even if climate change occurs, the amount of economic damage it may cause can be reduced by undertaking measures to adapt.

As Professor Garnaut and others have noted, reducing emissions is subject to free riding: any reduction in emissions affects the entire atmosphere, no matter where the reduction comes from and who achieves it. Thus any benefit of a reduction in emissions is spread among all countries, whilst the costs are localised.

Adaptation, on the other hand, tends to have more private good characteristics: as a general proposition the benefits of any adaptation measures adopted by Australia will not spill over into other countries, and so Australia will be able to largely capture the benefits of these policies. Put another way, the opportunities for international free riding on adaptation are much more limited, compared with measures taken to reduce emissions.

From an insurance point of view, both strategies make sense for individual countries and the world as a whole, and should play a part in any sensible climate change policy.

But the key economic question is: how much of a part should each policy play? The answer will vary across countries, regions, local communities and households, since the value of a dollar spent on adaptation depends on local circumstances. Since resources are finite, every measure taken to reduce emissions (which, as Treasury's modelling confirms, reduces the economy's future production possibilities) must reduce adaptation possibilities.

Treasury's modelling completely ignores adaptation and in doing so ignores the adaptation opportunities that will be foregone as a result of lower GDP. Treasury's modelling therefore ignores a key component of the opportunity costs of reducing emissions and ignores a vital aspect of the policy response to climate change.

National policies geared to adaptation to climate change are just as important as those geared to mitigation. And unlike mitigation, adaptation can effectively be pursued unilaterally (Productivity Commission 2008).

The Australian economy must remain economically strong, particularly if it is to be in the best position to allocate scarce resources to climate change adaptation. The accumulation of GHGs already in the atmosphere means that a degree of climate change is inevitable. While uncertainty surrounds the nature, scale and timing of these impacts, Australia faces a number of adaptation challenges that will have economic, social and environmental dimensions.

According to the IPCC (2007b), potential impacts on Australia include: increased water security problems in southern and eastern Australia; risks to coastal development from sea-level rise and coastal flooding; loss of biodiversity in ecologically rich sites; risks to major infrastructure from extreme events; and decline in production from agriculture and forestry. In a similar vein, the Garnaut Climate Change Review identified four areas where the impacts of climate change are expected to be large. These were: irrigated agriculture in the Murray-Darling Basin; urban water supply infrastructure; buildings in coastal settlements; and ecosystems and biodiversity (Garnaut 2008a, chapter 15).

Adaptation is part of the broader risk management task entailed in Australia's policy response to climate change. Important roles for government include supporting the creation and dissemination of information on climate change impacts at a national, regional and local level. This has a critical public good role in its own right, helping communities and individuals to develop the necessary localised adaptation solutions. It is also a key input for ensuring insurance and other markets are equipped to respond to particular risks in a timely and effective way.

A significant amount of scientific work suggests large parts of rural Australia will be both hotter and drier in future. No matter what the Australian Government does about domestic emissions, farmers will suffer the effects of climate change. A priority must be to devise strategies for Australian agriculture to adapt, not only to changes in local climate but also to the changes in international prices and trade flows that will inevitably arise from changes in both the supply of and demand for agricultural products around the world.

Responding to such challenges will demand a major national investment over many decades. To the extent that a poorly designed ETS has the potential to weaken Australia's economy, it has a capacity to delay and diminish necessary adaptation responses. Finally, it is the case that climate change will occur everywhere, with many projections suggesting that impacts will be large on the Indian subcontinent, Africa and elsewhere. Australia is therefore likely to be called on to increase support to other countries for climate change adaptation. Again, this can only occur based on a strong domestic economy.

14. TERMS OF REFERENCE: FOURTEEN

The economic impact of the Government's emissions trading scheme on farming and agricultural industries, even if those industries are not covered in any scheme before 2015;

As mentioned above, the introduction of the ETS will have an impact on all parts of the Australian economy including those not directly included in the scheme. This is because the relative prices of energy (and some other inputs) will rise after the introduction of the ETS and a significant share of those cost increases will be passed onto farmers. Given that Australia is a price taker for the vast majority of agricultural commodities produced it follows that the scheme will put downward pressure on profitability of the sectors that are the most intensive users of those inputs. At the same time however, other costs will also change. For example, as already mentioned, the scheme may be associated with a reduction in real wage costs. If this reduction in costs is sufficient to offset the increases in other input prices some sectors may expand relative to what otherwise would have occurred. It is typical in published modelling results for the impacts of an ETS on agriculture to see projections of cropping industries expanding to a limited extent and some livestock industries contracting. This result generally occurs both because cropping is less greenhouse gas intensive than livestock production and because the cropping sector becomes relatively more competitive than some other competing sectors elsewhere in the economy.

The overall impacts of the scheme on the farm sector will be largely determined by the actions of our overseas competitors. If those competitors do not introduce equivalent schemes and agriculture is not effectively shielded then a large share of the input cost increases of a scheme will be borne by farmers who will become less profitable relative to what otherwise would have occurred.

In a practical sense there are no commercially available technologies that exist today that could be applied to reduce methane emissions in the extensive rangeland based livestock industries. In addition, it will be challenging to devise a means of determining which producers have actually reduced emissions and which have not so it is likely that the monitoring and enforcement costs in agriculture will be much higher than in other parts of the economy.

There has been much debate about the possible role of soil carbon in offsetting industrial emissions and the possibility of the farm sector generating emissions credits by sequestration of additional carbon in soils. While all avenues for offsetting carbon emissions need to be explored there remains much uncertainty around the potential fluxes of carbon that might be induced by drought and other seasonal conditions and around the international rules that might be negotiated to include soil carbon in an international regime.

15. TERMS OF REFERENCE: FIFTEEN**The desirability of fixed-price permits, versus a price cap on permits;**

The Government's White Paper proposes that the price of permits be capped at \$40 per tonne (rising by 5 per cent in real terms) for the five years of the policy. Thus, under the Government's proposal, the price may be less than the cap but can never exceed the cap in the initial years of the scheme.

Professor Garnaut, on the other hand, proposes that the price of permits remain fixed from 2010 to the end of the Kyoto period (2012). Thus the permit price would neither be below nor exceed the proposed fixed amount for the first two years of the scheme.

Treasury's modelling does not analyse or shed any light on the economic effects of a price cap of \$40 as opposed to a fixed price or floating price. This is a major oversight.

16. TERMS OF REFERENCE: SIXTEEN

The impact of the Government's proposed emissions trading scheme on the financial viability (as opposed to economic viability) of coal-fired electricity generators, both in the short run and long run;

Treasury's analysis concedes (p. 178) that:

This report projects retirement of electricity generation units by modelling them as physical economic assets. It does not take account of the impact of financial considerations, such as debt-equity ratios or ownership structures, on retirement decisions.

Thus, the financial viability of coal-fired power stations is not considered. This means that the issue of whether the White Paper's proposed assistance is sufficient to maintain the financial viability of these assets – and whether this is consistent with Treasury's assumptions regarding their continued operation - is not examined.

This is yet another element of the government's preferred policy approach that does not appear to have been modelled by Treasury.

17. TERMS OF REFERENCE: SEVENTEEN**The cost and accuracy of compliance measurement, both in Australia and internationally;**

An emissions permit constitutes a legal right to emit; it is a property right. Enforcing and monitoring these rights requires accurate measurement, which in turn can be difficult and costly. A small percentage of measurement error on a large volume of permits can have significant economic implications for the individuals trading or surrendering those permits. Treasury's modelling does not analyse the economic implications of these issues.

The Treasury modelling also ignores the compliance costs of the scheme. The design of penalties for non-compliance influences the incentive to comply. The nature of the scheme's regulatory and enforcement regime will determine the probability of detection and punishment. This, together with the design of punishments – the size of fines and imprisonment terms - will determine the expected punishment, which is the effective 'price' of non-compliance.

None of these details have been finalised by the government, but they are crucial for determining costs to businesses and individuals, economic incentives and how individuals and businesses will react and behave when the scheme is introduced.

Treasury's modelling appears to have ignored these important institutional and regulatory features.

18. TERMS OF REFERENCE: EIGHTEEN

The economic and environmental implications of the White Paper (due December 2008);

The Treasury document considers four policy scenarios. However, the policy proposed in the White Paper is that in the absence of a comprehensive global agreement Australia will undertake unilateral action to attempt to achieve a 5 per cent reduction in emissions on 2000 levels by 2020.

Treasury modelling does not include this unilateral scenario. As already mentioned the Treasury CPRS -5 (5 per cent reduction) scenario is based on the assumed multi-staged introduction of equivalent climate change policies in overseas countries.

Moreover, Treasury's modelling assumes 'shielding' for EITE industries according to the proposed scheme outlined in the Green Paper. But the White Paper proposes a different, more complicated shielding scheme. Treasury's modelling, published prior to the release of the White Paper, does not analyse this revised shielding scheme.

Finally, as noted earlier, the White Paper proposes a permit price cap in the first five years of the scheme. Treasury's modelling, published prior to the release of the White Paper, does not analyse the economic effects and implications of this policy.

In summary, the Treasury modelling does not actually model the government's preferred policy approach. A complete analysis and assessment of the economic costs and benefits of the government's preferred policy approach has yet to be published by Treasury.

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APPENDIX A TERMS OF REFERENCE DOCUMENT

SENATE SELECT COMMITTEE ON FUEL AND ENERGY

A PEER REVIEW OF THE TREASURY MODELLING OF THE ECONOMIC IMPACTS OF REDUCING EMISSIONS

That Dr Brian Fisher (former Executive Director of ABARE and currently of Concept Economics) be engaged to provide a review of the Treasury Modelling *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* including all relevant publicly available information, and having requested full access to the government's model, documentation, codes and databases, any further information made available by the government, with particular reference to the following:

1. Sensitivity analysis of the assumptions on which the modelling has been undertaken;
2. The impact on global emissions of the government's proposed emissions trading scheme and the potential leakage of Australian jobs and industry in:
 - 2.1 emission intensive trade exposed industries such as aluminium, LNG, cement and agriculture;
 - 2.2 non trade exposed industries such as electricity.
3. The economic and environmental consequences of the Government's proposed eligibility thresholds for emissions intensive, trade exposed (EITE) industry assistance;
4. The consequences of more realistic assumptions concerning:
 - 4.1 the likelihood of the rest of the world taking similar actions to Australia;
 - 4.2 the participation of China in a global emissions trading scheme by 2015;

- 4.3 the participation of India in a global emissions trading scheme by 2020;
- 4.4 the immediate participation of the United States in a global emissions trading scheme;
- 4.5 the likelihood of a global agreement being sustained through the year 2050;
- 4.6 commercial scale availability and use of carbon capture and storage technology, particularly in the light of assumptions regarding the path of the carbon permit price;
- 4.7 low or non-existent barriers to international trade in carbon permits;
- 4.8 the taxation treatment of permits, both in Australia and overseas.
- 5 The failure to include the impact of the global financial crisis on:
 - 5.1 Australia's capacity to bear the costs of participation in a global emissions trading scheme;
 - 5.2 the rate at which other countries will commence participation in a global emissions trading scheme.
- 6 The impact of the Government's emissions trading scheme on issues of national security including fuel resources and refining, construction resources and energy security;
- 7 The impact of the Government's emissions trading scheme on government revenue and spending, and the total revenue that the Government can expect to collect from the scheme through the year 2050;
- 8 The economic costs of the Government's expanded renewable energy target compared to the costs of alternative policy approaches;

- 9 Testing the veracity of the conclusions that under the Government's emissions trading scheme by 2050 electricity prices in Australia would rise five times as much as in the US, Canada, Japan and the EU and three times as much as in China over the same period;
- 10 The impact of the Government's emissions trading scheme and a rising carbon price in all years that the scheme is in place on:
 - 10.1 unemployment;
 - 10.2 cost of living pressures for households, pensioners and individuals more generally;
 - 10.3 inflationary pressures;
 - 10.4 nominal interest rates, and real interest rates;
 - 10.5 Aggregate productivity.
- 11 The economic impact of Australia introducing a poorly designed scheme in 2010, rather than a better designed scheme in 2011 or 2012, taking into account the decisions of major emitters;
- 12 The discounted present value of the economic costs and benefits of the Government's proposed emissions trading scheme;
- 13 The adaptation opportunities that could be foregone as a result of implementing a poorly designed emissions trading scheme, and the economic costs of not implementing those opportunities;
- 14 The economic impact of the government's emissions trading scheme on farming and agricultural industries, even if those industries are not covered in any scheme before 2015;
- 15 The desirability of fixed-price permits, versus a price cap on permits;

- 16 The impact of the government's proposed emissions trading scheme on the financial viability (as opposed to economic viability) of coal-fired electricity generators, both in the short run and long run;
- 17 The cost and accuracy of compliance measurement, both in Australia and internationally;
- 18 The economic and environmental implications of the White Paper (due December 2008).

Duration

That the review be completed by 30 January 2009.

Content

That the review consist of written analysis together with supporting data in tabular and diagrammatic form.

Contract

That the consultant comply with the terms of the attached contract.

APPENDIX B FUGITIVE EMISSIONS ABATEMENT CURVES IN GTEM

B.1. RELATIONSHIP BETWEEN EMISSIONS FACTORS AND CARBON PRICE

In the case of GTEM the model allows for fuel switching between fuel sources in response to changes in relative prices. In the case of fugitive emissions and emissions from industrial processes emissions in GTEM do not respond directly to relative prices but are reduced according to the carbon price along an emissions intensity curve.

In the MMRF abatement in all sectors is determined according to estimated emissions intensity of output curves. For both GTEM and MMRF these relationships are modelled using an exponential function.

Some features to note about the curves used in the models are:

- In the document, the curves are referred to as marginal abatement cost (MAC) curves, although they are not MAC curves as widely understood. Curves approximating MAC curves can be derived by rearranging the functional form assuming that the marginal cost of abatement is equal to the carbon price.
- At reference year emissions intensities, each industry has an implied negative marginal abatement cost. Additionally, due the parameters used in the GTEM and MMRF models, each industry can reduce their fugitive and industrial process emissions by 3 per cent before they incur any abatement cost.
- The curves have no time dependency, meaning that industries can adjust their emissions intensity at the same cost in the short run as they can in the long run.

B.2. FUNCTIONAL FORM OF THE RELATIONSHIP

The functional form of the curves used in the GTEM and MMRF models is described in Box 1. The functional form is misleading for several reasons.

- The equation is referred to as a MAC curve. However it does not give the MAC as a function of abatement; rather it gives an index of the emissions factor relative to the reference year as a function of the carbon price. The MAC is left undefined by the function.
- The 'index of the emissions factor relative to the reference year' is not specifically defined in the text. Using broader definitions, it has been taken to be the ratio of emission intensity in the current year to the emissions intensity in the reference year.
- Additionally, the use of t to denote the carbon price differs from the traditional mathematical usage of t to denote time.

Box 1: Functional form of the relationship between the carbon price and emissions

$$\Lambda = \begin{cases} e^{-\alpha(t+1)^\gamma} & \text{if } \Lambda > \min \Lambda \\ \min \Lambda & \end{cases}$$

Where:

Λ is an index of the emissions factor relative to reference year;

t is the carbon price;

α is set to 0.003 unless otherwise noted;

$\min \Lambda$ is the minimum emissions intensity of output possible; and

γ sets the speed of adjustment of emissions intensity in response to a carbon price, a higher γ represents a faster adjustment.

The MAC as a function of the percentage reduction in emissions intensity is given in Equation 1.

Equation 1

$$mac = t = \begin{cases} \left(\frac{-\ln(1-A)}{\alpha} \right)^{1/\gamma} - 1 & \text{for } A > \max A \\ \infty & \text{for } A \leq \max A \end{cases}$$

Where:

A is equal to $1 - \Lambda$, and is the percentage reduction in emissions intensity by the industry; and

mac is the marginal abatement cost.

Some key features that can be noted about the 'MAC curve' by looking at its functional form are:

- When the emissions intensity is equal to the emissions intensity of the reference year, a cost saving (rather than a cost increase) is implied by an emissions reduction; and
- Once the lower bound for an industry's emissions intensity is reached no further gains are possible.

B.3. SHAPE OF THE MARGINAL ABATEMENT COST CURVES

The shape of the derived MAC curve is specified by the alpha and gamma parameters. In both GTEM and MMRF, the MAC curves specified for fugitive and industrial process emissions are convex and upward sloping. This means that the marginal cost of abatement grows with the amount of abatement, and that these increases in marginal abatement costs are accelerating.

GTEM fugitive and industrial process emissions

In the GTEM model, the MAC curves for fugitive and industrial process emissions are upward sloping with a convex shape. These curves are illustrated in Figures A1 to A5. Industries such as Coal, Oil and Gas have flatter MAC curves implying that these industries can decrease emissions at a lower cost than industries such as Livestock, Crops and Fertilizer use that have steeper MAC curves.

The alpha coefficient used in the GTEM model is equal to 0.03 for each industry, while the gamma coefficients have a range of 0.45 to 0.9. Coal has the highest value of gamma with 0.9. This gives coal the flattest curve implying that coal can reduced its emissions intensity at the lowest cost. Crops and fertilizer have the lowest value of gamma each with 0.45. This gives crops and fertilizer the steepest MAC curves, implying that crops and fertilizer experience a high cost for reducing their emissions intensity.

The use of a common alpha, equal to 0.03, means that each industry can reduce its emissions by approximately 3 per cent without incurring a cost.

Figure A1: GTEM coal industry fugitive and industrial process emissions curve

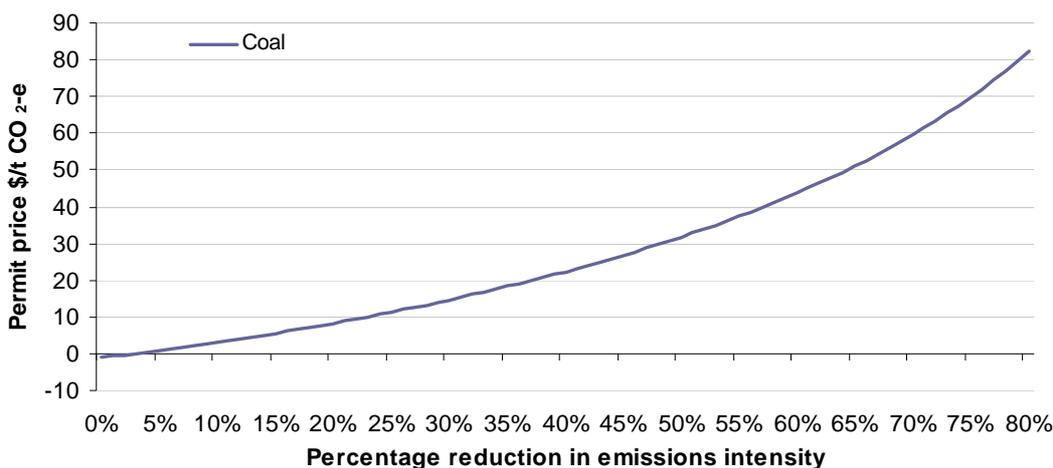


Figure A2: GTEM oil industry fugitive and industrial process emissions curve

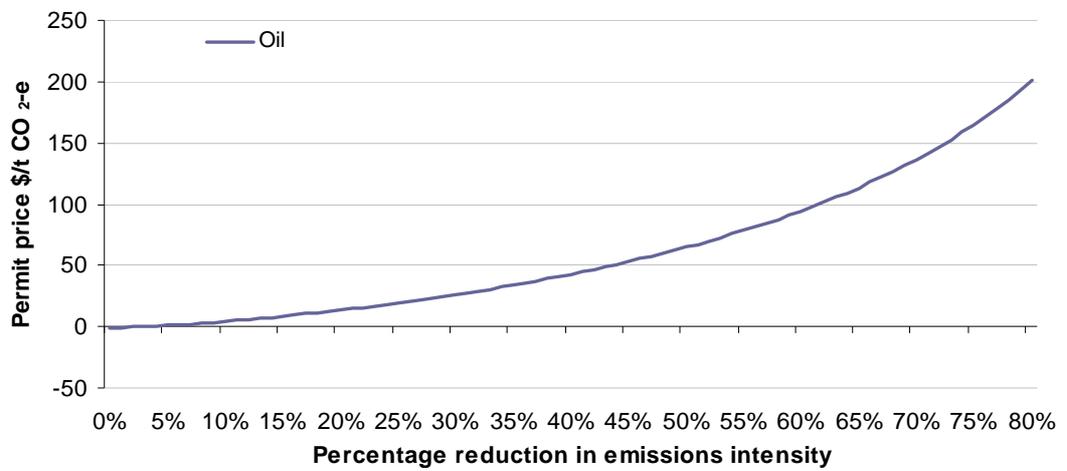


Figure A3: GTEM livestock industry fugitive and industrial process emissions curve

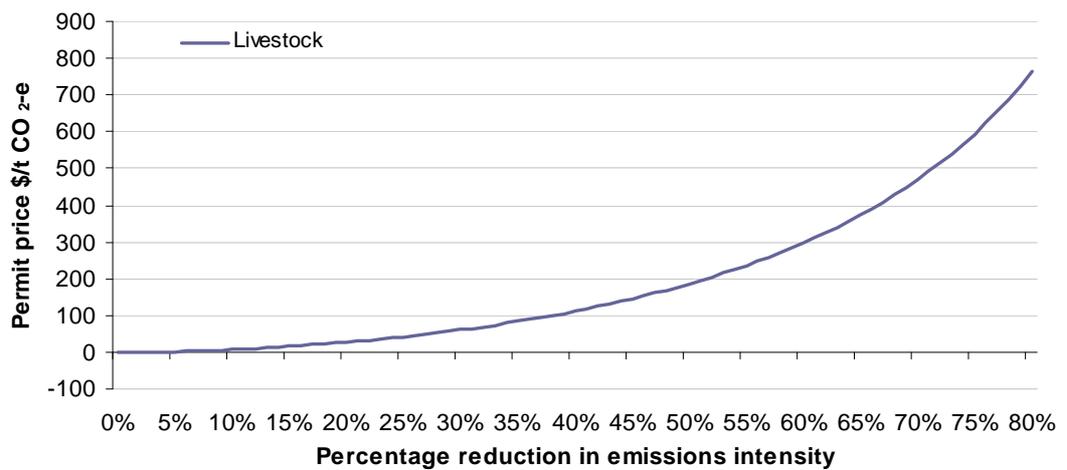


Figure A4: GTEM non ferrous metals industry fugitive and industrial process emissions curve

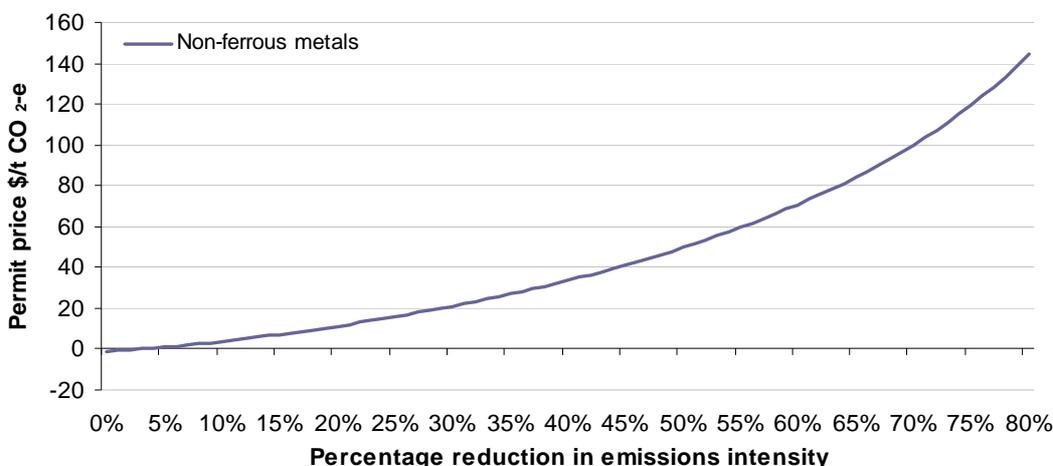
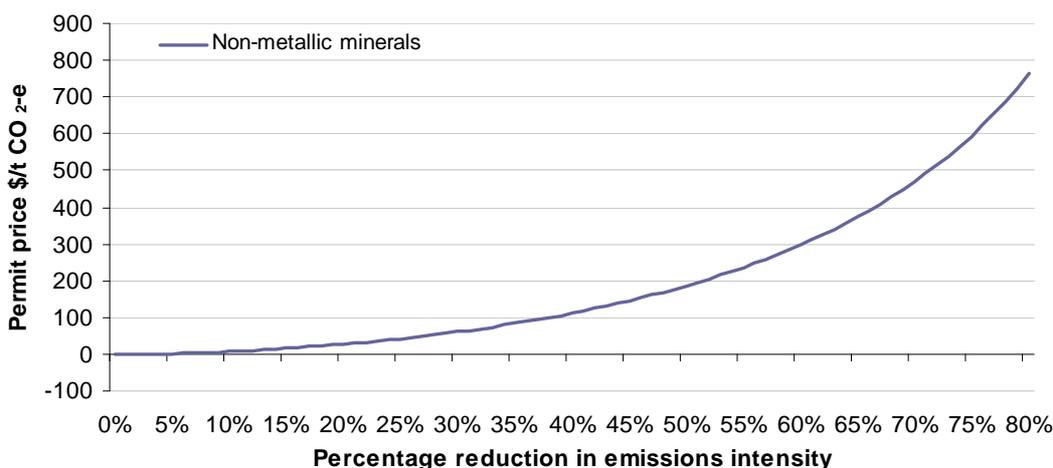


Figure A5: GTEM non-metallic minerals industry fugitive & industrial process emissions curve



MMRF fugitive and industrial process emissions MAC curves

The MMRF uses similar coefficients for the fugitive and industrial process emissions MAC curves to those used in GTEM except that in the case of MMRF these curves are applied to all sectors. Again alpha is set to 0.03 for each industry. Gamma has a range of 0.50 to 0.99. These parameters give the fugitive and industrial process emissions MAC curves used in the MMRF model very similar shapes to those used in the GTEM model.

In addition, MMRF imposes similar curves in the case of combustion emissions except in the case of combustion emissions a different parameter set is used. The MAC curves are no longer strictly convex and may be concave in places, although the MAC curves are still upward sloping. These MAC curves are steeper at lower levels of abatement and then tend to flatten out. This means that initial reductions are made at quickly accelerating costs.

However, after this initial acceleration the rate of MAC increase declines to close to a constant rate.

A selection of the curves used in MMRF is shown in Figures A6 to A14.

Figure A6: MMRF livestock industry fugitive and industrial process emissions curve

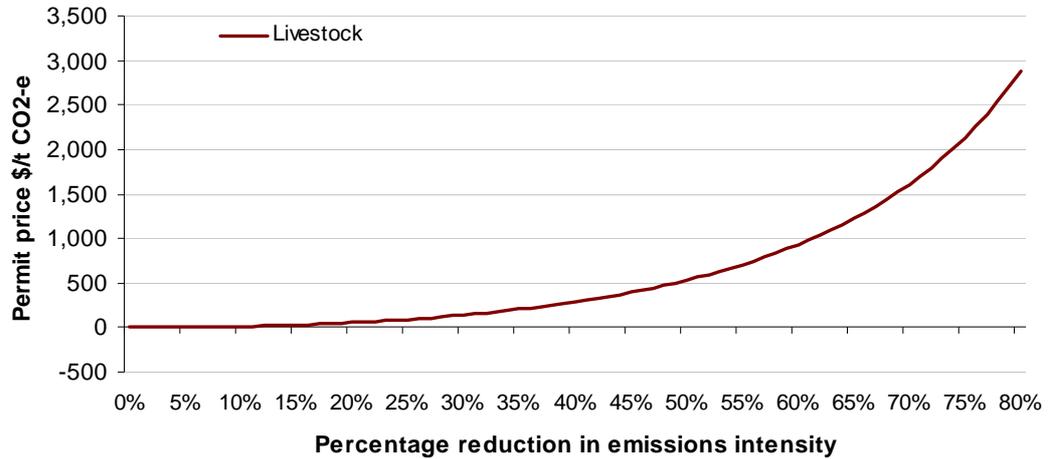


Figure A7: MMRF coal industry fugitive and industrial process emissions curve

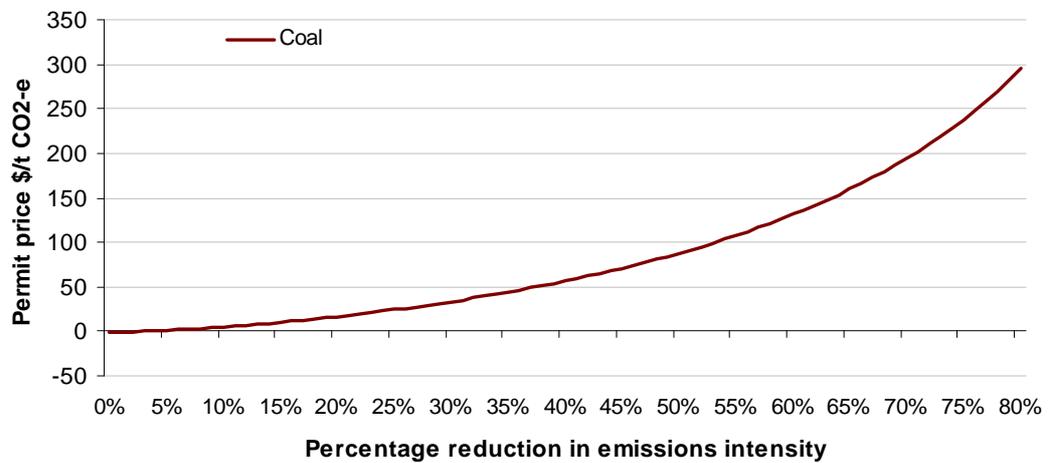


Figure A8: MMRF cement industry fugitive and industrial process emissions curve

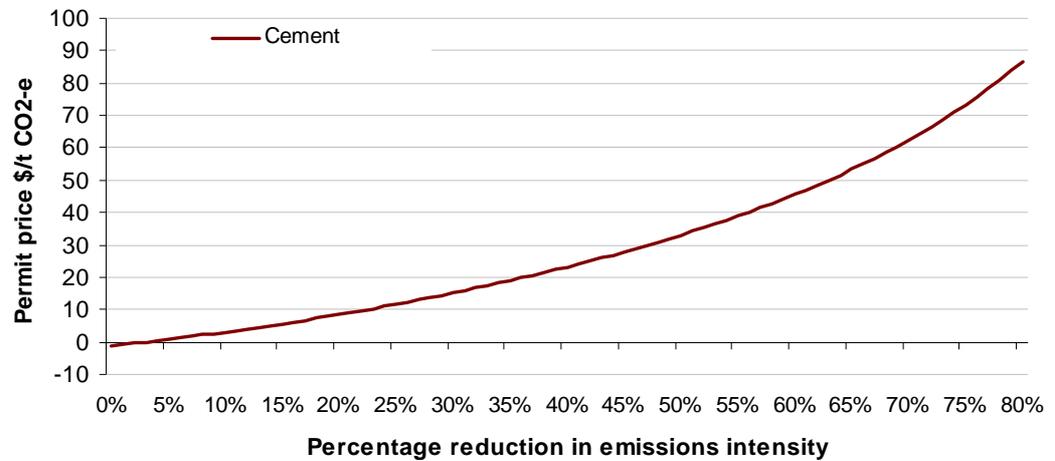


Figure A9: MMRF steel industry fugitive and industrial process emissions curve

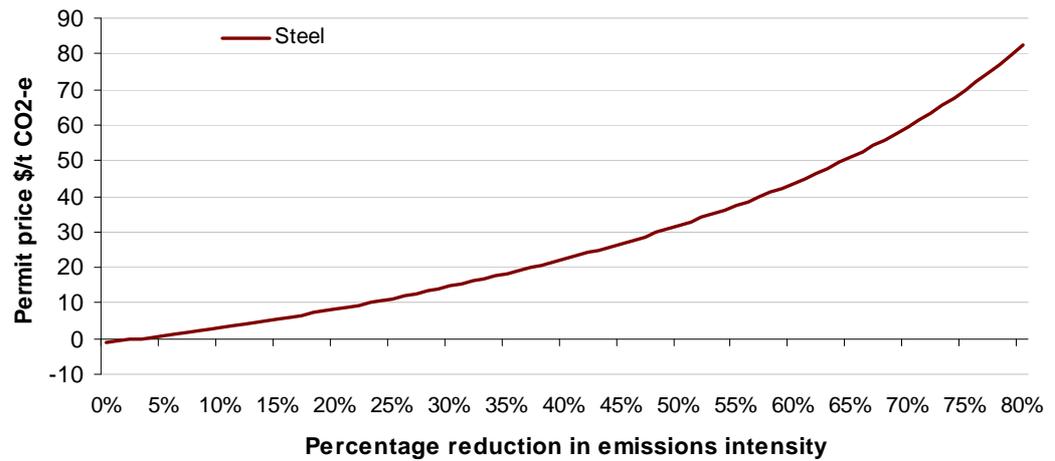


Figure A10: MMRF aluminium industry fugitive and industrial process emissions curve

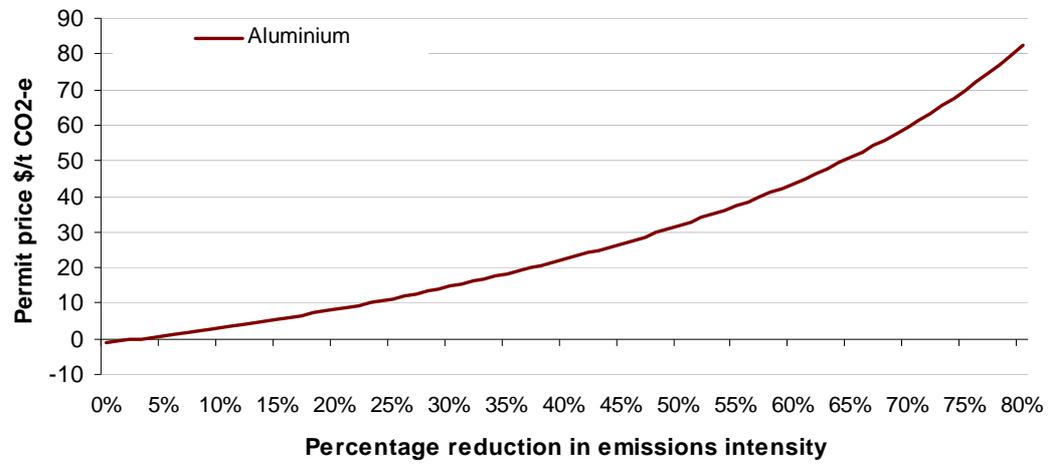


Figure A11: MMRF private electricity industry fugitive and industrial process emissions curve

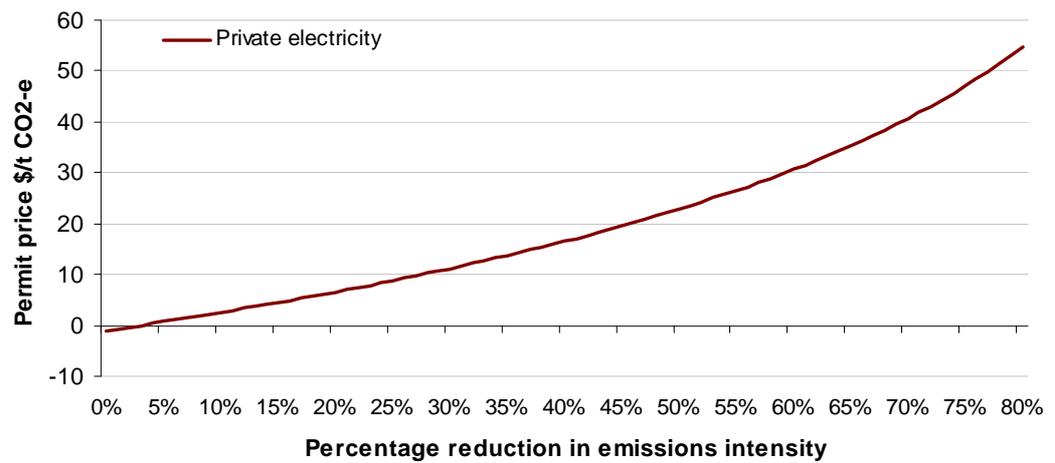


Figure A12: MMRF coal combustion emissions curve

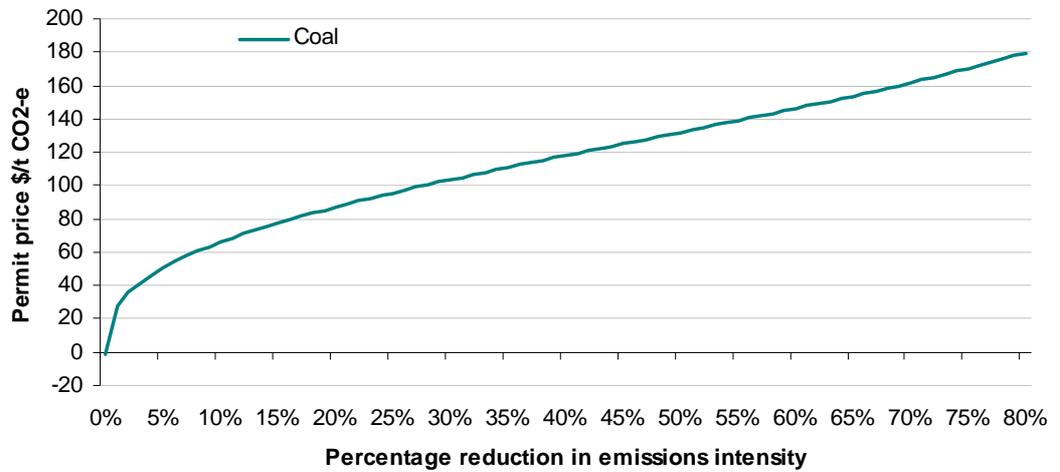


Figure A13: MMRF gas combustion emissions curve

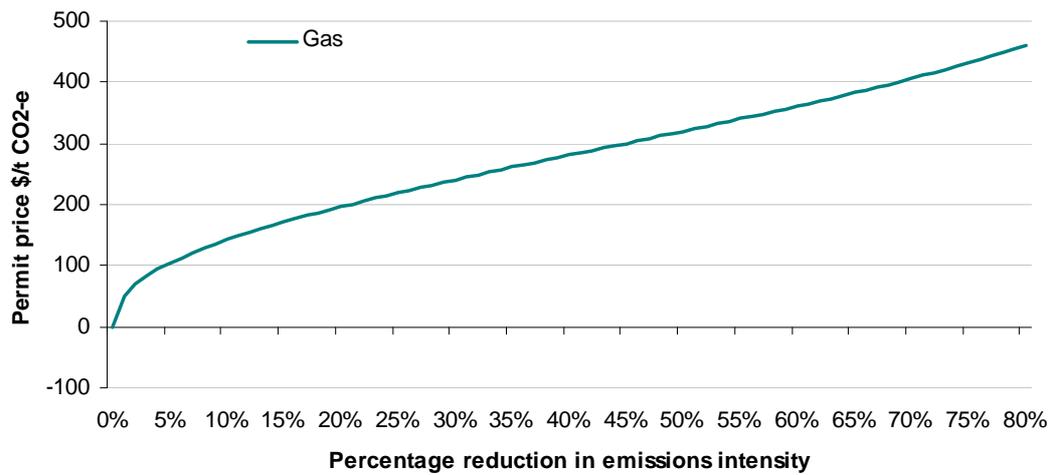
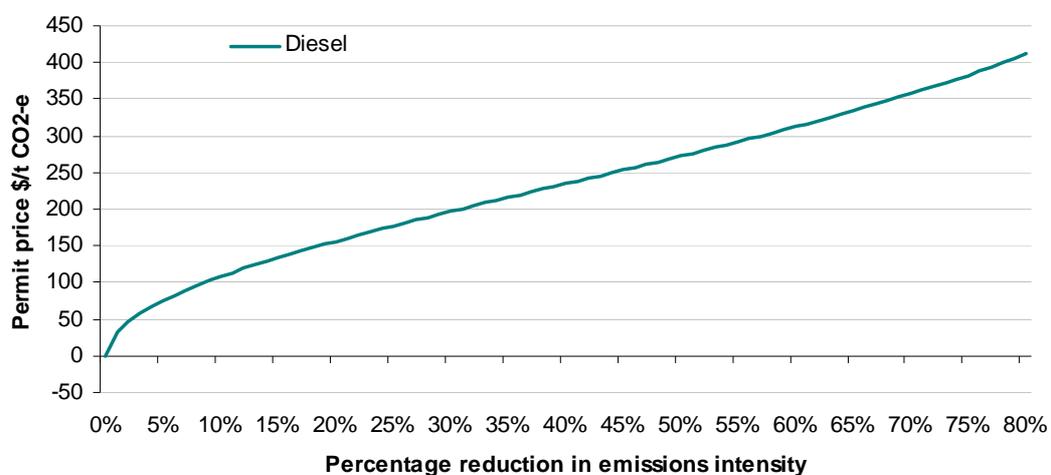


Figure A14: MMRF diesel combustion curve



B.4. TIME INDEPENDENCE OF CURVES

The curves used in the model are independent of time. This means that the emission intensity of industries would be the same next year if a \$100 carbon price is imposed as they would be in 2020 with the same carbon price.

In the short run, fixed capital and technologies are likely to mean that industries cannot make the same low cost abatements that could be made in the longer term when industries have more scope to adjust the capital and technologies employed in production. This would imply that industries face a steeper MAC curve in the short run when compared with the long run.