Regional Employment and Greenhouse Policies

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Summary

The unwillingness of the Australian Government to take serious measures to reduce greenhouse gas emissions, and its obstructionist approach to international negotiations, are heavily influenced by estimates of the economic cost of reducing emissions. Claims about the potential loss of jobs in regional and rural Australia have been particularly influential.

An apparently objective basis for the belief that cutting emissions would be very costly has been provided by a number of studies drawing on economic models. A report last year by the Allen Consulting Group entitled *Meeting the Kyoto Target: Impact on Regional Australia* has played a pivotal role in reinforcing perceptions that cutting greenhouse gases would result in large economic costs and extensive job losses, especially in regional and rural Australia. The report was commissioned and paid for by the Minerals Council of Australia and four major mining companies.

Yet examination of the Allen Consulting report itself, rather than the media releases and newspaper reports arising from it, reveals that the modelling work suffers from several simple but vital errors and misinterpretations which, taken together, render its conclusions worthless.

This paper has two parts. The first part reviews the Allen Consulting report. The second part provides an overview of the growth and employment opportunities – especially in regional Australia – that are likely to be generated by measures to reduce greenhouse gas emissions. It brings together some of the information that has led many business people and, increasingly, trade unionists to the belief that the need to cut emissions provides an opportunity for Australia to build new industries that will drive growth and employment in the future.

The forecast job losses in regional Australia, which provided the boldest headlines from the Allen Consulting report, are based on a series of wrong assumptions and misinterpretations of the data. The major faults in the report can be summarized as follows.

1. Forecast job losses in some regions are due not to greenhouse measures in Australia but to decisions by governments overseas, yet the report attributes all job losses to 'Australian compliance' with the Kyoto Protocol.

2. Some regions predicted to have major job losses turn out to have no special dependence on fossil fuels either for domestic consumption or export. The job losses arise from a predicted sharp decline in agricultural output due to the imposition of a large tax on methane emissions (a 'belch tax'), a policy response that is fanciful and unnecessary.

3. The modelling ignores the two largest tranches of emission cuts in Australia that are available at no cost or very low cost, namely, accelerated energy efficiency and the end of land clearing.

4. Allen Consulting uses a 'carbon tax' scenario which it knew from its previous work would be much more expensive than a 'policy mix' scenario. According to its own analysis, the latter would impose minimal costs on the economy.

Allen Consulting has itself stated that the 'policy mix' scenario is more realistic.

5. The analysis makes no attempt to capture adequately the likely technological response of industry to measures to cut emissions. It has no representation of the renewable energy and energy efficiency industries. The modelling is structured in a way that can capture only the downside and not the upside for industry of cutting emissions.

In addition, Allen Consulting misinterpret the results of the model, stating that Australian compliance with the Kyoto Protocol would reduce GDP by '1.9 per cent a year'. This is incorrect. In fact, the model results show that overall GDP would be 1.9 per cent lower in 2012 than it otherwise would be in the absence of greenhouse policy measures. This means that between 2000 and 2012 real GDP would increase by 39.1 per cent instead of 41 per cent.

Coincidentally, every one of the errors and misinterpretations in the Allen Consulting report has the effect of exaggerating the apparent costs to GDP and employment of meeting Australia's greenhouse obligations under the Kyoto Protocol. Since the Allen Consulting modelling makes no attempt to take into account the costs of *failure* to deal with climate change, it is not possible to make a case against reducing emissions on the basis of the model results.

A review of real-world cost data shows that making use of energy efficiency opportunities and ending land clearing would alone provide 140 Mt of abatement – easily enough to meet the Kyoto target – at a cost of less than $2 per tonne. The key assumption driving the Allen Consulting estimates of economic and job losses – that the marginal cost of abatement would be $34 per tonne – is therefore fallacious.

The information reviewed in this paper provides a 'reality check' against the extravagant claims being made about the economic damage that complying with our Kyoto target would cause. While these claims have been based on results generated by sophisticated economic models, these models are especially prone to the GIGO problem – garbage in-garbage out.

Contrary to the bleak scenario painted by Allen Consulting, there will be no need to reduce employment in agriculture or the alumina and aluminium industries. Indeed, there is every reason to believe the latter would be stimulated. Overall, then, there is no basis for the conclusion by Allen Consulting and others that meeting our Kyoto target would result in significant job losses in the regions.

On the other hand, there will be growing job opportunities for regional and rural Australia from the development of new industries associated with greenhouse gas abatement measures. Renewable energy sources – including opportunities for wind, solar and biomass energy – are located predominantly in regional areas, as are most of the huge investments in cogeneration. Several regional areas have already been revitalised by investments in new low-emissions industries.

1. Introduction

There is a legitimate concern that the structural adjustment costs of policies to reduce greenhouse gases may be high. Since 1995, these concerns have been turned into widespread fear that the economic impacts of anything other than voluntary measures and persuasion are to be avoided. The unwillingness of the Australian Government to take serious measures to reduce greenhouse gas emissions, and its attempts to water down and even undermine international agreement, are heavily influenced by estimates of the economic cost of reducing emissions. Claims about the potential loss of jobs in regional and rural Australia have been particularly influential. In this environment, it has been easy for supporters of the fossil fuel industries to gain a sympathetic hearing for their claims that meeting the terms of Kyoto Protocol would be economically ruinous for Australia.

What is the basis for these claims? An apparently objective basis for the belief that cutting emissions would be very costly has been provided by a number of studies drawing on economic models. Indeed, each international climate change conference has been preceded by another modelling study from the Government or fossil fuel interests that generates alarming headlines.

Prior to the Kyoto Conference in late 1997, the Australian Bureau of Agricultural and Resource Economics used its MEGABARE model to predict severe economic consequences from any international attempts to cut emissions that did not give special concessions to Australia (e.g. DFAT & ABARE 1995). The MEGABARE model was subsequently discredited after the Commonwealth Ombudsman reported on industry funding of ABARE's climate change work (Ombudsman 1998). It also came under criticism from other economists, including a statement signed by 131 professional economists who said the costs of reducing emissions had been exaggerated and the benefits understated.[1]

More recently, a report by the Allen Consulting Group entitled *Meeting the Kyoto Target: Impact on Regional Australia* (Allen Consulting 2000b) has played a pivotal role in reinforcing perceptions that cutting greenhouse gases would result in large economic costs and extensive job losses, especially in regional and rural Australia. The report was commissioned and paid for by the Minerals Council of Australia and four major mining companies.[2]

The Allen Consulting report made a series of very strong claims suggesting severe economic impacts on certain industries and in certain regions. These strong claims were successful in attracting media attention with headlines such as 'Cuts to greenhouse gases will hit GDP and jobs' and 'Victoria facing huge job losses'.[3]

Yet examination of the Allen Consulting report itself, rather than the media releases and newspaper reports arising from it, reveals that the modelling work suffers from several

[1] See Hamilton (2001, p. 56).
[2] It is perhaps with the MEGABARE saga in mind that Allen Consulting (2000b) goes out of its way to emphasise its 'independence' in its report prepared for the Minerals Council.
[3] *Australian Financial Review* 12 October 2000; *The Age*, 12 October 2000. *The Age's* report was particularly uncritical, reproducing the most alarming numbers and containing no dissenting opinion.

simple but vital errors and misinterpretations which, taken together, render its conclusions worthless. It is perhaps for this reason that the report was dismissed by the main political parties, with Environment Minister Senator Robert Hill saying the report was "drastically overly pessimistic" and Labor's environment spokesperson Nick Bolkus characterizing it as "unhelpful scare-mongering". [4]

While the present report points to the errors in the Allen Consulting report, it should not be construed as a criticism of greenhouse policy modelling as such. Modelling can be useful for exploring economic interactions and it often throws up unexpected outcomes that require explanation. However, models can be misused for political purposes. While economic models are often extremely complex in structure, as a rule only a few key relationships are important for explaining their results.[5] Moreover, modellers must make a series of assumptions about how an economy works and which factors to include in a model and which to leave out. The choice of assumptions essentially determines the results that emerge from the end of the modelling process. These facts mean that economists who build and use models can effectively determine the outcome by changing the model in sometimes obscure ways. For these reasons transparency in building models and reporting their results is crucial to their credibility.

This paper has two parts. The first part exposes a number of serious errors and misinterpretations in the Allen Consulting report on regional job losses. The second part provides an analysis of the growth and employment opportunities that measures to reduce greenhouse gas emissions would generate, especially in regional Australia. It is not a systematic study involving detailed modeling, an expensive task that no one has yet carried out. But it does bring together some of the information that has led many business people and, increasingly, trade unionists to the belief that the need to cut emissions provides an opportunity for Australia to build new industries that will that will drive growth and employment in the future.

[4] *Australian Financial Review* 12 October 2000

[5] For a more extensive commentary on the uses of models in Australian climate change policy see Hamilton and Quiggin (1997). For similar critiques of international modelling see Weyant (2000) and Repetto and Duncan (1997).

2. How much will Kyoto really cost?

The Allen Consulting report on regional employment impacts of Kyoto targets built on an earlier report by the same organisation on the implications of reducing emissions through emissions trading (Allen Consulting 2000a). The earlier report – entitled 'Greenhouse Emissions Trading' – was commissioned by the Kennett Government in Victoria and drew on modelling results commissioned from Monash University's Centre of Policy Studies (COPS).[6]

The Allen Consulting report on regional employment impacts says that the results of its analysis show that complying with the Kyoto Protocol would be costly for Australia, with large job losses in some regional areas. It describes its main findings as follows:

- 'complying with the Protocol will reduce Australia's GDP by around 1.9 per cent a year (over $140bn over a decade)'
- 'some industries experience severe production declines, particularly aluminium and alumina (-24 per cent) and black coal (-17 per cent)'
- 'over 50,000 jobs would be lost in non-metropolitan Queensland'
- 'employment will fall by almost 40 per cent more in non-metropolitan than in metropolitan areas'
- 'employment will decline by over 8 per cent' in the Latrobe Valley and the Fitzroy region in Queensland (Allen Consulting 2000b, pp. 2-3).

These claims are based on at least nine major mistakes in the modelling itself or in the interpretation of the modelling results. We consider each in turn.

2.1 Wrongly attributing blame

The economic costs to Australia of emission reductions under the Kyoto Protocol arise from two sources – the domestic cost of reducing Australia's emissions and the effects on Australia from measures taken by other countries to reduce their emissions. In the latter case, the main influence would be falling demand for our coal exports. Clearly, the Australian Government can influence the first source of costs (by deciding whether and how to comply with our obligations under the Protocol) but can have no influence over how other countries meet their obligations. In other words, the external costs will be imposed on Australia no matter what we do.

The Allen Consulting report makes a serious mistake by adding together the two effects and claiming that the fall in GDP and the job losses are the result of Australia complying with the Kyoto Protocol. The report makes this claim in many places. For example, the briefing material used extensively by Allen Consulting says:

[6] The COPS model is known as MMRF-GREEN, and is a more advanced version of the ORANI-E model. The later Allen Consulting report on regional job losses linked information on the price of emission permits taken from ABARE's GTEM model (the successor to MEGABARE and GIGABARE) with the MMRF-GREEN model.

> Complying with the Protocol will reduce Australia's GDP by around 1.9 per cent (over $11bn at current prices) a year …. Meeting Australia's Kyoto obligations would have a major detrimental effect on industries and employment in rural and regional Australia. [7]

This is also how the media reported the results.[8] Yet this claim is clearly fallacious. The predicted job losses from reduced coal exports would be expected to occur if Australia wholly ignored the Protocol and took no domestic actions. The fall in GDP and total job losses attributed to domestic policy actions in Australia are therefore much greater than should properly be attributed to this policy action.

In fact, there is reason to believe that external effects will account for most of the economic costs in Australia from the Protocol. Although one should not give its results much credence, the MEGABARE model indicated that the economic costs to Australia would derive about equally from measures to cut emissions in Australia and measures taken by other countries to cut their emissions (falling coal export revenue) (DFAT & ABARE 1995). If this is accurate, the Allen Consulting report has mistakenly doubled any costs from Australia complying with its Kyoto obligations. In fact, as we will see, the cost of cutting domestic emissions is likely to be substantially lower than estimated by both Allen Consulting and ABARE, so that any costs are likely to be due largely to external factors beyond the control of the Australian Government.

This is particularly important for those regions dependent on coal exports, such as the Fitzroy Basin in Queensland, that are claimed in the report to experience heavy job losses from Australia's domestic policy approach. It is evident from analysis of the report that the Fitzroy Basin job losses arise mostly from reduced coal exports, which could occur even if Australia did nothing on domestic compliance.[9]

The Allen Consulting report makes another mistaken attribution of external effects to the effects of Australian compliance. It states that some of the job losses predicted in the aluminium industry are due to a forecast 'exogenous' decline in world prices for aluminium (2000b, p. 26). Thus some of the job losses in the aluminium sector attributed in the report to Australian greenhouse policies are in fact due to entirely external factors.

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[7] Elsewhere, the Allen Consulting report (2000b) says 'compliance with the Kyoto Protocol is likely to be costly for Australia' (p. 2) and 'meeting Australia's obligations under the Kyoto Protocol would come at a high cost' (p. 6), and refers to 'the cost to Australia of complying with the Protocol' (p. 35).

[8] The *Australian Financial Review* wrote that the study 'said reducing Australia's greenhouse emissions to levels required under the Kyoto Protocol could reduce national GDP by 1.9 per cent annually' (12 October 2000).

[9] On the question of the effects of the Kyoto Protocol on Australia's coal exports, there are some strong indications that the projections made by the models are unduly pessimistic. The assumption that other countries will use less coal and therefore import less from Australia does not account for the fact that many economies, such as Germany and China, are taking a critical look at their energy industries and closing down some of their own, less efficient coal mines. In some cases, they may use less coal but import more of it, including more from the world's biggest coal exporter, Australia. These trends are already being reported by the Australian coal industry. For instance, the major Australian coal company Enex Resources recently stated that demand for export coal is expected to grow strongly over the next several years aided by small producers pulling out of Europe where subsidies are being cut back thereby making imports more attractive (*Canberra Times*, 8 August 2001).

This key methodological fault in the report in relation to aluminium raises the question of the extent to which other job losses forecast in the report are due to expected falls in world prices for other commodities. To illustrate, the model assumes that the world price of black coal will fall by 11.39 per cent to 2009-10 (Appendix Table A8, p. 33), a factor beyond the influence of Australia that accounts for some of the regional job losses reported. Yet instead of clearly separating

- the effects of greenhouse reduction measures in Australia,
- the effects of greenhouse measures in other countries, and
- other changes in the world economy unrelated to greenhouse,

the report lumps them all together and describes them as the results of Australian compliance with the Kyoto Protocol. This procedure is grossly deceptive, especially when combined with the inflation of job losses arising from other factors to be considered below.

2.2 A belch tax?

In the Allen Consulting report agriculture is listed as a job loser industry with output falling by 8.4 per cent below the base case (Allen Consulting 2000b, Appendix Table A12). An analysis of the job losses across different regions in the report shows that many of the regions experiencing job losses have no 'loser' industries other than agriculture. For instance, the regions of Murray and Murrumbidgee in NSW are shown as relatively heavy regional job losers, although these regions have no employment in the fossil fuel-based loser industries (like black coal mining, coal-based electricity generation and aluminium smelters).

Although the necessary data are not reported, given the large size across Australia of agricultural employment compared with sectors such as black coal mining, electricity generation and aluminium smelting, it can only be concluded that the great preponderance of the regional job losses claimed in the report, across most regions and regional Australia as a whole, are due to the inclusion of agriculture as a loser industry following the introduction of greenhouse policies.

Why does agriculture appear in the Allen Consulting report as a 'loser' from measures to cut emissions?

The report shows the agricultural sector responsible for 93 Mt of carbon dioxide equivalent (CO_2-e) emissions (or 23 per cent of total emissions excluding land use change in the 1993-94 model base). Of this amount, 88 Mt (94 per cent) is accounted for by sources other than fossil fuels, mainly methane from livestock year (Allen Consulting 2000b, Appendix Table A1).[10]

[10] In 1999, enteric fermentation contributed 64 per cent of non-energy emissions from agriculture. Agricultural soils contributed 18% and burning of savannas around 14% (NGGIC 2001a, p. A-23). While the costs of some inputs to agriculture would rise, emissions associated with electricity are equivalent to 2.8 Mt (with direct energy use accounting in 1999 for 4.1 Mt (NGGIC 2001a, p. B-96). In other words,

Therefore, when the Allen Consulting report refers to agricultural emissions it means essentially methane emissions (although nowhere in the report does it state this explicitly). The report states that emissions from agriculture would be controlled under its assumptions by 'economic instruments' (Allen Consulting 2000b, p. 16). This means a tax or a system of emission permits that polluters must pay for. The argument seems to be that as methane emissions contribute almost 20% to overall emissions they would have to make their contribution to reducing the total by being cut back proportionately through an economic instrument. This is the underlying but hidden reason for claiming there would be job losses in agriculture.

What are we to make of this? The model links livestock emissions directly to the price of carbon (through the price of an emission permit or a carbon tax). Using 'various sources', the report assumes that imposition of a carbon tax of $100 per tonne of CO_2-e would cause non-fuel emissions from agriculture to fall by 60 per cent (Appendix p. 11). This implies a 60 per cent decline in the number of cattle and sheep. In other words a tax of $100 would largely wipe out Australian agriculture. In practice, the model assumes an international price of carbon of around A$34 per tonne of CO_2-e in 2009-10, rather than $100 (Appendix p. 18). In this case, emissions from livestock and livestock numbers in the livestock sectors fall by 20 per cent, indicating a projected fall in agricultural employment of around 20 per cent.[11]

In sum, Allen Consulting assume that in the target period 2008-12 the Australian government would seek to cut agricultural methane emissions, mostly deriving from farm animals, by possibly one fifth, by using an economic instrument such as emission permits or a carbon tax, a policy that would see sheep and cattle numbers decline by the same proportion. How realistic is this assumption?

Using an economic instrument as proposed by Allen Consulting would require accurate measurement of emissions from sheep and cattle down to the individual farm level (that is, tallying the exact number of sheep and cattle per farm, and estimating the relative methane contribution of each type of stock on each farm). A charge taking the form of a tax or an auctioned emission permit would then be applied to each farm. Could such a 'belch tax' be feasibly applied in practice? It is tempting to paint a scenario in which a measuring instrument is attached to each end of every cow and sheep. Daily emissions could then be registered at the Australian Taxation Office, which in turn would issue an assessment notice to the owners. Even at a more aggregated level in which each primary producer is taxed according to the number of each type of animal, distinguished by breed, age, feed and methane emission factor it is difficult to see the belch tax working smoothly, even without consideration of the political obstacles.

The belch tax is a fanciful idea, yet it is the policy assumption that drives most of the regional job losses predicted by Allen Consulting. How would the Federal Government deal in practice with emissions from agriculture? Methane emissions from agriculture have been relatively stable since 1990, rising by around 3 per cent by 1999 (NGGIC 2001a, p. 68). While they will require attention, they are not the most worrying

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the modelled job losses in agriculture due to greenhouse policies arise predominantly from the 'belch tax' rather than increased costs of fuel and electricity.

[11] The overall reduction in emissions demanded of the model is 17 per cent below business-as-usual projections (Allen Consulting, 2000b, p. 13).

component of the growth of Australia's greenhouse gas emissions. Moreover, structural changes in the dairy and beef industries and the growth of farm forestry to replace more marginal grazing in some areas will reduce methane emissions. There are various ways methane can be reduced, including vaccination and changes in diet, with research indicating that substantial reductions could be obtained relatively cheaply. These are not incorporated into the later Allen Consulting report yet, in its earlier report for the Victorian government, Allen Consulting (2000a) described a 'realistic scenario' in which the government subsidises the vaccination of animals as a feasible way of tackling this issue.

These sort of realistic approaches to agricultural emissions would not result in large tax-induced reductions in herd sizes and resultant loss of jobs. Thus most of the regional job losses envisaged in the Allen Consulting report are based on an unrealistic approach to cutting agricultural methane. Yet this key assumption hidden in the report is the basis for most of its conclusions about adverse jobs impact in the regions. Overturning only this one assumption largely demolishes the general conclusions of the report about large job losses in regional Australia.

2.3 Downplaying land clearing

Land clearing accounted for around 21 per cent of Australia's total emissions in the 1990 base year and it has fallen sharply to around 12 per cent since then, from 103 Mt to around 64 Mt in 1998.[12] Australia won a special concession at Kyoto that allows us to take account of emissions from land clearing. The more that emissions from land clearing fall between 1990 and 2008-12, the more fossil and other emissions can increase while Australia still meets its target of 108 per cent.[13]

The Allen Consulting report assumes that in the period 2008-12 emissions from land clearing will total 60 Mt of CO_2 a year, or about the same level in the model base case. In other words, the rapid decline in land clearing since 1990 is assumed to stop for the next decade. This arbitrary assumption is extremely unrealistic for the following reasons:

- emissions from land clearing show a long-term trend downwards due to the changing economics of cattle grazing and the depletion of suitable land, and (despite an upward trend for the last couple of years) this trend is likely to continue;

- there is a growing tide of public opinion against large-scale clearing of land, as the costs of such clearing in terms of land degradation, water salinity and biodiversity loss becomes evident. This view is increasingly held by farmer bodies as well as the general public, and can only intensify;

- all of the major political parties and governments now accept that something must be done to halt large-scale land clearing. The Coalition has committed itself to

[12] They stood at 64 Mt in 1998 using the 1998 methodology, but were measured at 72.3 Mt using the 1999 methodology (NGGIC 2001b, p. A-12). The 1990 number is unaffected.
[13] For a detailed analysis see Hamilton and Vellen (1999).

achieving no net loss of vegetation in the next few years and the Queensland Government has made it clear it wants to reduce land clearing substantially; and

- all political parties and governments have recently moved to accept the need for some form of payment to landholders not to clear.

The assumption made about the extent of land clearing in 2008-12 is extremely important in estimating the economic cost of meeting Kyoto targets because the cost of ending land clearing is likely to be much lower than the cost of reducing fossil emissions. While Allen Consulting assumes that the marginal cost of reducing emissions will be around $34 per tonne of CO_2, some estimates indicate that the cost of ending land clearing (measured by the forgone agricultural output) would be as low as $1-2 a tonne (Ryan 1997). This may take the form of payments to landholders encouraging them not to clear.

In light of the above, it is wholly unrealistic for Allen Consulting to assume that in a period ten years into the future when an Australian Government is struggling to cut overall emissions, it will ignore a huge tranche of very cheap emission cuts, one that it fought so hard at Kyoto to get access to. Indeed, it may well be that businesses seeking the cheapest emission reduction options may introduce their own mechanisms to discourage landclearing, because the alternative would be to buy much more expensive emission permits. The effect of this Allen Consulting assumption is that fossil and other emissions must be cut in the model by 113 Mt by 2012 instead of more like 60-70 Mt, which clearly drives up the estimates costs, especially in regional Australia. In other words, this simple assumption about land clearing greatly increases the economic cost estimated by Allen Consulting.

Moreover, Allen Consulting has elsewhere conceded that its assumption that emissions from land clearing will be 60 Mt in 2008-2012 does not make much sense. In its report to the Victorian government, Allen Consulting (2000a) itself described its own scenario in which land clearing emissions are cut to 20 Mt as more realistic than its other scenarios where such emissions remain at 60 Mt. (This scenario is discussed in section 2.7 below). Why did it adopt such an assumption it had previously acknowledged to be unrealistic in its report for the Minerals Council?

2.4 Misleading assumptions about energy efficiency

Another major inaccuracy in the Allen Consulting modelling also results in a large overestimate of the cost of cutting emissions. The model assumes that there are no energy efficiency opportunities beyond the rate of improvement implemented in the past, so that prices and policy changes cannot induce a greater level of investment in energy efficiency. The model assumes that firms act fully 'rationally' in the sense that they could not do anything differently that would increase profits. This is an article of faith built into the very structure of the model rather than an assessment based on practical observation. Yet several studies based on industry surveys, including one by ABARE itself, show that energy consumption in Australia could be cut by 20-40 per cent *at no net cost* (Wilkenfeld 1996). Given the extent of these savings, if these data were incorporated in the Allen Consulting modelling then the marginal cost of

abatement would be $0 a tonne or less, much lower than the $34 used in the Allen Consulting report (or the $44 estimated in its previous report).[14]

2.5 Absence of induced technological change

One of the most important determinants of the costs of making a transition to a lower-emissions economy will be the effect on technological change of measures to reduce emissions.

The Allen Consulting model results are based on an assumed rate of technological change that is based on recent historical rates of technology uptake (Allen Consulting 2000b, p. 26). The model does not allow for new technological improvements that would be induced by policies designed to reduce greenhouse gas emissions. Yet this is exactly how the market could be expected to respond, and described in the next part of this report.

In fact, there is no explicit representation of the renewable energy and energy efficiency industries in the model. The model results suggest that there would be almost no stimulus given to these industries from the imposition of a large carbon tax with the results showing the 'Electricity Other' sector expanding by only 0.2 per cent extra over a decade or more. We are expected to believe that while output of electricity from brown coal and black coal fall sharply (by 16 per cent and 12 per cent), renewables will expand by only 0.2 per cent over the decade or so from the implementation of the policy (Appendix Table A12, p. 36). This is scarcely credible in light of the fact that the Federal Government's 2 per cent renewables legislation, a very minor measure in comparison to the proposed carbon tax, has sparked a number of substantial investments in renewables.[15] This extraordinarily pessimistic assessment of the way the market would react to a big new greenhouse policy has the effect of driving up the economic costs and job losses from emission cuts.

2.6 Aluminium smelter technology

In the Allen Consulting report, aluminium smelting is one of the industries hardest hit from measures to cut emissions, with output projected to fall by a huge 24 per cent (Appendix Table A12, p. 36). However, as the recent decision by a consortium to invest $3 billion in a new smelter in Gladstone suggests, claims of an investment flight from aluminium are grossly exaggerated.

The model predicts a large fall in aluminium output due to an increase in the costs of electricity. How sensitive is the industry to changes in electricity prices? Decisions about the location of aluminium smelters worth billions of dollars and with life-spans of 30 years or more are highly complex management decisions involving a range of factors including the location of raw materials, political stability, tax systems and government sweeteners, availability and costs of labour, and access to markets, as well as prices of

[14] In this case, and those discussed in the next paragraph, the marginal abatement costs depend on the quantity of abatement available at those prices. The same applies to the figures used in Table 1. See also footnote 16.

[15] For some assessments from the industries affected see Issues 3-5 of *EcoGeneration*, the journal of the Australian EcoGeneration Association – www.ecogeneration.com.au.

energy. To characterise these location decisions as dependent solely on the price of electricity, as the model does, is absurd. Further, it seems obvious that beyond 2012 emissions from developing countries will be progressively incorporated into international agreements, so any advantage from relocation is likely to be short-lived.

Aluminium smelters in Australia already enjoy highly subsidised prices for electricity as a result of bidding wars by state governments[16] and energy prices are so low compared to other producing countries that even large increases in electricity prices would still see Australian smelters face favourable conditions (thus the decision to build a large new smelter at Gladstone).

Moreover, in June 2000 it became publicly known that there had been two major technical breakthroughs, one each by the two large aluminium companies Comalco and Alcoa, relating to electricity use and greenhouse emissions in the smelting process. The breakthrough by Comalco is expected to reduce the amount of electricity for a given amount of aluminium by 30 per cent (*The Australian*, 8 July 2000, p. 48). The Alcoa breakthrough could well reduce emissions per unit by 15 per cent. It was reported that it was likely that both new technologies will spread rapidly in the aluminium smelting industry generally.

The effect of these breakthroughs would be to make the forecasts in the Allen Consulting report of the impact of greenhouse measures on the aluminium industry quite invalid. The industry now faces a radically different future in relation to greenhouse measures, and this further undermines the conclusions in the report on the regional job impact of greenhouse measures.

The Allen Consulting figures for the South West region of Western Australia illustrate the misleading way aluminium is treated. This region is shown to have by far the biggest job losses in WA, a 12 per cent decline. The report suggests that this huge fall would arise from declining output from agriculture and the alumina industry. We have seen above how agriculture is treated in a misleading way.

With respect to job losses in the alumina industry, there is no aluminium smelting in Western Australia. The report itself acknowledges that due to the aggregation of alumina and aluminium in official statistics, the job losses in this region may be exaggerated (Allen Consulting 2000b, p. 25). In fact, 80 per cent of alumina produced in Australia is exported and would therefore be little affected by any decline in production of aluminium in Australia.

Measures by other countries to cut their greenhouse gas emissions are likely to lead to an expansion of employment in the alumina industry, as the lightweight properties of aluminium are expected to lead to increased demand worldwide for fuel-efficient vehicle manufacture. Alumina production is much less energy-dependent than aluminium smelting, and is usually located near to major bauxite deposits. Therefore, the projected job losses in Southwest WA have no basis in fact. Yet the impression remains that greenhouse policies would be severely damaging to the industry.

[16] A fact established by Turton and Hamilton (1999) and confirmed in a forthcoming publication from The Australia Institute.

2.7 The missing Scenario 4

The results of economic models depend entirely on the policy scenarios that the modellers feed into the model. In its report on the regional impacts of meeting the Kyoto targets, Allen Consulting (2000b) fed the following policy scenario into the model:

- The Commonwealth Government imposes a cap-and-trade emission permit system under which all sectors responsible for greenhouse gas emissions must hold permits. These permits are given to polluters free of charge on the basis of their historical emissions (grandfathering).

- It is assumed that these permits are valued at the international price of A$30-$35/tonne of CO_2-e over the commitment period, equivalent to a carbon tax at this level.

- Land clearing emissions are assumed to be the same in the commitment period 2008-12 as at the end of the 1990s, i.e. 60 Mt CO_2-e.

This was the main scenario; a second scenario differed from the first by assuming that the emission permits are sold to polluters rather than issued free based on historical emissions. The conclusions differ little between the scenarios.

On this basis, Allen Consulting concludes that compliance with the Protocol would be 'costly' for Australia, resulting in a fall in GDP 'by 1.9 per cent a year', 'severe production declines' in some industries, over 50,000 jobs lost in non-metropolitan Queensland, and so on.

A different scenario could produce very different results. Indeed, in its earlier report to the Victorian Government, which also used the MMRF-GREEN model, Allen Consulting (2000a) considered four scenarios. The scenario closest to the one used in the regional impact study estimates a carbon price of $42 (compared to $30-$35 given in the world market in the later study). Even though the price of carbon was 30 per cent higher in the earlier study, the estimated economic cost was a fall in GDP of 1 per cent in the commitment period, only half of the 1.9 per cent predicted in the later study. While not explained in the report, the difference seems to be due to the inclusion of external global factors in the later modelling.[17]

More importantly, the earlier study included a scenario, known as Scenario 4, which did not rely on the imposition of a large carbon tax (or equivalent emission permit system) on the economy but developed a 'policy mix' that combined regulatory measures and economic instruments. In particular, it assumed that:

- emissions from land clearing fall from their current level of 60 Mt to around 20 Mt in the commitment period;

[17] This adds further to the belief that more than half of the job losses claimed in the Allen Consulting report are due to factors beyond the influence of Australia and therefore unrelated to Australia's compliance with the Kyoto Protocol.

- in the transport sector, governments implement annual vehicle inspections that help phase out older, more inefficient vehicles;
- petrol taxes rise by 5c to 10c a litre;
- subsidies are provided for tree planting;
- vaccines are applied to ruminant livestock to cut methane emissions by a third;
- subsidies are provided for the installation of insulation in existing dwellings;
- voluntary agreements with industry are strengthened; and
- a cap-and-trade emission permit system is applied to the stationary energy sector (mainly electricity).

Allen Consulting aver that this scenario 'may be more realistic' than the other three (2000a, p. 7). They also point out that Scenario 4 has greater external benefits (such as protecting biodiversity and reducing salinity) than the others, and these enhance its desirability. Every indication is that a package designed to achieve the required cuts would contain the sort of policy mix envisaged in this scenario rather than a single large carbon tax or emission trading system. (After fighting so hard to insert the 'Australia clause' into the Kyoto Protocol, it is hard to see why the Government would not make use of it).

What would be the economic cost of the 'policy mix' scenario? After feeding the details into the model, Allen Consulting conclude that the effect would be to reduce Australia's GDP by around 0.1 per cent in the year 2011-2012 (Allen Consulting 2000a, p. 7). This 0.1 per cent compares with the estimated cost to GDP of 1.9 per cent, 19 times higher, reported in the later report commissioned by the Minerals Council.

This leads the disinterested observer to ask why in its later report did Allen Consulting choose to use a scenario that would generate high costs and big job losses, when it knew from its previous work that there are much cheaper and more realistic options available.

2.8 Revenue recycling

Carbon taxes or auctioned emission permits can raise very large amounts of revenue. A carbon tax at the price of $34 assumed by Allen Consulting in its regional jobs report would raise around $9 billion in annual revenue if applied to all energy. It is well established in the economics literature that the way in which this revenue is returned to the economy can make a very big difference to the overall impact of greenhouse measures on GDP and jobs.

The first point that needs to be made is that this $9 billion will not disappear from the economy. At worst, it would boost consolidated revenue so that government could retire debt more quickly. Alternatively, it could cut taxes, improve services or subsidise other industries. The flow of this revenue through the economy provides benefits to most business sectors that offset the impact of the cost of emission permit costs. This is why

all economic models show that only a small number of sectors of the economy would suffer as a result of emissions trading – generally these are the sectors that mine and sell fossil fuels or are very energy or greenhouse intensive.

Although there is some variation across countries according to economic and tax structures, in general modelling studies show that the best option, measured by GDP and employment growth, is to cut taxes on investment and payrolls. The next best is to cut corporate taxes, and the worst options are to cut income taxes and to make lump-sum transfers to consumers. The Allen Consulting report assumes in its second scenario that the revenue would be returned through a cut in the rate of GST (2000b, p. 17). This is one the worst options for recycling revenue. It is, moreover, one that Allen Consulting concedes would not happen in practice and that 'it is much more likely that the funds would be recycled into reducing taxes on business' and into measures targeted at the most-affected sectors.

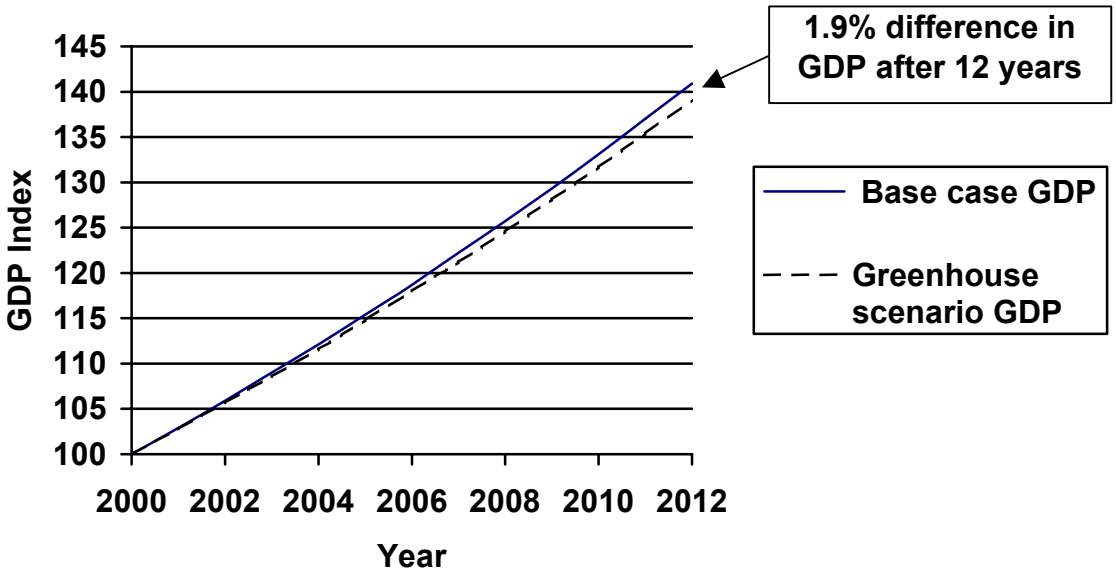
If Allen Consulting had taken its own advice then the job losses predicted by the model would have been much lower. For example, using the ORANI-E model, an earlier version of the MMRF-GREEN model used by Allen Consulting, McDougall and Dixon show that revenue recycling can turn a negative impact into a positive one. They show that while using carbon tax revenue to cut the government budget deficit results in net job *losses* and a *decline* in GDP, using it to reduce payroll tax results in net job *gains* and an *increase* in GDP (McDougall and Dixon 1996). Yet, in its report for the Minerals Council, Allen Consulting chose to assume that the revenue would be used in one of the most economically damaging ways.

2.9 Misunderstanding of modelling results

The MMRF-GREEN modeling results do not show that GDP will be reduced by '1.9 per cent a year' as claimed in the Allen Consulting report. Most people would interpret this expression to mean that growth of GDP will be 1.9 per cent lower than it otherwise would have been so that the cumulative effect is to reduce GDP at the end of the period by around 20 per cent.

In fact, properly understood, the results show that by 2012, the end of the first commitment period, real GDP would be 1.9 per cent lower than it would otherwise be without the effects of the Kyoto Protocol (see Allen Consulting 2000b, Appendix p. 40). As we have seen, the real cost of cutting emissions would be much less than the 1.9 per cent projected by Allen Consulting. But if 1.9 per cent were an accurate estimate of the reduction in real GDP, how sizable would it be? The model assumes a rate of real GDP growth of 2.9 per cent per annum in the base case (Allen Consulting 2000b, p. 28). This means that between 2000 and 2012, real GDP is expected to increase by 41 per cent. The correct interpretation of the model results means that the effect of meeting Kyoto targets would be to cause this to be 1.9 per cent lower, so that real GDP would increase by 39.1 per cent instead of 41 per cent. The significance of this reduction in GDP is shown graphically in Figure 1.

Figure 1 Allen Consulting's projected GDP decline due to 'Kyoto compliance' (GDP = 100 in 2000)



Put another way, real GDP is expected to be 41 per cent higher on 1st January 2012 in the absence of measures to reduce greenhouse gases, but we will have to wait until 1st September 2012 to reach that same level of income if greenhouse measures are adopted. This is a very small impact by any measure. It would be swamped by other decisions by government, such as the timing of an interest rate cut, and is certainly not the 'very costly' measure suggested in the paper.

As we have seen, the Allen Consulting report says that GDP will be reduced by 1.9 per cent by the year 2011-12 and this 'equates to around $140 billion over a ten year period' (2000b, p. 18). In fact, the model results show that the decline in GDP does not kick in until 2006-07 and reaches around 1.9 per cent in the following year, so that GDP is around 1.9 per less than it would otherwise be for only the three years to 2011-12 (Appendix Figure 1, p. 40). Thus the decline in GDP equates not to $140 billion but perhaps a third of that amount (assuming we accept all of the other assumptions and interpretations in the report).

2.10 Summary

Table 1 collects together a range of estimates of the costs of reducing carbon dioxide emissions by one tonne, including a number of energy efficiency methods, planting trees and investing in renewable energy. We could expect renewable energy costs to lie somewhere between the Green Power cost and a negative cost, depending on the actual circumstances, and the extent to which energy market pricing reflects the real costs of conventional energy supply options. Clearly, there are many options available to the Government to induce businesses and households to cut emissions by large amounts at very low or even negative cost, so that the sort of carbon price used in the Allen Consulting report – $34 – is much higher than would actually apply in the real world.

Yet the Allen Consulting carbon price is the one that drives the large reductions in output and employment that have attracted the headlines.

Another set of evidence that is only now emerging supports the cost information indicated in Table 1. The Federal Government has allocated $100 million a year for four years to the Greenhouse Gas Abatement Program. The Program has been designed to fund the marginal costs of large abatements (at least a quarter of a million tonnes per year). Many of the projects funded estimated that they could achieve the specified emission cuts at a cost around $4-6 per tonne or less.[18]

The information contained in Table 1, along with other abatement cost figures reported in previous sections of this paper and elsewhere, are summarized in Table 2, along with estimates of the amount of abatement available at the prices indicated. Allen Consulting maintain that Australia must reduce emissions by 113 Mt per annum in the commitment period 2008-2012 in order to comply with the Kyoto Protocol, and that the marginal cost of doing so is $34 per tonne. This is the basis for their claims about job losses in regional Australia and an overall fall in GDP of 1.9 per cent.

Yet it is clear from Table 2, based as it is on real-world cost data, that the first two tranches of emission cuts, namely making use of energy efficiency opportunities and ending land clearing, would provide 140 Mt of abatement at a cost of less than $2 per tonne. There are at least another 61 Mt available at less than $15 per tonne. In other words, the key assumption driving the Allen Consulting estimates of economic and job losses is grossly inaccurate.

In summary, the Allen Consulting report's estimates of regional job losses and GDP effects cannot be taken seriously.

The forecast job losses in regional Australia, which provided the biggest headlines from the Allen Consulting report, are based on a series of grossly inaccurate assumptions and misinterpretations of the data. Some of the forecast job losses are due to factors outside Australia's control and some are the result of modelling errors. The major faults in the report can be summarized as follows.

[18] Personal communication with experts associated with GGAP.

Table 1 Costs of reducing emissions for a business that normally achieves 15% annual rate of return on investment

Action	Cost/tonne CO_2	Comments
Buy 'credits' from tree plantations	$5-$30	Cost depends on many factors
Buy permits on market	$7-$50	Economic modelling shows a wide range of costs, depending on assumptions in the modelling
Buy Green Power or other zero emission renewable power at 3 c/ kWh premium	$30 to $40/tonne (Aust'n mainland average - $22/t if it replaces Victorian average electricity, which gives a bigger CO_2 saving per kWh)	Use of energy involving capture of methane that would otherwise have been released into the atmosphere may have a lower cost/tonne of CO_2-e avoided, as the benefits of removing very greenhouse-active methane from the atmosphere may be counted
Buy low emission electricity at 1 c/kWh extra cost, eg. hypothetical small-scale cogeneration	$10 to $15	Assumes electricity at 1.0 kg CO_2/kWh replaced by electricity from cogeneration or combined cycle gas at 0.25 to 0.33 kg CO_2/kWh. If low emission energy purchased at same cost as BAU energy, cost/t CO_2 avoided is zero
Buy low emission electricity at 0.5c/kWh less, eg. cogeneration	–$3 to –$5	As for above
Invest in energy efficiency measure with 1 year payback	–$32 (a negative cost)	Assumes 10 year life of measure, 8 c/kWh and 1.0 kg CO_2/kWh for BAU electricity, and 15% pa discount rate to reflect 15% IRR annual rate of return on investment achieved by a successful business
Invest in energy efficiency measure with 5 year payback	–$4.50	Assumes 15 year life, 8 c/kWh and 1.0 kg CO_2/kWh for BAU electricity, and 15% pa discount rate to reflect 15% IRR threshold
Invest in energy efficiency measure with 7 year payback	$6.15	As above

Source: See Appendix for explanation

Table 2 Abatement cost and scale for different activities

	Abatement cost ($/tonne)	Abatement (2009-10)* (Mt)	Sources
Energy efficiency	<0	80	a
Land clearing	<2	60	b
Enteric fermentation	<7	21	c
Cogeneration	-5-15	40+	a,d
Forestry	5-30	~90	e
Renewables	20-40	substantial	f

* relative to baseline used by Allen Consulting

Sources:
a. Wilkenfeld 1996 (cogeneration included elsewhere); Allen Consulting 2000b, p. 32
b. Ryan 1997; Allen Consulting 2000b, p. 28
c. Allen Consulting 2000a, p. 120
d. See Table 1, Wilkenfeld 1996 (abatement estimate includes only that achieved at <$0/tonne)
e. See Table 1; estimate of annual abatement potential based on BTCE (1996, pp. 238-257) calculation of abatement that could be achieved for a marginal social cost of <$3/tonne CO_2.
f. See Table 1 and discussion in Section 3.

1. Job losses in some regions are due not to greenhouse measures in Australia but to decisions by governments overseas, yet the report attributes all job losses to 'Australian compliance' with the Kyoto Protocol. It also attributes to Australian compliance job losses from expected falls in world prices for aluminium and other commodities that are wholly unrelated to greenhouse policy.

2. Some regions predicted to have major job losses turn out to have no special dependence on fossil fuels either for domestic consumption or export. The predicted job losses arise from a sharp decline in agricultural output due to the imposition of a large carbon-equivalent tax on methane emissions (a 'belch tax'), a policy response that is fanciful and unnecessary.

3. The modelling ignores the two largest tranches of emission cuts in Australia that are available at no cost or very low cost, namely, accelerated energy efficiency and the end of land clearing. As a result the model shows much greater falls in GDP and higher job losses, yet pursuing the costless and low-cost options is far more likely.

4. Allen Consulting uses a 'carbon tax' scenario which it knew from its previous work would be much more expensive than a 'policy mix' scenario. The latter would impose minimal costs on the economy and Allen Consulting has conceded that the 'policy mix' scenario is more realistic.

5. The analysis makes no attempt to capture adequately the likely technological response of industry to measures to cut emissions. It has no representation of the

renewable energy and energy efficiency industries. The modelling is structured in a way that can capture only the downside and not the upside for industry of cutting emissions.

In addition, Allen Consulting misinterpret the results of the model, stating that Australian compliance with the Kyoto Protocol would reduce GDP by '1.9 per cent a year'. In fact, the model results show that overall GDP would be 1.9 per cent lower in 2012 than it otherwise would be in the absence of greenhouse policy measures.

Coincidentally, every one of the errors and misinterpretations has the effect of exaggerating the apparent costs to GDP and employment of meeting Australia's greenhouse obligations under the Kyoto Protocol. We wish we could report an error that worked in the opposite direction.

It goes without saying that the Allen Consulting modelling makes no attempt to take into account the costs of *failure* to limit global warming, which include a wide range of impacts such as loss of agricultural productivity, impacts on human health, cost of assisting climate refugees, and widespread environmental damage. It is therefore not possible to make a case against reducing emissions on the basis of the model results.

3. The economic opportunities from greenhouse

The decision facing the Australian Government is not whether we must cut emissions. Cutting emissions is inevitable, and larger cuts, far beyond those required to comply with the Kyoto Protocol, will follow. The Government must decide whether it will implement policies to manage the transition to a low-emissions future, or have the need to cut emissions thrust upon us. Managing the transition will be a challenge, but it is by no means an insuperable one. The structural adjustment issues will be no more severe than those that attended the tariff liberalisations pursued by successive governments in the 1980s and 1990s. Moreover, there is a substantial body of evidence suggesting that, if managed well, the transition to a low-emissions future could be beneficial for Australia economically, with higher growth and more and better jobs. Below we provide an overview of some of this evidence.

3.1 Business support for emission cuts

There is a strong belief within major segments of Australian industry that the Australian Government should ratify the Kyoto Protocol and use the process of cutting emissions to develop new energy industries that can be of great benefit to Australia's future development. Perhaps the best expression of the enlightened business view was put by the Prime Minister's own Science, Engineering and Innovation Council (PMSEIC), in a report completed in 1999. The Council draws together high-powered business interests and eminent scientists. PMSEIC urged the Government to go from a defensive to an attacking position on climate change policy. Noting that Kyoto is a watershed in the global greenhouse debate, it argued that it is a powerful instrument of change ignored at great cost. It drew an analogy with earlier industrial and social movements.

> In each, attitudes changed from defence and denial, to recognition of opportunities, and ultimately to the realisation that what is right for the community in the long term can be good for the growth and profits of industry … Increasingly the world's major corporations accept this transition. …. If we wait for ratification while other countries act, Australia runs the risk of missing out on global opportunities, and may be left behind in terms of greenhouse compliance (PMSEIC 1999 p. 3).

The report went on to observe that 'Kyoto has created a new business environment in which new industries, markets and technologies can flourish' and urged the Howard Government to adopt policies that would see Australia capture at least five per cent of the huge world market for greenhouse mitigation technologies.

A range of major companies and business figures have urged the Federal Government to change course on greenhouse policy for the benefit of the Australian economy. For instance, AGL has declared:

> Australia's national interest could be enhanced by the introduction of measures to reduce greenhouse gas emissions. Not only would such a change improve our international standing, but it would also be in the long-term economic interests of Australia. …. [AGL] Urges the government to ratify the Kyoto Protocol without delay in order to provide both certainty and leadership (AGL 2000).

Reviewing Australia in 1997, the International Energy Agency (IEA) concluded that:

> the results of the industrial energy audits, the absence of general mandatory standards for buildings and domestic appliances and the high level of fuel consumption by passenger cars all indicate that there is a great potential for improvements in energy efficiency (IEA 1997).

It recommended a series of reforms including higher fuel taxes, mandatory energy efficiency codes, stronger fuel efficiency targets for vehicles and improvements in public transport (IEA 1997).

More recently, the OECD has urged the Australian Government to pursue greater energy efficiency through the imposition of a carbon tax or equivalent measure:

> To achieve significant GHG emission reductions, structural adjustment towards a less GHG-intensive economy would be required. In the OECD's view, this would be most efficiently achieved by putting a price on emissions, either through an economy-wide tax or a permit trading scheme … (OECD 2001)

3.2 The sustainable energy industries

The transition to a low-carbon world will see some industries decline and others grow. Those in the traditional energy sectors will face the need to change, while those involved in sustainable energy will see exciting opportunities, driven by growth in activity.

But most Australian business will experience little impact. This is apparent even in the modelling studies. Only a few industries in the modelling studies are identified as losers, yet they are the ones that receive all of the attention. The vast bulk of business would either be unaffected or would benefit from measures to cut emissions. The problem is that the debate has been driven by the few who fear being losers.

Table 3 shows the results of Scenario 4 presented in Allen Consulting's report for the Victorian Government (Allen Consulting, 2000a). Even here the industries adversely affected by greenhouse response are few in number, and comprise only a small part of our economy. The lack of reference to the energy efficiency and renewable energy industries in the table reflects the structural weaknesses of the model.

Table 3 Australian industry winners and losers in a 'policy mix' greenhouse response

	Sector	Impact on activity, 2010
Winners	Electricity from gas	+6%
	Electricity from oil (!)	+2.4%
	Forestry	+1.0%
Neutral (+/- 1%)*	Most of the economy	
Losers	Electricity supply	-1.5%
	Natural gas	-1.5%
	Urban gas distribution	-1.5%
	Agriculture**	-1.8%
	Black coal	-2.5%
	Electricity from brown coal	-7.5%
	Aluminium	-11%
	Brown coal	-12.5%
	Electricity from black coal	-13%

* Note that the Allen Consulting (2000a) report does not actually mention the industries that comprise the rest of the Australian economy apart from those shown as winners and losers, so the author has presumed that they are unaffected (within +/-1%). This is consistent with the findings of other greenhouse modelling projects such as ABARE's 1997 modelling reports.
** This seems likely to reflect unrealistic application of a carbon-equivalent tax on methane emissions, as discussed earlier in this paper.

Regions dependent on the conventional energy supply industry will probably need transitional assistance. The policy challenge is to ensure that the development of sustainable energy industries benefits those regions and to satisfy energy service requirements in ways that create more local employment and keep money circulating in local economies. It should be noted that the expected change in regions such as the Latrobe Valley compared to the enormous change they have experienced through restructuring of the electricity industry. It is an indictment of governments of all persuasions that so little help has been given to the people of the Latrobe Valley and the Hunter Valley over the past 15 years.

Until recently the interest in energy efficiency and reducing greenhouse gas emissions was so slight that there was no recognition by government of a sustainable energy industry as such. However, there is growing recognition of this industry and its potential. The Sustainable Energy Industry Association of Australia (SEIA) covers a wide range of activities in the provision of equipment and services for sustainable (lower greenhouse emission) energy and energy efficiency.

A survey of the industry (SEIA, 2000) has found that it directly employed 22,800 people in 1999-2000. By comparison, in 1999 the whole Australian electricity industry employed 33,000 people, with a steady decline in numbers employed over the past decade (ESAA, 2000). At the time of the survey, the growth rate of the sustainable energy industry was estimated to be 12 per cent a year, a rate achieved with almost no direct government measures to control greenhouse emissions, suggesting that the industry could achieve an extraordinary rate of growth if government created a more sympathetic policy environment.

It is not clear to what extent employment in the industry at present is based in regional Australia. However, the cost of supply of conventional energy to rural and regional areas is much higher than in more densely populated areas, so sustainable energy solutions are more cost effective, and should therefore be adopted more rapidly in rural and regional areas. However, this will require existing market distortions to be addressed, either through removal of urban-rural subsidies.

Moreover, it is clear that when the potential growth of these industries is realised, they offer major jobs growth for regional Australia. An example of government action to promote sustainable energy is the federal governments *Renewable Energy (Electricity) Act*, passed in late 2000. Under this Act, the electricity supply industry is obliged to increase its use of renewable electricity by an additional 9,500 GWh by 2010, an increase that was originally meant to add 2 per cent to a base of about 10 per cent of total electricity supply now (almost all of which is large hydro). Most of the additional energy is likely to be generated in regional Australia, particularly from new wind farms, use of bagasse and forestry wastes and from mini-hydro. This is an early indication of the job potential for regional Australia from climate change action.

However, the 2 per cent policy is a very timid one compared to those being pursued in some other developed countries. The comparable objective in the UK for instance is an additional 10 per cent. The European Union recently adopted a directive requiring member countries to source 22.1 per cent of electricity from renewables by 2010.[19] A target in Australia comparable to the UK's would provide a large boost to regional job opportunities.

Prospects for regional job opportunities are shown in the potential for the growth of cogeneration in Australia, part of the broader sustainable energy picture. Cogeneration is the combined generation and use of heat and power in one operation. Because it uses waste heat from one operation for the other, it achieves energy efficiencies of 75 to 85 per cent compared with 30 to 35 per cent in conventional energy plants. Cogeneration is particularly well suited for regional industries where there are biomass wastes that can be used as fuel for heat and power for an industrial process, with excess electricity being sold to the grid.

The Australian EcoGeneration Association (AEA) represents firms involved in natural gas cogeneration, renewable energy and waste-to-energy industries. In October 2000, the AEA reported that renewable energy and gas-fired cogeneration are powering over $6 billion of new investment in manufacturing and processing industries. Of the 116 committed and proposed projects, 75 per cent are in regional and rural Australia (amounting to investment of between $3 billion and $4 billion) – see Table 4. The main point is that, even in the absence of effective policies, job creation is favouring regional Australia.

[19] www.edie.net.news/Archive/4668.cfm, 14 September 2001

Table 4 Ecogeneration Projects in Australia – Proposed and under construction

	Under construction	Proposed	**Total**
Number of projects	23	93	116
Regional and rural	13	68	81
Urban	10	25	35
Capacity (MW)	584	3300	3884
Regional and rural	507	2326	2833
Urban	77	974	1051

Source: *EcoGeneration*, Magazine of the Australian EcoGeneration Association, October 2000

There is a further crucial point that has so far been missing from the debate. While there is strong concern for regional job losses from measures to cut emissions, the fact that the electricity industry is based on a handful of very large coal-fired power stations means that most regional communities do not obtain any employment in the energy industries. The energy system that will supersede the current one will be less centralised with smaller and more widely distributed generating facilities. We are now seeing the development of renewable and energy cogeneration projects revitalising depressed regional economies. Examples include Ravenshoe in Queensland which has been revitalised by a new wind farm (including 84,000 visitors in its first three months of operation), Tumut in NSW benefiting from the new pulp mill that uses cogeneration, and Albany in WA, which generates 75 per cent of its electricity needs locally from its new wind farm.

3.3 Energy efficiency

Doing more with less is increasingly recognised as a strategy that can combine reduction in energy use with improved competitiveness and productivity. Around the world, numerous studies have shown that this approach offers enormous potential to cost-effectively reduce greenhouse gas emissions. While not everyone would agree with the assessment of 75 per cent savings potential made by US energy expert Amory Lovins (von Weisacker, Lovins and Lovins, 1997), there is no doubt the potential savings are impressive. Table 5 From the IPCC (2001) summarises the potential and indicates likely net costs – which are often negative.

Table 5 Estimates of potential global greenhouse gas emission reductions in 2010 and 2020

Sector	1990 emissions (MTCe/yr) *	Annual growth 1990-95 (% pa)	Potential emission reductions 2010 (MTCe/yr) *	Potential emission reductions 2010 (MTCe/yr) *	Net direct cost (US$/tonne of C avoided**)
Buildings (inc appliances, equipment)	1,650	1.0	700-750	1,000-1,100	Most reductions available at negative costs
Transport	1,080	2.4	100-300	300-700	Most studies estimate net costs below US$25/tC*
Industry – energy efficiency	2,300	0.4	300-500	700-900	More than half available at net negative costs
Industry – materials efficiency			~200	~600	Costs uncertain

*Note that 1 tonne C (carbon) = 3.67 tonnes of CO_2 as the latter includes the mass of oxygen as well as carbon. Thus US$25/tC = A$50/tC = A$13.62/t$CO_2$.
Source: IPCC 2001. Table SPM1

There are many sources of savings through energy efficiency improvement. For example, in buildings, improvements in lighting efficiency of up to 85 per cent have been achieved in Australia (CADDET, 1999). Appliance and office equipment efficiency improvements of 30-60 per cent have been achieved through energy labelling and energy performance standards, with larger savings predicted. Buildings are becoming much more energy efficient through use of insulation, advanced glazing, heat recovery and natural ventilation systems. One proposed Melbourne building, the 60L Green Building, is expected to consume less than 50 kilowatt-hours per square metre per annum, compared with good practice for new buildings at 140 kWh/m^2 and average existing buildings at around 270 kWh/m^2.

In transport, vehicle fuel efficiency improvement has stalled during the 1990s, due to the surge in purchases of large four-wheel drive vehicles. But a range of emerging technologies show potential to cost-effectively cut fuel use and greenhouse gas emissions. CSIRO has worked with Holden and the Axcess II car project to demonstrate that affordable hybrid technologies can deliver fuel savings of 50 per cent or more.[20]

[20] Australian Energy News, September 2001, and earlier issues.

Industrial process efficiency is improving as a result of improved management practices, more efficient equipment and improvements in process design. But progress has slowed over the past decade, partly due to low energy prices in the early phase of energy market reform. Uncertainty over greenhouse policy is also discouraging some industries from action.

Structural change towards less energy intensive sectors such as services and light manufacturing is also contributing to a decline in greenhouse intensity. A recent international comparison (Schipper et al, 2001) suggested that, even after adjusting for structural change, the relative decline in energy intensity of Australia's economy between 1974 and 1995 was less than that of the majority of countries evaluated. Particular opportunities for further savings were identified in passenger cars and light trucks, household appliances, air travel, industrial electricity and process heating. Over this period, Australia averaged a reduction in the ratio of energy use to GDP of around 1 per cent per annum. For comparison, many countries achieved rates of improvement of at least 2.5 per cent per year over the period from 1973-86 (Greenpeace, 1993)

The reality is that energy efficiency improvement offers Australia enormous potential to reduce greenhouse gas emissions cost-effectively. Much of this potential is still to be exploited.

3.4 Natural Gas

Allen Consulting's projections showing that the natural gas industry would be a 'loser' from measures to cut emissions are mystifying (Allen Consulting 2000b, Figure 3.9, p. 27). Natural gas is likely to be the greatest beneficiary over the next decade or two from measures to reduce the growth of Australia's emissions, because it releases lower emissions for a given amount of energy than coal. These emission reductions result from a combination of factors. First, the quantity of greenhouse gases emitted from combustion of gas is around 30 per cent lower, due to its chemistry. Second, gas technologies are often more efficient, so that a higher proportion of the energy released is converted into a useful form. For instance, a highly efficient combined cycle gas fired electricity power station may release around a half of the emissions of a coal-fired plant per unit of electricity supplied. Gas-fired cogeneration (where the waste heat is captured and used productively for industrial processes) can further reduce emissions to around a third of coal-fired generation. Vigorous steps in Australia to take action on climate change would therefore greatly expand the natural gas industry.

The natural gas industry will also benefit from actions in other countries on climate change. It is the view of industry analysts that the Kyoto Protocol and the on-going measures on climate change that are likely to follow it are providing a massive incentive for countries to shift to natural gas and away from coal in power generation. Australia is a major world supplier of natural gas already, and is likely to be an even bigger supplier in the future. Indeed, in 1999-2000, natural gas exports reached $1.95 billion, compared with $3.1 billion for steaming coal (ABARE 2000).

Currently Australia is the main supplier of natural gas to Japan and it is well placed to become the main supplier to China. Commercial natural gas fields are found in or near several regions of Australia the Pilbara region, the Kimberleys, near Alice Springs, the

Cooper-Enogera basin, and in Bass Strait off Gippsland. Greater use of natural gas is therefore likely to provide a powerful spur to higher employment in several regions of Australia where commercial reserves are found. Other regions in Australia will benefit in terms of jobs from greater use of natural gas, because they lie along natural gas pipelines that take gas to large markets. In many cases, this will replace higher emission coal and improve the competitiveness of the businesses that switch. Under the regulatory regime that ensures access to infrastructure such as gas pipelines, these regions are able to benefit from using gas taken from the pipeline as it passes through.

In summary, more vigorous actions within Australia on climate change, and the strengthening of international agreements on climate change, are likely to promote the use of natural gas within Australia and the export of natural gas from Australia. In this way action on climate change by governments will promote employment in all those regions of Australia that are near gas fields and through which gas pipelines run.

3.5 Wind power

Wind power is among the most competitive forms of renewable energy for generating electric power. One of the fastest growing forms of power in the world, in many countries it is now cheaper than fossil fuel sources. In Australia it is not yet competitive with coal-fired electricity, although according to Western Power the cost of electricity from the new Albany wind farm in WA is lower than coal-fired electricity when the benefits of renewable energy certificates are factored in.[21] However, the costs of wind power are falling steadily, as better sites are found, experience with operation increases, and the cost of generating equipment falls with its greater use round the world. The cost of generating electricity from wind power fell from around AUS20 cents/kWh in 1980 to around 7.5 cents in 1990 and has since fallen to around 5.5 cents.[22] A number of studies indicate that the unit price will fall by another 30 per cent by 2010 and a further 25 per cent by 2020.[23]

The Australian Wind Energy Association and Greenpeace have called for a target of 5000 MW of wind power capacity in Australia by 2010, up from the 72 MW at the end of 2001. Achieving this target would generate almost 10,000 new jobs, mostly in regional and rural Australia, involving $10 billion of new investment and generating enough electricity to run at least 2.3 million households (AWEA and Greenpeace 2001).[24] If fossil fuel electricity generators were required to meet the costs of their greenhouse emissions, wind power would be cheaper than coal-fired power in Australia today.

Another consideration, important for regional areas, is that the way that the electricity grid is currently operated means that the costs of transmission losses of electricity supply to more remote areas are not reflected in prices. When this anomaly is corrected,

[21] Personal communication.
[22] Kristian Pedersen, Paper delivered to the REGA Forum, Renewable Energy Generators Australia, Launceston, June 2001.
[23] AWEA and Greenpeace, Windforce 10: A Blueprint to Achieve 10% of the World's Electricity from Wind Power by 2020: The Australian Contribution.
[24] See the summary of the AWEA and Greenpeace report in *EcoGeneration Magazine*, August/September 2001.

as the national electricity market is fine-tuned, wind power generated in a regional location near to its regional market will become even more competitive. Wind farms have been built for remote locations where it already makes commercial sense, by power authorities wanting experience with this type of power, and to cater for the demand from green power customers. The size and number of such schemes is growing steadily, and there has been progress in the mapping of wind potential. Until recently the biggest wind farms in Australia were about 20 MW, but currently a 60MW plant is being built near Lake Bonney in southeast SA, while a 150 MW plant is proposed for the Portland district in Victoria. Provided that suitable sites are available in a region, wind power therefore offers an opportunity for regions to develop their own source of power, and to provide local jobs.

3.6 Some other renewables

There are a number of forms of solar energy. Passive solar energy includes solar hot water heaters and the design of houses and other buildings to have thermal mass for winter heating. Solar thermal power stations concentrate solar radiation with mirrors to heat water for steam to generate electricity. Photovoltaic (PV) cells generate electricity with panels of cells receiving sunlight, which is turned directly into electric current. PV electricity is currently not commercially competitive with coal-fired power in Australia, but the cost is falling steadily and it is likely that in a few years it will begin to be competitive with fossil fuel power in certain niche markets. Power would be provided from roof-top arrays and solar farms comprising an array of panels feeding a grid close to demand, and would be viable in almost any part of Australia.

Australia is a world leader in research on PV energy, with well-known research groups based at the University of NSW and ANU. The solar energy industry around the world (mostly PV) is currently expanding at 25 per cent a year, or a doubling every three years.

Tidal power developments would be located along the coastline of Australia where most of Australia's regional population lives. Tidal power has a history of some successful projects at suitable sites in various countries. Sites depend on a sufficient rise and fall between tides and a sufficient volume of tidal flows to justify the investment in barrages that channel the flows through turbines.

The most favoured site in Australia is near Derby in Western Australia, where tidal flows are very large. The future of this project is uncertain but, if it proceeded, would provide power to a number of towns and mining activities in the Kimberleys, as well as jobs and a local source of power for that region. There do not seem to be other current proposals in Australia for tidal power proposals. Tidal power systems have significant local environmental impacts, and sites must be selected carefully.

Geothermal sources of energy come in two forms, low temperature and high temperature. Low temperature use includes heating or cooling systems for buildings employing water pipes that run deep into the soil beneath them, sometimes supplementing more conventional heating and cooling systems. This form of energy efficiency is more widespread in many parts of the world than in Australia, and offers plenty of scope in regional Australia for energy efficiency gains. Throughout Australia,

there are substantial resources of low-grade geothermal heat that has been used in a variety of ways, such as swimming pool heating and hot water supply for hospitals.

High temperature systems involve pumping water over hot rocks deep under ground to make steam to generate electricity. It has been estimated that this form of power, if it could be tapped efficiently from some estimated reserves of the right type in Australia, could dwarf the present levels of power generated from burning coal in Australia. Major hot rock reserves in Australia have been discovered in the upper Hunter Valley, and in northern South Australia. If these sources of energy were to be exploited, there could be major employment generation in those regions.

3.7 Biofuels for electric power

Biomass from crops or forests can be burnt to generate heat to make steam to drive electric turbines. This is often done nowadays in conjunction with cogeneration, which minimises energy loss by using waste heat from power generation. This is a renewable operation because the regrowth of the crop or forest sequesters carbon from the atmosphere. In essence carbon is being recycled continually, not added permanently to the atmosphere in the form of carbon dioxide, as is the case with fossil fuels.

With its cropping and forest industries, regional Australia is a huge producer of biomass, which could be used for greenhouse-friendly power produced in the regions. The basis of biomass power is that large quantities of waste material are produced at sugar, pulp or other mills, and already need to be burnt or disposed of in some way. As these mills need power and heat already, using these wastes makes obvious sense. While this source of power is currently viable in some cases, what is needed is support based on the greenhouse benefit it provides.

The major form of biomass for electricity generation in Australia currently is the use of bagasse, the waste material left over from the harvesting of sugar cane. In Queensland bagasse already contributes 12 per cent of total energy use in that state, where it is used as a fuel by sugar mills, with excess power being supplied to the electricity grid. There is further scope for use of bagasse, particularly with the installation of more efficient boilers, cogeneration, and burning of all rather than part of the bagasse available. Cogeneration with electricity supply to the grid is already in operation at some sugar mills.

Another cost-effective current use of biomass is forestry waste in pulp and paper mills. An example is the mill being built in Tumut, NSW where waste is burnt to provide cogeneration heat and power, and excess power is sold to the electricity grid. However, there is widespread concern about use of biomass from inappropriate sources, such as native forests, and clear guidelines will be needed to ensure that other environmental factors are adequately considered as this resource is developed. There are also concerns about air pollutants released during combustion, although the use of modern technology can all but eliminate these.

In summary, Australia creates large amounts of biomass from various sources throughout regional Australia. There is huge scope for its greater use to generate electricity, but these opportunities will only be realised if this form of power were put

on a more competitive basis with coal-based power. This would lead to more localised production of power in regions, strengthen local industries and create more employment.

3.8 Ethanol, methanol and biodiesel

Oil provides over 45 per cent of the end-use energy (that is energy at the meter or petrol pump) used in Australia, and four-fifths of this is used for transport. Motor fuels in Australia are almost wholly based on petroleum, a fossil fuel that is responsible for rapid growth of Australia's greenhouse gas emissions. However motor vehicles can run on fuels based on biomass from crops. As such crops are planted again, drawing in carbon dioxide, they do not add over time to greenhouse gas levels. The two main possibilities in Australia are the alcohols ethanol and methanol as replacements for petrol for cars, and biodiesel as a replacement for fossil fuel diesel for trucks. An additional attraction of ethanol, methanol and biodiesel is that they are far cleaner than petrol and diesel in terms of urban air pollutants.

Ethanol is produced by the fermentation of sugars or starch in biomass. A wide range of plants can provide this biomass. The most commonly used crop to date for ethanol production has been sugar cane. Ethanol can be used in undiluted form as a fuel for cars, but the more frequent approach around the world has been to use it as an extender and oxygenator, with 10 or 20 per cent ethanol added to petrol, a process that requires no engine modification. Brazil has had very extensive experience with ethanol produced from its sugar crop as an extender or pure fuel. For some years its motor fleet has run largely run on ethanol. An additional greenhouse benefit of the very large ethanol industry that grew up in Brazil was the additional byproduct of bagasse. This has been used as a renewable biomass fuel in direct combustion, further reducing greenhouse gas emissions. Currently ethanol is used as an extender in several states of the US mid-west.

In Australia ethanol has been produced in recent years in small quantities at the Manildra flourmill near Nowra, NSW, from waste products from the processing of wheat, and at Sarina in Queensland from molasses. The ethanol has been used as an extender in petrol. In April 2001 it was announced that BP, with $8.8 million assistance from the federal government under its Greenhouse Gas Abatement Program, would spend $90 million on modification of its refinery in Brisbane so as to sell 10 per cent ethanol petrol to motorists in SE Queensland. It was expected that the plant would take 5 per cent of the Queensland sugar crop. Extending the use of ethanol would stimulate employment in areas growing suitable biomass and at refineries.

The demand for diesel in Australia is about half of that for petrol. Biodiesel is diesel fuel made from renewable crops such as canola and soybean. Engines do not need modification and performance is as good as with fossil fuel-based diesel. The widespread use of biodiesel in Australia would also be a major job generator in regional areas.

4. Conclusions

The purpose of this paper has been to provide a 'reality check' against the extravagant claims being made about the economic damage that complying with our Kyoto target would cause. The fact that some of these claims have been based on results generated by complex and sophisticated economic models does not diminish the 'bunkum factor'; indeed, it only serves to conceal insupportable claims behind a veneer of analytical respectability, as economic models are especially prone to the GIGO problem, garbage in-garbage out.

Australia was allocated an extremely lenient target at Kyoto, especially when combined with the 'Australia clause' governing emissions from land clearing. The Australian Government celebrated its 'victory' and Labor's environment spokesperson at the time accurately described it as a 'three-inch putt'. The leniency of the target means that it will be easy to meet. In fact the greater danger is that the target is too easy, so that while the rest of the world is making serious efforts to shift economies to low-emission technologies and industry structures, Australia will be left behind. In 1998 the Australian Greenhouse Office warned that Australia's special deal had signaled to industry that it could 'sit back and do nothing'.[25]

It seems likely that Australia's greenhouse gas emissions from all energy sources will be around 25-30 per cent higher than 1990 levels over the Kyoto commitment period of 2008-2012. Australia will still fall within the overall 108 per cent Kyoto target as long as net land clearing is eliminated and emissions from agriculture remain more or less stable. The fossil fuel based industries will therefore grow substantially while Australia meets its Kyoto target. Contrary to the bleak scenario painted by Allen Consulting, there will be no need for reducing output or employment in agriculture. The alumina industry will be stimulated by global efforts to reduce emissions, and there is no reason to believe that the aluminium smelting industry would be seriously disadvantaged. Certainly, recent investment decisions by the aluminium industry do not betray any real concerns on its part. Overall, then, there is no basis for the conclusion by Allen Consulting and others that meeting our Kyoto target would result in significant job losses in the regions.

On the other hand, there will be growing job opportunities for regional and rural Australia from greenhouse gas abatement measures, both over the next few years and especially in the second and subsequent commitment periods under the Kyoto Protocol. Renewable energy sources – including opportunities for wind, solar and biomass energy – are located predominantly in regional areas, as are most of the huge investments in cogeneration. Prior to 2008-2012, the growth of renewable sources of energy will be prompted not so much by the need to meet the target for the first commitment period, but by the desire of businesses and governments to be better prepared for the more demanding targets likely in the second commitment period after 2012.

Overall, regional Australia has very little to lose and much to gain from compliance with the Kyoto Protocol. On the other hand, it has a great deal to lose if climate change goes unchecked. The CSIRO's most recent projections show widespread drying as well

[25] *The Canberra Times*, 24 September 1998.

as warming across the continent, with El Nino conditions becoming normal, leading one to ask why groups such as the National Farmers Federation has been so keen to block greenhouse measures that are essential to protect its constituents from the most severe threats to their future viability.

It is time for Australia to have a considered national debate about how best to meet the problem of climate change and how best to manage the transformation of economic structure that will be necessary to achieve a low-emissions future. In this debate, we must listen more to the voices of the emerging industries that will solve the problem of climate change and less to the voices of the vested interests in the carbon lobby who are responsible for the problem. We should not be misled by scare-mongering from the carbon lobby even when it appears to be based on economic modelling, for when misused even the most sophisticated economic models can be made to lie.

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Appendix Explanation of Table 1

Table 1 is intended to allow businesses to compare the cost of a range of response options on a standardised basis and can be interpreted as the cost of buying emission permits or avoiding emission of a tonne of CO_2. In the case purchasing of permits, paying someone to plant trees, or buying Green Power, the cost is visible as a purchase cost.

For *emission permits*, a variety of studies have provided a range of possible permit prices. For example, AGO (1999) a range of prices per tonne of CO_2 is shown for three scenarios:

- Independent abatement (Australia introduces emissions trading independent of other countries' actions): A$40-87, with an early ABARE study suggesting $191
- Trading among developed countries: A$8-48
- Global trading: A$5-34

These estimated costs are sensitive to assumptions about the scope for low cost emission reduction, the level of reduction targeted within the study (the more aggressive the reduction the higher the cost).

The range of values shown is $10 to $50, which covers a reasonable spectrum of possibilities. Indeed, the above-mentioned AGO paper suggests that:

> It is feasible to assume that permits in the first commitment period [2008-2012] could be valued at between $10 and $50 per tonne of carbon dioxide (in current-valued Australian dollars). Notwithstanding the uncertainties inherent in the projections exercises, a mid-range estimate approaching $30 per tonne would put a value on Australia's first commitment period emissions allocation under the Kyoto Protocol of around $60 billion, or $12 billion per year (AGO 1999).

These comments support use of the prices applied here. See also the range of estimates reported by Turton and Hamilton (1999).

For *tree planting*, costs are fairly uncertain. The Bureau of Transport and Communication Economics has made estimates. The GreenFleet scheme charges $30 per year (tax deductible) to offset 4.5 tonnes of CO_2 emissions from car usage, which is equivalent to around $7/tonne or $5 after the tax deduction. Since this program uses volunteers, it is unlikely that many cheaper options would be found. A study by the Bureau of Transport and Communications Economics (1996) indicated that a marginal social cost of $2-$3 may apply to some plantings. However, the BTCE study seemed to include no costs associated with management and verification and, according to Roger Holloway (pers comm 2001), includes only establishment costs. At the high end, a study of combined fuelwood production and carbon credits in relatively low rainfall regions of Victoria by Holloway (2000) suggests that including the value of carbon credits at A$14 to $27/tonne results in healthy returns on investment. This paper also points out that discounting of the future costs of verification of carbon stored and

maintenance costs tends to understate the cash-flow implications of these ongoing costs. Holloway suggested (pers comm, 2001) that for smaller projects and short rotations costs could significantly exceed $30/tonne. On this basis, a rounded upper limit of $30/tonne of CO_2 was selected to reflect a maximum price farmers may charge for emission credits associated with such a commercial operation

As noted above, *Green Power* tariffs add $30-40/MWh to electricity prices. The upper limit of the cost per tonne is for a situation where the user pays $40/MWh and replaces average national electricity at 1 tonne of CO_2/MWh, giving a cost of $40/tonne of CO_2. The low end cost is where a user pays $30/MWh and replaces Victorian electricity, so for $30 they avoid 1.3 tonnes of CO_2, giving a cost of $30/1.3 – around $22/tonne of CO_2 avoided.

For *cogeneration*, an overall cost/MWh must be calculated for the cogeneration system, and compared with the price for which electricity may be purchased. If one pays 1 cent/kWh extra for cogeneration, that is an extra cost of $10/MWh, for which the emission reduction would be between 1 tonne (relative to Victorian electricity) and 0.7 tonnes (for national average electricity). So the cost per tonne of CO_2 avoided is between $10 and $15. This situation is equivalent to one where a cogeneration plant is not quite economic against grid power.

The second cogeneration scenario reflects a situation where the cost of cogenerated power is estimated to be slightly cheaper than buying from the grid – 0.5 cents/kWh saving is used in the example. This is equivalent to a saving of $5/MWh, which again saves between 1 and 0.7 tonnes of CO_2, depending on which source of electricity is displaced. The cost of CO_2 avoided is therefore -$3 to -$5.

The cost per tonne of CO_2 avoided by *energy efficiency* depends upon the cost-effectiveness of the measure, and the threshold rate of return against which it is compared. In the example, it is assumed that a business typically achieves a rate of return of 15% per annum on its investments. Note that this threshold rate of return should not be the threshold applied to investment decisions (which is often a three year payback or 33% per annum), but should be the actual rate of return achieved on the company's overall assets. In reality, many businesses struggle to return better than 5-10% per annum on capital invested, so using a 15% threshold is quite a stringent comparison.

In this case, the life of the equipment was assumed to be 10 years for the one-year payback measure and 15 years for the five-year payback measure. At a discount rate of 15% pa, the energy savings over a 10-year period are approximately equal to 5 years' nominal energy cost, and over a 15-year period are approximately equal to 6 years' nominal energy cost. That is, when future savings are discounted at 15% pa, the total lifecycle savings over 15 years are equivalent to 6 years' undiscounted savings.

The calculations in the slide were based on an electricity cost of around $80/MWh, a cost appropriate for medium-sized businesses. For large companies, a lower price would be appropriate, and for smaller companies a higher price is relevant.

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