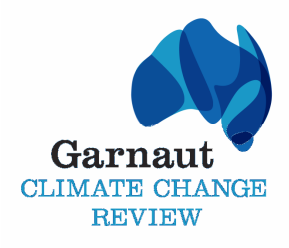
TARGETS AND TRAJECTORIES

SUPPLEMENTARY

DRAFT REPORT

SEPTEMBER 2008

Garnaut
CLIMATE CHANGE
REVIEW



Targets and trajectories

Supplementary Draft Report

Garnaut Climate Change Review

Contents

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The dollar amounts in this report are in 2005 Australian dollars, unless otherwise indicated.

1 SUMMARY OF CONCLUSIONS

The Supplementary Draft Report of the Garnaut Climate Change Review should be read in conjunction with the Draft Report released on 4 July 2008.

Is it possible to secure effective international action to reduce the risks of dangerous climate change to acceptable levels, presuming that Australia would play its proportionate part in the global effort? If so, what targets and trajectories for emissions reduction would produce the best possible outcome for Australia, and what would be an appropriate Australian contribution to the global effort? What should we do in the interim if it takes time to secure effective international action?

On the Review's analysis, the impact of unmitigated climate change on Australia would be severe. The Draft Report (Chapter 2) identified four categories of costs of climate change and benefits of mitigation. Joint modelling with the Treasury and the Review's own modelling quantify market-related benefits and costs based on 'middle of the road' impacts. Other costs of climate change and benefits of mitigation are discussed qualitatively.

Policy in the Kyoto period

In the remainder of the Kyoto period, ending 2012, Australia should ensure that it meets its Kyoto targets. It should have no great difficulty in doing so—and any adverse surprise over the next few years is unlikely to be so large that it cannot comfortably be met by the purchase of international permits. There are several good reasons why it is desirable for an Australian emissions trading scheme to commence in 2010.

The remainder of the Kyoto period is best considered as a transition period, in which the emissions trading scheme is established soundly for the larger task that will lie ahead of it after 2012. Australia's aim should be to work within the international community to secure a global agreement around a firm emissions stabilisation goal. It should be prepared to play its full, proportionate part in achieving that goal. Pending the completion of the international discussions on post-Kyoto arrangements, it is better not to focus on a single trajectory, but to have in mind a set of possibilities, the choice among which will be determined in an international context.

This approach has some implications for management of the emissions trading scheme in its early years.

Over the transition period, permits should be sold by the independent regulatory authority at $20 per tonne in 2010, rising each year by 4 per cent plus the percentage increase of the consumer price index. This is more or less the price path that the modelling suggests would be followed if there were effective global agreement directed towards stabilisation of global greenhouse gas concentrations at 550 ppm. If a post-Kyoto agreement were struck around 550 ppm, the fixed price is likely to allow relatively seamless transition to a floating price regime.

This is the fixed-price form of the emissions trading scheme that the Draft Report described as a 'legitimate second-best' during the transitional period to the end of 2012 (p. 392). With the price set consistently with what the modelling suggests will emerge from the recommended initial trajectory for the emissions trading scheme, I now think that it is the first best starting place for the transitional period. In addition to avoiding unproductive interaction between the early period of a new trading system and Australia's participation in crucial global negotiations, it will provide a less anxious environment for implementing the globally efficient approach to assistance to trade-exposed industries that is discussed later in this paper.

Beyond Kyoto

The Review has considered two cooperative global mitigation scenarios (introduced in Chapter 5 of the Draft Report). The two scenarios represent cooperative solutions in which the countries of the world agree to share the burden and to work towards stabilising greenhouse gases at a particular level. Under the '550' scenario, the world stabilises the concentration of greenhouse gases in the atmosphere at 550 parts per million CO_2-e. Under the more stringent '450' scenario, the concentration of greenhouse gases in the atmosphere initially overshoots but then returns to 450 parts per million CO_2-e. Given the current level of greenhouse gas emissions and atmospheric concentrations, temporary overshooting is unavoidable.

Australia's target, as explained in Section 5 of this report, should be to reduce emissions net of international trading by 10 per cent from 2000 levels by 2020 (30 per cent per capita), and 80 per cent by 2050 (90 per cent per capita). This is a reduction of 17 per cent (27 per cent per capita) from the levels that are expected in 2012, at the end of the Kyoto period. A binding international commitment to the 2020 outcome would be made within the context of, and conditional on, an effective global agreement that is designed to stabilise global concentrations of greenhouse gases at 550 ppm by mid-century. The Australian permit price would be set by the market without constraint, but with a wide range of opportunities for international trade in permits.

The trajectory for the emissions trading scheme should be consistent with the achievement of the emissions reduction trajectory. Permits would no longer be sold by the authority at a fixed price. The modelling and analysis suggest that the price would settle at about $23 in 2013, and rise at an annual rate of 4 per cent plus the increase in the general price level. If this were the outcome, there would be a smooth transition from the fixed permit prices of the transition period, to the floating price.

Some Australians advocate the postponement of any substantial effort until international agreement is reached, because they want Australia to do as little mitigation as possible. I am linking the central recommendation on targets and trajectories to comprehensive global agreement because international agreement is urgent and essential; because agreement is possible if Australia and some other countries attach enough importance to it; because it is the only way to remove completely the dreadful political economy risks, to Australia and to the global trading system, of payments to trade-exposed, emissions-intensive industries; and because the lower Australian mitigation costs with which it is associated allow us to be more ambitious about the reduction in emissions.

There are large risks to the Australian economy, and to Australian values manifested outside market processes, if the concentrations of carbon dioxide equivalent in the atmosphere reach 550 ppm and remain there. The analysis suggests that a global objective of 450 ppm, with discussion of transition to 400 ppm once the 450 ppm goal is being approached with confidence, would better suit Australian interests. However, the Review has reluctantly concluded that international agreement on a global goal of 450 ppm is not possible at this time. While the Review's modelling of the time path to a 450 ppm objective, with overshooting, is closely consistent with the G8 goal of 50 per cent reduction of global emissions by 2050, the awful arithmetic of developing country emissions in the Platinum Age (see Draft Report Chapter 4) makes it unlikely that this goal can be agreed in current circumstances. Achieving the objective of 450ppm would require tighter constraints on emissions than now seem feasible in the period to 2020.

If international developments change the conditions that led to this judgment, Australia should encourage acceptance of more ambitious global objectives. In any case, Australia should now indicate its willingness to play its proportionate part in future, and if possible early, movement towards a more ambitious global goal than 550 ppm. As such, the details of the targets and trajectories that the Review is recommending will not be the best for all time. They are the best available to us now.

The strengthening of the global, including Australian, effort in scientific, technological and economic research will make it productive to keep the possibility of higher ambitions under continuing review. The advance of knowledge from research, progress towards the initial goals, and advances in development and commercialisation of low-emissions technologies, would give confidence in stricter mitigation objectives within the global community. Within a global agreement to pursue 450 ppm, Australia would need to reduce its emissions rights to about 90 per cent below current levels by mid-century.

The ultimate achievement of 400 ppm would depend on commercialisation of technologies that can remove carbon dioxide from the atmosphere. This is a technical possibility at this time, notably through a range of biosequestration options. Such options may become commercially realistic through a combination of high carbon prices and support for research, development and commercialisation of low-emissions technologies.

Australian settings in an ad hoc policy world

In the absence of comprehensive agreement on global greenhouse gas emissions reductions (the ad hoc world), Australia, as one of the developed countries, should commit to reducing emissions from 2000 levels by 5 per cent (25 per cent per capita) by 2020. This is consistent with a linear path from expected emissions levels in 2012 towards the Commonwealth Government's policy of reducing emissions by 60 per cent by 2050. This would be an unhappy conclusion of discussions over post-Kyoto arrangements. Opportunities to hold risks of dangerous climate change to acceptable levels diminish rapidly after 2013 if no major developing economies are accepting constraints to hold emissions significantly below business as usual by that time.

Irrespective of outcome, it will be important for Australia to put in place, from 2010, the architecture that will deliver emissions reductions at the lowest possible cost to the domestic economy. Great care must be taken now as consideration is given to the design of a domestic emissions trading scheme. This is the necessary centrepiece in Australia's effort to reduce emissions.

The Review's Emissions Trading Discussion Paper (March 2008) and the Draft Report (Chapter 15) outlined proposals for the design of an efficient trading scheme. The recent public debate has focused attention again on the need for a highly principled approach. This is no more evident than when designing the appropriate assistance arrangements for trade-exposed, emissions-intensive industries in a world of ad hoc mitigation policy. It would be a significant failure of public policy if such assistance arrangements simply sought to compensate businesses for the effect of an Australian emissions trading scheme rather than the failure of our trading competitors to implement comparable policies.

In the unlikely event of complete failure of agreement at Copenhagen, and in the absence of any immediate subsequent agreement, and therefore in the absence of clear rules and opportunities for international trade in permits, Australia should maintain an emissions trading scheme, but continue with the fixed price of the transitional period, until international agreement or 2020. In these circumstances, the price of emissions permits should continue to be raised by 4 per cent plus the percentage increase in the Australian consumer price index each year. Continuing an emissions trading scheme would help to keep hopes alive of an international agreement, at reasonable cost, until all opportunities for progress had been exhausted. Current commitments by the governments of developed countries attach low probability to this outcome.

The success of Australia's mitigation efforts will depend crucially on the competitive sale of permits, and the effective use of the substantial revenues along the lines set out in the Draft Report (see Chapter 15).

The proposed targets for Australia have been selected because they involve comparable abatement effort to other developed and developing countries, calculated within an internally consistent framework compatible with global agreement around specified emissions concentrations objectives. The numbers expressed in absolute terms turn out to look less onerous for Australia in the early years, because they are based on per capita allocations of emissions rights. Australia's population, because of this country's longstanding and large immigration program, has been and will be growing much faster than populations in other developed countries.

Australians can think of many reasons why their situation is different from that of other developed countries, and why their emissions reduction targets should be less demanding. So can people from every other country. There will be no progress towards an effective international agreement if each country lays out all of the special reasons why it is different from others, and why it should be given softer targets. When climate change negotiators from any country list reasons why their country has special reasons to be treated differently, and take them seriously, we should be quick to recognise that the negotiators, and the countries they represent, intentionally or not, are inhibiting effective international agreement.

The focus on per capita allocations is legitimate. Indeed, it provides the only possible basis for an international agreement that includes developing countries, many of which have insisted on convergence over time to equal per capita entitlements. The Review's approach to allocation of emissions rights requires somewhat higher per capita reductions in Australia than in many other developed countries.

If there is to be an effective global agreement, it is not open to Australians, any more than to people from any other countries, to pick and choose among principles according to what suits them best in a particular and narrow context. The corollary of the focus on per capita allocation of emissions rights for interim targets is acceptance of long-term global allocation rules built around eventual convergence across countries in per capita entitlements. This is the source of the required 80 per cent reduction in Australian emissions by 2050. Such an approach, with these consequences, is in Australia's national interest. It is in Australia's national interest because the costs of accepting the approach are manageable, and because it provides the best chance of reaching an international agreement that reduces the risks of dangerous climate change to acceptable levels. Within an effective global agreement, actual emissions can exceed allocated permits alongside purchase of permits for countries with surplus. Countries with comparative advantage in emissions-intensive industries in the world of competitive pricing will have incentives to do so.

2 A FATEFUL CHOICE

There are moments in the history of humanity when fateful choices are made. The decision over the next few years on whether to take strong action to mitigate human-induced climate change is one such moment.

When societies receive a large shock to their established patterns of life, the outcome is unpredictable, and problematic. Things fall apart. The financial shocks that hit colonial Australia in the 1890s, the industrial world in the 1930s, and Indonesia in the late 1990s, were in themselves of substantial but manageable dimensions. But they were large enough to exceed some threshold of society's capacity to cope with change. In each case, what might have been a recession of significant but non-historic magnitude became a great depression. Total output fell by a fifth and more. The associated social convulsions fundamentally and permanently changed political institutions, and shifted the whole trajectory of economic growth.

The Center for Strategic and International Studies (CSIS) in Washington has recently published a study (2007) on the impact of climate change, based on several scenarios. One of these involves 'catastrophic climate change', based on an assumed 5.6 degree temperature increase over the course of the 21st century. This is similar to the central scenario developed by the Review, based on the 'business as usual' or 'no mitigation' case set out in Chapter 5 of the Draft Report. The CSIS paper found that this extent of climate change 'would pose almost inconceivable challenges as human society struggled to adapt'. It went on to note that: 'The collapse and chaos associated with extreme climate change futures would destabilize virtually every aspect of modern life' (Campbell et al. 2007, pp. 7, 9).[1]

The devastation wrought by a temperature increase of 5 or 6 degrees would be global in nature, but Australia and some of its developing country neighbours are among the most vulnerable (Draft Report Chapter 7).

One main theme of the Review is that the accelerated growth of the developing world, the Platinum Age, has not been factored into expectations of emissions, concentrations or temperatures (Draft Report Chapter 4). This growth, centred on but now extending well beyond China, is unprecedented, and likely to be sustained over a considerable period.

During the extensive discussion of the Review's Draft Report in July 2008, some critics claimed that some of the descriptions of impacts were 'alarmist'. I responded that I was simply telling the story as it fell out of the analysis, when the emissions growth from the Review's own work was applied to 'centre of the road' judgments on the relationship between concentrations of greenhouse gases and temperature derived from the mainstream science.

The Fourth Assessment Report of the IPCC presented a range of best-estimate temperature increases for this century from 1.8 to 4 degrees (or from pre-industrial levels, 2.3 to 4.5 degrees). The Review has generally accepted the scientific judgments of the IPCC, 'on a balance of probabilities', as a reasonable source of scientific knowledge on climate change. But the economic analysis of the IPCC rests on work from the 1990s, which the Review has shown to have been overtaken by events. The Draft Report has established that the IPCC's SRES scenarios, on which the IPCC's projections of climate change impacts are based, systematically underestimate the current and projected growth of emissions. Far from being 'alarmist', it is simply realistic to accept the conclusion from analysis, that if

[1] The report was prepared by, among others, former CIA Director James Woolsey, former Chief of Staff of the President John Podesta, former National Security Advisor to the Vice President Leon Fuerth, Pew Center Senior Scientist Jay Gulledge, and former Deputy Assistant Secretary of Defence for Asia and the Pacific Kurt Campbell.

the mainstream science is roughly right, then 1.8 to 4 degrees can no longer be accepted as the central range for temperature increases in the 21st century under business as usual.

The Review has had to answer a series of questions to arrive at the answers presented in the above summary of conclusions. This Supplementary Draft Report will take the reader through the analysis that led to the answers.

Is it possible to secure effective international action to reduce the risks of dangerous climate change to acceptable levels, presuming that Australia would play its proportionate part in the global effort? If so, what degree of mitigation would be in Australia's interests, and what would be an appropriate Australian contribution to the global effort? What should we do in the interim if it takes time to secure effective international action?

To answer these questions, we must look over the whole canvas of the Review's work: the analysis of the scientific impacts (Chapters 3, 5, 6 and 7 of the Draft Report); the projection of business-as-usual growth in emissions in the world and in Australia (Chapters 4 and 8); the assessment of Australia's share of a global mitigation responsibility (Chapters 11 to 13); and measuring the immeasurable, the framework for bringing together the various costs and benefits of mitigation (Chapter 2). The Review's suggestions for targets and trajectories also bring into account the quantitative work on costs and benefits of mitigation since the release of the Draft Report, which will be described in detail at the time of the Final Report.

The task of reducing the risks of dangerous climate change to acceptable levels is immense, and complex. It requires participation from all major economies. The process of international cooperation, escaping the prisoner's dilemma described in the Draft Report, is perhaps the most formidable of international relations challenges; more formidable than the multilateral trade negotiations which have recently collapsed. The development of domestic policies consistent with ultimate international agreement is immensely difficult in every country.

There is a chance, just a chance that humanity will act in time and in ways that reduce the risks of climate change to acceptable levels.

Since the release of the Review's Draft Report two months ago, and the Government's Green Paper on a Carbon Pollution Reduction Scheme in mid-July, there has been immense Australian public interest in and discussion of the global warming problem, and the possible contribution that Australia could and should make to the solution. From the general community, the demand for information and the search for understanding exceeds that associated with any public policy issue of my professional lifetime. The opinion polls reveal that an extraordinary proportion of the Australian community support an emissions trading scheme (61%), even at personal cost to respondents (56%),[2] and even if Australia is acting independently of the international community (60%).[3]

This interest and commitment from the general community seen in Australia is present in various forms in many countries. That is the saving grace, as governments seek to take action on this diabolical problem. The saving grace means that what might seem to be impossible from experience in other areas of international cooperation (such as international trade or arms control), has a chance. It is worth nurturing that chance.

The public support for government policy action on climate change is greater than and fundamentally different from that associated with other major changes affecting the structure of the economy that governments have sought to implement in recent decades.

[2] Survey conducted by Newspoll and *The Australian*, 27–29 June 2008.

[3] Survey conducted by Newspoll and *The Australian*, 25–27 July 2008.

Alongside the general public policy focus, there has been a contentious discussion of the effects of the emissions trading scheme on particular interests. This was predicted in the Draft Report. This experience underlines the importance of transparent rules, based on clear principles, for all parameters of the emissions trading scheme. It underlines the importance of minimising the discretion of administering authorities in the implementation of an emissions trading scheme. It underlines the importance of government setting clear policies, and delegating administration of the scheme to an independent institution, as argued in Chapter 15 of the Draft Report.

The independent recommendations on targets and trajectories presented in this Supplementary Draft Report respond to insights derived from a broad spectrum of the public discourse and are informed by modelling conducted jointly with the Australian Treasury.

3 SOLVING A DIABOLICAL PROBLEM IN STAGES

The diabolical problem of climate change has many elements. Two seem to make it intractable: uncertainties about the science of climate change and the costs of mitigation; and the prisoner's dilemma constraining international collective action.

Uncertainty about the benefits (in this case, the benefits of avoided climate change) and the costs of major structural changes in the economy constrain change and reform in many areas of policy. The uncertainties are particularly wide with climate change. They are compounded by the long time periods over which both the costs and benefits are expected to work their ways through the economy and society.

The prisoner's dilemma of international collective action on climate change is daunting. It was discussed in the Interim Report in February and the Draft Report in early July.

Uncertainties about the science of climate change and the cost of mitigation can be reduced by research, which requires time, and by new observations made available by the passing of time. The resolution of the prisoner's dilemma requires close communication between sovereign parties, to allow disparate perspectives to be reconciled, and confidence in collective action to be developed.

Time is an essential element in any resolution of the policy problem.

But the science, and the realities of emissions growth in the absence of mitigation, shows that there is not enough time. The world is rapidly approaching points at which high risks of dangerous climate change are no longer avoidable. Chapter 1 of the Draft Report noted that we would delude ourselves if we thought that scientific uncertainties were cause for delay. Such an approach would eliminate attractive lower-cost options, and diminish the chance of avoiding dangerous climate change.

In such circumstances, the only way through the constraints is to make a start on domestic and international action, along paths that may now be feasible, but which in themselves do not lead quickly to ideal outcomes. Early action, even if incomplete and inadequate, on a large enough scale, can buy time, and begin building the foundations for effective collective action.

But any old action will not help. To buy time and to help build the foundations for effective collective action it has to be well conceived in domestic and international terms. Actions that have high costs for minimal effect are likely to inhibit rather than build domestic support for effective mitigation. In the international sphere, policy initiatives which create tensions between countries over perceptions of equity, or which set in train protectionist actions and responses, will corrode rather than build confidence in collective action.

For these reasons, the best response may not involve immediate movement to an agreement designed to solve the global warming problem once and for all. Progress will be made by designing an interim objective large enough to keep open the better options for avoiding high risks, which is designed well to achieve its limited goals at low cost, which builds confidence that international cooperation is possible in this difficult area, and which encourages and allows time for the accumulation of the knowledge to reduce uncertainty about the science and about the costs of mitigation.

This is the context in which the Review has framed its recommendations on targets and trajectories. The details of the targets and trajectories that the Review is recommending will not be the best for all time. They are the best that are available to us now. In the context of well-designed domestic policies on emissions reduction, encompassing correction of market failures in response to prices being placed on emissions as well as to the emissions prices themselves, and carefully conceived international policies, they will lay the foundations for effective additional steps. Those steps will become easier to take as confidence grows in the knowledge base for strong policy action and in the feasibility of effective international action.

The first step, built around immediately moving onto a path of global emissions designed to stabilise concentrations of greenhouse gases at no higher than at 550 ppm, is large and far-reaching enough to keep open the possibility of avoiding high risks of dangerous climate change.

4 MITIGATION IN A COMPREHENSIVE GLOBAL AGREEMENT AND AN AD HOC WORLD

The reduction of emissions separately by individual countries has been a way of getting global mitigation started. Developments in the European countries, North American and Australian states and provinces, and in Japan, New Zealand and China have helped to establish momentum in global mitigation. We have a stronger base for moving towards effective global action than we would have had if every country and state had waited for a comprehensive global agreement. Indeed, the early actions have made it possible now to contemplate an effective global agreement. Pending international agreement, it will be helpful for individual countries to move forward unilaterally, so long as this is within policy frameworks that are designed to integrate productively with an emerging international agreement.

Nevertheless, mitigation within an ad hoc world is deeply problematic.

The Draft Report observed, in several contexts, that any Australian mitigation effort prior to comprehensive global agreement should be short, transitional, and directed at achievement of global agreement (Chapter 14). Unilateral mitigation within an ad hoc world is much more expensive for a given degree of emissions reduction. It allows only limited international trade in emissions entitlements, and therefore does not allow mitigation to be undertaken in the parts of the world at which it can be achieved at lowest cost.

Differences in carbon pricing across countries distort the location of production and investment in trade-exposed, emissions-intensive industries. This generates dreadful political economy problems in countries seeking to undertake mitigation, as companies seek shielding and preferment in relation to the carbon price. The domestic political economy pressures flow into the international sphere, and create risks of new kinds of trade protectionism.

Once there is a comprehensive international agreement, many aspects of mitigation change for the better. Trade in permits between different countries that have accepted emissions targets becomes possible: countries which are able to reduce emissions below agreed trajectories are able to sell

surplus permits to countries which are above their trajectories. This tends to equalise permit prices across countries, removing distortions associated with the trade-exposed industries. Countries in which mitigation costs are high buy permits from countries in which mitigation costs are low. This increases economic welfare in the buying and selling countries alike.

Countries with comparative advantage in emissions-intensive industries are able to buy permits to allow the expansion of those industries. This will be profitable for them, so long as they still have comparative advantage after taking the carbon externalities into account. This could be especially important for Australia. With comprehensive carbon pricing, the international prices of emissions-intensive goods and services would rise. Countries with comparative advantage in an emissions-intensive industry, after taking the costs of carbon into account, and firms with competitive advantage after taking the costs of carbon into account, would remain in and expand production, and buy permits on the international market to cover any domestic shortfall. The cost of the permits would be covered, more or less depending on the range of relevant elasticities, by the increase in the international price of the final product. Countries with comparative advantage in emissions-intensive goods and services would become net importers of permits, and their domestic emissions would exceed their allocations.

Emissions-intensive export industries in which the emissions intensity of production is lower in Australia than in its main competitors in international markets may expand exports and production under comprehensive agreements. The products of the sheep and cattle industries may be examples, where Australian producers are spared the emissions costs of heated barns and grain feeding in winter.

On the other hand, in any trade-exposed industry in which production is naturally more emissions-intensive in Australia than in major competing countries, output and exports will tend to contract under arrangements that generate comparable carbon pricing across countries. Aluminium might be an example, where the competitiveness of Australian production from coal-based electricity tends to decline over time, relative to production from hydro-electric power and natural gas in the rest of the world.

This would involve economically and environmentally efficient contraction of Australian production. Any attempt to slow its natural progress would increase the cost of Australian emissions reduction. More likely, and likely in current circumstances of high commodity prices, if Australia no longer had comparative advantage in an industry after all producers in the world faced comparable carbon prices, production would continue from established facilities at diminished levels of profitability, and new investment would shift towards places with carbon-inclusive comparative advantage.

In the case of sheep and cattle products, the expansion of production would lead to higher levels of emissions, and the purchase of permits from abroad. In the case of coal-based aluminium processing, all other things equal, there may be some tendency for production to fall, Australian emissions to fall, and Australia to sell permits.

I should add one qualification to the hypothetical aluminium story. In the Platinum Age, with rapidly increasing demand for metals, especially from China, there may be limits to the availability of industrial sites with access to low-cost, low-emissions energy supplies. Even at high carbon prices, some coal-based aluminium smelting may be necessary to meet global demand. In this case, the aluminium price would need to be high enough to keep production going, and perhaps expanding, at the world's lowest-cost locations for coal-based smelting.

None of this happens smoothly in an ad hoc world. There is a risk of 'carbon leakage', from countries with strong to countries with weak mitigation regimes. The risk is banished in a world of comprehensive agreement, even if the degree of restraint on emissions is much more severe on some countries (developed) than others (developing). Trade in permits will establish comparable carbon pricing, even if some countries face more demanding emissions reduction trajectories than

others. When an emissions-intensive industry comes under competitive threat, it cannot easily be established whether this involves economically and environmentally efficient restructuring, or carbon leakage.

All countries have powerful interests in moving quickly into a world of comprehensive carbon constraints, even one in which the commitments to emissions reductions are much tighter on themselves than on some other countries. For example, as shown in the modelling results (see Section 9), the cost to Australia of reducing emissions by 5 per cent from 2000 levels in 2020 in an ad hoc world is similar to that of reducing emissions by 10 per cent by 2020 in a world of comprehensive agreement (along the way to an 80 per cent reduction by 2050).

There is one other complication in comparing costs and benefits for Australia of mitigation in an ad hoc world and under comprehensive agreements. Global mitigation will shift demand away from fossil energy sources unless and until there is commercially successful geosequestration. Australian export volumes and export prices, and therefore output and incomes, will fall with international mitigation. Countries which import fossil fuels, like the United States, face an opposite and happier prospect. For them, import volumes and prices fall and output and incomes rise as a result of global mitigation. This is a significant factor in raising the cost of mitigation to Australia under a comprehensive agreement relative to the ad hoc world. Australia's status as the world's largest exporter of the world's most emissions-intensive major energy source makes it especially vulnerable to international mitigation agreements to which it is not a party. The strongest practical conclusion to be drawn from this line of analysis is that the future of the Australian coal industry depends critically on the success of carbon capture and storage not only in Australia, but in the rest of the world, and especially in Australia's major coal markets in Asia.

Box 4.1 The role for coal

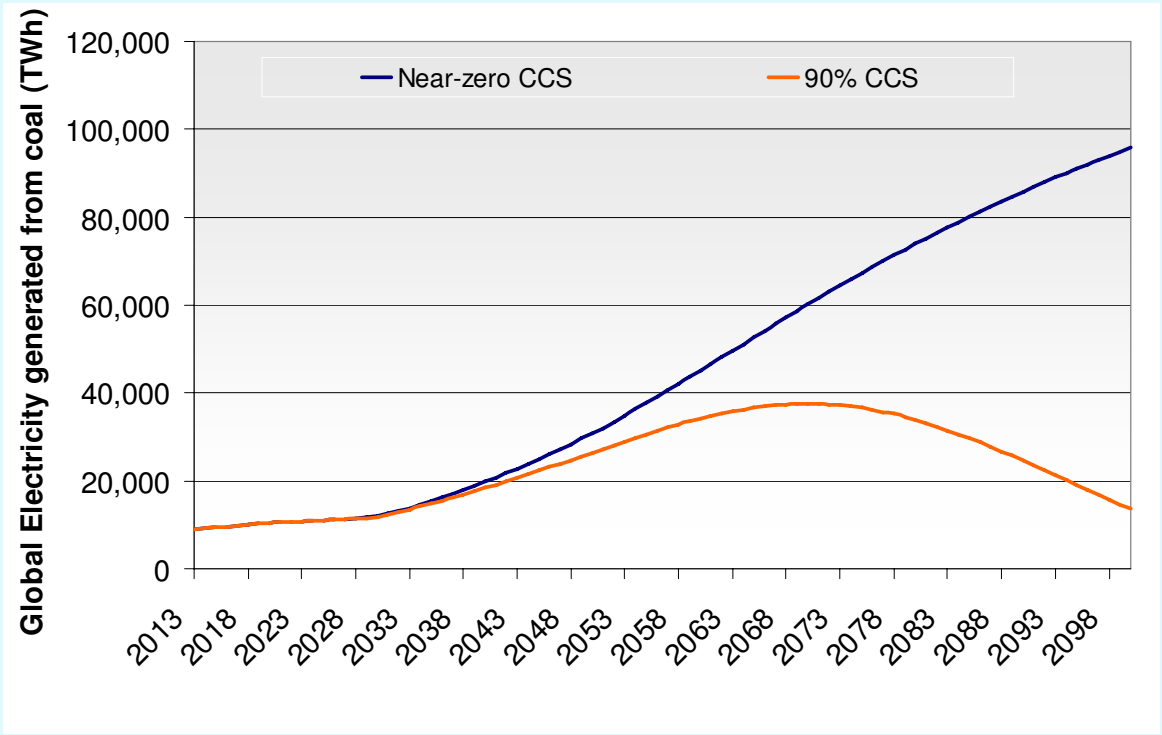
The Australian coal industry plays a key role in generating income for Australians, making up almost 13 per cent of the total value of exports in 2005–06. Since the majority of coal produced within Australia is exported (almost 90 per cent in 2005–06), its future will depend on the mitigation decisions made at a global level and the success, or otherwise, of carbon capture and storage (CCS) technologies.

Under the 550 ppm and 450 ppm global mitigation scenarios modelled by the Review, the demand for Australia's coal largely depends on the ability of coal generation to capture a share of an expanding electricity market in a rapidly growing world. The modelling assumes that CCS technologies from 2020 onwards are able to capture 90 per cent of coal-fired electricity generators' emissions. While this assumption causes global demand for coal to remain relatively high, global mitigation causes the rate of growth to moderate, such that Australian coal exports fall by around 25 per cent by 2050 and 20 per cent by 2100, relative to the base case.

As the carbon price rises to high levels, zero-emissions electricity generation becomes increasingly competitive against coal generation, even where 90 per cent of CCS is assumed. It is likely that the development of zero-emissions technologies would increase demand for coal-fired energy generation and hence maintain global demand for coal. Global modelling undertaken by the Review shows that the introduction of a near-zero-leakage CCS technology (with leakage reduced from 10% to 0.1%) would significantly increase the demand for coal-fired electricity generation and hence increase demand for Australian coal, relative to a scenario with only 90 per cent CCS. The chart below shows the impact of zero-leakage CCS relative to 90 per cent CCS.

Australian coal production moves in proportion with the global demand for Australia's coal exports. A future scenario in which Australia stands aside from a strong global mitigation effort is much more likely to damage than to assist the circumstances of the Australian coal industry.

Figure 4.1



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5 WHAT WOULD A COMPREHENSIVE GLOBAL AGREEMENT LOOK LIKE?

The recommended Australian commitment to reduce emissions, net of trading in permits, by 10 per cent at 2020 compared to 2000 levels (30 per cent in per capita terms) would apply in the context of an effective global agreement. Effectiveness requires that all major economies take on commitments that give incentives for comprehensive domestic mitigation policies (Chapters 11 and 12 of the Draft Report). The most likely form of commitment is a quantitative national emissions target. Countries could sell permits if their emissions were below their agreed targets.

While an effective international agreement would require all countries to accept trajectories for emissions over time, each country could choose the policies through which it achieved this outcome. Some may choose an emissions trading scheme, some a carbon tax, and some a set of regulatory interventions. Whatever the method of implementing its emissions-constraining policies, each country would be able to sell any surplus of emissions entitlements above its actual emissions to countries in deficit.

The most difficult issue in striking such any agreement is the differentiation of targets and thus efforts between countries. There will be no global agreement unless all of the major emitters see it as being in their own interests. Therefore the allocation of any burden of mitigation among countries must seem 'fair' or at least acceptable to all major countries. Each country has its own idiosyncratic view of what is fair, and there is no chance of agreement unless the gaps in perceptions between countries can be bridged. There will be no agreement unless each country's leaders and policymakers put in the necessary effort to understand each other's perspectives. If countries push forth only with their own assessment of what would be best for themselves, independently of the effects of that position on the international discussion, no agreement will be reached.

A dominant, and agreed, theme throughout the history of the global climate negotiations is that all countries accept or at least express support for the need to engage in mitigation, but that developed countries have a greater and more immediate responsibility to act (see Chapter 11 of the Draft Report). Listening closely, it is clear that most of the main developing countries are not saying that they will do nothing. They are saying that they will do something, indeed have already started to act, but only something that they consider to be fair. But the developing countries, too, will have to listen to the adjustment challenges of the developed countries. A comprehensive global agreement is in the interest of developing countries, now that the arithmetic of global mitigation does not add up without them.

What principles would have a chance of gaining acceptance across the international community? The Review has identified four elements in a global strategy (see Chapters 12 and 13 of the Draft report for more details):

- Developed country leadership in developing and transferring the low-emissions technologies through a well-funded Low-Emissions Technology Commitment.
- Developed country commitments to financially support adaptation in vulnerable developing countries, through an International Adaptation Assistance Commitment.
- Emissions targets and opportunities for international trade of emissions entitlements. Allocations would converge over time to equal per capita allocations, with special provisions for fast-growing developing countries during the start-up phase.
- Backup action in trade within a WTO agreement.

A system of targets based around per capita principles can 'add up' to the required global effort while being broadly acceptable to most players, as shown in below. A relatively gradual convergence to equal per capita allocations, with the year 2050 proposed by the Review, could be seen in developing countries as developed-country-biased, as it perpetuates for some time the current unequal patterns of use of the atmosphere. What is outlined is probably at the limits of acceptability to developing countries—it demands a modest departure from developing countries' current emissions growth path in the short term, and strong deviations in the medium term.

Emissions targets would be binding for high-income countries and China, as laid out in Chapter 12 of the Draft Report. During a transition period, targets could be one-sided for developing countries except China, providing the option to sell permits internationally but no obligation to buy for compliance. Least developed countries would not be expected to take on targets for the time being, but would be expected to implement agreed policies in trade-exposed, emissions-intensive industries. Not all developed countries would participate in international trade in emissions permits, and none would be required to do so. However, the more that do, the greater the incentives for developing countries to come on board. Commitments by high-income countries to funding research, development and commercialisation of low-emissions technology, and adaptation in developing countries, will need to be part of the package.

Some developing countries, most importantly Brazil from the 1990s, have made the case for recognition of historical responsibility for emissions concentrations now in the atmosphere, an idea recently taken up by the eminent Indian American economist Jagdish Bhagwati (2006). He has proposed that developed countries should help finance 'the purchase of environmentally-friendly technologies by developing countries', a proposal very similar to the Review's Low-Emissions Technology Commitment outlined in Draft Report Chapter 13. Bhagwati's proposal has turned what had been looming as a stumbling block in negotiations into a potentially productive component of a global strategy for transition to a low-carbon global economy.

It is worth reiterating that the reduction commitments are to emissions entitlements, or what we might describe as net emissions. They are not prescriptions of actual future levels of emissions emanating from within Australia's borders. Rather, they define Australia's allocation of emissions rights, with any excess in actual emissions to be made up by purchasing permits made available by emissions reductions beyond international commitments in other countries.

Of course, other allocations of emissions entitlements that 'add up' to a desired global outcome can be developed. Developing countries will generally favour earlier convergence towards equal per capita rights than is embodied in the Review's proposal. High-emitting developed countries would obviously find it more congenial to have later convergence. There will need to be extensive discussion within the international community, involving varying proposals for allocation of emissions entitlements, before there is a chance of agreement.

The important thing is that any proposals that do not 'add up' to a defined global outcome be quickly rejected.

If there is no comprehensive agreement involving developing as well as developed countries over the next few years, with major developing countries committing to reducing emissions below business as usual, the prospects for reducing the risks of dangerous climate change to acceptable levels will be diminished. A partial agreement—like Kyoto—may be all that is possible from the Copenhagen meeting late in 2009 and meetings following on from that. That would look very different. It would embody binding commitments to quantitative reductions in emissions only by developed and transitional economies, plus perhaps some other high-income countries. Given advance commitments by the major developed countries, this is a likely minimum outcome from the international process over the next few years. While falling far short of the global action required to limit the risk of

dangerous climate change to acceptable levels, it would be preferable to a no-mitigation scenario, as it would place developed countries on the track toward decarbonisation. By demonstrating that decarbonisation is indeed compatible with prosperity and continued growth, it would keep alive the possibility of later, comprehensive, if delayed, global action.

Allocating emissions entitlements across countries

Chapter 12 of the Draft Report argues that only an explicit distribution of the global abatement burden across countries has any chance of achieving the depth, speed and breadth of action that is now required by all major emitters. A key output of the global modelling is the derivation of an emissions allocation for Australia which represents its fair share of a global agreement.

The first conceptual step in any process of allocating emissions entitlements across countries is the identification of an agreed global emissions trajectory.

Global emissions trajectories consistent with the cumulative emissions modelled to achieve the 550 and 450 stabilisation objectives are shown in Figure 5.1. They illustrate what global emissions trajectories could look like in a world of early and comprehensive mitigation. Both scenarios would represent a daunting short-term challenge, as illustrated by Table 5.1. The 550 trajectory peaks at 2021 at a level only 5 per cent above 2012 levels, and the 450 smoothed trajectory by 2020 is 3 per cent below 2012 levels. This is against a backdrop of global emissions in recent years increasing by at least 2 per cent a year.

Figure 5.1 Global emissions trajectories for the 550 and 450 mitigation scenarios

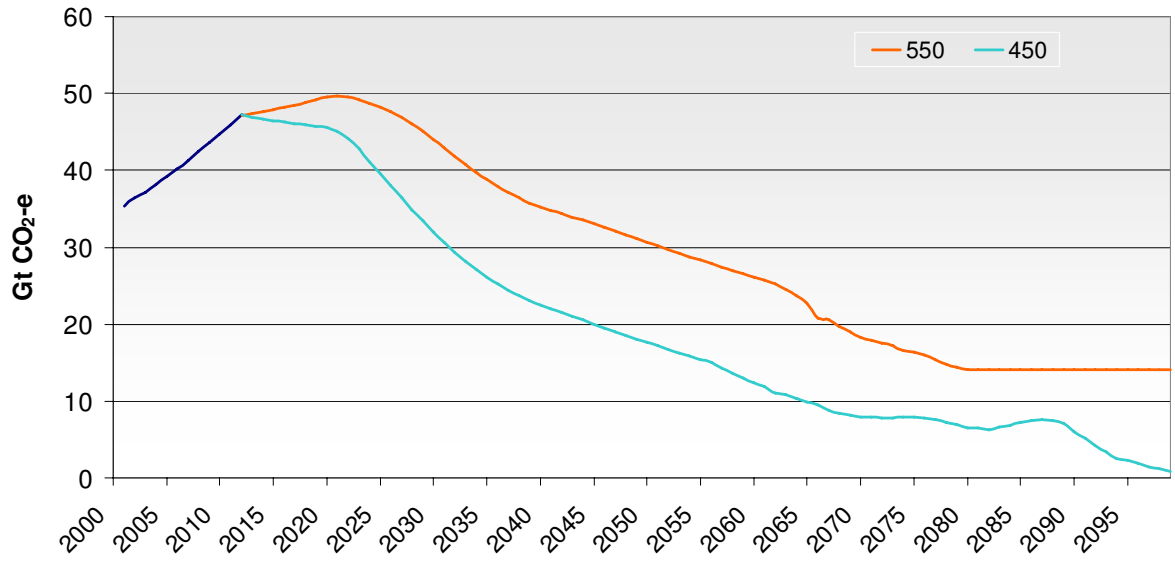


Table 5.1 2020, 2050 and 2100 global emission changes for the two cooperative mitigation scenarios, relative to 2001

	CHANGE IN GLOBAL EMISSIONS OVER 2001		
	By 2020	By 2050	By 2100
550	40%	-13%	-60%
450	29%	-50%	-98%

The trajectory for the 450 overshooting scenario is close at 2050 to the 50 per cent reduction in emissions relative to 2000 agreed to by the G8 in Japan in July 2008. This level is at one end of the range defined by the IPCC (2007) for the most stringent stabilisation scenario, which is -50 to -85 (on the 15th and 85th percentile of studies). The 550 reduction target for 2050 lies right in the middle of the relevant IPCC range (-30% to 5%).

This global emissions trajectory needs to be allocated between countries in the form of tradable emissions entitlements. Box 5.1 explains the detailed assumptions used to model the key features of the allocative approach outlined in Chapter 12 of the Draft Report. This approach gives an increasing weight to population, and a reducing weight to historical starting points over time, and gives rapidly growing countries 'headroom' so that they have time to adjust.

Box 5.1 Allocating the global emissions limit between countries using modified contraction and convergence

The main principle used by the Review to allocate emissions between countries is 'contraction and convergence': the idea that over time the entitlements of countries to emit should increasingly be linked to their population. Chapter 12 of the Draft Report laid out the argument that a gradual shift to equal per capita allocations is the only practicable principle for the allocation of emissions between countries, and also discussed the implications of this approach for Australia. To operationalise this basic idea, three questions need to be answered.

First, what is the starting level of emissions from which countries converge? Convergence begins in 2013. For Annex I countries which ratified the Kyoto Protocol, the starting point is their Kyoto compliance levels, so that countries do not gain an advantage from not complying with pre-existing commitments. The one exception to this is the Former Soviet Union (FSU), whose Kyoto targets are well above their business-as-usual levels. There is a clear case for the excess permits from the Kyoto period remaining legitimate and bankable, but not for the Kyoto special deal to be perpetuated. The FSU, USA and all non-Annex-I countries converge from their no-mitigation levels in 2012.

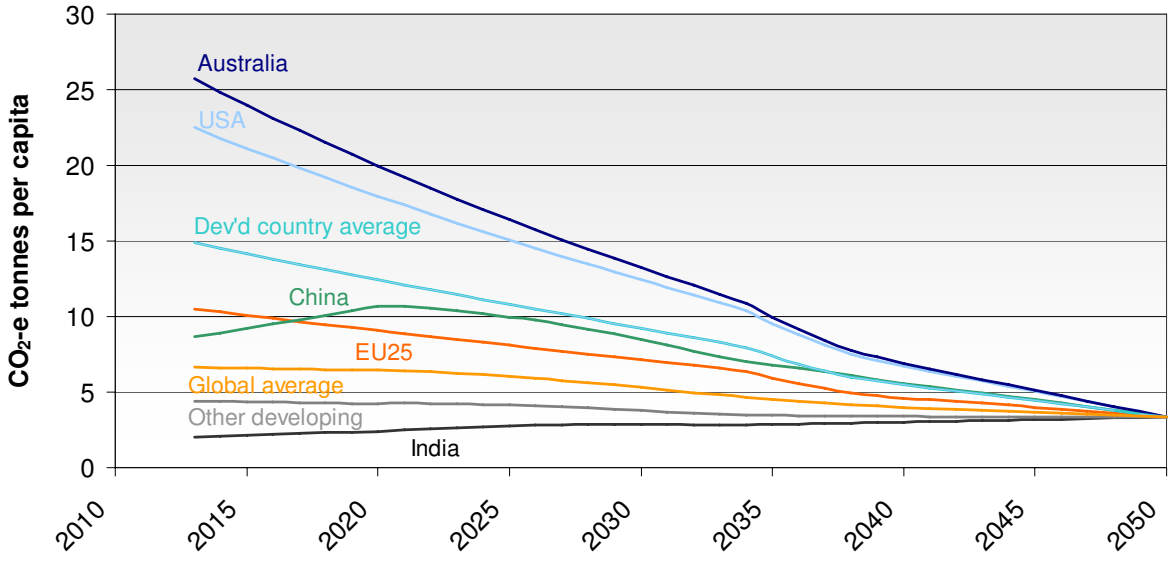
Second, what is the convergence date? The convergence date is defined as the year by which all countries have equal per capita emission allocations. The convergences date selected is 2050. It provides a substantial adjustment period, and, given the prominence of 2050 in the international debate, it is a natural focal point.

Third, how do countries move from their starting points to equal per capita emission entitlements at the convergence date? It can be argued that an equitable solution would require that all countries move quickly to the convergence level. This is not practical, however, as time for adjustment is required to avoid unnecessary increases in costs, and the speed of transition needs to be politically acceptable. The basic rule applied is that countries' allocations converge in a linear manner, faster if possible or necessary, and with an initial transitional period for developing countries. As a transitional measure, developing countries are guaranteed growth in emissions allocations at half the rate of their GDP, if this is greater than the growth in allocations under the convergence rule. This 'headroom' applies until 2020 or until such countries reach the developed country average, whichever occurs first.

This provision of 'headroom' is a modification to the standard contraction and convergence approach. It recognises that some developing countries will need a transitional period before they will adhere to a linear convergence line. This will be the case for rapidly growing developing countries, and for those with already relatively high per capita emissions, e.g. China. Deforestation emissions are treated separately: allocations for deforestation emissions are linearly reduced from starting levels to zero over a 30-year period.

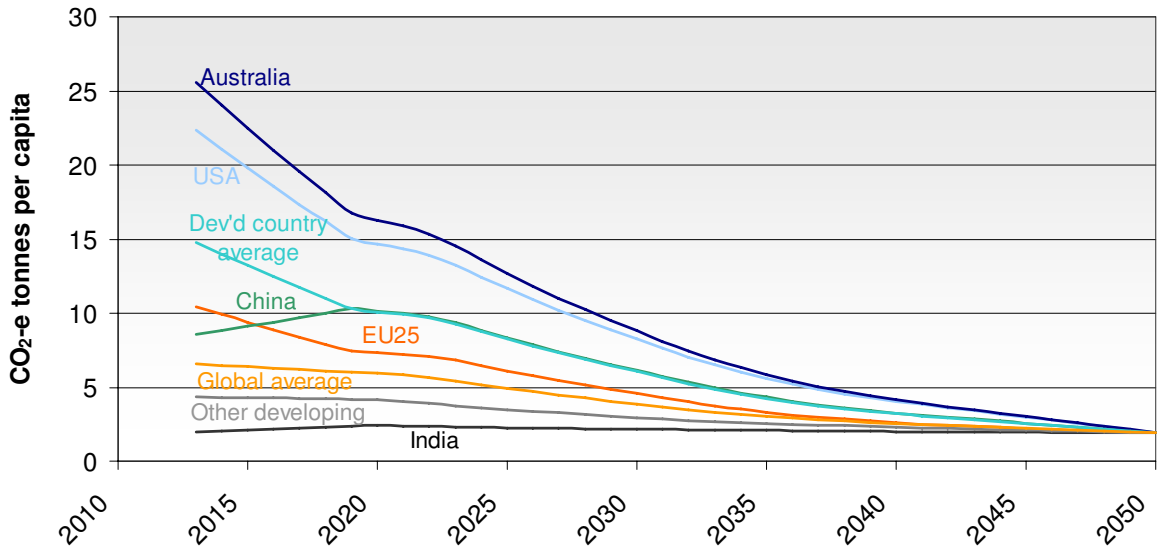
The results obtained using this method are shown in Figure 5.2 for the 550 scenario and in Figure 5.3 for the 450 scenario. The much greater stringency involved in the 450 scenario is evident.

Figure 5.2 Per capita emissions entitlements for the 550 scenario



Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the no mitigation scenario in 2012.

Figure 5.3 Per capita emissions entitlements for the 450 scenario



Note: The graph starts in 2012. Australia's 2012 starting value assumes Kyoto compliance, as do those for the EU25. Other countries start at their emissions level given by the no mitigation scenario in 2012.

The resulting allocations of emissions entitlements to different countries and regions are shown in Table 5.2 below, in terms of percentage reductions over 2001.[4]

Table 5.2 Emissions entitlement allocations for 2020 and 2050 relative to 2000–01

Total emissions	550		450	
	2020 over 2001	2050 over 2001	2020 over 2001	2050 over 2001
World	40%	-13%	29%	-50%
Developed	-15%	-76%	-31%	-86%
Australia	-10%	-80%	-25%	-90%
Canada	-33%	-80%	-45%	-89%
EU25	-14%	-69%	-30%	-82%
Japan	-27%	-75%	-41%	-86%
USA	-12%	-81%	-28%	-89%
Developing	91%	50%	85%	-14%
China	210%	-4%	195%	-45%
India	98%	230%	97%	90%

Note: Australia's allocations are relative to 2000 actuals, and are rounded. Actual numbers (also relative to 2000) are 10%, -80%, -27%, and -89%. All other countries are relative to 2001 no-mitigation scenario.

One of the striking features of this set of allocations is that there is little variation in the 2050 reductions in emissions entitlements for developed countries. The required reductions from them are in a fairly narrow range of 70 to 80 per cent for the 550 scenario and 80 to 90 per cent for the 450 scenario. As discussed in the Draft Report's Chapter 12, longer-term commitments arising from the per capita approach are broadly consistent with the emerging long-term emissions reduction goals of several developed countries. There is more variation in relation to developed countries' 2020 targets. These lie in the range of 10 to 30 per cent for the 2020 reduction target, and 25 to 45 for the 450 overshooting scenario. Australia lies at the lower end of the 2020 range for developed countries, with the smallest 2020 reduction target in terms of percentage of absolute emissions. The allocation formula takes into account starting levels, and also accommodates Australia's rapid population growth.

The story is quite different for developing countries. There is variation across developing countries reflecting different starting points, and growth between 2001 and 2012 that needs to be taken account of. In many cases, their emissions are allowed to increase significantly, reflecting their very low per capita starting point.

There is little difference between the 450 and 550 scenarios for developing countries up to 2020. They are protected in this period by the proposed transitional measures which ensure their emissions entitlements can continue to grow. After 2020, developing countries' allocations under the two

[4] 2001 is the base year in the GTEM model used by the Review.

scenarios diverge markedly. It is likely that many developing countries would hold actual emissions below entitlements, and many developed countries honour their commitments in part by purchasing permits.

The importance of population can be seen from Table 5.3, which presents the same data as Table 5.2 but in per capita terms. In per capita terms Australia is called on to do more than Europe and Japan, and about the same as Canada and the USA, because the allocative approach requires Australia to reduce its current high per capita emissions entitlement to the global average. As high per capita emitters, Australia, Canada and the USA have more 'distance' to move than the EU and Japan. The fact that the emissions reduction targets in absolute terms are much less stringent shows how the per capita approach protects Australia's position by allowing for population growth, a key factor in providing Australia with the least stringent 2020 reduction targets of any of the developed countries/regions modelled.

Table 5.3 Emissions entitlement allocations in 2020 and 2050 relative to 2000–01, expressed in per capita terms

Per capita	550		450	
	2020 over 2001	2050 over 2001	2020 over 2001	2050 over 2001
World	14%	-41%	4%	-66%
Developed	-22%	-79%	-37%	-88%
Australia	-30%	-90%	-40%	-95%
Canada	-43%	-86%	-54%	-92%
EU25	-17%	-69%	-33%	-82%
Japan	-25%	-69%	-40%	-82%
USA	-26%	-86%	-40%	-92%
Developing	49%	-5%	45%	-46%
China	179%	-13%	166%	-50%
India	53%	112%	52%	22%

Note: Australia's allocations are relative to 2000 actuals, and are rounded based on absolute values. (Actual figures consistent with Table 5.2 values are: -30%, -42%, -88%, -94%.) All other countries are relative to 2001 no-mitigation scenario.

While 2000 is a relevant comparator for Australia since it is the base year for the Government's announced emissions targets, 1990 is also a relative comparator year for international discussions. At the 2007 Bali climate change negotiations, a particular range of emissions reductions received prominent attention. It was proposed that developed countries (strictly Annex I countries) consider emissions reduction targets in the range of 25 to 40 per cent by 2020 over 1990 levels. This target range stems from an IPCC (2007) analysis for a 450-type trajectory. The equivalent range for a 550 trajectory is 10 to 30 per cent. The emission reduction targets for developed countries modelled by the Review are consistent with these Bali ranges, but at the lower end in terms of stringency, reflecting the limited progress made between 1990 and the current time towards mitigation.

Relative to 1990, Australia's targets are at around the average for developed countries (Table 5.4). They are the same percentage reduction as for 2000, as under Kyoto accounting rules Australia's emissions were almost the same in 1990 and 2000.

Table 5.4 shows the broad consistency of the model's approach with the 2020 targets announced by the European Union, which has committed to reduce emissions in 2020 by at least 20 per cent over 1990 levels, and by 30 per cent in the context of an effective international agreement. Under the allocative model applied here, the EU would need to reduce emissions by 20 per cent in a 550 agreement, and by 36 per cent in a 450 agreement.

Table 5.4 Emissions allocations for 2020, relative to 1990 for Annex I countries

	2020 OVER 1990 LEVELS	
	550	450
Developed	-11%	-28%
Australia	-10%	-25%
Canada	-7%	-24%
EU25	-20%	-36%
Japan	-22%	-37%
USA	0%	-19%

Note: 1990 levels taken from official data, rebased for comparison with modelled results. The rounded targets are used for Australia (see Table 5.2).

Table 5.5 defines the reductions required in 2020 relative to 2012 and business as usual. The reductions relative to 2012 for Australia are slightly below the developed country average. The reductions in 2020 relative to no mitigation are higher for Australia than the developed country average, though not much higher if we take as the counterfactual the more realistic 'with measures' projections of the Australian Government (Department of Climate Change 2008). These latter figures take into account measures already in place, and so give a better estimate of additional policy effort required.

In any case, the allocative approach adopted takes no account of what might happen in a no-mitigation world. This would always be counterfactual, would lend itself to special pleading, and would be impossible to use as the basis for allocating emissions across countries. Nevertheless, it must be acknowledged that Australia's rapid underlying emissions growth may require greater effort for Australia than others to comply with any comprehensive international agreement. For Australia, as a country likely to have comparative advantage in a range of emissions-intensive industries, the flexibility provided by international trading in allowances is of considerable importance.

The other key point from Table 5.5 is that the emissions allocations are only about 10 per cent below business as usual for developing countries, including China, by 2020. This suggests that the allocative approach adopted here is realistic. Developing countries need to be brought on board, but a transition period is required during which emissions allowances can keep growing. The relatively slow start provided to developing countries will also provide them with incentives and opportunity to reduce emissions below their allocations, and so finance their mitigation efforts through international sales of entitlements.

Table 5.5 Emissions entitlement allocations in 2020 relative to 2012/Kyoto commitments and no mitigation

Total emissions	2020 versus 2012		2020 policy vs. 2020 no mitigation	
	550	450	550	450
World	5%	-3%	-13%	-20%
Developed	-19%	-34%	-22%	-36%
Australia	-17%	-32%	-25 to -31%	-39 to -44%
Canada	-42%	-53%	-46%	-56%
EU25	-16%	-32%	-17%	-33%
Japan	-26%	-40%	-24%	-39%
USA	-17%	-32%	-20%	-35%
Developing	21%	18%	-8%	-11%
China	34%	27%	-6%	-10%
India	35%	35%	-10%	-11%

Note: Australian 2020 figures are relative to the Kyoto Protocol commitment for 2008–2012. Other countries are relative to the 2012 no-mitigation scenario. Two figures are used to compare Australia's allocation to a business-as-usual world: the no-mitigation scenario, which gives the upper bound, and the 'with measures' projections of the Australian Government (Department of Climate Change 2008), which give the lower bound, and a more accurate measure of additional policy effort required.

6 DOES AUSTRALIA MATTER FOR GLOBAL MITIGATION?

Only effective global action can solve the climate change problem. Australia is the source of only 1.5 per cent of global greenhouse gas emissions. So does Australian action have any effect on global warming?

If our own mitigation efforts had no effect at all on what others did, we could define our own targets and trajectories, and approaches to their realisation, independently of others' perceptions or reactions. We could enjoy the benefits of reduced risk of climate change from others' actions, without accepting our share of the costs. The optimal level of Australian mitigation effort—the level that maximised the incomes and wealth of Australians—is easily calculated. It would be zero. That is not far from the stance of Australian policy until recent times.

Whether we like it or not, Australia matters.

Australia's relevance to the international policy discussion has been apparent in the period since early 2001. The fact that Australia had joined the Bush administration in not ratifying the Kyoto agreement that we had each negotiated was a key fact in the American domestic discussion. Australia was presented as evidence that the Bush administration was not alone in developed countries.

All countries, Australia and the United States among them, agreed in United Nations meetings in Kyoto in 1997, that all developed countries would accept certain obligations. While the Review's analysis demonstrates that, going forward, a substantial majority of the increment of emissions will come from developing countries (Chapter 4, Draft Report), the international community has agreed

that the first steps in mitigation would be taken by developed countries. This gives every developed country a veto on substantial progress on global mitigation: the failure of any one of them to do what it said that it would do, would make it unlikely that the necessary following steps would be taken by major developing countries. We played that veto card.

There are more general reasons why Australia may be influential to global outcomes.

There is a role for countries of substantial but moderate weight—for 'middle powers'—in taking the initiative in leading global diplomacy on issues in which they have major interests. Global warming passes the interest test for Australia, as we are likely to be the developed country that is most damaged by a failure of effective global action. Australia—at times for good and at times for ill—has demonstrated on many issues at many times in history that it is effective in a 'middle power' diplomatic role, developing ideas to shape international cooperation, and persuading others that cooperation is in their own interest. APEC is one example.

Australia has some unusual diplomatic assets in the developing countries that are centrally important to successful global mitigation policy. Chinese policy is crucial to a successful global outcome. A history of close and productive cooperation on domestic and international policy through the reform period gives Australia a strong base for cooperation with China. The close and well-developed relationships with Indonesia (the world's third largest emitter of greenhouse gases in absolute terms) and Papua New Guinea (a large emitter in per capita terms, and one playing a global leadership role among less developed countries on greenhouse emissions policies) raise special opportunities.

The world, and especially developing countries, needs models of successful transition to low emissions while maintaining economic growth. Australia's established market economy and economic dynamism, with particular skills and natural resources in areas of special importance to the low-carbon economy, will be assets in making a successful transition, showing that it can be done.

Although it may miss our attention, others notice, and think it relevant, that Australia's economic strength in the early 21st century derives to a considerable degree from the higher terms of trade associated with the strong economic growth in Asian developing countries. They notice that strong growth in the Asian economies, and exceptional Australian prosperity, is the other side of the coin to the heightened urgency of the global warming problem.

Because Australia matters, we cannot contribute positively to an effective global agreement, and at the same time pick a trajectory for our own country's reduction in greenhouse gases that keeps costs low for us, without assessing whether this would be consistent with a global agreement to solve the problem.

This has implications for the emissions reductions that we would need to accept as part of a global agreement to limit concentrations to 450 ppm. The simple arithmetic, as explained in Section 5, says that a 450 stabilisation objective would require global emissions to fall by 50 per cent by 2050 for the world as a whole. As demonstrated in Chapters 4, 11, 12 and 13 of the Draft Report, the huge momentum of developing countries' emissions growth makes it impossible for that global goal to be reached without developed countries accepting much deeper cuts than 60 per cent.

It would help Australians to face some of these realities if we were more realistic about where we stand among developed countries in taking action to reduce greenhouse gas emissions. It is claimed by many Australians—some who want their country to be in a leadership position, and some who do not—that we are, or are about to be, ahead of other developed countries on greenhouse gas abatement.

Australia is in no danger of leading the world in greenhouse gas mitigation. In comprehensive national efforts at mitigation, it ranks behind all of the 27 European countries.

In practical policy innovation to reduce emissions, Australia ranks behind a number of states of the United States, including the largest, California, with its pervasive and costly regulation. The national governments of Japan, New Zealand, the United States and the European Union have engaged in a range of partial activities to reduce emissions. In all of these countries, there are domestic debates about national abatement initiatives at similar stages to our own.

What the rest of the world notices most about Australian emissions is that ours are the highest per capita in the OECD; that over the past several decades they have been growing faster than those in other OECD countries; and that while in 1971 the emissions intensity of Australian primary energy supply was similar to the OECD as a whole, in recent years it has been more than one-third higher (Draft Report, Chapter 8, Figure 8.6). There are good reasons why Australia became relatively more dependent on a high-emissions source of energy, coal, while the remainder of the OECD was reducing the proportionate role of coal and increasing the contributions of low-emissions energy, including nuclear. But whatever the reasons, they are not easily reconciled with the idea that Australia is leading the world in emissions reduction.

It is often said in Australia that developing countries are strongly resistant to reductions in emissions, and that it is unrealistic to expect them to participate in global constraints on emissions. This is too simple. China's selective withdrawal of export rebates within its value added tax, the export taxes on a range of energy-intensive products, its discouragement of expansion of energy-intensive industries and its specific regulatory constraints on investment in steel, aluminium and cement production add up to more substantial constraints on the most emissions-intensive industries than would occur in Australia in the early years of an emissions trading system. China's active encouragement of low-emission sources of power (hydroelectric, wind, nuclear, biomass, biofuels) goes beyond current Australian efforts. These measures stand alongside a domestic policy commitment to reduce the energy intensity of economic activity by four percentage points per annum until 2020. Data released in August 2008 show the energy intensity of Chinese GDP falling by 3.7 per cent in 2007—the first sign of good intentions on energy intensity being reflected in policy outcomes.

Among other developing countries, Papua New Guinea's Prime Minister has asked his country's newly established Climate Change Office to prepare an analysis of ambitious mitigation targets: a reduction in emissions of 50 per cent by 2020, and carbon neutrality by 2050. The Indian Government is well-known for its declamatory statements resisting commitments to reduce emissions until developed countries have gone much further. But if we listen carefully, it has also said repeatedly that it is prepared to commit itself not to increase its per capita emissions above developed country levels. India has long emphasised that convergence towards equal per capita entitlements would need to be a central part of any international agreement in which developing countries accepted constraints on emissions. Many developing countries have said they would be prepared to do more if there were commitments from developed countries to support transfer of low-emissions technologies and climate change adaptation.

It is easy to be cynical about statements of good intentions by others, as it is easy for them to be cynical about ours. There is a possible path to an effective international agreement if we observe carefully what others are doing, listen to what others say they are prepared to do and note the conditions for action. We need to listen as well to others' perspectives on our own policies and practices.

Australia matters. What we do matters. When we do it matters. It would be really silly to take action with costs to ourselves meant to assist the emergence of a good international agreement, but to do it too late to have a chance of avoiding high risks of dangerous climate change. What we do now, in time to influence the global mitigation regime from the end of the Kyoto period, is of high importance. What we do later runs the risk of being inconsequential in avoiding dangerous climate change.

7 MEASURING THE IMMEASURABLE

Does participation in global mitigation, with Australia playing a proportionate part, and with all the costs of that part, make sense for Australia? If so, what extent of mitigation would give the greatest benefits over costs of mitigation for Australians?

The answers are approached through the decision framework presented in Chapter 2 of the Draft Report and are informed by the modelling undertaken jointly with the Australian Treasury and independently by the Review. A full analysis of the modelling will be provided at the time of the Final Report.

Chapter 2 of the Draft Report warned us that these are the most difficult of policy questions to answer. The measurements and estimations of benefits and costs are difficult. We must include four types of benefits from reduced costs of climate change, and several of these are in their natures impossible or difficult to quantify. We must assess each of these four types of benefits and costs at different degrees of mitigation. Both the costs and benefits of mitigation, but especially the benefits, reveal themselves over much longer time frames than humanity is accustomed to taking into account.

The first type of cost (Type 1) discussed in Draft Report Chapter 2 has been measured through a computable general equilibrium model, based on measured market impacts of climate change in the median or 'average' cases suggested by the science. That is the easiest part of the problem, but still involves the most complex long-term modelling of the Australian economy ever undertaken. This modelling is the most detailed and sophisticated of its kind undertaken anywhere. The requirement to model changes in the structure of the Australian economy in a general equilibrium framework to the end of the 20th century takes the models to the limits of their capacities.

The second type of cost (Type 2) involves market impacts in the median cases, but for which effects cannot be measured with sufficient precision and confidence to feed into computable general equilibrium models. By their nature, these costs and benefits were not amenable to precise quantification. Our modelling team formed judgments about likely magnitudes, relative to the size of the impacts that were the focus of the formal modelling. These assessments were applied in a transparent way in adjustments to some of the model results, to remove the bias that would otherwise be associated with the exclusion of obviously important market impacts for which data were not available at the time of the modelling work.

The third type of cost (Type 3) is that associated with the chance that the impacts through market processes will be substantially more severe than suggested in the median cases. These derive their importance from the normal human aversion to risk in relation to severe outcomes, and from the possibility that the bad end of the probability distribution includes outcomes that are extremely damaging and in some cases catastrophic.

The fourth type of cost (Type 4) involves services that Australians value, but which do not derive their value through market processes. Examples include deterioration of environmental amenity, loss of species and more generally of biodiversity, and health and international development impacts that do not necessarily have their effects through the imposition of monetary costs on the Australian community.

It was sensible to end the modelling exercise in 2100, as the assumptions that we were making about economic parameters and relationships were becoming highly speculative towards the end of the century. And yet all of the detailed assessments of the economics of climate change have the main costs, and therefore the main benefits of mitigation, accruing in the 22nd and 23rd centuries and beyond (Stern 2006; Nordhaus 2008; Cline 2004).

The quantitative analysis provides an estimate of the costs of mitigation, net of the market-determined benefits of avoided climate change associated with the assessments of the median

impacts, out to the end of the 21st century. As it happens, by that time, the annual benefits of climate change avoided are close to the annual costs of mitigation. The decision problem then becomes: does the insurance value of reducing risks of extreme events and outcomes in the 21st century, plus the value of conservation of the many non-market services that would be damaged by unmitigated climate change in the 21st century, plus all of the costs and benefits of market-related economic benefits, insurance value and non-market services in the future of humanity beyond the 21st century, warrant the net costs incurred in mitigation in the 21st century?

The quantitative analysis of both the costs and the benefits of mitigation is technically path-breaking. I expect that the methods that have been applied within the work of the Review will be taken further over time, and naturally improved. Modelling over such long time periods is surrounded with uncertainty. No single view of the future world is self-evidently true.

We are nevertheless aware that when powerful incentives to innovation are introduced to a market environment, human ingenuity usually surprises on the upside. How will this ingenuity manifest itself in the face of high emissions prices and increased public support on a global scale for research, development and commercialisation of low-emissions technologies?

We do not know, but I for one expect that, if we get the policy settings right over the next few years, the technological realities later in the century will be greatly superior to those which, for good reason, are embodied in our standard technology models. These possibilities are explored in the Final Report.

As one alternative to the standard technology assumptions, the Review modelled an enhanced technology future, embodying various assumptions of more rapid technological progress, none of which seem unlikely.[5]

As another possibility for the future, the Review examined the implications of the commercialisation of a 'backstop technology', encouraged by high carbon prices, that, at a cost of $250 per tonne of carbon dioxide, takes greenhouse gases from the atmosphere, for recycling or permanent sequestration. As discussed in the Final Report, there is currently active work on some versions of possible backstop technologies, at all the various stages of research, development and commercialisation. In the modelling of the backstop, deployment starts between 2050 and 2075.

Of course, the 'backstop' and 'enhanced' technologies are possibly complements rather than alternatives, as they are assumed to be in the modelling.

Which of these three visions of the technological future, or which combination of them, or which alternative to all of them, defines the opportunities that evolve through market processes over the years ahead, will be revealed in due course as history.

Technological developments in response to a rising carbon price will have a large effect on the acceptability to the global community of 450 ppm and 400 ppm mitigation strategies in future years.

Just as difficult as imagining the technological future is taking into account the deadweight costs, negative and positive, of various policies that are used to achieve reductions in emissions. Nordhaus' pioneering work underlined the reductions in deadweight costs that could come from replacing distorting forms of taxation like income taxes by a carbon tax (Nordhaus 1994). Mitigation through a carbon tax—no exemptions, no shielding—had a positive economic benefit, because the carbon tax was less economically distorting than the taxes that it replaced. A similar result could be obtained by replacing distorting Australian taxes by revenue from competitive sale of permits from an emissions trading system. However, a distorted Australian emissions trading system, diverting management

[5] A more detailed account of the enhanced technology runs and other aspects of the modelling will be provided with the Review's Final Report.

effort from commercial activities into applying pressure for political preferment, could have large negative deadweight costs.

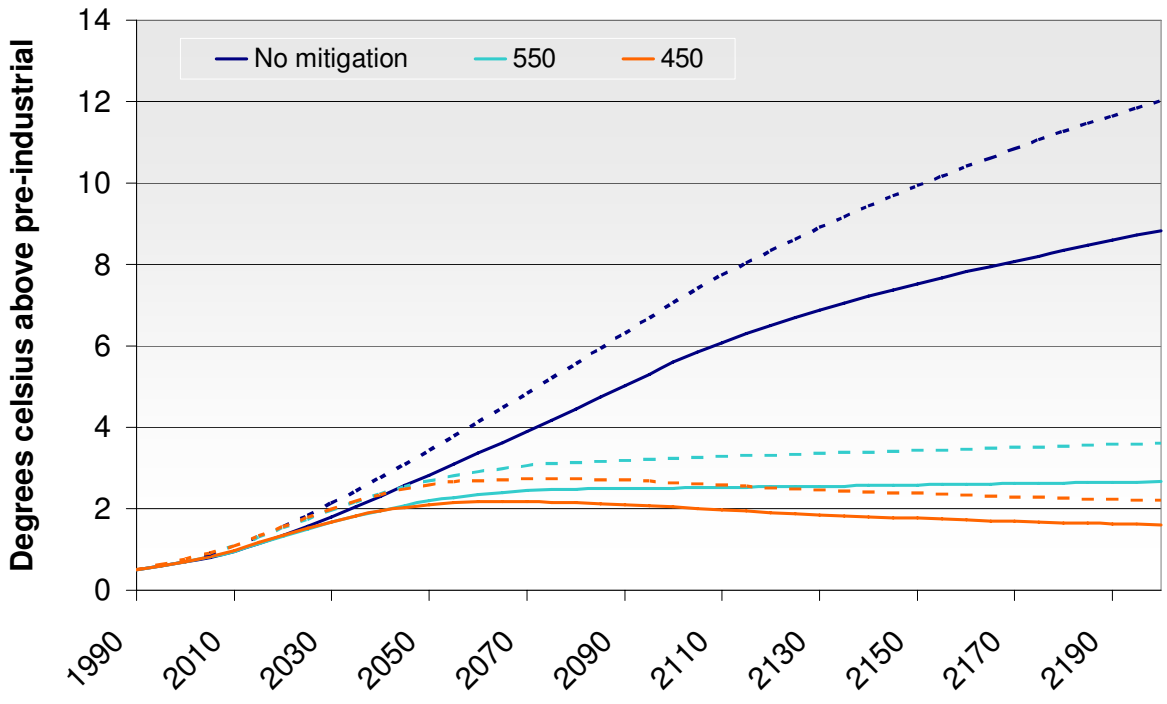
The modelling has assumed no net transactions and other deadweight costs of the mitigation regime. We will learn whether this was an optimistic or pessimistic assumption when the realities are revealed as history.

The costs of mitigation depend on who bears them. Australians, and people generally, judge that an increment of money is more valuable to the poor than the rich. It follows that the costs of mitigation are higher, and the optional amount of mitigation effort lower, the more the costs are carried by the poor. More mitigation is justified if compensation for low-income Australian households is a major feature of the policy framework. Similarly, more global mitigation can be justified if low-income countries carry low proportions of the costs. It happens that Australia has a strong interest in the burden of mitigation being carried equitably across countries, as it is the country whose terms of trade would be damaged most by any setback to income growth in developing countries.

Post-2100 climate change impacts

Expected climate change impacts become larger the further in the future one looks. The risks of awful outcomes tend to be much larger in the 22nd century and beyond than in the 21st century. In the absence of mitigation, temperatures will continue to increase into the 22nd century, as Figure 7.1 illustrates.

Figure 7.1 Temperature increase into the 22nd century



Note: As in Figure 8.2, best-estimate figures, shown in solid lines, are calculated with a climate sensitivity of 3ºC. The dashed lines show those temperatures which arise from using the climate sensitivity (of 4.5ºC) at the upper end of the IPCC likely (66%) range. Temperature increases from pre-industrial levels are derived from the MAGICC climate model (Wigley 2003). Temperature outcomes beyond 2100 are calculated under the simplifying assumption that emissions levels reached in each scenario in the year 2100 continue unchanged. They do not reflect an extension of the economic analysis underlying these scenarios out to 2100, and are illustrative only. It is unlikely that emissions in the reference case will stabilise abruptly in 2101 with no policies in place, and hence the

temperatures shown underestimate the likely warming outcomes if continued growth in emissions was assumed.

Table 7.1: Temperature increase into the 22nd century

No mitigation	5.6	7.1	8.8	12.0
550	2.5	3.2	2.7	3.6
450	2.0	2.6	1.6	2.2

Note: The 'best estimate' and 'upper end of likely range' temperature outcomes were calculated using climate sensitivities of 3ºC and 4.5ºC respectively. See notes to Figure 7.1.

Climate change comes with long lags. Today's greenhouse gas emissions have warming effects in the atmosphere for decades and centuries, and many of the effects of warming on earth systems will play themselves out over even longer time frames. For example, irreversible melting of the polar ice caps may be set in train now, but it and the accompanying sea-level rise will continue for centuries. The translation of emissions to warming to impacts is by no means a linear process.

Numerous potential feedback loops and thresholds or 'tipping points' have been identified, as discussed in the Draft Report. Furthermore, there are cumulative effects. For example, an agricultural activity might be able to continue in modified form in a drying local climate, but become impossible once mean and extreme temperatures compound the impact. Some impacts expand with scale. The interaction of increasing greenhouse gas concentrations with cumulative effects, feedback loops and the progressive passing of trigger points means that the passage of time is likely to be associated with rapid acceleration of costs, for a considerable time into the future. Together, these effects result in strong non-linearity through time of expected economic impacts from climate change, and even greater non-linearity for the loss of ecosystems, and the risk of abrupt and irreversible climatic changes. The possibility of outcomes that most people would consider to be catastrophic makes this a particularly important element of the assessment, and by some considered the main element (Weitzman 2008).

The lags and non-linearity of climate change impacts, even looking just at the medians of expectations and market impacts, is reflected in the climate impact estimates for Australia constructed for the Review. The estimated impacts in the unmitigated scenario increase threefold from 2050 to 2075, and then threefold again from 2075 to 2100. This rate of increase in damages far outstrips the projected rate of increase in temperatures. It is obvious that if the analysis were continued into the 22nd century, estimated market impacts from climate change would be very much higher even than for the latter decades of the 21st century.

William Cline (2004) used a modified version of Nordhaus' climate change model going out to the year 2300. Base case emissions growth is lower than in the Review's modelling, but a scenario with a higher climate sensitivity yields temperature outcomes close to the Review's no-mitigation scenario at 2100, and temperature continues rising to a 15 degree increase at 2300. In Cline's scenario, climate change damages as a percentage of global GDP are 9 per cent by 2100, about 25 per cent by 2200, and a remarkable 68 per cent by 2300.

The Stern Review's attempt at a more comprehensive assessment of global climate change damages, including market as well as non-market impacts and a probability distribution over a range of possible outcomes to 2200, is another useful illustration. Stern's analysis shows impacts on expected per capita consumption at 3 per cent at 2100, rising to 14 per cent at 2200.

Discounting

How much value should be attached to climate change impacts that occur beyond the lifetimes of most of those alive today? In comparing utility across generations, we need to determine the discount rate. In the Review's modelling, only the market costs and benefits of median impacts of climate change mitigation are assessed, and only to the year 2100. Nevertheless, any view formed on discounting is important also in an assessment of qualitative climate change impacts in the longer term, and its implication for mitigation policy today.

As discussed in the Draft Report (Chapter 2), there are two reasons why society may place less value on income and consumption in the future than on the same income and consumption today. The first element in the discount rate is the rate of pure time preference, that is, the rate at which future utility is discounted simply because it is in the future. Many of the philosopher kings of economics, from Ramsay to Sen, have argued for a pure rate of time preference that is close to zero, thus placing no discount on the utility of people in the future just because today these people are young or not yet born. By contrast, some economists including Nordhaus (2008), a pioneer of economic modelling of climate change, use a pure rate of time preference of 1.5 per cent or higher. The Review judges that a near-zero pure rate of time preference is appropriate. The only reason for a positive rate of pure time preference is the risk of human extinction in any one year. This should be a low number, and the Review uses a rate of pure time preference of 0.05 per cent.

The second element in the discount rate is the marginal elasticity of utility with respect to consumption. This is a measure of society's concern for equity in income distribution. We accept that a dollar of incremental income means less to the utility of the rich than of the poor. The people of tomorrow will have higher material incomes and wealth than people today, although this is likely to be offset by reduced environmental amenity in assessment of utility. It is reasonable to value future income at a lower rate than current income. How much less? Higher and lower values have been suggested, but no one contests that income has diminishing marginal utility with increased income. An elasticity of 1 was used in the Stern Review, and a strong case can be mounted for that parameter choice (Quiggin 2008). Higher values have also been suggested, on the grounds that they more adequately reflect distributional concerns and observed savings rates (Dasgupta 2007), though these savings rates vary greatly between countries and through time. Nordhaus uses a parameter value of 2.

The argument for being careful about the sacrifice of current utility through expenditure on mitigation in pursuit of future income is a powerful one. But there is one important qualification of this case for caution about strong mitigation on intergenerational income distribution grounds. The rate of substitution between conventional consumption and non-market services is likely to be low when incomes and material consumption are much higher than they are today. Climate change may greatly diminish the availability of non-market services for future generations. As a result, one cannot be sure that, despite much higher material consumption, the average utility of people in future will be greater than the average utility today. Hence, linking the marginal elasticity of utility to the growth in per capita income may lead to higher than intended discount rates. Furthermore, if considerable weight is given to the bad end of the probability distribution of outcomes from climate change, there is a possibility that utility may be lower for many people in future than at present.

The Review uses two alternative parameter values for the marginal elasticity of utility, 1 and 2. Under an elasticity of 1, future income is discounted at the same rate as the increase in per capita income (plus the rate of pure time preference), while at an elasticity of 2 it is discounted at twice that rate. The average annual growth rate in Australian per capita income from 2013 to 2100 in the base case is 1.3 per cent. Thus the two real discount rates used by the Review for assessment of discounted net costs of mitigation of climate change in Australia are 1.35 per cent and 2.65 per cent.

There is another view, that market discount rates reflect the time preferences that are revealed in actual decisions on savings and investment, which are the vehicles for arbitrage between future and current economic activity. This raises two questions. What is the appropriate market discount rate? The other and more fundamental question is whether discounting is a normative or a positive issue, and so whether it is appropriate to use a market rate.

On the first question, a case can be made for using the market rate for sovereign debt in countries like Australia. The mid-point of this range roughly coincides with the inflation-adjusted long-term market rate of return of government bonds in Australia and the United States, which stands at 2.2 and 2.1 per cent respectively. These would seem to be more appropriate than equity market rates, which are much higher, reflecting perceptions of firm-specific and other risks that are not relevant to the current analysis.

A social discount rate, lower than market rates, is commonly used in cost–benefit analysis of public policy (Little & Mirrlees 1968). The Review is of the view that a normative approach is warranted on an issue that affects society as a whole over long time frames and on fundamental issues. Rates that the Review derived from analysis, presented above, straddle the market rate that is judged to be most appropriate. In this case at this time, there is no conflict between normative and positive approaches.

The modelling for the Review has been calibrated with percentage points of GDP. The use of a discount rate that is higher than the rate of growth of GDP will cause the present value of a percentage point of current GDP to be greater than that of a percentage point of future GDP. The use of a discount rate that is lower than the rate of growth of GDP causes the present value of a percentage point of future GDP to exceed that of a percentage point of current GDP.

In Australia's case, unlike for most developed countries, the modelling points to the expected rate of GDP growth (2.1 per cent over the remainder of the 21st century) falling within and towards the upper end of the range of discount rates thought to be relevant (1.35 to 2.65 per cent). It follows that at the lower discount rate, the present value of a percentage point of GDP in the early 22nd century will exceed by a wide margin that of a percentage point of GDP now.

8 IS MITIGATION WORTH THE COST FOR AUSTRALIA?

The modelling undertaken by the Review with the Australian Treasury has evaluated outcomes from three mitigation strategies. One is 'no mitigation'. The other two are cooperative global mitigation strategies, the 550 parts per million carbon dioxide equivalent (CO_2-e) stabilisation ('550') and the 450 ppm CO_2-e with overshooting ('450') scenarios.

Figure 8.1 compares the concentration of greenhouse gases in the scenarios modelled jointly with Treasury. In the no-mitigation scenario, emissions continue to grow, increasing everywhere, but mainly in the developing world (Chapter 4 of the Draft Report). Concentrations climb rapidly.

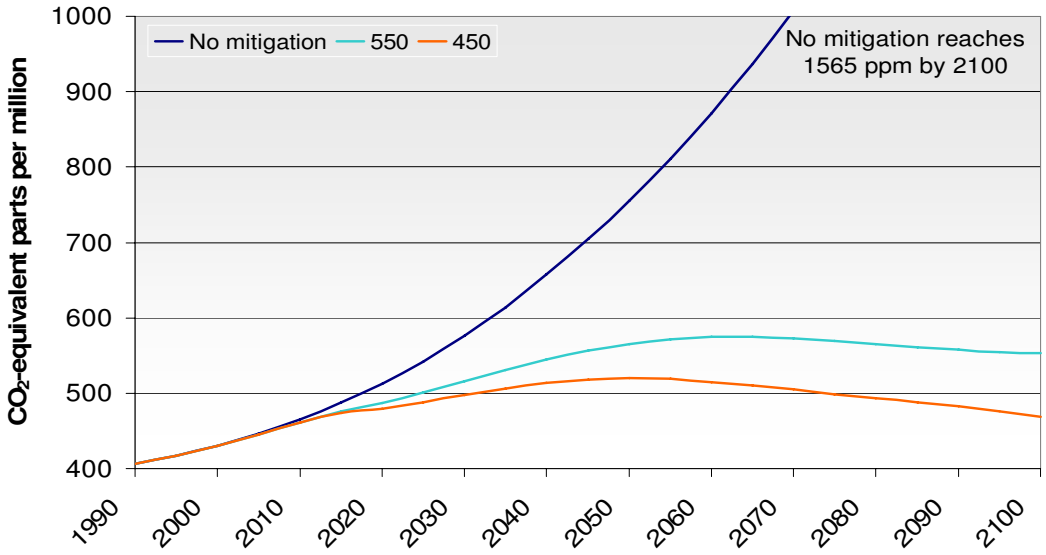
Today, the atmospheric concentration of greenhouse gases is about 455 CO_2-e ppm (2005) (Draft Report, p. 67). In the no-mitigation world, this would reach 550 by 2030, 750 by 2050, 1000 by 2070, and 1600 by 2100.

The concentration of CO_2 (the main greenhouse gas) within this scenario would reach 1000 ppm at 2100, compared to a band of natural variability of carbon dioxide over the millennia of between 180 and 280 ppm, and 280 ppm in the early years of modern economic growth in 1840.

In the 550 scenario, concentrations stop rising around 2060, and stabilise around 550 ppm, one-third of the level reached in the no-mitigation scenario by the end of the century. In the 450 scenario, the peak in concentrations occurs in 2050, and 450 ppm is reached at the end of the century.

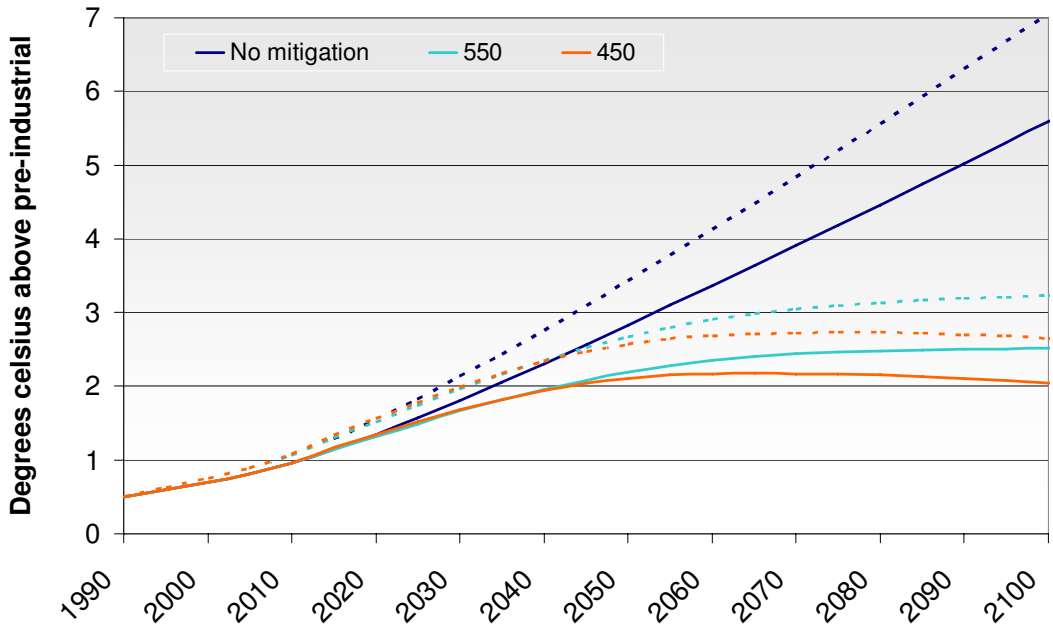
Atmospheric concentrations of greenhouse gases are important primarily because of their impact on global temperature. Figure 8.2 shows the expected increases in global temperature associated with each of the three scenarios, as well as the temperature consistent with the highest climate sensitivity in the 'likely' range defined by the IPCC. In the absence of mitigation, the world is heading for a 2.8 degree Celsius increase over pre-industrial levels by 2050, and 5.6 degrees by 2100. Temperatures would continue to rise to as high as 9 degrees by the end of the next century (Box 8.1) or higher if the climate sensitivity were above its central estimate. The 550 and 450 scenarios will limit end-of-century temperature increases to 2.5 degrees and 2.0 degrees under the central estimate for climate sensitivity. But even with these levels of stabilisation, an end-of-century increase of 3.2 degrees and 2.6 degrees above pre-industrial levels is still within the likely range of the 550 and 450 scenarios respectively.

Figure 8.1 Atmospheric concentration of greenhouse gases under the no-mitigation, 550 and 450 scenarios



Source: Concentrations are derived from the MAGICC climate model (Wigley 2003).

Figure 8.2 Temperature increases above pre-industrial levels under the no-mitigation, 550 and 450 scenarios



Note: Solid lines show best estimates based on a climate sensitivity of 3ºC. Dotted lines show those temperatures which arise from using the climate sensitivity (of 4.5ºC) at the upper end of the IPCC likely (66%) range for this variable. Temperatures are derived from the MAGICC climate model (Wigley 2003).

Table 8.1 Temperature increases above pre-industrial levels under the no-mitigation, 550 and 450 scenarios

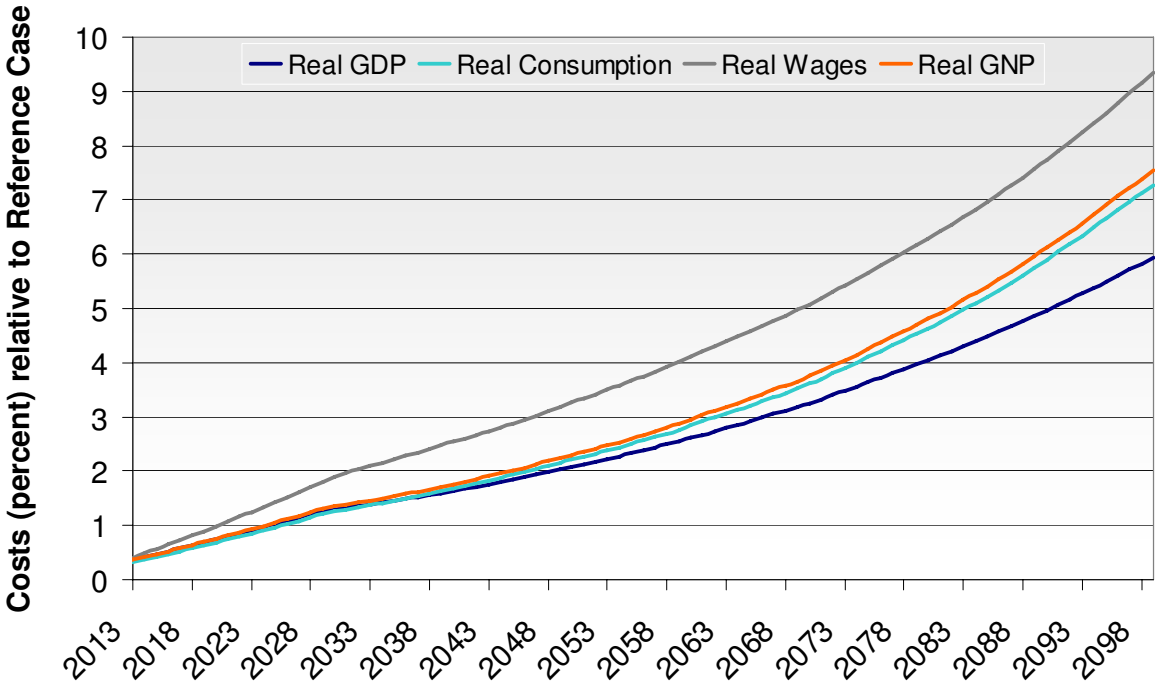
Scenario	2050		2100	
	Best estimate	Upper end of *likely* range	Best estimate	Upper end of *likely* range
No mitigation	2.8	3.4	5.6	7.1
550	2.2	2.7	2.5	3.2
450	2.1	2.6	2.0	2.6

Note: The 'best estimate' and 'upper end of likely range' temperature outcome were calculated using climate sensitivities of 3ºC and 4.5ºC respectively. See notes to Figure 8.2.

The two mitigation scenarios are much closer to each other than either is to the no-mitigation scenario. Here we focus on the comparison between 550 ppm and no mitigation, to test the case for action. A later section discusses the relative merits of 550 ppm and 450 ppm.

The Review quantified only the first of the four types of costs of climate change, Type 1, the expected market costs of the median outcomes of impacts for which data were available, and only up to 2100. These are shown for unmitigated climate change in Figure 8.3. This modelling was done by the Review based on the reference case and policy scenarios developed with the Australian Treasury.

Figure 8.3 The modelled expected market costs for Australia of unmitigated climate change up to 2100 (Type 1 costs only; excluding Type 2)



For reasons set out in the Draft Report (Chapter 10), it was estimated that the second type of cost, Type 2, covering the expected market costs of the median outcome of impacts for which data are too unreliable to feed into general equilibrium modelling, are about one-third the size of the first type of cost. Taken together, the Type 1 and Type 2 costs amount to approximately 8 per cent of GDP, 10 per cent of GNP and consumption, and 12 per cent of wages by the end of the century. (Note that gross domestic product and gross national product results often diverge significantly in the modelling (for example, Figure 8.3). Since consumption tracks GNP closely, most of the results are expressed in terms of GNP.)

These are significant damages. They are much higher than estimates from earlier quantitative studies of the global costs of climate change. Stern (2007), for example, found a reduction in global GDP per capita as a result of climate change of only 2.9 per cent in 2100 after taking into account all four of the categories of costs described above, two of which the numbers in the preceding paragraph exclude. For Stern, as with other authors of major quantitative studies, Cline (2004) and Nordhaus (2008), the costs of climate change are overwhelmingly concentrated in the years after the current century. The Review's modelling shows much higher costs for Australia this century, with strong momentum towards even higher costs as the 22nd century approaches.

The earlier and larger costs of climate change in our study derive in large part from the application of realistic, Platinum Age assessments of the growth in emissions in the absence of mitigation (Chapter 4 in the Draft Report). The other side of the coin is that Platinum Age growth in emissions under business as usual increases the urgency and cost of mitigation. In the face of such large temperature changes as those identified under business as usual in modelling for the Review, the third and fourth costs—the risks of large and possibly catastrophic damage from severe outcomes (Type 3), and the effects on non-market values (Type 4)—are likely to be of particular importance and concern. Although these categories of costs could not be quantified, the Review was able to undertake analysis and assessment of impacts, as summarised in the Draft Report (Chapter 7).

The risks associated with sea-level rise illustrate the benefits of climate change mitigation beyond the early Type 1 benefits that are brought to account in the modelling: the risk of 21st century market impacts way beyond the median outcomes considered in the modelling (Type 2); the impact on non-market values in the 21st century (Type 4); and all impacts in the years beyond the end of the 21st century.

An updated version of Table 5.1 of the Draft Report (shown below as Table 8.2) presents results from a survey of the recent scientific literature. This suggests that there would be an 85 to 100 per cent chance of the triggering of an irreversible melt of the Greenland ice sheet under the temperatures expected at the end of century in a no-mitigation scenario. Given the uncertainties of when the melt would start, and when it would translate into sea-level rises, the effect has been neither modelled, nor included in our Type 2 estimates of the costs of climate change. As the sea level rose over a matter of centuries by 7 m, it would certainly have a large negative impact on the world, and Australia, post-2100, on the basis of median expectations of market impacts, through the risks of severe and possibly catastrophic impacts, and effects on non-market values. These would also be the conditions under which irreversible melting of the West Antarctic ice sheet would be most likely to occur, so that the correlation of risks increased the chance of severe outcomes.

Table 8.2 Selective summary of outcomes which may occur under the range of temperatures for the three scenarios by 2100

Outcome or impact	450 mitigation	550 mitigation	No mitigation
2100 temperature from pre-industrial	**1.3–2.6ºC**	**1.6–3.2ºC**	**3.5–7.1ºC**
(a) Percentage of species at risk of extinction	5–23%	8–39%	48–100%
(b) Likelihood of initiating irreversible melt of the Greenland ice sheet	6–54%	12–77%	85–100%
(c) Percentage of mortality in tolerant coral species	0–79%	44–87%	90–100%

Notes: The temperature ranges shown are increases from pre-industrial levels based on climate sensitivities of 1.5ºC and 4.5ºC for the lower and upper temperatures respectively. The IPCC considers that climate sensitivities under 1.5ºC are considered unlikely (less than 33% probability), and that 4.5ºC is at the upper end of the range considered likely (greater than 66% probability). The approach is different to that used in Table 5.1 of the Draft Report, which showed the range of median outcomes from three separate climate sensitivity studies.

(a) The percentage of all species 'committed to extinction' due to shifts in habitat caused by temperature and climate changes, from sample regions covering 20 per cent of the earth's land surface. The upper limit (>3.5ºC) is based on less comprehensive datasets and is therefore more uncertain (Sheehan et al. 2008).

(b) Cumulative probability based on four estimates on the threshold for collapse of the Greenland ice sheet from the literature (Sheehan et al. 2008).

(c) Percentage of reef area in which there is widespread mortality in slow-growing, tolerant reef species on a frequency of less than 25 years, based on a range of studies from the literature (Sheehan et al. 2008).

The Review's analysis, presented in the Draft Report, confirms that impacts will be much more costly in the next century. The greater significance of the modelled market impacts of the unmitigated scenario is not so much their absolute magnitude, but their gradient (Figure 8.3). The costs of climate change grow at an increasing rate. This is a trend that would continue into the 22nd century.

Other studies of climate change also show much higher costs from climate change in the next than in the current century (see Section 7). As discussed earlier in this Supplementary Draft Report, under reasonable assumptions, the present value of a percentage point of Australian GDP in a century's

time may be as high as a percentage point of GDP this century. Non-market values are likely to rise in importance relative to consumption of goods and services, for reasons discussed in Chapter 2 of the Draft Report. The large impacts of climate change on environmental amenity that are likely in the 22nd century and beyond (Table 8.2), as discussed in the Draft Report, are likely to be viewed to have considerable importance, alongside the greatly increased impact on material consumption.

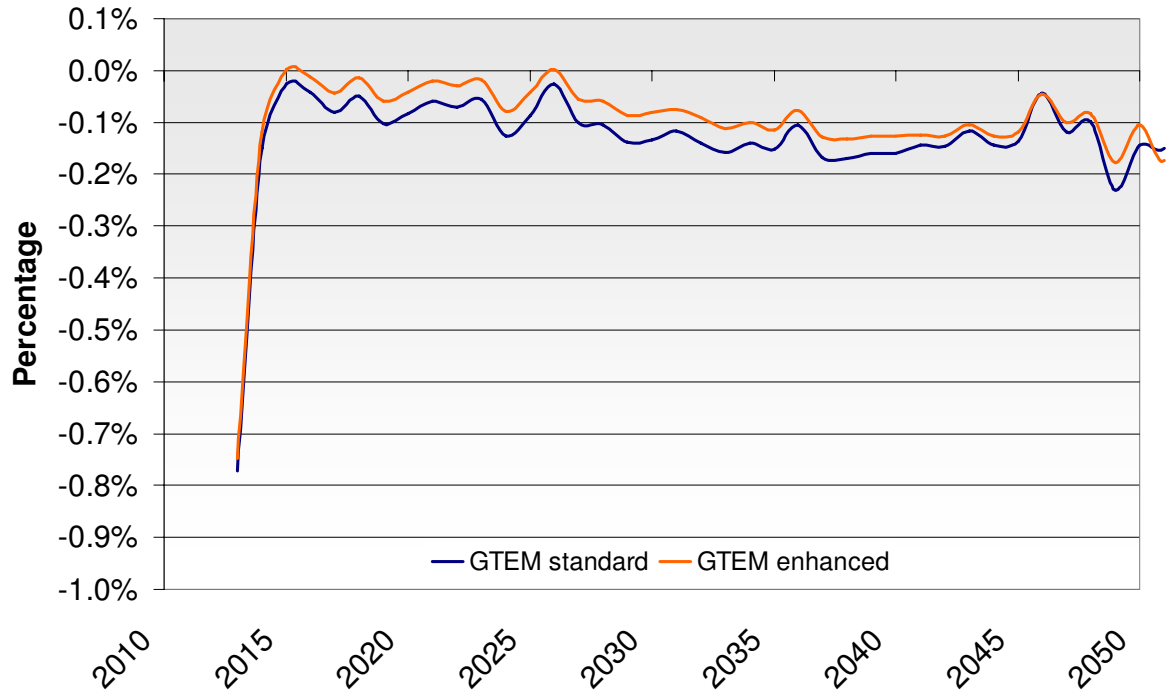
There is a risk that temperature increases, and therefore all of the impacts that are related to temperature, will be much greater than anticipated in the standard cases of the modelling because of positive feedback effects. These are difficult to quantify, but real and potentially large. Once temperature increases above some threshold points, massive carbon and methane stores on earth and in the oceans may be destabilised, leading to much greater volumes of greenhouse gas release from the natural sphere, and further temperature increases (see Section 5.4.1 of the Draft Report).

To summarise, temperature increases of this order of magnitude—an expected increase of 6 degrees, a 9 degree warming at the top of the likely bound, and a smaller probability of a double-digit temperature increase—would not lead to a marginal reduction in human welfare. Their impacts on human civilisation and most ecosystems are likely to be catastrophic. This is the situation to which attention was drawn in the CSIS paper, to which reference was made in the opening paragraphs of this report.

To point to the devastating impact of temperature increase for this century, and of significant further increases next century, and to the possibility that such increases would leave both global and Australian welfare at the end of this century lower than at the start, is not to be alarmist. It is simply to recognise the reality of rapid emissions growth, its likely continuation in the absence of climate change mitigation, and the possibly catastrophic consequences of such large, rapid temperature increases.

Is mitigation worth the cost? Figures 8.4 and 8.5 depict the costs of mitigation up to 2050 under a strategy directed at stabilisation at 550 ppm, as implemented in the two models of the Australian economy used by the Review, GTEM (Global Trade and Environment Model) and MMRF (Monash Multi-Regional Forecasting Model). See the next subsection for further elaboration on the modelling. The GTEM results, below in Figure 8.4, are shown under both standard and enhanced assumptions concerning technological progress, as discussed in the previous section.

Figure 8.4 Reduction in Australia's annual GNP growth (percentage points lost) due to gross mitigation costs under a 550 stabilisation strategy under standard and enhanced technology assumptions, 2013–2050



Note: Results are from the GTEM model.

After an initial modelled shock to the economy of around 0.8 percentage points (a cost which in reality would be spread over several years), the gross costs of mitigation as modelled in GTEM typically shave a bit above 0.1 per cent per annum from GNP growth until after the half-way mark in the century. This can be seen as sacrifice of material consumption in the early decades.

Modelling the costs of mitigation in the second half of the century is more complex for two reasons. First, as discussed earlier, technological options become more uncertain. It is unrealistic to expect that carbon prices will continue to rise to the many hundreds of dollars (as in Figure 8.6) without the development of new technology to offset emissions. Accordingly, very long run cost modelling is best undertaken with the assumption that at some price a backstop technology develops, even if there is uncertainty about the price at which that technology will develop, and the precise form it will take.

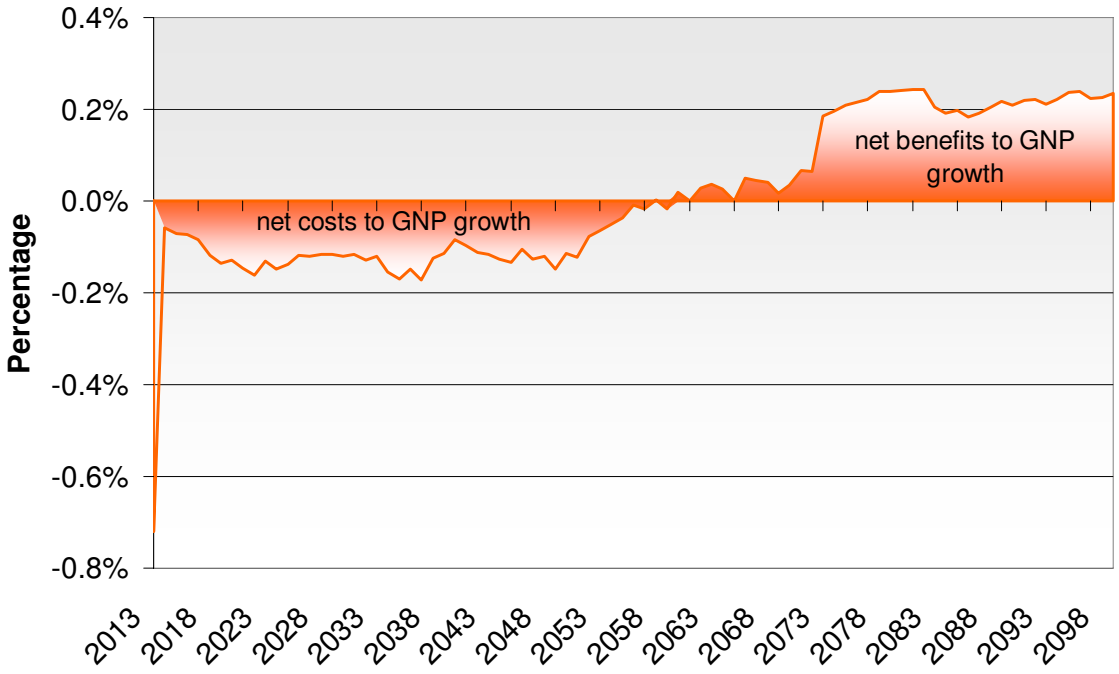
Second, avoided expected climate damages become significant, so measures of costs without them (such as modelled in GTEM) become uninformative. The net mitigation costs calculated in MMRF take into account both the gross costs of mitigation and the benefits of avoided expected climate change market impacts. For the reasons put forward in the Draft Report (see Chapter 10) it is estimated that the 'avoided expected climate change impacts', as modelled in MMRF, cover about 75 per cent of total avoided expected climate change impacts. This is reflected in an adjustment to modelled estimates of climate change damages under different scenarios outside the modelling. This is obviously not as good as modelling these costs within the general equilibrium framework would have been if the data had been available to allow it, but it is clearly better than leaving them out altogether.

These net costs of mitigation as modelled and accounted for here are not meant to represent the full benefits of mitigation, as they do not seek to capture the Type 3 and Type 4 and post-21st century

benefits of mitigation. They do, however, provide an indication of the amount Australia will need to pay to have access to the insurance value, non-market values, and post-21st century benefits of any climate change mitigation strategy.

Figure 8.5 shows the net cost of mitigation (including expected market costs as well as benefits) for the 550 scenario using the MMRF model with an extension implemented by the Review to allow for a backstop technology to emerge post 2050.

Figure 8.5 Change in annual GNP growth (percentage points lost or gained) due to net mitigation costs under a 550 strategy in Australia, 2013–2100



Note: The figures reflect results modelled in MMRF adjusted to incorporate Type 2 costs as per the method described in the text.

Figure 8.5 shows that in the second half of the century, mitigation towards the 550 goal adds to the growth rate of the economy, as, at the margin, more new climate change damages are avoided than new mitigation costs are added. In fact, by the end of the century, GNP is higher than it would have been without mitigation, even when all the costs and only the expected market benefits (Types 1 and 2, but not Types 3 and 4) of mitigation are taken into account.

Despite the boost to growth in the second half of the century, the sacrifice in the first half of the century is substantial, though the loss to GNP is fully recovered with a margin by the end of the century. The benefits that are purchased by this sacrifice take several forms. One is insurance against the effects of severe and possibly catastrophic outcomes on material consumption during this century. Another is increased protection against loss of non-market services this century. Yet another is avoidance of all of the rapidly increasing costs in through the 21st and into the 22nd century and beyond: the rapidly increasing negative impact on material consumption; the risk of outcomes much worse than the median expectations from the applied science (although beyond the 21st century, the median outcomes include more and more of the severe and possibly catastrophic); and the impacts on non-market values.

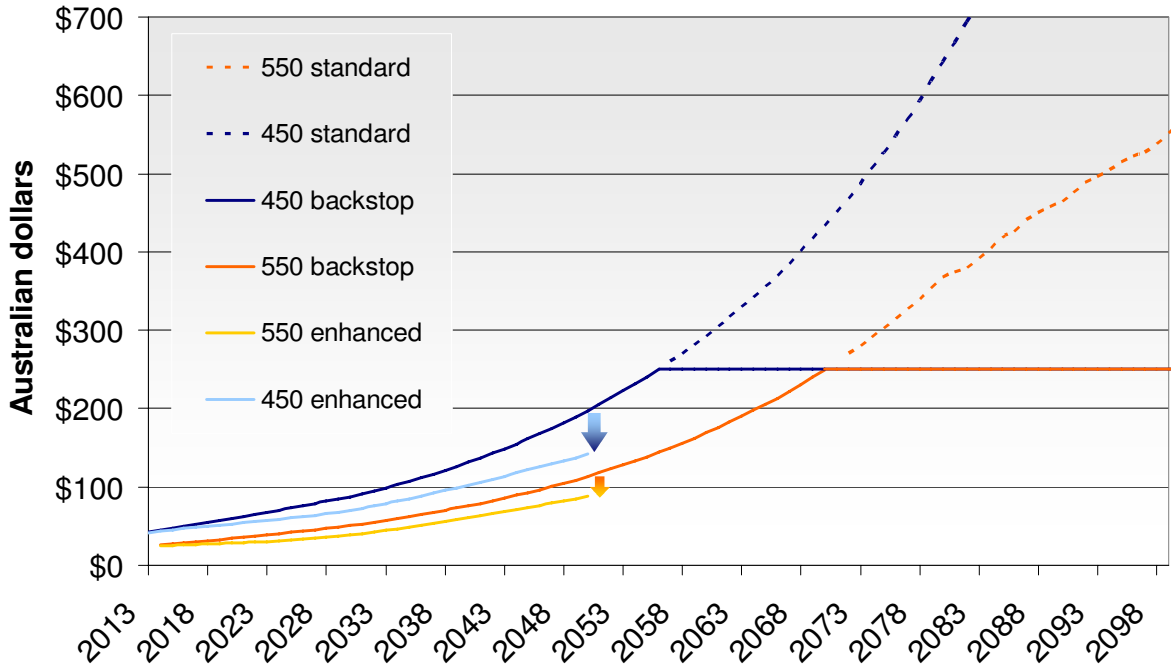
The costs of well-designed mitigation, substantial as they are, do not threaten to derail the long-term growth path of Australia, its developing country neighbours, or the global economy. Unmitigated climate change probably would.

How much mitigation?

How much mitigation is justified? Is it in Australia's interests to support a global goal of limiting the concentration of greenhouse gases to 450 ppm CO_2-e or to 550 ppm? A major portion of the Review's modelling went into weighing the relative benefits of the 450 and 550 strategies.

The modelling is based on costs associated with Australia adhering to an emissions allocation, derived from an international agreement to limit the concentration of greenhouse gases to, respectively, 450 and 550 ppm CO_2-e. As shown in Section 5, Australia's emissions entitlement allocation falls by 80 per cent of its 2000 level in the 550 scenario, and by 90 per cent in the 450 scenario. Australia's emissions can exceed that allocation if Australia buys permits from other countries. It can do so at the global carbon price, which prevails within Australia and across the world. The global carbon price increases over time, along a path which ensures that emissions fall sufficiently for the two concentration targets to be achieved. As a small emitter in global terms, Australia's emissions do not affect the global carbon price, which is taken as a given in the domestic modelling. Figure 8.6 shows the 450 and 550 global carbon prices in 2005 Australian dollars under different assumptions about technology.

Figure 8.6 Australia's carbon prices under different technological assumptions



Note: The rising carbon price paths are derived in GTEM and implemented in MMRF, except for the prices derived under the enhanced technology assumptions which are implemented only in GTEM, which is reported up to 2050. The 450 and 550 price paths move on to the horizontal backstop path when they reach about $250. The two arrows show the extent to which the enhanced technology assumptions reduce the carbon price relative to the standard technology assumptions.

What overall assessment can be made of the relative mitigation costs associated with the 450 and 550 mitigation strategies? Table 8.3 presents data on the present or discounted value of the excess of costs of mitigation in the 450 over the 550 mitigation strategy through the 21st century. It summarises results using the GTEM model for gross mitigation costs out to 2050 (where avoided climate damages are small), and the MMRF model (with the post-2050 backstop) for net mitigation costs (costs net of Type 1 and Type 2 benefits). It calculates the net present value of these costs using two discount rates the Review considers appropriate, namely 1.4 and 2.7 (see Section 7 for their derivation). At the bottom (1.4%) of the range of discount rates considered, and for both models, and time periods and methods, the net present value of the excess cost of the 450 over the 550 strategy is 0.7 to 0.8 per cent of discounted GNP. At the top end of the range of discount rates (2.7%), the premium is in the range of 0.7 to 0.9 per cent of discounted GNP.

Table 8.3 Net present cost of the 450 relative to the 550 and 450 mitigation strategies (in terms of no-mitigation GNP), to 2050 and to 2100

(a) Discount rate of 1.4%	550	450	450 premium
Gross mitigation cost (to 2050)			
GTEM standard	2.6%	3.3%	0.7%
GTEM enhanced	1.9%	2.6%	0.7%
Net mitigation cost (to 2100)			
MMRF	3.2%	3.9%	0.8%
(b) Discount rate equals 2.7%	**550**	**450**	**450 premium**
Gross mitigation cost (to 2050)			
GTEM standard	2.4%	3.2%	0.7%
GTEM enhanced	1.8%	2.5%	0.7%
Net mitigation cost (to 2100)			
MMRF	3.2%	4.1%	0.9%

Note: The figures give the discounted costs as a percentage of discounted GNP. The '450 premium' is the excess of the 450 cost over the 550 cost. Costs in GTEM are gross costs of mitigation; costs in MMRF are net costs (gross costs net of Type 1 and Type 2 benefits). MMRF modelled results are adjusted to incorporate Type 2 costs as per the method described in the text.

Is it worth paying over the course of the century less than 1 per cent of GNP for the non-market benefits, insurance value and the enhanced value beyond the 21st century of the 450 strategy? What are the non-market and insurance benefits of a 450 scenario relative to a 550 one?

Differential avoidance of non-market climate change impacts. Neither strategy will lead to the complete avoidance of non-market climate-change-related impacts altogether. The Draft Report found that even a 1 degree increase could result in a 50 per cent decrease in the area of rainforests in North Queensland (p. 183). The analysis presented in the Draft Report suggests that the difference between 450 and 550 ppm could be of major significance for a range of environmental impacts. For example:

- **The 550 strategy would be expected to lead to the destruction of the Great Barrier Reef and other coral reefs. The 450 strategy would be expected to damage but not destroy these coral reefs.** The analysis reported in the Draft Report found that one expected outcome of the 550

strategy would be the 'disappearance of the reef as we know it'. The three-dimensional structure of the corals would be largely gone and the system instead would be 'dominated by fleshy seaweed and soft corals'. Under the 450 strategy, the reef would still suffer—mass bleaching would be twice as common as it is today—but its disappearance would be much less likely (Table 7.2 in the Draft Report).

- **The 550 strategy would lead to far more species extinction.** As per Table 8.2, reproduced from the Draft Report, under the 550 strategy 8–39 per cent of species would still face extinction worldwide. This is reduced to 5–23 per cent under the 450 scenario.

Differential insurance value of the 450 and 550 strategies. As important as these differential non-market impacts are, perhaps the decisive advantage of the 450 strategy over 550 is its insurance value. While neither the 450 nor the 550 strategy would eliminate climate change risks, the 550 strategy would leave the world, and Australia, open to larger risks of exceeding threshold temperature values, even if these 'tipping points' cannot be known in advance with certainty (Lenton et al. 2008).

Temperature within the 550 strategy is expected to reach 2.5 degrees by the end of the century (Figure 8.2). Temperatures would continue to rise and the increase would eventually reach 3 degrees. As Figure 8.2 shows, there is a one-sixth chance that the temperature increase would reach 3 degrees more by the end of the century.

The Center for Strategic and International Studies study (Campbell et al. 2007) included a scenario of 'severe climate change', within which temperatures increased by 3.1 degrees over pre-industrial levels by 2040. In the 550 strategy modelled by the Review, this is not far above the top end of the likely range by 2050 (Figure 8.2). CSIS found that under this scenario 'nations around the world will be overwhelmed by the scale of change and pernicious challenges, such as pandemic disease. The internal cohesion of nations will be under great stress … both as a result of a dramatic rise in migration and changes in agricultural patterns and water availability. [There will be] flooding of coastal communities around the world...' (Campbell et al. 2007).

Is it worth paying less than 1 per cent of GNP through the 21st century for the insurance and non-market impacts, and these and market benefits beyond 2200, of the 450 strategy? This is a matter of judgment. Judgment will be affected greatly by the success of mitigation regimes and progress in research, development and commercialisation of low-emissions technologies over the years ahead. The Review thinks it likely, with a significant and rising carbon price and support for emergence of low-emissions technologies, and confidence that the new policies are permanent features of the economic environment, there will be technological progress of kinds not currently anticipated. Such developments would greatly favour a 450 over a 550 strategy.

Given the benefits after 2200 of stronger mitigation, and the greater risks of catastrophic consequences to the natural environment under the 550 strategy, the Review judges that it is worth paying less than 1 per cent of GNP as a premium for the 450 strategy.

But Australia alone is not in a position to achieve 450 ppm. Is the international community ready to commit itself to such a strong outcome? Not yet.

The G8 leaders' meeting committed the main developed countries to a global objective of reducing emissions by 50 per cent by 2050. This is consistent with achieving a goal of 450 ppm. But the developed countries are yet to demonstrate their seriousness about such a commitment, and in any case cannot alone deliver such an outcome in the Platinum Age. Substantial reduction in emissions below business as usual in developing countries would also be required, and constraints in the order of what is required are not likely to be accepted over the next few years.

The 450 scenario as modelled requires global emissions in 2020 to be 3 per cent below their 2012 level (Figure 5.1). Developing countries, which have not so far been subjected to quantitative

emissions reduction targets, can reasonably be expected to contain but not to reduce their emissions in the immediate post-Kyoto period—although the current international discourse is not even covering the modest initial reductions below business-as-usual paths for developing countries assumed in the Review's analysis of the 550 and 450 scenarios (Table 5.5).

Achieving the emissions limits set by the 550 scenario over the next decade would be a major win, reflecting unprecedented levels of global cooperation. It might just be feasible. It is not realistic to expect that the international community would, in the few years immediately ahead, agree on the even tighter emissions containments and reductions consistent with a 450 world.

The Review recommends that Australia commit itself to a goal of stabilising emissions at 450 ppm, and express its willingness to play its proportionate part in an effective global agreement to achieve this outcome. At the same time, Australia should work purposefully towards the difficult but immediately achievable goal of 550 ppm, again making it clear that it is willing to make its proportionate contribution to an effective global agreement. Australia should do this with the aim of encouraging the world to a lower long-term goal at the earliest feasible date. As costs and benefits become clearer, and there is progress in low-emissions technologies, the world will be able to show that it can agree on reducing, and actually reduce, emissions consistently with such an agreement.

It is salutary to keep in mind that atmospheric concentrations are already at 455 ppm. Stabilising at 450 ppm, let alone reducing concentration levels below this mark, is no longer possible without overshooting to higher levels and then falling.

The most important first step towards stabilisation at 450 ppm CO_2-e is to quickly put in place an effective international agreement directed at 550 ppm, to put in place the national and international carbon pricing and support for research, development and commercialisation of low-emissions technologies that can lower the costs of mitigation, and to begin the process of reduction of emissions.

A similar case can be made for the superiority of 400 ppm overshooting over 450 ppm overshooting, as for 450 ppm over 550 ppm. Continued work on the science, technology and economics may, and probably will, make a stronger case for 400 ppm as time goes by. It would be critical for the prospects of 400 ppm that there should be a peaking of concentrations and the beginnings of their decline under a 450 overshooting strategy. Thus, just as the path to 450 ppm travels through early progress to 550 ppm, so the path to 400 ppm passes through early progress to 450 ppm.

Indeed, for any mitigation scenario aiming to reduce concentrations to a low level, the world will need to aim not so much for greenhouse gas concentration stabilisation, but for what is known in the climate change literature as 'peaking'.

9 POLICY SETTING IN A WORLD OF AD HOC MITIGATION

Australia's policy priority must be to seek a broad and comprehensive agreement for the reduction of global emissions. The implications for Australia are obvious. Acting alone we can have little impact on the atmospheric concentrations. We cannot prevent the potentially devastating futures that climate change may wreak.

Australia acting in isolation would be deeply problematic. It would impose domestically costs that are higher than they would otherwise need to be and it potentially leaves our traded sector at a competitive disadvantage, for no worthwhile environmental benefit.

This is not a problem unique to Australia. It is the diabolical problem of which I first spoke last November at the S. T. Lee Lecture. Without a framework for global cooperation, every country has an incentive to free-ride on the actions of others while making as little effort as possible in the meantime. Collectively, this can only lead to one outcome, namely, inaction and the inexorable accumulation of greenhouse gases in the atmosphere. By the time the manifestation of climate change is sufficiently powerful enough to overcome the free-rider problem, most options will have been consigned to history.

These are extraordinarily difficult domestic and international problems of political economy for countries willing to show leadership. Ultimately, the only countries that will be able to overcome these problems of political economy will be those whose citizens enjoy stable and enduring socio-political institutions and living standards that are at little genuine risk from the relatively low costs of acting ahead of others. There must also be a willingness to accept alternative perceptions of 'fairness' as discussed above.

In this light, Australia must be among those nations that act ahead of a comprehensive global agreement. This is an obligation that we have already undertaken to fulfill along with the other developed countries. We must be prepared to commit to action without condition but we do so in the expectation that this will only be necessary for a period that is short, transitional, and directed at achievement of global agreement. We must commit to action in order that the ad hoc policy world that requires us to make such commitments can quickly be brought to an end—replaced by the cooperative arrangements that are necessary to reduce the risk of dangerous climate change.

In the ad hoc world, other countries will be in the same position as Australia. Each country will adopt its own trajectory and implement its own policies. There is no guarantee that these policies will be well coordinated or integrated with those implemented in other countries. The potentially adverse consequences for internationally efficient resource allocation will be significant.

Setting interim and unconditional targets in the ad hoc policy world

In an ad hoc world, the setting of national emissions reduction targets is at once a science and an art.

The Emissions Trading Discussion Paper and the Draft Report released by this Review in March and July, respectively, argued that once the total level of emissions over a period of time has been defined, one trajectory was no more or less efficient than any other trajectory. Of greater importance is the design of the market over which that trajectory presides. A well-designed market that maximises opportunities for trade among participants, at a point in time and inter-temporally, will work to allocate scarce permits efficiently.

The Commonwealth Government's policy of reducing emissions by 60 per cent from 2000 levels by 2050 provides the basis for Australia's unconditional commitment in a world of ad hoc national policies. (As noted above, greater reductions will be required, but can be achieved at lower overall cost, under a comprehensive global agreement.) Further, if a well-designed market is in place, as discussed in the Interim Report (February 2008) and the Draft Report (July 2008), there is no reason to suggest that other trajectories would be superior to one defined by a linear reduction in emissions.

The interim target for Australia is defined, therefore, as the first step along a linear path from 2013 towards meeting the Government's stated goal of reducing emissions by 60 per cent from 2000 levels by 2050. This unconditional policy commitment requires a reduction of emissions by 5 per cent from 2000 levels by 2020. This equates to a 25 per cent reduction in per capita emissions from 2000 levels. This compares with the European Union's recently announced unconditional offer, which in corresponding terms equates to reducing per capita emissions by 17 per cent from 2000 levels by 2020.

In the modelling results presented below, this ad hoc scenario is referred to as the 'Copenhagen Compromise', in which it has not been possible to achieve, by December 2009 (or in meetings that follow immediately afterwards), a comprehensive agreement on emissions reductions. Nevertheless, developed countries have endorsed a successor agreement to the Kyoto Protocol. Developing countries are assumed to adopt less stringent commitments as described in Chapters 12 and 13 of the Draft Report.

In the unlikely event that in December 2009 the Copenhagen Conference fails completely to achieve an international agreement with binding commitments at least from developed countries, Australia will be on the cusp of implementing an emissions trading scheme within a highly uncertain international context. Without clear rules defining opportunities for international trade in permits, the Australian emissions trading scheme will be able to do no better than to continue indefinitely with the fixed price permits of the transitional period. This approach would be reviewed in light of a comprehensive or partial international agreement being struck. In the modelling results presented below, this ad hoc scenario is referred to as the 'Waiting Game'.

The dreadful problem of the ad hoc world

A world of ad hoc policies raises the costs of mitigation by limiting opportunities for low-cost abatement to be realised wherever it is most cheaply available. It also distorts investment decisions, as the comparative advantage of countries becomes distorted under an uncoordinated patchwork of national commitments (or lack thereof). These distortions are most acutely manifested in the traded sector by businesses operating in trade-exposed, emissions-intensive industries.

The Draft Report released in July 2008 advocated a three-pronged approach to solving what I have called the 'dreadful problem' that policy makers in every country face. All options must be pursued simultaneously. Two of the options rely on international agreements, namely:

- a comprehensive global agreement on mitigation under which all major emitters have national emissions limits; or
- effective sectoral climate change agreements for trade-exposed, emissions-intensive industries placing particular industries on a more or less level playing-field, through the application of broadly comparable carbon pricing on a sectoral basis. These agreements are discussed in Chapter 13 of the Draft Report.

The third is a domestic arrangement that will need to be deployed if the first two options cannot be achieved in time for the first application of the emissions trading scheme, and involves:

- domestic assistance measures for our most exposed industries that address the failure of our global competitors to act on limiting their carbon emissions.

Contingency planning for the third option is therefore required and is a matter of urgency in preparation for an ad hoc world.

Unravelling the Gordian knot: Assistance arrangements in an ad hoc world

Unless we take a principled policy approach to tackling this 'dreadful' problem, it has the potential to undermine the efficiency and effectiveness of the emissions trading scheme and with it, Australia's commitment to reducing greenhouse gas emissions. There is a view that we don't necessarily have to get it absolutely right from day one; that we will have other chances to deal with the 'dreadful problem' as time goes by—as the rest of the world adopts similar policies. This is a myopic view.

We might not have to get it absolutely right. But if we get it wrong, we will have heavily, maybe permanently, compromised our ability ever to find our way back onto a sound path.

What does 'wrong' mean in this context? It comes down to how we view our domestic policy within the context of the international efforts to deal with climate change. All the models currently in the debate proposing various formulations for the shielding or compensation of our trade-exposed, emissions-intensive industries, despite paying lip service to the contrary, are all predicated on beliefs that:

- nothing is happening elsewhere in the world
- nothing will happen elsewhere in the world
- nothing done by Australia makes any difference to what happens elsewhere in the world.

These three views are simply wrong. Australian policy is not being made in a world of stagnant attitudes towards climate change policy. It is a highly dynamic environment in which every country is closely monitoring the policies and actions of every other country.

Countries around the world are acting to limit their emissions and are likely to do so with increasing ambition. This is already having an effect on global markets for goods and services that are emissions intensive. This is favouring, for example, Australian exporters of natural gas and potential exporters of coal-seam gas, whose markets relative to other fossil fuels are stronger than they were a few years ago. It is favouring Australian exporters of aluminium, some of whose overseas competitors are facing higher costs as a result of other governments' measures to constrain energy use and emissions.

The Europeans, Americans, Chinese, Indonesian and Japanese, among others, are all watching Australia with acute interest to see how we handle the problems of our trade-exposed, emissions-intensive industries. If we get this wrong, it will give every country on earth another excuse to also get it wrong. In aggregate, the global outcome will be a shambles with greatly reduced scope for emissions reductions and the potential for serious damage to the global trading system.

China, the United States, the European Union, Japan—the big economies—may find ways partially and expensively to protect their own industries in a mad scramble for preferment in a world of deep and differentiated government intervention over the dreadful problem. Middle-sized countries like Australia will find it more difficult. But if we get it right, then we can help other countries to get it right. Getting it right means we have to shift the mindset that is currently dictating the policy debate in Australia.

It is important that we stop thinking in terms of payments to Australian firms in order to compensate them for the effects of the domestic emissions trading scheme. There is no basis for compensation arising from the loss of profits as a result of this new policy. The reason for payments to trade-exposed, emissions-intensive industries is different and sound. It is to avoid the economic and environmental costs of having firms in these industries contracting more than, and failing to expand as much as, they would in a world in which all countries were applying carbon constraints involving similar costs to our own.

There is a strong case to be made on the basis of transitional arrangements that are based on efficiency in international resource allocation. There is a clear distinction between compensation and payments to correct for distortions in the efficiency with which resources are used. Providing assistance to address the failure of our global competitors to act on limiting their carbon emissions is not the same as compensating domestic firms for the government's decision to implement a domestic emissions trading scheme. A constructive and efficient solution must focus on policy design that assists our domestic industries to address the failure of our global competitors to act on limiting their carbon emissions.

Despite this being a complex problem, the correct response is simple. The analytic basis was set out in the Review's Emissions Trading Scheme Discussion Paper (March 2008) and in the Draft Report—in each case too obscurely in appendices.

The correct response is based on the following policy prescription:

> **For every unit of production, eligible firms receive a credit against their permit obligations equivalent to the expected uplift in world product prices that would eventuate if our trading competitors had policies similar to our own.**

It is simple. It ensures that firms are encouraged to produce at levels that are sustainable in the context of a global agreement, but they are not required to bear the full cost of doing so on their own until such time as there is an agreement.

It rewards firms that might be described as 'early movers' but does not penalise other producers. It encourages firms to invest in new low-emissions production processes rather than rewarding those who are most successful in their lobbying efforts. Unlike the input-based compensation arrangements currently dominating the debate, this approach fully accounts for the policies of our trading competitors. In this sense it is self correcting. As long as other countries do not impose carbon constraints, payments continue in full.

As trading competitors adopt emissions reduction policies such as ours, observed world product prices will increasingly reflect their true carbon-inclusive value. As this occurs, the gap between the two will narrow and payments will decline without recourse to a political process. The scheme will simply become redundant once a global agreement is in place. Sectoral agreements for particular products will also remove the need for payments to firms in covered industries.

This formulation for calculating payments ensures non-distorted price signals for Australian businesses from the outset of the scheme. Firms will face incentives that accurately reflect those that will eventuate with global or sectoral agreements in place. Australian-based businesses will only reduce domestic production if that is consistent with the long-term loss of comparative advantage in a world of carbon-inclusive pricing.

As with customs and taxation, the potential revenues from the sale of permits suggest strong arguments for delegating administrative judgments to an independent entity. An independent authority will need to be established with the necessary skills to develop carbon-sensitive price models for relevant product markets. Some simple administrative steps could reduce administration costs.

In an open economy like Australia, there are very few non-traded products. Almost all businesses face some degree of trade exposure. It would be nonsensical to think that the above formulation could or should be applied to every product, particularly as in most instances the impact on global product prices from an international carbon price will be negligible.

An eligibility threshold is required. It is defined most appropriately in terms of the expected uplift in the unit price (in percentage terms) in the given compliance period such that:

- only products that are expected to increase in price by a percentage in excess of a low threshold would attract credits under the scheme
- eligible producers would receive credits for that part of the expected price uplift that is in excess of the threshold
- an eligible firm could not receive credits in excess of its permit obligations in any compliance period.

This is best demonstrated with a numerical example in which the threshold ratio has been set at, say, 3 per cent and the observed world price for a particular product is $1000. Following the introduction of the Australian emissions trading scheme, an independent authority forecasts that if a corresponding global carbon-pricing regime were in place, then the world price would rise by $90 per unit (to $1090). The firm would be eligible for credits for each unit produced in Australia because the

projected price rise, at 9 per cent, is in excess of the 3 per cent eligibility threshold. The firm would receive credits against its permit obligation valued at $60 per unit of domestic production.

Special arrangements may be required, as a safeguard, where the estimated price uplift factor exceeds a relatively high proportion of gross value added per unit of production.[6] This is intended as an exceptional rather than a standard design feature.

The calculation of expected price uplift factors, the frequency and timing of credits being distributed to eligible firms, and the relevant accounting rules should all operate to ensure minimum disruption and maximum certainty. Expected price uplift factors would be produced by the independent authority at regular intervals (at a minimum, yearly) through a transparent and consultative process.

Bedding down the appropriate institutional arrangements, methodologies and operating rules should be a matter of priority. As the same arrangements would be of benefit to every country tackling the 'dreadful problem' in regard to its own trade-exposed, emissions-intensive firms, Australia should, over time, look to form international institutions to provide global price indexes for use in calculating credit arrangements for eligible businesses in all countries. This would ensure globally efficient outcomes.

The cost of meeting interim targets

The proposed interim target for Australia's mitigation effort is not a single number. It is a set of numbers and trajectories linked to various outcomes from international discussions.

The Review's timetable did not allow us to extend the joint modelling with the Treasury to targets for the ad hoc world, before there is an international mitigation agreement. We therefore undertook separate analysis of the costs of mitigation in an ad hoc world. Long-term 450 or 550 mitigation in Australia is not viable in an ad hoc world, so this modelling was run only to 2020, and did not extend to benefits of mitigation.

As discussed above, the first best approach for Australia would be to pursue a comprehensive and cooperative global agreement targeting stabilisation of atmospheric concentrations at 550 ppm. This would entail Australia reducing its net emissions by 10 per cent (or 30 per cent per capita emissions) from 2000 levels by 2020.

Failing this outcome, a 'Copenhagen Compromise' would see Australia join a successor agreement to the Kyoto protocol with an unconditional policy commitment to reducing emissions by 5 per cent from 2000 levels by 2020 (or a 25 per cent reduction of per capita emissions) with other developed countries making commensurate commitments.

In the unlikely event that the Australian emissions trading scheme must be implemented without any clarity about an international agreement (partial or comprehensive), the so-called 'Waiting Game' scenario, Australia would continue with a fixed price permit regime.

All scenarios would have a transitional fixed price permit from the commencement of the emissions trading scheme in 2010. The starting price would be set at $20 per tonne. In the '550 stabilisation' and 'Copenhagen Compromise' scenarios, the price would float in line with the international permit price from 2013 when Australian emitters are able to trade on international permit markets. Under the 'Waiting Game' scenario the fixed price regime remains in place as no trade is assumed available in the absence of any international framework agreement.

[6] For example, if the ratio of price uplift (in dollar terms) to gross value added per unit of production exceeds a proportion in the order of, say, 10 per cent, then eligible producers could receive credits for that part of the expected price uplift that is in excess of the threshold when the latter is calculated in dollar terms.

The preliminary and independent analysis by the Review of the costs of Australian mitigation in an ad hoc world provides useful insights. Unlike the more detailed modelling of the 550 scenario, which requires consideration of the benefits arising from climate change avoided as a result of successful mitigation, the ad hoc scenarios focus only on the period to 2020. As this is a period in which climate change impacts are minimal, the ad hoc modelling focuses exclusively on the costs of mitigation only.

Table 9.1 shows macro-economic outcomes for the three policy scenarios (550, the 'Copenhagen Compromise' and the 'Waiting Game') as well as results from the modelling of the long-term policy objective of even lower levels of emissions.

The results have two clear implications.

First, the overall cost to the Australian economy from tackling climate change is manageable and in the order of one-tenth of 1 per cent of annual economic growth. Australia can readily afford to make unconditional and conditional policy commitments of respectively reducing emissions by 5 per cent and 10 per cent in 2020 from 2000 levels (equivalent to per capita reductions of 25 per cent and 30 per cent, respectively).

Second, there are clear benefits from broadening the level of international cooperation in implementing mitigation policy. Australia can significantly increase its mitigation effort at negligible additional cost if the broadest possible agreement can be reached by the global community. The broader the opportunities for low-cost abatement, the lower the overall cost for Australia.

It would be inappropriate and ill-informed to interpret these results as suggesting that Australia should not proceed with its unconditional offer. Although the 'Copenhagen Compromise' is a second-best outcome, as discussed at length in this Report, it may be the necessary intermediate step on the path to the first best outcome. To avoid any doubt, the results summarised in Table 9.1 cannot be read as providing a menu of options.

The only option for Australia at this time is to pursue global agreement to stabilise atmospheric greenhouse gas concentrations at 550 ppm. The 'Copenhagen Compromise' and the 'Waiting Game' describe the consequences in 2020 for Australia of not achieving this outcome.

Beyond this time, not only will the adverse effects of climate change begin accumulating (as described elsewhere in this Report), but the opportunity to avoid the risks of dangerous levels of climate change may well have passed into history.

Table 9.1 Modelling results in 2020 for policy scenarios

	AS SOON AS POSSIBLE	FIRST BEST Conditional offer	SECOND BEST Unconditional offer	THIRD BEST
Scenario	**450 ppm scenario**	**550 ppm scenario**	**'Copenhagen Compromise'**	**'Waiting Game'**
Emissions reduction commitment for 2020 relative to 2000				
Level	-25 %	-10 %	-5 %	—
Per capita	-40 %	-30 %	-25 %	—
Deviations from reference case in 2020				
GDP	-1.6 %	-1.1 %	-.3 %	-0.9 %
GNP	-2.0 %	-1.5 %	-1.4 %	-0.9 %
Consumption	-2.4 %	-1.8 %	-1.6 %	-1.2 %
Carbon price in 2020				
Domestic*	$60.0	$34.5	$52.6	$29.6

* Price is denominated in 2005 Australian dollars.

The effect of varying some key design features

The ad hoc scenarios are predicated on a range of assumptions. From a policy perspective, the most notable of these relate to sectoral coverage, use of permit revenue, international trade in permits, and shielding of highly affected trade-exposed, emissions-intensive industries.

The modelling assumes full coverage of all sectors from the outset of the scheme. All permits are auctioned. Revenue is used to assist highly emissions-intensive industries in the traded sector, with all remaining revenue returned to households in a way that does not distort the effect of price signals emanating from the implementation of the emissions trading scheme.

The Review undertook some preliminary analysis of varying the assumptions in relation to the ability of Australian emitters to partake in a global permit market and the consequences of shielding policies.

Trade in international permits is found to be of particular importance and benefit to the overall economic effects of meeting an emissions reduction objective. For example, adopting emissions reduction targets such as those in the 'Copenhagen Compromise' but artificially restricting access to an international permit market would result in a much higher permit price by 2020. The higher price is explained by the forcing of abatement in areas of domestic activity that would otherwise have been unnecessary and could have been achieved at lower cost in other countries. Consequently, there are adverse effects on macro-economic measures such as GDP and GNP.

Some preliminary analysis on the whole-of-economy implications of providing assistance to trade-exposed, emissions-intensive industries was also examined. This analysis shows that in the presence of a quantitative constraint on emissions, macro-economic variables such as GDP and GNP in 2020 are hardly affected at all by shielding trade-exposed, emissions-intensive industries. The main effect of shielding is to redistribute the burden of costs across parts of the Australian economy.

The Review has not modelled the transaction costs associated with alternative compliance arrangements for the emissions trading scheme. This could turn out to be a substantial deadweight loss on the economy, particularly in relation to the treatment of trade-exposed, emissions-intensive industries in an ad hoc policy world. If this issue is not handled well, uncertainty will affect the supply price of investment. It will lead to a diversion of management effort into rent-seeking behaviour rather than the pursuit of low-emissions production processes. It could potentially lead to a wide corrosion of good economic governance. In the worst of circumstances, it could turn out to be as expensive as the costs of mitigation itself.

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