GARNAUT CLIMATE CHANGE REVIEW

INTERIM REPORT TO THE COMMONWEALTH, STATE AND TERRITORY GOVERNMENTS OF AUSTRALIA

February 2008

Table of Contents

List of Figures

List of Tables

List of Boxes

Executive Summary

This Interim Report seeks to provide a flavour of early findings from the work of the Review, to share ideas on work in progress as a basis for interaction with the Australian community, and to indicate the scope of the work programme through to the completion of the Review. There are some important areas of the Review's work that are barely touched upon in the Interim Report, which will feature prominently in the final reports. Adaptation to climate change, energy efficiency and the distribution of the costs of climate change across households and regions are amongst the prominent omissions from this presentation.

Many views put forward in this Interim Report represent genuinely interim judgements. The Review looks forward to feedback from interested people before formulating recommendations for the final reports.

Developments in mainstream scientific opinion on the relationship between emissions accumulations and climate outcomes, and the Review's own work on future "business as usual" global emissions, suggest that the world is moving towards high risks of dangerous climate change more rapidly than has generally been understood. This makes mitigation more urgent and more costly. At the same time, it makes the probable effects of unmitigated climate change more costly, for Australia and for the world.

The largest source of increased urgency is the unexpectedly high growth of the world economy in the early twenty-first century, combined with unexpectedly high energy intensity of that growth and continuing reliance on high-emissions fossil fuels as sources of energy. These developments are associated with strong economic growth in the developing world, first of all in China. The stronger growth has strong momentum and is likely to continue. It is neither desirable nor remotely feasible to seek to remove environmental pressures through diminution of the aspirations of the world's people for higher material standards of living. The challenge is to end the linkage between economic growth and emissions of greenhouse gases.

Australia's interest lies in the world adopting a strong and effective position on climate change mitigation. This interest is driven by two realities of Australia's position relative to other developed countries: our exceptional sensitivity to climate change: and our exceptional opportunity to do well in a world of effective global mitigation. Australia playing its full part in international efforts on climate change can have a positive effect on global outcomes. The direct effects of Australia's emissions reduction efforts are of secondary importance.

Australia has an important role to play alongside its international partners in establishing a realistic approach to global mitigation. Australia can contribute to the development of clear international understandings on the four components of a successful framework for global mitigation: setting the right global objectives for reduction of the risk of dangerous climate change; converting this into a goal for stabilisation of greenhouse gases in the atmosphere at a specified level; calculating the amount of additional emissions that can be emitted into the atmosphere over a specified number of years if stabilisation of atmospheric concentrations is to be achieved at the desired level; and developing principles for allocating a limited global emissions budget among countries.

Australia should make firm commitments in 2008, to 2020 and 2050 emissions targets that embody similar adjustment cost to that accepted by other developed countries. A lead has been provided by the European Union, and there are reasonable prospects that the United States will become part of the main international framework after the November 2008 elections. Some version of the current State and Federal targets of 60 per cent reduction by 2050, with appropriate interim targets, would meet these requirements.

Australia would need to go considerably further in reduction of emissions as part of an effective global agreement, with full participation by major developing countries, designed to reduce risks of dangerous climate change to acceptable levels. Australia should formulate a position on the contribution that it would be prepared make to an effective global agreement, and offer to implement that stronger position if an appropriately structured international agreement were reached.

The process of reaching an adequate global agreement will be long and difficult. Australia can help to keep the possibility of eventual agreement alive by efficient implementation of its own abatement policies, and through the development of exemplary working models of cooperation with developing countries in regional agreements, including with Papua New Guinea.

Australia must now put in place effective policies to achieve major reductions in emissions. The emissions trading scheme (ETS) is the centre-piece of a domestic mitigation strategy. To achieve effective mitigation at the lowest possible cost, the ETS will need to be supported by measures to correct market failures or weaknesses related to innovation, research and development, to information, and to network infrastructure.

Establishing an ETS with ambitious mitigation objectives will be difficult and will make heavy demands on scarce economic and finite political resources. The difficulty of the task makes it essential to use the most efficient means of achieving the mitigation objectives. That means efficiency both in minimising the economic costs, and in distributing the costs of the scheme across the Australian community in ways that are broadly seen as being fair.

To be effective in contributing as much as possible to an effective global effort to avoid unacceptably high risks of dangerous climate change, soundly based domestic and international policies will need to be sustained steadily over long periods. Policy-makers will need to eschew short-term responses that seem to deal with immediate problems but contribute to the building of pressures for future policy change. The Review aims to provide the basis for steady long-term policy at Commonwealth and State levels, and for productive long-term Australian interaction with the international community on climate change policy.

1 Introduction

The Garnaut Climate Change Review ("the Review") has made considerable progress across its broad terms of reference since July 2007, when an independent secretariat supported by all State and Territory Governments was established within the Victorian Department of Premier and Cabinet. A Commonwealth component of an integrated secretariat, located in the Commonwealth Department of Climate Change, joined the work in January 2008.

The Review seeks to define a way forward for Australia, in a world that is taking seriously the challenge of climate change.

To address the Terms of Reference (see Attachment 1), the Review will provide an Australian perspective on:

- the impacts of climate change on Australia, both directly, and indirectly through its effects on other countries;
- the policies that are most suitable for reconciling the maintenance of rising living standards in Australia and abroad with effective mitigation, and also adaptation to the climate change that will inevitably occur;
- the contribution that Australia can make to an effective global approach to mitigation of climate change;
- the development of market-based approaches to mitigation and adaptation for Australia wherever these are likely to be effective, and the recommendation of other forms of intervention when there is clear evidence of market failure, which can be corrected efficiently by such intervention;
- policies to distribute the burdens of mitigation of, and adaptation to, climate change, over time, between countries, and among citizens, in ways that are widely recognised as being fair—for reasons of equity, and to provide a sound domestic and international political foundation for sustained and effective policy effort over long periods; and
- the appropriate locus of responsibility within the Australian Federation for various mitigation and adaptation policies.

Public forums and lectures held by the Review are an opportunity for experts and the public to contribute to the work of the Review. Since its inception, the Review has held public forums on land management, agriculture and forestry and their place in climate change mitigation (held in Melbourne in August, 2007); the financial and insurance services required for managing the risks posed by climate change and for supporting carbon trading (Sydney in October 2007); review of scientific developments and the need to develop new emissions scenarios (Melbourne in November 2007); and research and development related to low-emissions energy technologies (Brisbane in December 2007). I delivered a public lecture at the Australian National University in Canberra in November 2007, providing a conceptual framework for a number of the issues covered by the Review.

In the first quarter of 2008, the Review intends to hold two more public discussions. There will be a public forum on transport and urban planning in Perth on February 19. In early March, there will be an opportunity for public discussion of a Review paper on design principles of an Australian ETS. Additional public lectures will focus on the international context for Australia's mitigation effort (Adelaide, February 20), and domestic distributional issues raised by introduction of an ETS (Canberra, April).

1.1 The Interim Report

This Interim Report seeks to provide a flavour of early findings from the work of the Review, to share ideas on work in progress as a basis for interaction with the Australian community, and to indicate the scope of the work programme through to the completion of the Review. There are some important areas of the Review's work that are barely touched upon in the Interim Report, which will feature prominently in the final reports. Adaptation to climate change, energy efficiency and the distribution of the costs of climate change across households and regions are amongst the prominent omissions from this presentation.

Many views put forward in this Interim Report represent genuinely interim judgements. The Review looks forward to feedback from interested people before formulating recommendations for the final reports.

The Interim Report begins with a discussion of some background issues related to the science of climate change (section 2.1), and likely present and future emissions growth in the absence of successful mitigation policies (section 2.3). This is necessary background to an assessment of impacts (section 2.4) and to the development of policies to assist in adaptation to future climate change (section 3.3). Consideration of these issues in the Interim Report is brief, and is meant only to provide an indication of the directions of work in progress and an outline of emerging policy ideas.

The Interim Report focuses most strongly on mitigation. The crucial international context of mitigation is discussed in section 4.1. International cooperation in mitigation must be built around principles for defining a limitation on global emissions, and for sharing that limitation among countries. These principles can lead to assessment of what would be an appropriate Australian share of the limited global emissions rights over the years ahead. These crucial issues have been barely mentioned in high-level Australian or international policy discourse, and we are aware that we are making a pioneering contribution to what will become a rich Australian and global debate. While our current views are in an early stage of formation and will undergo change in the period before the release of the full draft report, we thought it important to expose them to Australian comment and discussion. We look forward to the responses from Australians and others assisting in the development of the policy framework presented in the final reports.

To minimise the cost of Australia living within its share of a global emissions budget, an Australian market in emissions (ETS) will need to be established, and a number of weaknesses and failures in related markets addressed. This is the subject of section 4.2. A more detailed paper on design principles for an Australian ETS is being developed for release and public discussion in early March.

The Interim Report concludes with some comments on how well Australia is placed relative to other countries to make its way in a world of constrained global greenhouse gas emissions (section 5).

2 The Climate Science

Climate change policy must begin with the science. When people who have no background in climate science seek to apply scientific perspectives to policy, they are struck by the qualified and contested nature of the material with which they have to work. Part of the uncertainty derives from the complexity of the scientific issues. Part derives from the enormity of the possible consequences of anthropogenic global warming, which encourages a millennial perspective on it. Part derives from the large effects of possible policy responses on levels and distributions of incomes, inviting intense and focussed involvement in the discussion by vested interests.

2.1 A growing body of evidence that the world is warming

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007), recognised an improvement in the scientific understanding of anthropogenic influences on climate change, and concluded that the warming of the climate system is 'unequivocal', and that there was a 'very high confidence' - a greater than 90 per cent chance – that 'the global average net effect of human activities since 1750 has been one of warming'[1].

There is statistical evidence that the global temperature has been on an upward trend in recent times. This would seem to confirm the science that anticipated such warming as a result of increased concentrations of greenhouse gases. However, some people with relevant scientific credentials (and many who lack them) argue that the warming trend may be mainly the result of factors independent of human activity that have been responsible for continuously changing global climate since homo sapiens have been on earth. If there were natural as well as anthropogenic causes of recent global warming, it is not obvious that this would reduce the urgency or importance of reducing anthropogenic greenhouse gas emissions. It could be argued that the presence of additional sources of warming actually increased the importance of early and strong action to moderate the contributions over which humans have some control.

Be that as it may, the Review is in no position to adjudicate on the relative merits of various expert scientific opinions. The Review has neither the time nor the resources to do so. The large majority of the relevant scientific opinion, and of the leadership of the learned academies of science in the countries of great scientific accomplishment, hold the view that human-induced climate change is with us, and that it is already affecting natural and human systems and will increasingly create risks to current patterns of human settlement and activity. The Review takes as a starting point, on the balance of probabilities and not as a matter of belief, the majority opinion of the Australian and international scientific communities.

The IPCC plays an important role in bridging the gap between science and policy, and has had considerable influence on the development of international and domestic climate change policy. The United Nations Framework Convention on Climate Change (UNFCCC) has said that the Assessment Reports are widely recognised by policymakers to be the 'most comprehensive and authoritative assessment of climate change to date, providing an integrated scientific, technical and socioeconomic perspective on relevant issues' (UNFCCC, 2007).

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[1] IPCC (2007a), Summary for Policymakers

The Review takes the work of the IPCC as its starting point for analysis of the impact of climate change and the costs and benefits of mitigation. Again, the Review has made this choice on a balance of probabilities, and not as a matter of faith. Concerns have been raised regarding some elements of the IPCC approach including the objectivity of the IPCC process, apparent influence by political considerations (House of Lords, 2005), and the misrepresentation of climate science by individuals invoking the authority of the IPCC (Landsea, 2005).

The IPCC's view that climate change is happening, and in the absence of effective mitigation has the potential to impose huge costs on human society, is supported by the large majority of scientific opinion. The IPCC has demonstrated that the possible costs of the outcomes are large enough to justify action to avoid or reduce the risks. It would be imprudent beyond the normal limits of human incaution to choose to do nothing in the hope that the problem will go away.

Without in any way diminishing the value of the IPCC's work, the Review considers that there is value in expanding the global scientific effort, and in ensuring that it is open to alternative perspectives beyond the IPCC. In the full reports, the Review will make suggestions on expanding and strengthening the pluralist character of the Australian research efforts in climate change science.

Box 1: The Intergovernmental Panel on Climate Change (IPCC)

The IPCC was established jointly in 1988 by the World Meteorological Organisation (WMO) and United Nations Environment Programme (UNEP). The IPCC does not undertake scientific research, but rather uses material published in the peer-reviewed scientific literature to assess 'on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation' (IPCC, 2004). The IPCC has three working groups and a Task Force on National Greenhouse Inventories. Working Group I looks at the science of climate change. Working Group II looks at vulnerability of both society and natural systems to climate change. Working Group III looks at mitigation (options for how greenhouse gas emissions could be reduced).

Since its establishment, the IPCC has released four comprehensive Assessment Reports, in 1990, 1996, 2001 and 2007. These bring together peer-reviewed studies and are typically a collaborative effort between several thousand experts from around the world. They are extensively reviewed by specialists and governments. For each Working Group report, a 'Summary for Policymakers' is produced, which is approved line-by-line by governments in IPCC plenary sessions. In addition, the IPCC produces a series of Special Reports, Technical Papers, methodologies and guidelines, including the Special Report on Emissions Scenarios (SRES; IPCC, 2000).

The IPCC uses specific terminology when discussing the uncertainty surrounding its conclusions, which represent separately its confidence in the underlying science, and the likelihood of a specific outcome. The likelihood of a specific outcome is represented in terms of probabilities. It refers to means of distributions of outcomes, but also to higher and lower possibilities, with probabilities attached to outcomes that are much more damaging or much more benign.

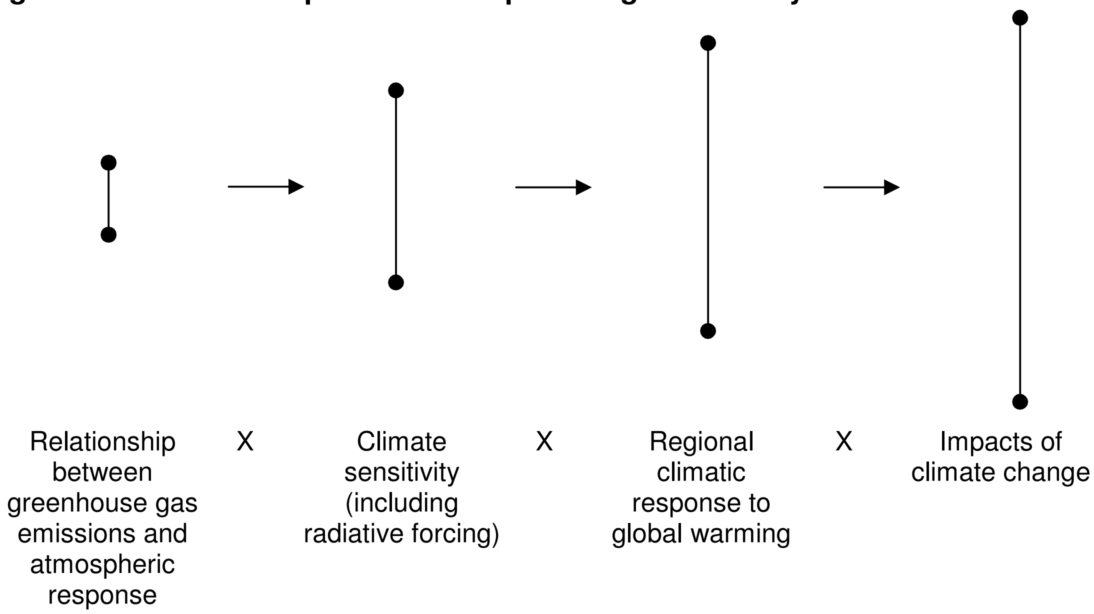
2.2 Uncertainties in the climate change science

Acceptance of the majority perspective of the mainstream science does not end the uncertainties. There are three main areas of uncertainty in climate change science. One involves the relationship between the rate of greenhouse emissions and the concentrations of these gases in the atmosphere. A second involves the extent of the warming that results from any specified change in concentrations. The third is associated with the timing and extent of impacts from a given degree of warming (see Box 2).

The cumulative nature of these uncertainties (see Figure 1) means that the range of outcomes when they are all included can be considerable, making the underlying message unclear.

In the assessment of climate change risk, it is not only the consequence of the impacts of climate change that need to be considered, but also the probability of various levels of impact. A thorough understanding of the uncertainties is essential to the development of good policy decisions.

Figure 1: Schematic depiction of compounding uncertainty



Source: adapted from Jones and Preston (2006).

Box 2: Uncertainties in the climate change science

Greenhouse gas emissions and atmospheric concentrations

Future trends in greenhouse gas emissions are the product of complex interactions between driving forces such as population growth, economic growth and technological change. Developments in these ‘drivers’ are more uncertain the further one goes into the future. The emissions scenarios in the literature suggest a wide range of potential emissions outcomes by the end of the century. Economic analysis can take us a considerable way in defining more likely scenarios. The Review is seeking to narrow the range of uncertainty through analysis of likely rates, distributions and patterns of global economic growth.

The atmospheric concentrations of greenhouse gases are functions not only of the rates of emissions, but also of the rates at which they are removed through various processes. Most gases are removed from the atmosphere by reacting chemically to become another compound, or destroyed by ultra-violet radiation. In contrast, CO_2 is exchanged between the atmosphere, ocean and the land through processes including ocean-air gas transfer and dissolution in the oceans, weathering of rocks and soils and biological processes such as photosynthesis and respiration (that is, through the global carbon cycle).

Natural sinks in the ocean and land remove part of the carbon dioxide emitted each year. The amount varies considerably from year to year.

The amount of CO_2 removed from the atmosphere is affected by climate-carbon feedbacks. Feedbacks are present when changes in climate affect the rate of absorption of CO_2 in the land and ocean. Climate models run to date unanimously agree that climate-carbon feedbacks occur, but the magnitude of these impacts is uncertain. In general, higher atmospheric concentration of greenhouse gases, and larger changes to the climate, reduce the absorptive capacity of the carbon cycle. (IPCC, 2007a[2]).

Examples of climate-carbon feedbacks include the decrease in the ability of the oceans to remove CO_2 from the atmosphere with increasing water temperature; the weakening of the uptake of carbon in terrestrial sinks due to heat and water stress (Canadell *et al.*, 2007); and the release of methane from hydrates in the ocean and permafrost as temperatures rise (IPCC, 2007a[3]).

Radiative forcing

Radiative forcing is the term used to quantify the instantaneous warming effect that can be attributed to a certain concentration of greenhouse gases and aerosols in the atmosphere. It is measured in Watts per square metre. The ‘forcing’ due to CO_2, methane, nitrous oxide and halocarbons is relatively well understood. However, the contribution of stratospheric and tropospheric ozone, aerosols and linear contrails[4] is poorly understood (CASPI, 2007).

Aerosols are tiny particles in the atmosphere including sulphates and black carbon that can be natural or anthropogenic in origin. The major anthropogenic source is fossil fuel combustion. Aerosols can contribute to climate forcing either directly through scattering and absorbing radiation, or indirectly by modifying cloud formation and optical properties

2 IPCC (2007a), Chapter 10, p. 750.

3 IPCC (2007a), Chapter 8, p. 642.

4 A contrail is the white line-cloud often visible behind aircraft. Contrails are triggered from the water vapour emitted by aircraft. Their optical properties depend on the particles emitted or formed in the aircraft plume and on the ambient atmospheric conditions. The radiative effect of contrails depends on their optical properties and global cover, both of which are uncertain (IPCC, 1999).

(IPCC, 2007a[5]). The overall effect of aerosols on radiative forcing is negative, creating a cooling effect. There is great uncertainty about the magnitude of the impact. Because the lifespan of aerosols in the atmosphere is much shorter than greenhouse gases, the effects are more likely to be felt in the region in which the aerosol is produced. Further, cessation of aerosol emissions could have a rapid effect on radiative forcing.

Uncertainty in the amount of radiative forcing from greenhouse gases is usually incorporated into uncertainty associated with climate sensitivity (CASPI, 2007).

Climate sensitivity

Climate models provide a wide range of estimates as to how the climate system will respond to increased concentrations of greenhouse gases in the atmosphere. The range results from limitations in scientific understanding and in the computing power of the models. Since the IPCC Third Assessment Report (2001), substantial progress has been made in understanding differences in climate response between models.

The response of the climate system to changes in greenhouse gas concentrations is referred to as ‘climate sensitivity’. The equilibrium climate sensitivity is a measure of the climate system response to sustained radiative forcing, defined as the global average surface warming following a doubling of CO_2 concentrations. In the Fourth Assessment Report (2007), the IPCC estimates that it is likely that climate sensitivity is between 2°C and 4.5°C. It is considered very unlikely that climate sensitivity will be less than 1.5°C. Values substantially higher than 4.5°C – including as high as 10ºC – cannot be excluded. The best estimate of the IPCC is about 3°C (IPCC, 2007a[6]).

Climate feedbacks contribute to uncertainty in climate response to changes in concentrations, just as they do to the relationship between emissions and concentrations. For example, increases in surface albedo occur, where warming causes snow and ice to melt. They are replaced by land and oceans which absorb more solar radiation, and so contribute to more warming (IPCC, 2007a[7]). Warming causes an increase in atmospheric humidity (and water vapour is the most important greenhouse gas in the atmosphere). It also causes changes in the radiative properties of clouds (IPCC, 2007a[8]). The largest source of uncertainty in the current estimates is in the direction and magnitude of changes in cloud properties (IPCCa, 2007[9]).

The IPCC estimated the temperature change out to 2100 using 19 atmospheric-ocean general circulation models for a range for different scenarios of future greenhouse gas emissions. In the scenario representing strong economic growth and dependence on fossil fuel-derived energy – the A1FI emissions scenario[10] – results showed a median value of 4.5ºC, with a possible range of 3.5ºC to 5.5ºC within one standard deviation. If carbon cycle feedbacks are assumed to be higher than the medium setting, the range of temperature increase extends from 3.4ºC to 6.1ºC (IPCC, 2007a11).

5 IPCC (2007a), Glossary, p. 941.

6 IPCC (2007a). Chapter 10, p. 799.

7 IPCC (2007a), Glossary, p. 941.

8 IPCC (2007a), Chapter 8, p. 630 -632.

9 IPCC (2007a), Chapter 10, p. 799 and Chapter 8, p. 630.

10 As discussed later in the report, the IPCC has structured its projections about future trajectories for greenhouse gas emissions and climate change under various scenarios. The IPCC scenario with assumptions of future economic growth and emissions intensity which analysis of the Review to-date indicates is the most likely to be closest to the twenty-first century reality in the absence of any effective mitigation (“business as usual”) is called A1FI.

11 IPCC (2007a), Chapter 10, p. 802 - 804.

Regional and global impacts of climate change

A large amount of research in recent years has generated a more systematic understanding of how the timing and magnitude of climate change impacts might be affected by varying amounts and rates of warming. However, model results still show a wide range of responses in some climate variables, and also 'thresholds' at which key vulnerabilities may occur.

A key uncertainty in the analysis of climate change impact on the local scale is the magnitude and direction of changes in precipitation. Changes in precipitation are anticipated as temperatures rise due to an increase in water vapour in the atmosphere and changing wind patterns (CSIRO and BOM, 2007). Variations in rainfall can be quite sensitive to small differences in atmospheric circulation, and as a result different climate models simulate different rainfall changes under the same temperature increase. For the A1FI emissions scenario in Australia, by 2070 the range of change to the annual precipitation is -30 per cent to +20 per cent, with considerable variations between seasons and regions. Assessments regarding the level of rainfall have a considerable impact on the analysis of the costs of climate change in relation to agricultural productivity, fire hazard and water supply.

On the global scale, there is considerable uncertainty in the amount of sea level rise occurring under different levels of anthropogenic emissions. The IPCC Fourth Assessment Report estimates that sea level rise by the end of the century under A1FI, the highest emissions scenario through the twenty first century, will be between 0.26 and 0.59 metres, and under B1, the lowest SRES scenario, between 0.18 and 0.38 metres (IPCC, 2007a[12]). These figures include rises due to thermal expansion of the oceans, and some consideration of ice flow from Greenland and Antarctica. However, they do not include potential rises from climate-carbon cycle feedbacks or the full effects of ice-sheet flow. Further uncertainty lies in the threshold temperatures leading to the melting of the Greenland Ice Sheet, which range from 1ºC to 3ºC (Preston and Jones, 2006). Estimates of the warming necessary to melt the west Antarctic ice sheet range from 1ºC to 10ºC (Oppenheimer and Alley, 2005). If the Greenland ice sheet were to melt, it would add about seven metres to the world's ocean, and the west Antarctic ice sheet up to six metres, over a long period. To the extent that the melting of the ice sheet is small, increased snowfall over the Antarctic ice sheet would increase mass, and moderate the increase in sea level.

2.3 Emissions trajectories

Estimating future emissions growth

In order to assess the potential impacts of climate change and impacts of mitigation, we need to estimate future emissions growth.

The scenarios developed by the IPCC in the SRES provide a wide range of future emissions paths for use in climate change analysis. The SRES scenarios project emissions out to 2100 under four different 'storylines' of how the future might evolve, each with many variations that embody different assumptions about technology and energy use. The SRES scenarios have been used extensively as the basis for scientific and economic analysis of climate change impacts and mitigation, with a considerable amount of this work evaluated in both the Third and Fourth Assessment Reports of the IPCC. The SRES scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume

12 IPCC (2007a), Summary for Policymakers, Table SPM3.

implementation of the emissions targets of the Kyoto Protocol. However, greenhouse gas emissions may be directly affected by a range of non-climate change policies such as pollution management (IPCC, 2000[13]).

This Interim Report focuses most strongly on one of the many SRES scenarios, A1FI, and makes comparative reference to two others, A1B and B1.

A1FI

The SRES A1FI emissions scenario—which assumes the continuation of strong global economic growth (averaging around three per cent for 1990-2100) and strong continuing dependence on fossil fuel for energy—has the highest continuing emissions growth and total twenty first century emissions of all IPCC scenarios. A1FI was generally considered to be "extreme" prior to the work of this Review. In fact, emissions have been growing even faster in recent years than under the A1FI scenario.

A1B

The A1B scenario has strong emissions growth rates until around 2030, but then has emissions plateauing, and subsequently declining from around the middle of the twenty-first century. It seems unlikely that such a sharp slowdown and turnaround would occur in a world without climate change mitigation policies.

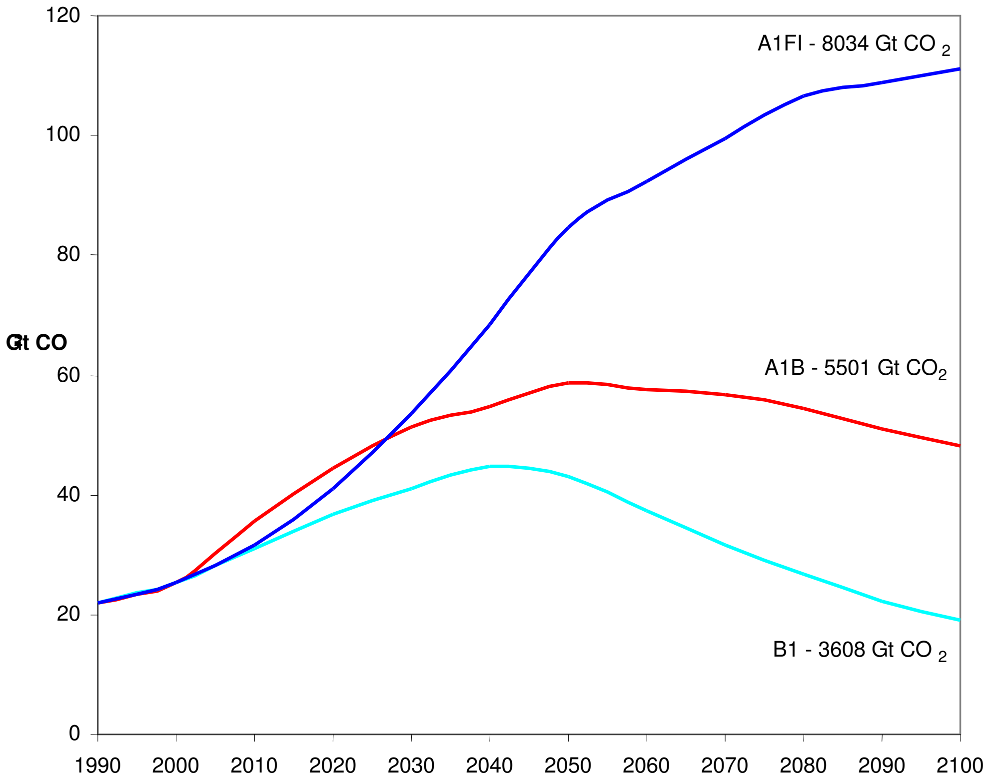
B1

At the other end of the spectrum, the B1 scenario is a widely-referenced low-emissions scenario. It shows moderate growth in emissions until 2040, and then a decline in absolute terms. The long-term trajectories of these three SRES scenarios which the Review uses for comparative purposes are shown in Figure 2.

All the SRES scenarios were assigned equal likelihood, however implausibly, and the IPCC analysis covers the entire range of scenarios. However, in practice there has been a tendency to focus on the more 'moderate' of the SRES scenarios both in the literature and in the communication of climate change issues. For example, the video presentation by the Chairman of the IPCC, Rajendra Pachauri, at the Conference of the Parties in Bali, referred to a range of possible temperature increases, but placed more emphasis on the lowest end of the range represented by scenario B1 (Pachauri, 2007).

[13] IPCC (2000), Summary for Policymakers, p. 3.

Figure 2: Selected SRES scenarios, showing annual emissions out to 2100. Labels indicate accumulative emissions out to 2100



Note: Values in Gt CO_2 shown in labels are cumulative emissions out to 2100 based on values in Table 5-2, Section 5, IPCC 2000[14].

Source: IPCC (2000).

Global economic growth is driving higher emissions

Growth in carbon dioxide (CO_2) emissions from fossil fuel burning and industrial processes has lifted markedly in the early twenty first century.

These emissions grew at only 1.1 per cent a year on average from 1990 to 1999. They increased at 3.1 per cent per year from 2000 to 2006. This increase occurred despite the dampening effect of extraordinarily large increases in petroleum prices, and through short-term cross-substitution, prices of other fossil fuels.

Global emissions from combustion of fossil fuels accelerated sharply from around 2000. Since 2000 actual emissions have grown significantly faster than one of the high-growth SRES scenarios (A1FI) and about as fast as a second, A1B, which has the fastest short-term growth of all SRES scenarios (Figure 2).

Global emissions are likely to continue growing rapidly in the absence of effective mitigation measures. Global economic growth, the energy intensity of growth, and the carbon intensity of energy in the early twenty first century have all been

14 The SRES scenarios shown are: the marker scenario for B1 (IMAGE model), which represents the lowest of the SRES marker scenarios; the illustrative scenario for A1FI (MiniCAM model); and the AIB marker scenario (AIM model). Source: SRES Final Data (version 1.1, July 2000) – http://sres.ciesin.columbia.edu/final_data.html

exceeding expectations that had been built into the most influential assessments of climate change.

Over recent years, average annual global economic growth has been around five per cent (using purchasing power parities (PPPs), as one should[15], rather than market exchange rates (MERs)). This is much higher than in the last quarter of the twentieth century.

This accelerated expansion has been led by growth rates of ten to twelve per cent in China and eight to nine per cent in India. The evidence is accumulating that these high average growth rates of the early twenty-first century are not temporary phenomena. In China, there are reasonable prospects for growth rates in the vicinity of ten percent per annum—higher still for a while—to continue for some time, and for high growth to continue until average Chinese productivity levels and living standards are approaching the range of developed countries in the late 2020s (Garnaut and Huang, 2007; Garnaut, 2007a). In India, the new, higher growth trajectory is soundly based, and has strong momentum.

Global GDP growth at market rates has averaged 3.6 per cent for the last five years, compared to the A1FI scenario growth rate for the first decade of the twenty-first century of 3.3 per cent[16]. Global growth will accelerate in coming decades as the economic weight of the rapidly growing developing countries increases, at least in line with the modest increases foreseen by A1FI, perhaps more.

Second, the IPCC scenarios presume continued reductions in the energy intensity of global growth along the lines of the late 20th century. This perspective would have been strongly influenced by perceptions of developments in China. The energy intensity of Chinese growth fell markedly through the first two decades of Chinese reforms in the 1980s and 1990s, when price reform and the dismantling of central planning led to large one-off gains. However, energy intensity of Chinese growth in the twenty-first century has been far higher than in the 1990s. The more recent tendency for energy intensity to increase is in line with the experience of most countries at similar levels of development.

Energy intensity of global GDP fell by just 0.2 per cent per year from 2000-2005, compared to 1.4 per cent during the 1990s. In the SRES A1FI scenario, energy intensity is assumed to fall by 0.8 per cent per year from 2000-2010, with higher reduction rates after 2010.

The fossil fuels of oil, gas and coal currently dominate the global energy mix. While increasing demand and limitations on expansion of production have lifted oil prices to exceptional levels and seem likely to keep them high, there is no similar scarcity constraint on coal, and total fossil fuel consumption could continue to increase rapidly for many decades to come. There is no necessary reason why the

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15 It is preferable on conceptual grounds to use PPP-based global growth rates (Castles and Henderson, 2003). MERs give a lower global growth figure than PPP due to the smaller weight they give to rapidly-developing countries.

IMF *2007 World Economic Outlook*, Table A1, 1999-2008 and 2003-2008; simple average of annual growth rates; 2007 and 2008 are forecasts. In late 2007, the World Bank announced that it was making large reductions in its PPP measures of GDP for a number of important developing countries, including China and India. This has reduced the weighting for the time being of rapidly growing developing countries in the IMF's calculations of PPP-based estimates of growth in global GDP. By implication, it also raised estimates of growth in the emissions intensity of GDP.

16 The majority of the models used in the SRES study used MERs, therefore MER figures are presented here for comparative purposes.

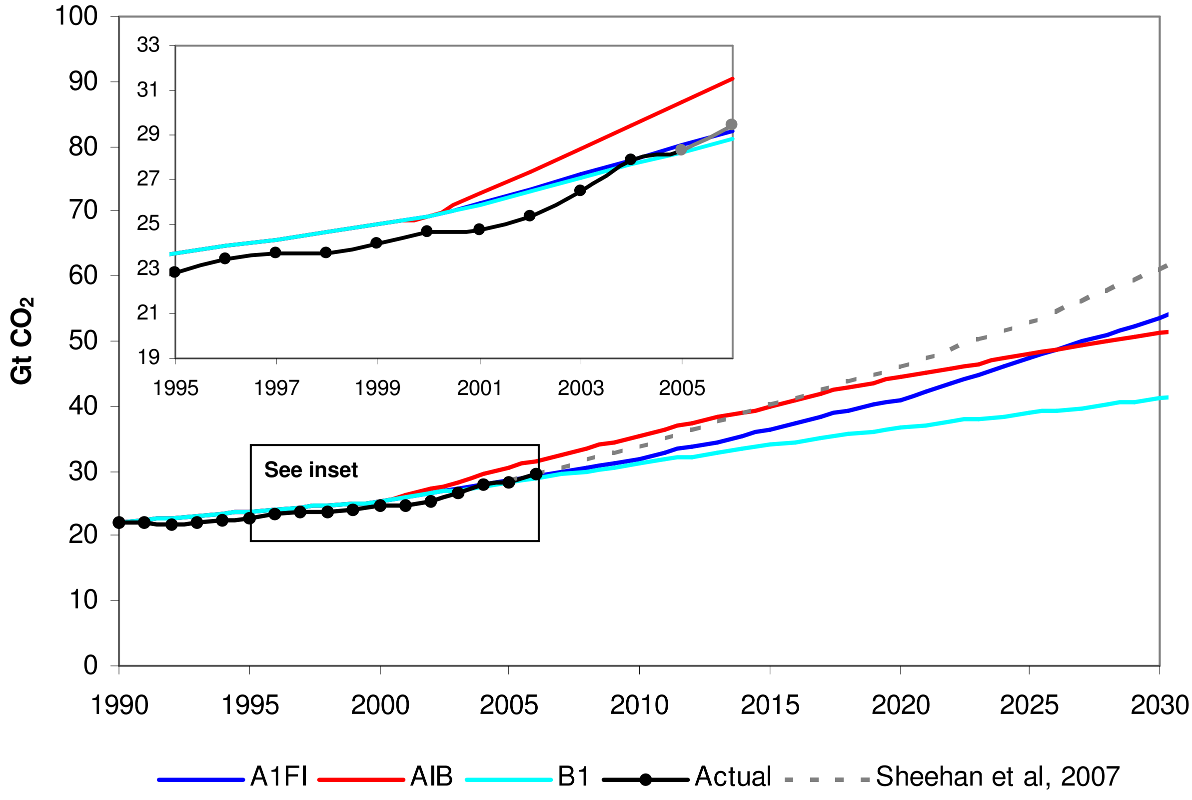
relationship between fossil fuel emissions and economic growth will change markedly and favourably without effective policy interventions. Technology for carbon capture and storage, if and when it becomes commercially available, would carry significant additional investment and operating costs and so will only be deployed under mitigation policies.

The recent effects of higher oil prices are instructive. Two highly emissions-intensive alternatives – coal and synthetic liquid hydro-carbons (derived from coal, tar sands, shale or natural gas) – are expanding their roles in the major developing countries and in much of the world more rapidly than the lower-emission alternatives.

Globally, the emissions intensity of total energy supply increased by 0.4 per cent per year from 2000-2005, compared to a reduction of 0.2 per cent per year over the previous decade. The A1FI scenario assumes an annual reduction of 0.2 per cent from 2000-2010, and the same to 2030.

Initial analysis carried out for the Review suggests the likelihood, under business as usual, of continued growth of emissions in excess of the highest IPCC scenarios. Figure 3 shows that assuming more realistic growth and energy intensity for China and India alone produces higher projected global emissions from fuel combustion than even the most pessimistic of the IPCC scenarios out to 2030 (Sheehan et al., 2007).

Figure 3: Global CO_2 emissions from fossil fuel use and cement: actual emissions and updated projections against selected SRES scenarios.



Notes:

- The comparison between SRES and actual emissions shows the overestimation of emissions by the SRES scenarios during the 1990s, and the sharp increase in actual emissions after 2000. The updated projection suggests how emissions would greatly exceed the highest of the SRES scenarios if current trends continue.

- A1FI and A1B are high-emissions-growth scenarios, while B1 is a widely-used low-emissions-growth scenario.

- Emissions shown are CO_2 sourced from fossil fuel combustion and cement only – emissions from land use change are not included.

- 'Actual' combustion emissions data is sourced from International Energy Agency to 2005. 2006 data (shown in grey) is from the Netherlands Environmental Assessment Authority, 2007, based on estimates from BP energy data for consumption of coal, oil products and natural gas. Cement data to 2004 is sourced from Carbon Dioxide Information Analysis Centre (Marland *et al*., 2007), with projections included for 2005 and 2006 data. Emissions from cement represent around 3-4 per cent of the total.

- The updated projections from Sheehan *et al.* (2007)[17], reflect the implications on global emissions projections of what are judged to be realistic growth and

[17] Sheehan, P., Jones, R., Jolley A., Preston, B., Clark, M., Durack, P., Islam, S., Sun, F., and Whetton., P (2007). Climate Change and the New World Economy: Implications for the Nature and Timing of Policy Responses. CSES Working Paper No. 12, http://www.businessandlaw.vu.edu.au/cses/documents/working_papers/climate/Ccwp_12.pdf.

emission intensity trends in China and India (between 7.5 and ten per cent per year). Global projections are made by Sheehan *et al*. (2007) with historic emissions (to 2003) from the IEA.

Source: Sheehan et al. (2007)

This section has reported initial findings. The Review is undertaking detailed work on likely energy and emissions trends under 'business as usual', 'ad-hoc and partial mitigation' and 'comprehensive mitigation' scenarios, in the light of analysis of recent trends in the fast-growing economies of Asia, and future prospects there and elsewhere in the developing world.

These more realistic growth trajectories bring forward in time the critical points for high risks of dangerous climate change. Time is running out.

Stabilisation scenarios

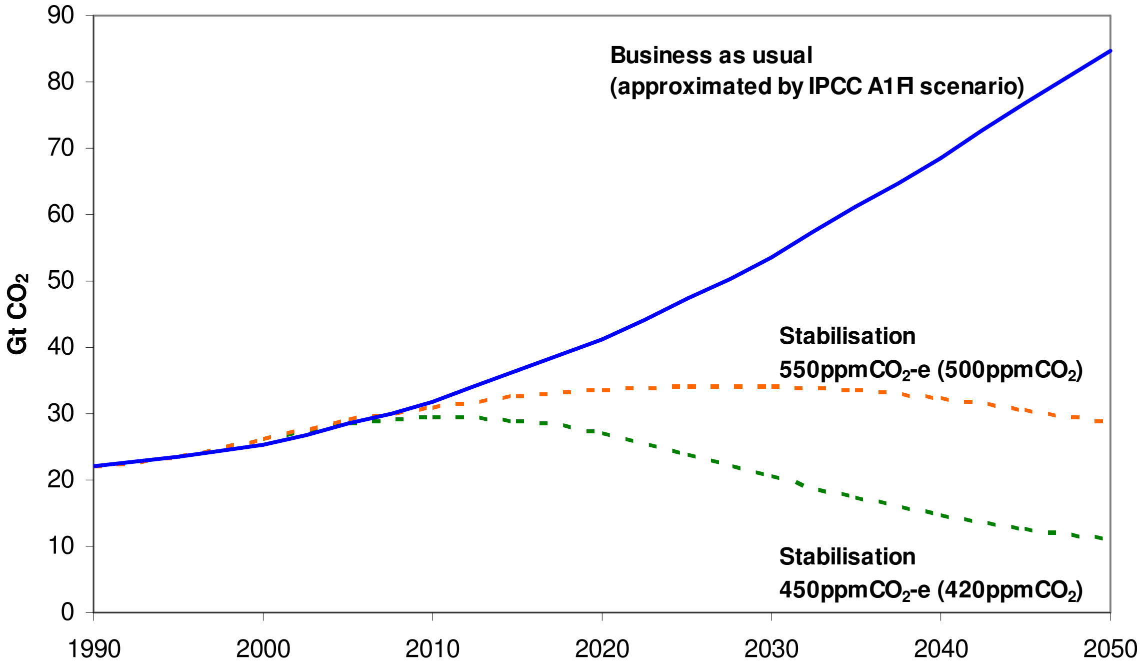
A target concentration of around 450 ppm CO_2-e has been widely discussed in the literature, and was the basis of the 25-40 per cent emissions reduction proposal for developed countries discussed at the Conference of Parties in Bali (see section 4.1).

Achieving stabilisation at 450 ppm CO_2-e target would require dramatic and immediate changes in global emissions. An initial simulation scenario for this stabilisation target carried out for the Review (using CO_2 stabilisation at 420ppm as a proxy for stabilisation of all greenhouse gases at 450 ppm CO_2-e) has global emissions peaking around 2010, falling to 2000 levels by soon after 2020, and then to less than half of 2000 levels by 2050 and less than a quarter by 2100 (Figure 4).

A less ambitious target, leaving much higher risks of dangerous climate change, is to restrict greenhouse gas concentrations to 550 ppm CO_2-e (see section 3.2). An initial simulation scenario to achieve this stabilisation target has global emissions slowing, peaking by 2030, and then falling back to 2000 levels around the middle of the century (Figure 4).

These stabilisation paths are only illustrative, as there are multiple paths to any specific concentration target. However, they make the point that only urgent, large, and effective global policy change leaves any hope of holding atmospheric concentrations at the 450 ppm or even the 550 ppm levels.

Figure 4: Annual global emissions under a "business as usual" emissions growth scenario and two stabilisation scenarios



Note: The two stabilisation scenarios represent initial work undertaken for the Review (CASPI, 2007), and are illustrative only. The 450 ppm CO_2-e scenario allows for temporary overshooting to around 500 ppm.

Temporary overshooting of ambitious concentration targets may be unavoidable, but poses dangers.

The 450 ppm CO_2-e stabilisation scenario depicted here involves allowing the greenhouse gas concentration to reach around 500ppm CO_2-e before it declines to 450 ppm CO_2-e later ("overshooting"). Keeping the concentration to 450 ppm CO_2-e or less would require a peaking of global emissions in 2010 followed by a very rapid fall. The Stern Review estimated that to keep below 450 ppm at all times would require sustained annual reductions of seven per cent. Recent acceleration of global emissions growth has made the task even harder than anticipated just two years ago. Peaking of global emissions in the near future, followed by very rapid falls, is clearly not feasible, given long lead-times and lifetimes of energy sector investments, and the huge momentum of emissions growth especially but not only in developing countries.

Overshooting atmospheric concentration implies that global temperatures may exceed the eventual equilibrium temperature for the target stabilisation for some time. Although the temperature will decrease, with a lag, once atmospheric concentrations return to the stabilisation target, overshooting increases the risk of irreversible climate change impacts occurring. Overshooting implies the prospect of earlier climate change than would otherwise be the case. This increases the cost of possible future climate change in present value terms.

More broadly, the case of overshooting raises the issue of pathways to stabilisation. Different trajectories can ultimately achieve the same concentration target at a given point in time, but with different mitigation costs and climate impacts and costs. The Review will undertake modelling of the expected least-cost trajectory to achieve emissions budgets through time, both globally and for Australia. Modelling will also explore the effect of emissions trajectories on the costs of climate impacts.

2.4 Consequences of climate change

Observed climate change

The reality of observed climate change in recent years has surprised mainstream scientific opinion, exceeding expectations from the increase in emissions concentrations that have accumulated to date (see the presentations at the Review's November 14 Forum in Melbourne).

Comparisons between observed data and model predictions suggest that the climate system may be responding more quickly than climate models indicate (Rahmstorf et al., 2007).

- Global mean surface temperature increase since 1990 has been measured at 0.33ºC, which is in the upper end of the range predicted by the IPCC in the Third Assessment Report in 2001, as shown in Figure 5 (Rahmstorf *et al.*, 2007).
- Sea level rise since 1993 has shown a linear trend of 3.3 ± 0.4 mm/year. In 2001, the IPCC projected a best estimate rise of less than 2mm/year, as shown in Figure 6 (Rahmstorf *et al.,* 2007).
- The IPCC Fourth Assessment Report recognised that the capacity of the oceans and the terrestrial biosphere to absorb increasing emissions would decrease over time. Observations suggest that absorptive capacity has been falling more rapidly than estimated by the main models. If these trends continue, a greater proportion of emitted carbon dioxide will remain in the atmosphere in the coming years, which will exacerbate the warming trend (Canadell *et al.*, 2007).

Figure 5: Observed temperature data against IPCC predictions

Future temperature as projected by the IPCC in 2001, indicated by the grey regions and dashed lines. The oscillating solid lines show observed changes in annual global-mean land and ocean combined surface temperature from GISS (red) and Hadley Centre (blue), with their trends shown in bold.

Source: Rahmstorf et al. *(2007).*

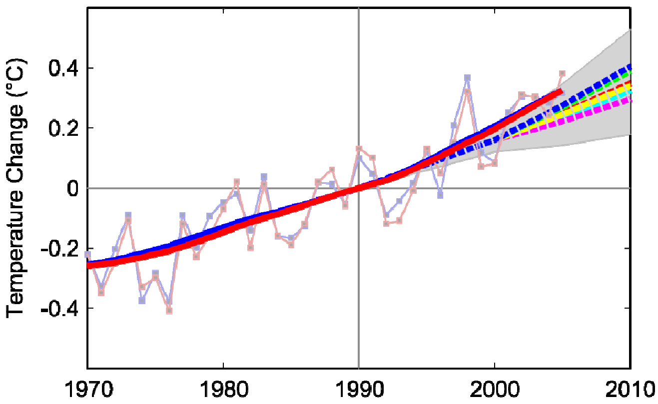
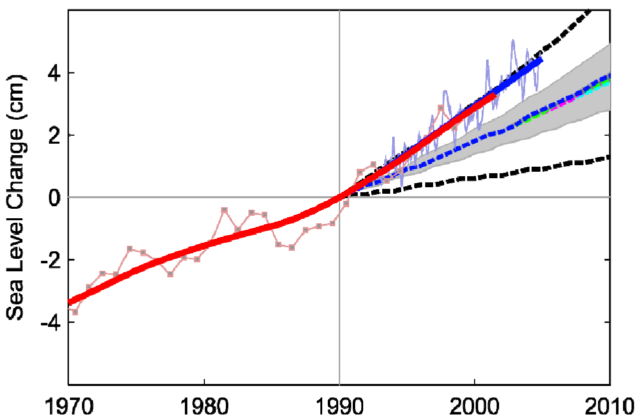


Figure 6: Observed sea-level data against IPCC predictions

Future sea-level change (right panel) as projected by the IPCC in 2001, indicated by the grey regions and dashed lines. The oscillating solid lines show observed changes based on tide and satellite data, with trends shown in bold.

Source: Rahmstorf et al. *(2007).*



These observations are tracking at the high end of IPCC predictions. The lag in the climate system resulting from the slow response of the oceans to absorb emissions (IPCC, 2007a[18]) means that the changes that have been observed to date are a result of historic emissions. The consequences of the unexpectedly high level of emissions in the early years of the twenty-first century will be felt in future decades.

Climate change in Australia – current and future

The final reports of the Review will consolidate expert research into impacts of climate change on regions and sectors of Australia. They will take into account the indirect effects on Australia from climate change impacts on other countries in Asia and the Pacific. The Review will also explore the whole-of-economy consequences of these impacts, and the extent to which they can be avoided through successful global mitigation.

The Australian climate has changed notably over the past 50 years.

Annual mean temperature in Australia has increased by up to 0.7°C since 1950. According to the IPCC, there is a greater than 90 per cent probability that the warming observed since the 1950s is due to human activities (IPCC, 2007c[19]). There has been a striking change in precipitation trends in Australia since the 1950s. North-west Australia has seen an increase in annual rainfall of more than 30mm per decade, while decreases along parts of the east coast have exceeded 50mm. While it is not yet possible to attribute all the rainfall changes to anthropogenic climate change, some of the changes are likely to be at least partly due to increases in greenhouse gases (CSIRO and BOM, 2007).

Much warming between now and 2030 is locked into the system as a product of past greenhouse gas emissions.

There are several reasons why Australia is likely to be more exposed to the impacts of climate change than other developed countries. First, our climate is already hot, dry and variable. Second, the sensitivity of our temperate agriculture assumes special importance because of the large role that agriculture plays in the Australian relative to other developed economies. Third, our terms of trade are highly sensitive to economic performance in Asian developing countries that are vulnerable to climate change. Fourth, our close proximity to fragile developing countries which seem to be disproportionately exposed to damage by climate change introduces special geo-political risks.

Table 1 describes some climate change impacts likely to be associated with various increases in temperature before the end of the twenty-first century under the ‘business as usual’ (SRES Scenario A1FI), and under the 450 ppm and 550 ppm CO_2-e stabilisation scenarios.

[18] IPCC (2007a), Chapter 10, p. 822.

[19] IPCC (2007c), Chapter 11, p. 509.

Table 1: Possible climate impacts in Australia for a range of temperature increases

Global average temperature increase by 2100 shown for business as usual and stabilisation targets discussed in this report – regional temperatures in Australia may vary from these values

Approximate rise in global temp by 2100 (A1FI, 550 ppm, 450 ppm) / Temp rise above 1990-2000	**Biodiversity and Ecosystems** (Preston and Jones 2006, The Climate Institute 2007a)	**Primary Industries** (Preston and Jones 2006)	**Human Health** (Preston and Jones 2006, The Climate Institute 2007a)	**Settlements and Infrastructure** (CSIRO, Maunsell Australia Pty Ltd, Phillips Fox (2007), Maunsell 2007)	**Impacts in the Asia-Pacific Region** (IPCC 2007, Preston and Jones 2006, NEF 2007, Dupont and Pearman 2006)	**Abrupt and Large Scale Impacts** (Preston and Jones 2006, Stern 2006)
<1ºC	▪ Shrinkage of snow-covered area in the Australian Alps by 10-40%	▪ Livestock heat stress leads to decline in milk production	▪ Annual heatwave deaths increase from 134 (today) to 165-189 in Brisbane	▪ Decrease in thermal efficiency of electricity transmission infrastructure	▪ A decrease of between 2-5% in India's yield of wheat and maize ▪ Global rice yields could be reduced by 10% ▪ Sea level rise could lead to the flooding of residences of tens of millions of people in the low lying areas of South, Southeast, Northeast Asia and the South Pacific	▪ 14% decrease in North Atlantic Ocean Thermohaline Circulation, causing regional climate shifts
1-2ºC	▪ Between 60-80% of the Great Barrier Reef is bleached every year ▪ Murray-Darling river flows fall by 10-25% ▪ Significant species extinction in internationally significant environments in north Queensland and Western Australia	▪ High annual costs of approximately $12million/yr to manage the southward spread of the Queensland fruit fly	▪ Southward spread of malaria receptive zones ▪ 1,200-1,400 more heat related deaths a year in major population centres	▪ Peak energy demand increases in Brisbane , Adelaide and other cities ▪ Increased bushfire damage ▪ Storm winds become more intense		▪ Significant reduction in global ocean Thermohaline Circulation ▪ Potential for the Greenland Ice Sheet to begin melting irreversibly ▪ Rising risk of collapse of the Atlantic Thermohaline Circulation ▪ Rising risk of collapse of West Antarctic Ice Sheet
2-3ºC	▪ Almost all of the Great Barrier Reef is bleached every year ▪ 80% of Kakadu's freshwater wetlands lost to sea level rise	▪ 40% reduction in livestock carrying capacity for native pasture systems	▪ Southward spread of dengue transmission zone as far as Brisbane	▪ Increases in sea level expected to exponentially affect storm surge height – causing damage to coastal infrastructure	▪ Changes to India's annual monsoon could lead to severe droughts and intense flooding in parts of India ▪ Tibetan Plateau glaciers shorter than 4 km in length could disappear, with shrinkage of snow and ice cover affecting water supply in the Indus, Ganges, Brahmaputra, Yellow, Yangzi and Mekong rivers	
3-4ºC	▪ Shrinkage of snow-covered area in the Australian Alps by 20-80%	▪ 25-50% decrease in 'generic' timber yield in north Queensland and the Top End.	▪ Up to a 200% increase in temperature related mortality among people aged over 65 years in capital cities			
4-5ºC	▪ 60-90% loss of core habitat for Victorian vertebrate species.			▪ Coastal settlements and infrastructure commence relocation due to anticipated extreme sea level rise		
>5ºC	▪ Under the A1FI scenario, the IPCC predicts that global average temperatures could rise by up to 6ºC, and perhaps more if positive feedback effects amplify the warming effect of greenhouse gases. The impacts of this level of temperature increase are difficult to capture in current models as they are so far outside human experience.					

Temperatures shown on left represent approximate global average increases above 1990-2000 levels, based on Figure SPM 8, IPCC FAR WG III. Note that at the national scale, climate change impacts are highly dependent on the level and pattern of rainfall and extreme events, which are highly variable and less certain than temperature increases. Note that temperature increases for given stabilisation scenarios are often quoted as the 'equilibrium temperature', which may not be reached until decades or centuries after stabilisation is reached. The level of temperature increase by 2100 also depends on the time taken to reach stabilisation, and hence the emissions trajectory. The ranges shown indicate the temperature change under the 'likely range' from the IPCC Fourth Assessment Report of 2ºC to 4.5ºC. Note that this table has been prepared using information currently available in the published literature. It will be updated for the Draft Report using relevant primary research conducted for the Review.

Source: Chart adapted from Preston and Jones (2006), and Stern (2006).

3 Comparing costs of climate change and mitigation

The Review's Terms of Reference require an assessment of the relative costs of action and inaction on climate change. The Review has received advice from the Australian scientific community that it should, to the extent possible, build the comparisons around IPCC scenarios. It will follow that advice, although the realities of emissions growth will require at least qualitative assessment of the impacts of rates of emissions growth that exceed the A1FI scenario.

3.1 Determining 'business-as-usual'

We have formed the interim view that, of the SRES family, the A1FI scenario (one of the rapid-emissions-growth scenarios discussed in 2.3) provides a conservative first approximation for "business as usual" in the twenty-first century. The work suggests that A1FI may underestimate "business as usual" emissions in the early twenty-first century, possibly by a considerable margin. It could possibly overstate "business as usual" emissions later in the century as feedback from climate change itself raises questions about the sustainability of rapid economic growth and as economic growth propels some large countries to the frontiers of global incomes and productivity.

The Review does not consider "business as usual" a likely outcome. There is considerable momentum towards mitigation across many countries, led by original Kyoto signatories in Europe, Japan and New Zealand. There has also been significant policy action in Australia, the most important being tighter restrictions on land clearance. There is significant regional action on mitigation in the United States, almost certainly to be joined by strong Federal steps over the next several years. Across developing countries, the increasing profile of climate change mitigation is notable in China, and is likely eventually to result in noticeable reductions in the emissions intensity of economic activity.

The current pattern of loosely co-ordinated action by developed countries, accompanied by partial action in a number of major developing countries, first of all China, seems likely to continue for several years. We will seek to define and to analyse the case of an '*ad hoc*, partial mitigation, mainly amongst developed countries' world that is in prospect around the Bali roadmap.

The European Union has adopted an objective of limiting the global mean temperature increase to 2°C above pre-industrial levels (European Council, 2005), which is seen as a threshold above which the risk of extreme climate change impacts becomes high. A stabilisation target of 450 ppm CO_2-e gives about a 50 per cent chance of meeting this objective (Meinshausen, 2006). However, this would seem to be beyond reach without overshooting followed by a period in which emissions fall below that of the natural sequestration rate.

Stabilisation at 500ppm or 550 ppm of CO_2-e would be less politically demanding, with less costly mitigation. It would be more likely to be achieved, but be associated with much higher risks of dangerous climate change. 550 ppm is the level to which implies a 50 per cent chance that temperatures will increase 3°C above pre-industrial levels[20].

[20] Based on a 'best estimate' climate sensitivity of 3°C, stabilisation at 550 ppm is likely to lead to an equilibrium global mean temperature increase of 3°C above pre-industrial levels, with a 21–69 per cent chance of exceeding 3°C (IPCC, 2007c; Meinhausen, 2006).

In all, the Review will analyse the costs of climate change and mitigation based on four possible emissions paths: business as usual; partial, *ad hoc* mitigation; effective firm global mitigation (550 ppm); and effective ambitious global mitigation (450 ppm).

The Australian Conservation Foundation and other non-government organisations have asked the Review to focus as well on a 400ppm objective. They argue that the risks of immense damage to aspects of the Australian environment, including the Great Barrier Reef and Kakadu National Park, are unacceptably high at 450ppm.

We appreciate their concern, and note only that the prospects of achieving the global mitigation effort that would be necessary to achieve this outcome appear to be remote in early 2008. Changes in ambition would require radical changes in the global approach to mitigation, and also major technological progress in the development of low-emissions technologies. To keep the possibility of eventual attainment of a 400ppm objective (with overshooting) alive, the 450ppm objective could be pursued with a view to tightening emissions targets if at some future time the political and technological conditions for far-reaching mitigation had improved.

While it is too soon to provide definitive judgements about how Australia would fare in these four scenarios, enough work has been completed to provide glimpses of possible futures.

3.2 Seeking strong action is in Australia's interest

These glimpses suggest that it is in Australia's interest to seek the strongest feasible global mitigation outcomes – 450 ppm as currently recommended by the science advisers to the UNFCCC and accepted by the European Union.

Failing international agreement on this ambitious target – and its realisation would require strong commitments to demanding targets from all major developing countries from 2013 – preliminary analysis suggests that it would be in Australia's interests to seek international agreement on the most ambitious feasible global mitigation target.

The extent of Australia's own commitments to mitigation would depend on progress towards effective global mitigation.

The final reports will present the results of detailed analysis of Australia's interests in various levels of international mitigation effort.

3.3 The necessity of adaptation

Historic greenhouse gas emissions have already committed us to substantial further warming through the twenty first century.

Due to the inertia of the climate system and longevity of greenhouse gases in the atmosphere, climate change will continue to occur even after the cause of that change has been removed – in this case, increasing anthropogenic greenhouse gas concentrations. Modelling undertaken by the IPCC suggests that if concentrations of greenhouse gases were stabilised at 2000 levels, an additional 0.3-0.9ºC of warming would occur by the end of this century. However, the level of climate change that is essentially unavoidable will be greater than this, as it is impossible to instantly stabilise concentrations (IPCC, 2007a[21]).

Adaptation has already begun in response to observed climate change, and more will be necessary to address the impacts resulting from unavoidable climate change.

The challenge of climate change will be severe for Australia, but we take some assets into the response. Australia has a high level of adaptive capacity. We have adjusted to living in a highly variable climate. We have a well developed economy that is socialised to structural change. An exceptional human resource base in engineering and science and well developed disaster mitigation strategies and biosecurity management capacity will have high value.

Adaptation issues will feature prominently in the final reports. The Review will take the local and regional nature of the challenge fully into account in its discussion of the key roles of State and local Governments in developing optimal adaptive responses. The challenge of adaptation will be severe in many of Australia's close neighbours. Australia's adaptation challenges will inevitably extend to sharing responsibilities outside its own borders.

[21] IPCC (2007a), Chapter 10, p. 822.

4 Mitigating Climate Change

4.1 Accelerating effective international action: Australia's role

Climate change can only be addressed by effective global action. The international architecture underpinning such action will draw elements from beyond a single multilateral agreement and at least in the formative years include unilateral and regional commitments and actions. The principles underpinning unilateral and regional policies must be consistent with steps towards effective global action. This section defines the essential components of an effective international architecture, assesses the slow progress towards putting such an architecture in place, and asks how progress can be accelerated. It does this first in purely global terms, and then looks at the implications for Australia.

The destination: principles for effective international action

The first task is to articulate the areas where broad international agreement will be required if there is to be effective international action.

Broad international agreement will require acceptance of global limits on emissions, sharing of rights to emissions across countries within these limits, and international collaboration to help achieve the national restrictions.

Setting a budget

Setting limits on global emissions involves trading off the benefits associated with smaller and slower climate change and the costs associated with larger and faster mitigation. Setting emission limits is complicated by three factors.

First, there are considerable uncertainties attached to both climate change impacts and mitigation. Many would argue that the uncertainty requires a conservative rather than ambitious approach to mitigation. But what is conservative in a context where the possible outcomes include some that most humans today would consider catastrophic? Conservatism may in fact require erring on the side of ambitious mitigation. After all, prudent risk management would suggest that it is worth the sacrifice of a significant amount of current income to avoid a small chance of a catastrophic outcome.

There is a strong case for high investment in the early years in research on climate change, and in research, development and commercialisation of mitigation technologies and approaches, to reduce the uncertainty on both sides of the equation.

A second complication is that the costs of mitigation come much earlier than the avoided costs of climate change. A dollar of cost now is worth less than a dollar of avoided cost later, for two good reasons. The first is that humans value the present somewhat more highly than the future—they discount future income to some extent, though the extent and even the need for discounting when it comes to inter-generational equity is a matter of debate. The second is that people in future are likely to be more prosperous than people today, suggesting higher valuation of a dollar today for this income distribution reason. Of course, the second of these reasons goes into reverse if and to the extent that climate change has the capacity to reduce the welfare of future generations below the welfare of the current generation.

A third complication is that the burdens both of the costs of climate change and the costs of mitigation are unevenly distributed among regions of the world, and among people of differing incomes and wealth and with different skills and economic resources. Some of these distribution effects can be foreseen with relative clarity. Some geographic regions may benefit at least initially from some aspects of anticipated changes in rainfall and temperature patterns, accompanied by price adjustments associated with global climate change and mitigation: the northern regions of Eurasia and North America, and within Australia, perhaps Tasmania. Some will be exceptionally disadvantaged by changes in temperature and rainfall: the temperate zones of mainland Australia, the Indian subcontinent and sub-Saharan Africa. In general, developing, poorer countries will suffer proportionately more, and be less well equipped to adapt.

Owners of some resources will receive large windfall gains: firms and people with engineering and management skills relevant to innovation in the resources and energy industries; owners of uranium mines or windswept land adjacent to urban centres; owners of agricultural land which retains most of its productive capacity, and so is able to take advantage of higher product prices. Others will be large losers: people living in what were once the most favourable areas for human civilisation, in the great river deltas of Eurasia in particular, and more generally people who depend for their patterns of life on steady flows in the great rivers fed by melting ice and snow, or on low-lying land. Some people will lose because those to whom they are closely linked by proximity or trade are disproportionately damaged.

Some distribution effects would be highly uncertain: people living in the great river valleys of Asia who would be damaged by shrinking of ice cover on the Tibetan Plateau, or disruption of the South Asian monsoon, the extents of which are uncertain across a wide range of emissions scenarios. Mitigation will also have distributionally-diverse impacts. Coal mining districts may become regions of stagnation and decline under ambitious mitigation strategies if carbon capture and storage (CCS) turns out not to be commercially viable even with high carbon prices, but regions of expansion and exceptional prosperity—possibly well beyond previous contemplation—if CCS turns out to be commercially successful.

Given the complexity, the choices will need to be set in sound but simple terms. The long-term choices facing the world can best be cast in terms of *stabilisation concentrations* and *global budgets*.

The energy balance of the climate system is, among other things, determined by the concentration of greenhouse gases and aerosols in the atmosphere (IPCC, 2007a[22]). If the volume of greenhouse gases emitted over a certain period is greater than the level naturally removed from the atmosphere (see Section 2), a fraction will remain in the atmosphere and accumulate over time causing an increase in global mean temperatures (Stern, 2006). These temperatures will continue to rise unless the concentration of greenhouse gases in the atmosphere is stabilised, which will involve reducing annual greenhouse gas emissions to the natural capacity of the earth to remove emissions from the atmosphere (Stern, 2006).

Various scenarios for stabilising the atmospheric concentration of greenhouse gases have been proposed to limit global temperature rise. The 450 ppm and 550 ppm thresholds were discussed earlier.

It is possible to broadly define a global 'budget' that represents the total volume of greenhouse gases that can be emitted over time to achieve a certain atmospheric concentration[23]. After stabilisation occurs, emissions could not exceed the natural sequestration level. The advantage of focusing on a global budget as against end-year

[22] IPCC, 2007a. Summary for Policymakers.

[23] As noted in Section 2, different greenhouse gases behave differently in the atmosphere.

targets (an x per cent reduction by year y) is that it highlights the importance of total emissions, rather than emissions at any point of time.

New scientific knowledge or changes in the pattern of international cooperation may provide reasons for changing the global budget over time. There is a strong case for setting an initial global budget which is tight enough to support substantial early progress on mitigation, while recognising that the global budget may need to be reduced in future in clearly defined circumstances and at clearly defined times.

Interim targets will be needed along the way.

Interim targets, consistent with credible progress to long-term goals, will be needed along the way to guide and assess global progress. They also are important in embodying choices about the path to stabilisation: how slowly or quickly the world moves to the stabilisation concentration; and whether temporary overshooting of the stabilisation level is required for tighter targets. The targets discussed so far in international arenas (typically expressed as a percentage reduction by, say, 2020 or 2050) have value in these contexts. Whether or not this is the best way to express interim goals is a matter for analysis, and will be discussed in the full reports[24].

Allocating the budget among countries

Once the global greenhouse gas budget is determined, an effective response to climate change requires that this budget be allocated among countries, using widely accepted principles.

Effective global action can only be ensured by individual countries taking on responsibility for emissions mitigation. The allocation of global emissions capacity across countries has to be seen widely as being equitable. Unless all countries, or at least all major emitters, take on targets, it will be impossible to ensure that action at the global level is adequate (adds up to an effective global mitigation effort), and that some countries are not free-riding on the effort of others. Adoption of national budgets also opens the door to international emissions trading, and comprehensive emissions pricing with comparable price levels across countries which will provide international support for the most efficient, low-cost abatement options, and an important basis for transfers to developing countries.

Alternative approaches to the targets-and-trading have been proposed, and a comparison of possible approaches will be provided in the full report. Some argue that there are better prospects for progress if, rather than seeking comprehensive agreement on targets, each government makes efforts in line with its own judgements about the seriousness of the problem, the costs of mitigation in its own country, and the mitigation cost that it is prepared to carry. Others prefer that effort be concentrated on seeking international agreement on a common rate of carbon tax. These two perspectives, and some others, share doubts about the value of international trade in permits. (See McKibbin and Wilcoxen (2002, 2006) and Stiglitz (2006) for examples of alternative approaches.)

The Review accepts that a satisfactory international agreement will be difficult to reach. The prospects depend on the community interest that is being shown in this issue in many countries, together with increasing knowledge of the urgency of the risks, expanding the political possibilities in the period ahead. The Review recognises that there are advantages in individual countries choosing their own mixes of policies to meet

[24] The discussion in this section has abstracted from the fact that some (non-CO_2) greenhouse gases are short-lived. This issue will also be explored further in the full reports.

agreed budgets. It attaches high value to unilateral, bilateral and regional mitigation initiatives that can generate working models for progress, and reassure others that they are not alone.

Nevertheless, the Review so far has come to the view that only an international agreement on distributing the abatement burden across countries has any chance of achieving the depth, speed and breadth of action that is now required in all major including developing countries. Such an approach builds on current international architecture (which submits developed countries to targets). It provides incentives for developing country participation. The gains from international trade in permits can significantly reduce abatement costs. And explicit agreement on sharing the abatement burden, after a period of experiment and confidence building, allows the resolution of the "prisoners' dilemma" that otherwise blocks mutually beneficial collective action (Garnaut 2007b).

Partial application of an independent, national approach may have a role in an eventual global mitigation effort, mainly, in relation to developing countries. This could be especially significant in relation to the least developed economies that are either unable or unwilling to accept binding budgets. Such countries might be considered to comply with international requirements if they tax carbon at the rate of the emissions price of some specified developed country or region (and keep the revenue), or adopt equivalent policies and measures.

To be widely accepted, principles to guide the allocation of a global emissions budget across countries will need to be simple, transparent and readily applicable. To be considered fair, they will need to give much weight to equal per capita emissions rights. To be considered practical, they will need to allow long periods for adjustment towards such positions.

Proposals for equitable allocation of a limited global emissions budget, as considered by the Review, are at an early stage of development. A variety of models for principles-based allocation of emissions rights have been proposed, including variants on per capita allocations. The Review is exploring these options and is commissioning relevant modelling. Here we introduce some ideas that we hope will stimulate Australian and international discussion, with a view to the eventual emergence of sufficiently wide support for some set of allocation principles to form the basis of international agreement. Pending the emergence of wide international support for some principles, practical unilateral and regional action will require individual countries and groups of countries to act on the basis of principles that they consider to have good prospects of eventually being accepted internationally.

Contraction and convergence

It is clear already that per capita allocation will have to play a strong role in principles for national budgets. Indeed, it appears inevitable that if global per capita emissions fall to the level required by stabilisation scenarios, then the current stark divergences in national per capita emissions rights will inevitably diminish— though variation in national emissions levels will be possible through the trading of emissions rights.

Some argue that a population-based allocation encourages environmentally damaging global population growth. This is unlikely, as population growth is decided by far more fundamental economic and social determinants. This argument is not at all relevant to countries – mostly developed countries, and first of all Australia and Canada – where population is growing through immigration. As discussed later, a focus on per capita allocations is essential for equitable treatment across developed countries with and without high levels of immigration.

The more important point is that any allocative formula that does not emphasise population over current or past emissions levels as the basis for long-term emissions rights has no chance at all of being accepted by most developing countries.

One approach worth considering, consistent with giving weight to population and with the need to allow time for adjustment, would be the "contraction and convergence" approach that was developed by the Global Commons Institute in the early 1990s, and has been discussed favourably in Germany and the United Kingdom in recent times (WGBU, 2003; RCEP, 2000).

Under this approach, emissions budgets start out equal to each country's current emissions, moving over time to equal per capita emissions budgets, while ratcheting down the overall global emissions budget. "Contraction and convergence" combines political realism about high emitters' positions in starting from the status quo, with recognition of developing countries' claims to equitable allocation of rights to the atmosphere.

A key equity lever is how fast to move from the status quo to per capita emissions rights: slower convergence favours higher per capita emitters, and vice versa. It would not make sense to allow convergence to equal per capita emissions at a date after stabilisation of global emissions concentrations had been reached.

To make this approach acceptable and flexible enough to a broad majority of countries, including emerging major emitters, additional features would be needed. In particular, the world would need to provide headroom for emissions growth in rapidly growing developing countries, within a general principle of sharing the adjustment burden.

The headroom may take the form of challenging emissions intensity targets for developing countries growing too rapidly for it to be possible for them to hold to a budget tied mechanically to "contraction and convergence". For example, the benchmark might be for emissions intensity of output to fall by half of the GDP growth rate, which in turn would increase annual permit allocations by half the rate of GDP growth for the countries that are being provided headroom.

A limit would need to be placed on the provision of headroom for rapidly growing developing countries. For example, if the "contraction and convergence" approach were to be accepted as the first organising idea, and an "emissions intensity" alternative introduced for rapidly growing developing countries, the "headroom" could be capped at the point where the developing country's rising emissions per capita reach a benchmark trajectory in per capita emissions. This benchmark trajectory could be based on an average of the emissions profiles of moderately emitting developed countries (e.g. Europe, Japan, New Zealand), which would be expected to be much lower than at present at the point where the two trajectories intersect.

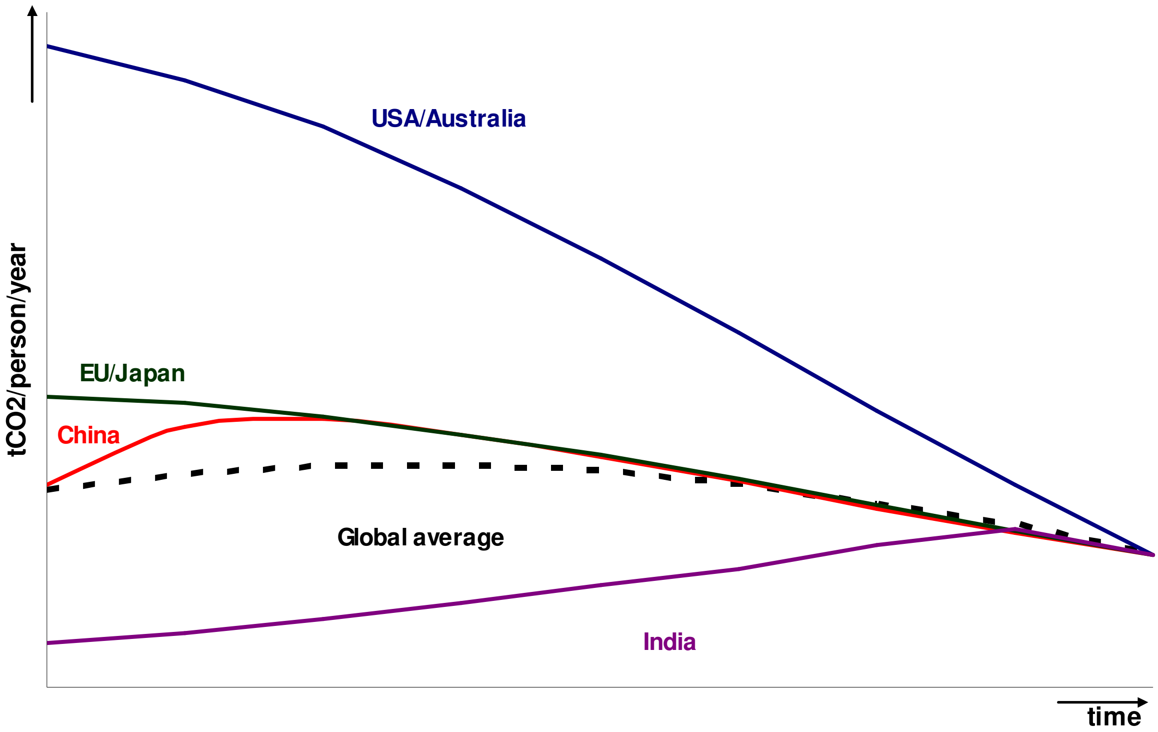
A stylised example of such a scheme is shown in Figure 7. Here, global average per capita emissions are held constant for some time, then reduced. For high per capita emitters such as the United States and Australia (currently around four times global average per capita CO_2 emissions), emissions rights are on a steeper convergence path than developed countries such as Europe and Japan. China, due to be on par with the global average about now, would get headroom for emissions rights above global average per capita levels, linked to GDP growth, until meeting the benchmark trajectory. Low-emitting countries on a per capita basis such as India would receive increasing per capita emissions rights for quite a few years.

Assuming that emission rights can be traded internationally, the envisaged convergence can be in terms of national emission rights rather than national emissions. Countries will then be able to emit at above their convergence levels provided that they buy surplus credits from other countries.

To be politically acceptable in the developed countries, developing country participation in trade in permits, from ‘emissions savings’ below their contraction and convergence or emissions intensity growth lines, would need to accept binding targets, transparent monitoring, and a climate change policy or development framework around revenues from sale of permits. Such an approach would provide a strong incentive for developing countries with low emissions per capita, or large opportunities for low-cost reductions in per capita emissions, to accept binding targets.

We are aware that some people in developed countries are critical of the possibility that some low-growth developing countries could benefit from sale of permits, while making minimal mitigation efforts themselves. The final reports will examine the empirical significance of this concern and explore alternative approaches that remove its significance.

Figure 7: Contraction and convergence for different countries with headroom for the rapidly developing economies: a stylised, illustrative scenario



International emissions trading will help developing nations

Australia’s circumstances give us important perspectives to bring to international discussion of these matters. Relevant circumstances include Australia’s proximity to the rapidly developing countries of Asia, two of the world’s biggest per capita developing country emitters (Indonesia (the world’s third largest emitter in absolute terms because of deforestation) and Papua New Guinea (with per capita emissions potentially similar to or higher than Australia, again due to land-use change)), while being one of the three exceptionally large per capita developing country emitters itself.

Within a regional agreement, Australia, through development assistance, could assume responsibility for development of emissions monitoring mechanisms. Each country would be free to develop its own domestic policies to achieve its national budgets. But collaboration across countries, through trading and complementary commitments by richer countries, would also be important. These additional provisions would greatly assist developing countries, and thus make more ambitious commitments possible. Emissions allocations would be tradable between countries, and revenue used for climate and development needs.

Trading of emission rights would tend towards equalisation of the permit price and marginal cost of abatement across countries, contributing to an economically efficient distribution of abatement action.

Emissions trading would also be a principal avenue for addressing international equity concerns in greenhouse gas mitigation. These concerns require that developed countries, which are responsible historically for the great bulk of greenhouse gas emissions and which have greater financial capacity, help developing countries meet the costs of mitigation and adaptation.

Many developing countries have low-cost mitigation options, and so would be sellers of permits on the international market, which could pay for the cost of restructuring and offer financial incentives above that cost. For example, developing countries with high current per capita emissions due to deforestation (including Indonesia and PNG) could be expected to reduce their emissions quickly and be financially rewarded for doing so by being able to sell their excess permits (i.e. they will be below their convergence line). Low-emitting and slower growing developing countries are likely to have space below their convergence line which will likewise provide the basis for selling permits on to the international market.

The income generated by reductions in emissions could be large in some developing countries which currently have abundant low-cost abatement opportunities, notably through reduction of deforestation and promotion of reafforestation. Such large payments could become controversial in the countries buying permits if they were not embodied in a development framework. Such a framework would need to be agreed between Governments. Such a framework could be developed more readily within a bilateral or regional than within a global arrangement.

Some developing countries might not opt for a domestic emissions trading scheme, finding it instead more efficient to live within their national budgets through the application and administration of a carbon tax. A domestic emissions trading scheme would not be a prerequisite for international trading, as a country, typically through its government, would be able to sell any excess of permits (however that excess is achieved) in the international market.

Pre-requisites for joining regional or international trading schemes

Countries would, however, have to meet certain pre-requisites to be able to join a regional or international trading scheme. All countries participating in trade would have to have: a similar definition of a carbon unit; monitoring and enforcement mechanisms of a minimum standard; and a defined emissions budget over the period during which the trade is to occur and for which the permits were to be valid, with only the “savings” from the defined budget being available for trade. A country which operated emissions trading systems with caps and floors would not be able to participate fully, except through national authorities (for example, the Government, or a central carbon authority), since that country could then flood the market with additional permits, or be forced to buy up permits without limit.

Once countries were linked, actions taken in one country would affect the market in another. For example, a decision by one country to exceed its emissions budget would reduce prices in all linked markets. The spread of an international carbon market is therefore likely to take place incrementally as countries establish credibility as well as market infrastructure.

Emissions budgets and trading would usefully be complemented by commitments by high-income countries to finance climate-related public goods, with a particular focus on development of new technologies.

An optimal level of global investment in research, development and commercialisation of the new technologies that will lower the costs of adjustment to a low-emissions economy, requires public sector contributions. These are necessary to correct for the public good character of research, and the external benefits of private expenditure on development and commercialisation. The relevant research, development and commercialisation will mainly be a responsibility of developed (and the most technologically and economically advanced of the developing) countries, because of their high incomes, and technical and commercial capacities. One country's public efforts to support innovation will benefit others, so there is a danger that individual decisions will lead to inadequate total levels of funding. This creates a strong case for an agreement among higher income countries, that each will contribute reasonably to maintaining an adequate global commitment of public resources to these activities. Agreed commitments to research, development and commercialisation by developed countries, and to facilitate transfer of technology to developing countries that accept emissions targets, could be a useful component of an international set of agreements to encourage acceptance of demanding emissions restriction targets in developing countries.

As part of the agreement, countries above a per capita income threshold would commit to spending a fraction of their GDP above the threshold on public support for research, development and commercialisation of new technologies relevant to the transition to a low-emissions economy.

The choice of what to finance would be left to each government, subject to meeting agreed criteria for the public good or global benefit nature of the spending on technological development. In Australia, for example, this could include commitments to development and commercialisation of CCS and selected renewable energy technologies, in which Australia had comparative advantage in technological development in a global context, combined with economic interests. It could include expenditure related to the transfer of low-emissions technology to developing countries. Spending could be undertaken in each country domestically, or internationally, including through new climate change research agencies modelled on the Consultative Group on International Agricultural Research or the Australian Centre for International Agricultural Research. Australia could usefully play a leading role in the development of a system of international climate change research, as it did in the development of the established system of international agricultural research.

The current international discussions within the Bali roadmap envisage developed country support for adaptation in developing countries. Formal commitments to minimum levels of adaptation expenditure in developing countries by developed countries, would be a useful complement to the research, development and commercialisation agreement. If access to these funds were confined to countries which had accepted binding targets, the availability of support for adaptation would increase incentives for developing countries to join the international mitigation effort.

Finally, enforcement mechanisms would need to be developed for any international agreement. Responses to transgressions or non-cooperation must be carefully considered and measured when implemented. More consideration will be given to enforcement mechanisms in the full reports.

Evolution of the global architecture

The world is a long way from an effective international architecture of the kind described above. Only a few countries have proposed national targets, and fewer still have sought to ground their targets in a framework based on global emissions budgets derived from explicit mitigation objectives.

Most developed countries have committed themselves under the Kyoto accord to emission limits to be achieved by 2008-2012. Some rich countries have unilaterally defined longer-term targets, from which implicit national carbon budgets can be derived. Australia has recently committed itself to a reduction in 60 per cent of emissions by 2050 relative to 2000. The European Union has committed itself to a reduction of 20 per cent from 1990 levels by 2020, and 30 per cent provided that other developed countries commit themselves to comparable emission reductions, and to 60-80 per cent reductions by 2050. The US federally is yet to commit to either short- or long-term targets, though recent legislative initiatives suggest that it may soon have long-term targets in place. California has legislated a reduction to 1990 levels by 2020 and 80 per cent reduction below 1990 by 2050, and many other US States have adopted targets.

Some developing countries have made important domestic commitments. For example, China has announced that it will reduce the energy intensity of economic activity by 20 per cent below 2005 levels by 2010, and that the contribution of renewables to total energy supply will rise sharply. These are highly ambitious targets that will not be easy to realise.

However, all developing countries, which are now responsible for most of the growth in emissions, continue to reject binding targets. It is unfortunate that an undifferentiated categorisation of “developing” countries has assumed such central importance in the international discussions, when there are, in fact, huge differences within the category. It is an urgent matter for the higher income and rapidly growing developing countries to accept demanding targets at an early date, if there is to be any chance of holding risks of dangerous climate change to moderate levels.

There is much less urgency about participation of the many small, low-income developing economies. It is important that the difficulties of securing their early participation in a comprehensive international agreement with internationally binding targets do not delay effective global action. Their acceptance of binding targets could be accelerated by the conditional provision of opportunities for gains from trade in permits.

The Kyoto Protocol: only a starting point

The Kyoto Protocol commits developed countries but not developing countries to national targets for carbon emissions. The agreement allows developed countries to achieve their targets in part through the purchase of clean development mechanism (CDM) “carbon credits” generated by developing countries. However, in the absence of national targets one cannot be confident that CDM carbon credits in fact represent overall carbon emission savings.

The decision not to ratify Kyoto by the United States and Australia after the election of the Bush administration seven years ago was of historic importance in disrupting an international approach. Australia’s return to the international fold following the election of the Rudd Labor Government is an important corrective. It is an equally important reality, however, that there will be no adequate global mitigation unless the major developing countries soon become part of the global mitigation effort. The world must move beyond Kyoto.

An effective international agreement is still a long way off

The Kyoto Protocol runs to 2012. International negotiations are currently underway to develop a successor framework to Kyoto. Current plans envisage such a plan to be agreed at the 2009 UNFCCC conference in Copenhagen.

The December 2007 Bali conference developed the agenda or framework for the post-Kyoto negotiations. The likely cornerstone, agreed at Bali, is that developed countries take on quantitative commitments, while developing countries are to undertake "measurable, reportable and verifiable" mitigation actions, but not with quantitative, national commitments and emissions trading. Sectoral approaches to mitigation, incentive mechanisms to reduce tropical deforestation, and a broadened CDM are expected to expand the reach of a post-2012 framework. New support mechanisms are likely to be created for adaptation, technology development and diffusion, as well as financing and investment.

If such an agreement were to be reached globally, this would be a step forward from Kyoto but still fall far short of getting deep cuts in global emissions underway. This is because there are no comprehensive commitments for major developing countries (and thus only patchy carbon price signals in large and rapidly growing countries), and because it will be difficult in these circumstances to agree ambitious reduction targets among all developed countries. There is no prospect within this framework of holding the risk of dangerous climate change to moderate levels.

Multilateral climate negotiations are dogged by very difficult circumstances.

The incentives facing individual delegations in a single, large, multilateral negotiation are not conducive to reaching sound agreement. Each country will try to secure a "better deal" than others, with equity concerns figuring large and incentives for free-riding working against cooperative outcomes. Countries' circumstances and interests in the negotiations differ widely, and geopolitical considerations interfere. The dominant outcome is a low common denominator. This is evident from the experience with the Kyoto Protocol.

The underlying free-rider problem can only be solved through a repeated game with signalling and learning (Axelrod, 1984), and in agreements that are individually and collectively rational, and considered fair (Barrett, 2003). But this requires time, and time is running out.

Without strong action by both developed and major developing countries alike between now and 2020, it will be impossible to avoid high risks of dangerous climate change.

The initial stabilisation scenario work undertaken for the Review provides a compelling illustration of this point. On current rates of growth (over six per cent per year between 2000 and 2006) for emissions from combustion of fossil fuels, developing country emissions alone would exceed the illustrative 450 ppm CO_2-e stabilisation trajectory discussed earlier before 2020 (see Figure 4), and the 550 ppm CO_2-e stabilisation trajectory before 2025.

Even with strong, early cuts in emissions in developed countries, there is limited headroom for continued emissions growth in developing countries. To illustrate, assume that all developed countries cut their emissions by one-third between 2000 and 2020 (which against the backdrop of the Bali roadmap, would be seen as a successful outcome of the post-2012 negotiations). To keep global emissions growth within a trajectory that could lead to stabilisation of atmospheric concentrations at 450 ppm CO_2-e (with overshooting), developing countries would only be able to emit roughly the same amount in 2020 as in 2005. Developing country emissions would need to peak within the next few years and then fall considerably. This contrasts with fossil fuel emissions having grown at over six per cent on average in developing countries from 2000 to 2006.

For the 550 ppm CO_2-e illustrative stabilisation scenario, the same one-third cut in developed country emissions would leave developing countries having to hold emissions growth to 2.5 per cent per year between now and 2020, less than half the rate of increase of the early twenty-first century.

Expectations need to be raised for the post-Kyoto framework

Given the urgency of the problem, the world should aim for a post-Kyoto agreement in which all major emitters, developed and developing, are subject to emissions budgets. As the analysis of the preceding section showed, waiting until 2020 (potentially the starting time for an agreement to follow the one currently being negotiated) would be to abandon hope of achieving climate stabilisation at moderate levels.

Why would any developing countries accept emissions budgets, which they resisted under Kyoto and also at Bali? First, as their attention is drawn to the realities of prospective emissions growth and the risks associated with them, they might come to see it as being in their interests as a precondition for an effective global agreement to combat climate change. China has already advanced a considerable way down that path. Second, they might come to see it is as equitable that all countries have budgets, but that richer countries have much more stringent budgets (in relation to rates of growth, but not in total emissions) than developing countries. In this context, it will be important for “developing countries” not to be seen as an undifferentiated category, and for relevant differences in circumstances to be acknowledged. Third, developing countries need to be offered financial incentives for accepting targets.

All of these elements have to be part of the solution. In particular, the terms of the international argument have to shift from which countries should be subject to budgets to how stringent the budgets should be (with more severe budgets—again, in relation to rates of change, but not absolutely—for developed countries) and what financial support there will be for poorer developing countries to achieve their budgets. Note that these two are related: the less stringent the budgets to which developing countries agree the greater will be the financial transfers they will be able to receive through trading of permits. Such a model would be squarely within the paradigm of “common but differentiated responsibilities” articulated in the UN Framework Convention on Climate Change.

Budgets can be designed, and stringency defined, in various ways. Within an overall framework which defines long-term budgets in per capita terms, developing countries can be asked to accept budgets which embody less severe cuts (slower growth in emissions rather than absolute reductions), budgets that are linked to economic growth, and, with less overall value, budgets for particular sectors (e.g. forestry or heavy industries).

Financing for developing countries to reduce emissions in the absence of national emissions budgets may not lead to greenhouse gas reductions. Such financing might subsidise low-emission projects that would have occurred anyway, while no constraints are applied to high-emission projects. This is a particularly serious problem if such support generates credits which substitute for domestic action by developed countries (as is currently the case with the CDM).

Unilateral and regional action can accelerate progress

Given the difficulty of the problem, not everything can be left to the multilateral process. Developed countries need to show unilateral and regional leadership. Given the limitations inherent in any multilateral process of negotiations, accelerating progress will also require that countries act unilaterally and in regional groupings to accelerate progress, and increase the chance of a successful multilateral outcome.

Developed countries can offer steeper cuts if developing countries also adopt budgets but need to show leadership and good faith by accepting binding budgets immediately and unconditionally. Some developed countries, including Australia, have now indicated initial offers for the post-Kyoto period. No significant progress in the multilateral sphere will be possible, however, until the United States shows that it is serious about addressing climate change by adopting a long-term target. Legislative initiatives underway in the U.S. are encouraging in this regard, and a new Administration is widely expected to take a much more proactive role in international climate policy. Australia should do all it can to encourage the U.S. in this direction.

Agreement on difficult political and economic issues can be much easier to achieve among small groups of countries than in large multilateral negotiations. That is because in negotiations among small groups of countries, it is easier to establish trust, to take account of individual countries' circumstances and preferences, and to link across issues. Furthermore, self-selected groups are much less subject to being held hostage by the least willing.

Formations of groups of countries that are prepared to subject themselves to binding budgets can accelerate global action, by demonstrating that ambitious cooperative action is possible. In particular, groupings that bring together developed and developing countries into regional trading systems have the potential to show that developing countries can live within, and indeed benefit from, national budgets.

The hurdle for developing countries to take on emissions targets could be much lower in such a situation, as any commitments could be fashioned around the capabilities, needs and aspirations of each individual country. Similarly, it would make it easier for developed countries to enter arrangements that include large-scale resource transfers to developing countries for climate change mitigation.

Early unilateral and regional efforts will help secure a more ambitious post-Kyoto framework.

Unilateral, regional and multilateral efforts underway in parallel might make for a 'messy' process, but it is one which has the highest chance of success in the short time available. The more and the sooner individual countries and groups of countries undertake unilateral and regional efforts to mitigate climate change, the greater the prospects for a comprehensive and ambitious future global framework.

Importantly, however, to ensure compatibility, unilateral and regional schemes would need to be based around common guiding principles. Early movers on regional agreements would need to base their actions on explicit principles for allocating a global emissions budget that they consider to have good prospects for wider international acceptability. Early action on the basis of such principles would then play a role in the encouragement of international discussion of principles and eventually in the movement towards international agreement. This relates in particular to the setting of budgets, both for groups of countries in aggregate and differentiation between countries. This would provide a vehicle for testing such a guiding principle as modified contraction and convergence.

Implications of international negotiations for Australia

Allocating global budget on a 'per capita' basis makes sense

Australia needs to decide what sort of destination it will support for an effective global agreement, and how to accelerate progress to that destination. As discussed in section 3, preliminary work suggests that it is in Australia's interests to advocate as strict a global stabilisation budget as is feasible. Given an allocation rule between countries, the national emissions budget for Australia can be derived.

The costs and benefits of various possible global budgets for Australia will be assessed in the full reports. There will always be uncertainty over important considerations in the choice of budget. The evidence base is likely to shift over time, requiring mid-course adjustments. At the same time, the supply price of investment in the transition to a low-emissions economy, and therefore the cost of mitigation, will be much lower if there is stability of budgets and policies. Adjustments should be kept to a minimum, and occur at defined times in response to clearly defined sets of information. Whichever global budget is advocated by Australia, it is clear that there will be a requirement for large cuts in Australia's emissions budget, as part of an effective international agreement.

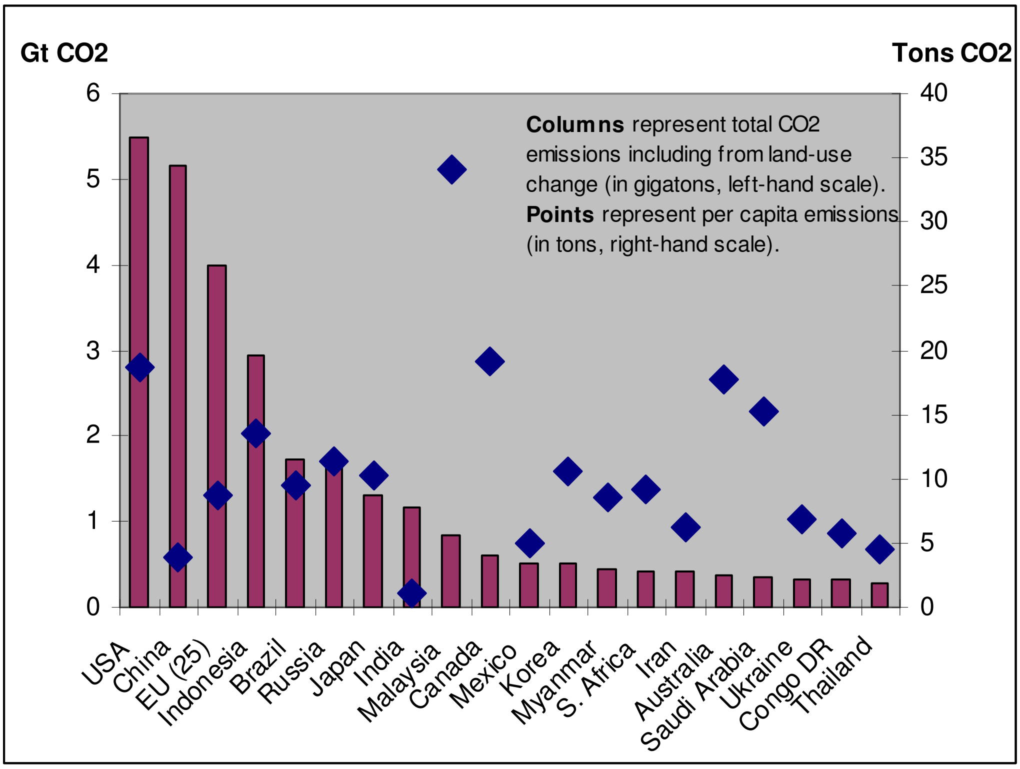
Under the 450 ppm and 550 ppm CO_2-e stabilisation illustrative scenarios referred to earlier, if it were agreed that per capita emissions would converge by 2050, then Australia's absolute emissions would have to be roughly 90 per cent and 70 per cent respectively below 2000 levels in 2050[25]. These numbers are purely illustrative, as the exact allocations would depend on the rules adopted for emissions rights, the trajectory of emissions through time, future population growth in Australia and globally, and other variables.

Note that a reduction target of, say, 70 per cent does not imply that actual future emissions in Australia would be restricted to the extent suggested by the reduction in emissions rights. Only the level of permits would be thus restricted. Additional permits could be bought, for example from developing countries that find it attractive to remain below their emissions budget and sell the "excess" permits.

Australia is a low emitter of greenhouse gases in absolute value (though still in the top 20 emitters) but a high per capita emitter (Figure 8). Some might argue that it makes no sense for Australia to have any tolerance for a per capita rule, given our initial position. This would be mistaken for several reasons. First, without effective international action, there can be no effective mitigation of climate change, and, as argued earlier, per capita considerations are going to provide an important element in any practical allocation rules for emission rights across countries. Second, Australia's ongoing population growth means that Australia will find it easier to cut in per capita rather than absolute terms. Population growth considerations are centrally important to equitable distribution of the adjustment burden between Australia and other developed countries.

[25] These numbers can be approximately replicated through the following simple computation: Global CO_2 emissions under the illustrative 450 ppm CO_2-e scenario at 2050 are 14 $GtCO_2$, with the global population projected at 9 billion, to yield emissions rights of 14/9=1.6 t/person in the world at 2050. Australia's population is conservatively projected at 30 million at 2050, giving total emissions rights of 1.6*30=48 million tons for Australia. Compared to CO_2 emissions in Australia of around 400 million tons in 2000, this is an 88 per cent reduction. Higher population growth in Australia and higher global stabilisation concentrations will require a lower reduction.

Figure 8: CO_2 emissions including land-use change, 20 largest emitters, and per-capita emissions



Note: Total emissions combine fossil fuel emissions for 2004 and land-use change emissions for 2000. Per capita emissions divide this total by 2004 population. Note that estimates of land-use change (deforestation) are subject to large uncertainties in many of the main emitting countries.

Data source: World Resources Institute.

The case for dual carbon budgets

Strategic as well as policy considerations argue for multiple carbon budgets: one representing what Australia is prepared to do initially as part of the developed country contribution to keeping open the possibility of effective, comprehensive global agreement; and the others representing what Australia would be prepared to do in the context of effective, global action. The more effective and ambitious the agreement(s) reached, the more Australia should be prepared to move towards its full share of a fully effective agreement.

There is no risk that an emissions reduction schedule culminating in a 60 per cent reduction from 2000 levels by 2050, will be more restrictive than would be required as Australia's contribution to enforcement of an environmentally satisfactory global budget.

The importance of interim targets

There is strong international and domestic interest in interim targets, and in particular the target for 2020 – underlined by recent discussions at the Bali UNFCCC meeting.

Interim targets, alongside Australia living within its "share" of a long-term global budget, are important for several reasons. They require immediate action, and so are seen, domestically and internationally, as evidence of the seriousness of the Government's commitment to longer-term objectives. If taken as firm targets to be met independently of other considerations, they affect the cost of mitigation (more restrictive targets than would be set by the market raise the cost of mitigation). They also affect the costs of climate change (more restrictive interim targets if shared by a substantial part of the international community could lower the present value of the cost of climate change).

Interim targets for developed countries have become the subject of international negotiation, independently of their effects on the cost of mitigation or climate change. A key sticking point at the Bali negotiations was a reference to a 25 per cent to 40 per cent reduction range for developed countries, at 2020 compared to 1990 (UNFCCC, 2007). This range is in line with the EU 30 per cent reduction target, conditional on commitments by other countries, and with Germany's announced objective of a 40 per cent reduction.

The setting of interim targets is a major focus of the Review's continuing work. Pending the completion of the Review, Australian policy-makers should keep in mind several points that have been absent from the international discussion so far.

First, the starting point matters, and it is not obvious that 1990, favourable to Europe (including Russia), is the logical starting date. A strong case could be made for using the average emissions between 2008-2012 as the base, using actual emissions for developing countries and target emissions for Annex I countries under the Kyoto Protocol. It would be unrealistic to expect fast-growing developing countries such as China and India to enter discussions on targets using a 1990 baseline, given the high emissions growth that has occurred since that time. Extensive negotiations and discussions were undertaken as part of the Kyoto process that lead to the eventual national targets for the 2008-2012 period. There would be problems in using a baseline that involved re-visiting these debates. By using the agreed Kyoto target emissions for the Annex I countries rather than actual emissions, those signatories that failed to meet their obligation would face a tougher task in the next commitment period.

Second, for interim targets, as for longer-term targets and the global budget, population is an important variable in determining the difficulty and cost of achieving specified outcomes. It would be more appropriate to base percentage reductions on per capita rather than national total emissions. The difference between per capita and total bases over one or more decades is large for Australia relative to the low-immigration developed countries—Europe (including Russia) and Japan. Europe's population is expected to shrink, and may fall to 1990 levels by around 2020. An absolute reduction of 30 per cent compared to 1990 for Europe is similar to a 30 per cent reduction in its per capita emissions. Australia's population by contrast is increasing, by 1.5 per cent in the year just passed (ABS, 2007) – a rate that will be more or less maintained if proportionate immigration rates remain at current levels. In these circumstances, a 30 per cent reduction in absolute emissions would imply a fall of well over half in per capita terms – a very much heavier burden than would be carried by Europeans.

There are large opportunities for relatively low cost early reduction in Australian emissions, as they would be measured in an international agreement. Some would arise from the promotion of energy efficiency and renewable energy. Others would emerge through international trading with regional partners, which could utilise opportunities created by major reductions in deforestation. Wider opportunities for international trade in permits would reduce the costs of meeting tightly defined targets for particular years.

The Review's final advice on interim targets will keep in mind the international expectations that have developed over starting dates, the base for percentage reductions, the opportunities for international trade in permits and the relationship between point-in-time and multi-year objectives. It will take into account the role that strong interim targets for developed countries could play in securing appropriate developing country commitments. It will also explore the environmental and economic advantages of varying the currently favoured approaches to defining interim targets, and the scope for influencing international expectations in more favourable directions.

Australia should play a lead role in accelerating progress

The absence of Australian perspectives on these and other matters has been costly to the quality of the international discussion. The disadvantageous starting point for the current international discussion of interim targets can be counted as a cost of Australia's delayed ratification of the Kyoto Protocol. The Review will assess the opportunity for correcting this disadvantage in the process of formulating its recommendations.

Australia can play an important role in accelerating progress towards an effective global architecture by increasing the level of ambition for a post-Kyoto framework, and by pursuing supportive regional agreements.

As a country particularly exposed to climate change impacts, Australia needs to do all it can to work towards a more ambitious and comprehensive framework. This includes making the argument that the case for urgent action is much more compelling than earlier realised, and showing willingness to provide developing countries with greater financial opportunity and assistance in return for them adopting appropriate targets.

Australia's multilateral efforts, principally to raise the level of ambition in a post-2012 framework, should be complemented with unilateral and regional initiatives, over which it can exercise more influence and which can serve as examples internationally.

Opportunities for regional partnerships

Australia can play an important international role by developing and applying exemplary national and regional mitigation arrangements. Australia can promote agreements with developing country neighbours which will reduce emissions and have an important demonstration effect by showing that developing countries can live within and indeed benefit from the adoption of national targets.

Indonesia and PNG provide opportunities for such an approach. Both have expressed interest in cooperation with Australia on climate change policy, and this was consolidated in bilateral Heads of Government meetings in Bali in December 2007. Both are high per capita emitters due to land-use change, in particular deforestation (see Figure 9). Both would have a large strong interest in reducing emissions from deforestation provided that they were compensated for the loss of economic opportunity and were able to sell the avoided emissions on an international market.

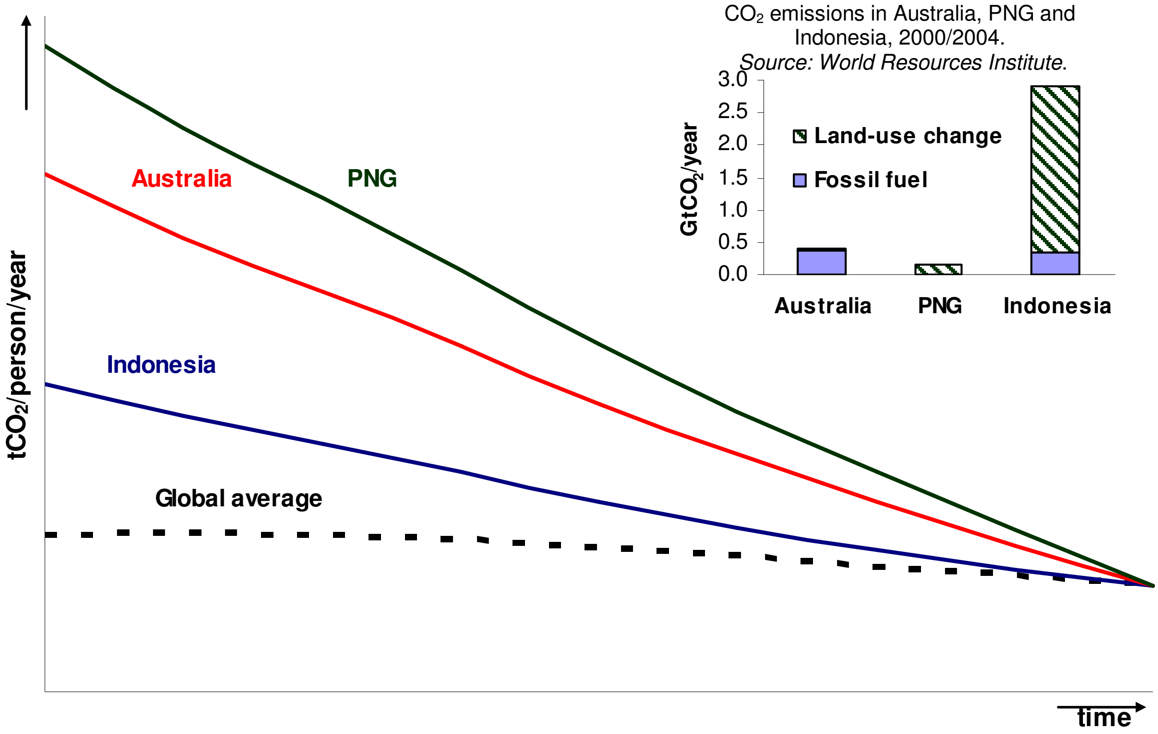
The immediate opportunity is for agreement with Papua New Guinea and other South Pacific countries. The Australian and Papua New Guinea Prime Ministers agreed in their bilateral meeting in Bali in December that cooperation on climate change would be a major feature of the future relationship. The two countries together could achieve substantial reductions in emissions relatively fast, if policies to reduce deforestation were pursued with vigour and the necessary financial and political backing, and if a congenial environment were established for utilisation of Papua New Guinea's extraordinary potential for low-cost renewable energy. National budgets for emissions, coupled with international permit trading, would be the central elements of a framework for achieving this.

Such an agreement, if built around a framework for utilising large revenue flows for the sale of emissions permits for development purposes, including cash and development opportunities for village communities currently enjoying cash and services from forestry operations, could provide major advantages for PNG.

Such an agreement would also be strongly in Australia's interest. Both countries would need to define an emissions contraction path that they thought could later be consistent with an international approach to allocating a global emissions budget, perhaps built around the contraction and convergence path described above. Both Australia and Papua New Guinea would face declining entitlements to emit (as Figure 9 illustrates below). Given the scope for large cuts in emissions in PNG through rapid reductions in deforestation, it is highly likely that Australia could purchase freed-up emissions permits, and so be able to achieve reductions in emissions (net of trade) at lower cost than when acting alone. This could be considered in setting Australian interim and long-term targets.

The potential for mutually beneficial arrangements involving Australia's near neighbours is suggested in Figure 9. Indonesia's emissions are thought to amount to as much as two $GtCO_2$ per year, around five times Australia's total CO_2 emissions, with over three quarters of that from deforestation. PNG's forestry related emissions may exceed 100 $MtCO_2$, a quarter of Australia's total CO_2 emissions.

Figure 9: Contraction and convergence for Australia, PNG and Indonesia



Developing country adoption of national targets and participation in a regional trading scheme in this manner would be a world first and would have substantial demonstration impact. In addition to large gains through emission reductions, it could help generate momentum towards the adoption of binding targets by developing countries by demonstrating that it could be in their financial interests to do so.

The Review will undertake further analysis on how a regional trading scheme might work, and on the preconditions for its compatibility with principles guiding other emissions trading systems.

Whether the world will be able to accelerate progress to the degree required is unclear, but it is in Australia's interests to do as much as it can to support acceleration.

Whether the post-Kyoto framework will be one which commits all major countries to targets is at best uncertain. But given the rapidity of emissions growth, a more ambitious post-Kyoto framework is essential. Australia, despite half a dozen lost years for international climate policy in the early twenty-first century, can play an important leadership role. If the post-Kyoto framework is not ambitious, Australia will need to continue with its unilateral and regional efforts. But between now and 2012, there is still a window of opportunity to adopt a variety of unilateral, regional and multilateral initiatives to help instil greater ambition into a post-Kyoto international framework.

4.2 Living within Australia's emissions budget

The Report by the Task Group on Emissions Trading (2007) established by the former Prime Minister, building on the work of the States' and Territories' National Emissions Trading Taskforce, provides an important landmark in the development of an Australian emissions trading scheme.

This Review endorses many of the design features proposed by the Task Group — for example: principles governing the coverage of greenhouse gas emissions and industrial sectors; the benefits of including domestic and international offsets in order to lower the cost of mitigation; the desirability of international cooperation and linkages; and the need for complementary measures guided by a market failure framework.

The ideal domestic mitigation strategy would have five components: a price on emissions; corrections of market failures across three areas (research, development and innovation, demand-side energy use, and provision of network infrastructure); and supporting governance arrangements.

First, it would place a price on emissions (sometimes simply referred to as a "carbon" price), at a level that introduced sufficiently strong incentives for the private sector to adjust its behaviour in ways that caused emissions to fall within Australia's share of the global budget (herein referred to as "Australia's emissions budget").

Second, it would correct the market failure associated with innovation, research and development. It would recognise the need for high levels of expenditure on research, development and commercialisation of new, low-emissions technologies and approaches, and the reality that private investors are not able to capture for themselves the full social value of their innovations. It would introduce public assistance, in different forms for different stages of the innovation process.

Third, it would address a range of market failures in end-use of energy, such as misplaced incentives, and high costs for gathering and analysing information that would reduce energy consumption and confer external benefits. It would include mechanisms for subsidising the provision of information related to innovation in reduction of demand for energy, and regulatory responses where these were the most efficient means of correcting market failures in information.

Fourth, it would recognise that there are external benefits from pioneering private investment in provision of network infrastructure related to electricity transmission, natural gas pipelines and carbon dioxide pipelines associated with geo-sequestration. Here the potential for market failure derives from the external benefits conferred on others by the first mover in establishing what becomes new network infrastructure. The appropriate response may involve some combination of regulatory action and transitional financial support for investment.

Finally, the ideal mitigation strategy would embody measures that correct the tendency for regulatory and institutional arrangements and policy uncertainty to create significant barriers to change.

The carbon price, innovation and network infrastructure issues are discussed briefly in this Interim Report. These and the other elements of a successful mitigation strategy will be addressed in detail in the full reports. A more detailed paper on design of the

Emissions Trading Scheme (ETS) is being developed for release and public discussion in early March.

Emissions Pricing and the Emissions Trading Scheme (ETS)

Designing an efficient ETS

The introduction of a price on emissions is the primary instrument for securing the environmental objective. There are two possible market-based approaches to securing Australia's emissions budget, each involving the setting of an emissions price. One is an emissions tax. The other, an ETS, places caps on total emissions over specified periods of time, issues permits for emissions in quantities that correspond to these caps, requires firms to hold permits for any emissions that they generate, and allows trade in permits amongst firms. An ETS relies more completely on market processes, and if properly designed, and allowed to play its role without extraneous interventions to vary the budget or control the price, would be the more direct instrument for securing the Australia's emissions budget.

The most efficient ETS would allocate rights to emit within Australia's emissions budget over a specified period and allow the owners of permits to use them at a time of their choosing within that period.

The market would establish a forward price for permits, rising from the price at a rate of interest corresponding to alternative investments available to holders of permits. This is because investors will be choosing between alternative investments, with an emissions permit being one possible investment. Investors will assess whether the long term value of holding an emissions permit is higher or lower than the return from an alternative investment. This leads to selling or buying of emissions permits until a forward price curve emerges that causes the expected return from holding a permit to be equivalent to that on alternative investments. Thus the forward price tracks up at a rate determined by the opportunity cost of capital.

The whole price curve—the spot price, and all of the forward prices, together—would embody the market's expectations on what was necessary to induce the necessary substitution of low emissions goods and services for high emissions ways of providing those goods and services, and for economising on use of goods and services that incorporate high proportions of emissions. The market for emissions permits would take on characteristics of mature commodity markets which had depth and high liquidity, and in which stocks of the traded asset were large relative to short-term demand in use. It is likely that the closest comparator would be the gold market, with its characteristic contango: the forward price rising at the interest rate, and with spot and forward prices adjusting immediately to any change in expectations in demand or supply or in the interest rate. This price curve provides fundamental stability to the market, with opportunities for hedging price risks, and adjusting quickly to new information

Using the power of the market to minimise mitigation costs

To minimise mitigation costs, the market would set the rate at which Australia's emissions budget was utilised within the period over which emissions were to be restricted. If there were high expectations of future progress with new, low emissions technologies, the market would set a relatively low price curve, allowing relatively high use of Australia's emissions budget in the early years, followed by later rapid reductions in emissions. Low expectations of future technological improvements favouring low emissions would generate a higher price curve, a faster decline in emissions in the early years, and more gradual reductions in later years.

Any new information that increased optimism about new, lower-emissions ways of producing some product, whether they were expected to become available immediately or in the future, would shift downwards the whole structure of carbon prices, spot and forward. Any new information that lowered expectations about the future availability of low-emissions alternative technologies would raise the whole structure of carbon prices, spot and forward.

However, while efficient markets will minimise mitigation costs over time, they will not internalise the costs of climate change and the influence of the timing of utilisation of the emissions budget on these. That is, markets will not take account of the potential for climate change costs to be lower if the available emissions budget is utilised later rather than earlier. The Review is undertaking further work on the quantitative importance of this matter. To the extent that it turns out to be of substantial importance, we may need to suggest additional measures to encourage optimal timing of the use of permits. In addition, final recommendations on Interim and Long-Term emissions targets will need to take account of the content of: (i) emerging international agreements on these matters and (ii) the institutional context (domestically and internationally) and the capacity of these arrangements to support optimal market-based outcomes.

It is important to allow permits to be used when they have greatest value to market participants, to the extent that this is consistent with taking account of any additional climate impacts of early use of permits and with emerging international agreements.

The practical way to achieve the desired outcome would be for the Government to define an optimum path for use of permits—ideally based on analysis of the minimum cost path of emissions reduction within the total emissions budget—and to issue permits over time in line with this trajectory of emissions reduction. The fixed schedule for release of permits could then be accompanied by provision for banking permits in excess of current economic use, and borrowing from the future allocations when the value of current relative to future use suggested it. The banking and borrowing would allow the market to modify the rate at which permits were used in a way that minimised the cost of mitigation. It would allow the market to shape and reshape the "depletion curve" in response to new information about emissions-related technology or practices.

Robust institutional arrangements are needed

Care would need to be given to the design of the institutional arrangements for administering the allocation and use of permits. Variations in the number of permits on issue or the price would have huge implications for the distribution of income, and so could be expected to be the subject of pressure on Government. There is a strong case for establishing an independent authority to issue and to monitor the use of permits, with powers to investigate and respond to non-compliance.

The rules under which the independent authority would operate would *inter alia* specify the number of permits to be allocated over long periods ("the budget") and the amount of permits that would be issued each year within that budget; the circumstances in which the budget may be varied in response to new scientific information or international agreements; the extent of use of international permits and offsets to acquit local obligations; and the conditions whereby the independent authority might lend permits, including conditions related to creditworthiness and provision of security that would be placed on borrowers.

In addition, the independent authority could be given the roles of ensuring that Australia met its obligations under international agreements to reach emissions targets (for example, to buy permits on the international market when the private sector was a net borrower from the authority in a year in which Australia was required to meet an international target); and to assess and make payments related to incentives for operation of trade-exposed, emissions-intensive industries.

An ETS should have as broad coverage as practicable

An efficient ETS would have as broad coverage of emitting sectors as possible within practical limits imposed by factors such as measurability and transaction costs.

The proposals by the Task Group on Emissions Trading (2007) suggested relatively wide coverage for an Australian ETS. The recently announced proposals for a New Zealand ETS includes all sectors. Some sectors that are usually considered to be difficult, like forestry, are to be included from the beginning, and others, like agriculture, are to be included later, to allow time to develop ways to include them.

In Australia, there is considerable potential for sequestering large amounts of carbon through changes in land and forest management and agricultural practices. It is important that incentives to realise this potential are in place as early as possible in the life of the ETS. Full inclusion of agriculture and forestry could require consideration of measures available to other trade-exposed, emissions-intensive industries.

International linkages would benefit Australia

Australia would benefit from linking its market with others. For Australia, the largest gains from trade may come through links with its immediate region (see section 4.1).

It would be better to define opportunities for international trade as fully as possible from the beginning, rather than to cause surprise while the ETS is operating. An announcement at the beginning of the ETS of the conditions on which international trade in permits would be introduced should cover timing of planned expansion of opportunities for trade, and the conditions that would need to be met before the scope for trade would be expanded.

In circumstances in which the price structure in a large potential trading partner diverges from the optimal pattern (for example, there is no forward market in which the price is rising at the interest rate), there is potential conflict between domestic intertemporal and international efficiency. Unlimited trade with a large partner would cause domestic prices to move towards those of the large partner. This will need to be considered in decisions on allowing international trade between the Australian ETS and other schemes.

There are also circumstances in which potential conflict between domestic efficiency and international commitments would require participation in international trade. For example, the presence of international targets for emissions in particular years (for example, in relation to an interim target for 2020), may require the carbon authority to buy permits internationally to back any net domestic borrowings from the authority in the year of account.

Distributional impacts of an emissions price

It is important to understand how the imposition of an emissions price will flow through the economy in order to address its distributional impacts and to design appropriate policy responses.

Establishing a price on emissions affects the economy in two ways: it causes the substitution of higher-cost, low-emissions processes or goods and services for lower-cost established processes, goods and services; and it generates rent from the scarcity of the permits.

The former is a real cost to the economy as it involves the reallocation of resources to uses that would not otherwise have attracted them. The second involves a transfer of wealth from the economic agent to whom the price is ultimately transferred (in some cases businesses, but mostly households), to whomever receives the scarcity rents of the permits (established emitters if the permits are simply given to them; or to the Government in the first instance, and then to the beneficiaries of reduced taxation or increased public expenditure, if the permits are sold competitively).

This highlights an important difference between the legal and economic incidences of the emissions price. There is a crucially important distinction to be drawn between firms which face a requirement to hold permits that are in a position to pass on the prices of permits to customers, and firms which are not in a position to pass on the prices of permits. For the former, the legal and economic incidences of the cost of carbon are separated. In the latter, the legal and economic incidences of the carbon price coincide. For the most part, the distinction is between firms selling into the non-traded domestic sector, which will mostly be in a position largely to pass on the permit price, and firms in the trade-exposed, emissions-intensive sector, which mostly will not be able to pass on the price of permits (in part of in whole) unless and until relevant competitors in global markets are in a comparable position.

In the case of the domestic energy sector, which in Australia is a particularly large source of emissions, the legal responsibility to purchase emissions permits will largely rest with energy generators (or possibly with their upstream suppliers of fossil fuels, who will pass the price on to generators). However, the cost of these permits, their economic incidence, will mostly be passed through to consumers in the form of higher electricity and other energy prices, at least in the early years of the scheme when a relatively low proportion of energy derives from alternative, low-emissions sources embodying greater economic costs. These price rises will disproportionately affect low income households, for whom the affected products make up a larger portion of expenditure and who are less able to afford investment in product with lower energy (and emissions) profiles.

As a major environmental reform, an ETS is not intended incidentally to have large and arbitrary effects on the distribution of income—and in particular, not to redistribute income away from people on low incomes. The first form of the European ETS (corrected in the proposals for post-2012), where most permits required by the domestic energy sector were issued free, and yet the price of the permits was passed through to households, demonstrates that the transfer of large amounts of income from ordinary households to increased profits of the energy sector leads to political resistance to environmentally efficient emissions prices.

In the case of households, there is a strong environmental as well as equity rationale for returning the revenue from the rent value of the permits that is passed through to households, in an economically and environmentally efficient way.

It is important for the environmental integrity of the ETS that the distribution of the rent value of permits takes forms that preserve the higher relative prices of emissions-intensive products. Policy instruments for returning rents collected from households could include adjustments to the social security and income tax systems, and, assistance through information or capital subsidies to support efficient household adjustment to higher energy prices.

That part of the price of permits that does not pay for the higher costs of substitutes, and cannot be passed on to households, may compress profit margins in emissions-intensive businesses. This will occur where a business, due to the competition it faces, cannot pass the costs on to consumers. This is most obviously and importantly the case with trade-exposed, emissions-intensive industries. In Australia, industries included in this category may include non-ferrous metals smelting, iron and steel-making, and cement.

Addressing impacts to trade-exposed, emissions-intensive industries

There are environmental and economic reasons for establishing special arrangements for highly emissions-intensive industries that are trade-exposed and at risk during the transition to effective global carbon pricing arrangements. The case for special arrangements is based on efficiency in international resource allocation.

All other factors being equal, if such enterprises were subject to a higher emissions price in Australia than in competitor countries, there could be sufficient reason for relocation of emissions-intensive activity to other countries. The relocation may not reduce, and in the worst case may increase, global emissions. The economic costs to Australia and the lack of a global environmental benefit of such relocation of industry are obvious.

Clearly, such market failures would not arise if a comprehensive international arrangement were in place. In the presence of a global carbon price (and the absence of other distortions), the overall comparative advantage of regions and nations would dictate where firms invested in new productive capacity. Second best solutions (after comprehensive global carbon pricing) would be arrangements within which the main countries producing trade-exposed goods in each sector imposed carbon pricing measures of similar incidence, so-called “sectoral arrangements”.

In the absence of a first- or second-best global arrangement, the challenge in designing an Australian emissions trading scheme is to identify transitional arrangements that are environmentally and economically efficient, equitable, and built on sound governance principles.

Guiding principles should require the application of a principle of materiality: effects on profitability should be counterbalanced when they exceed some threshold. They should require an independent authority to assess frequently and regularly the effects of differential international pricing of carbon on the prices of tradeable goods produced by Australian firms. The independent authority would prepare assessments of the effects of the price distortions on the profitability of enterprises producing in Australia, and make counterbalancing payments on a timely basis.

Such a formulation would see the special arrangement phased out automatically if and as the world moved towards more comprehensive sectoral or global carbon pricing arrangements.

For reasons of good governance as well as fiscal prudence, assessment of losses should be undertaken on the basis of objective contemporary evidence of loss provided to an independent authority with information discovery powers.

It has been suggested that the permits themselves should be the currency of assistance to the trade-exposed, emissions-intensive industries. It is worth considering whether such assistance would be a sufficiently transparent way of compensating for loss of income. The alternative of selling permits through a competitive process, and compensating through timely cash payments will be considered in the Review.

The report by the Task Group on Emissions Trading (2007) discusses some of the design challenges that will need to be faced in implementing efficient and effective transitional arrangements related to “compensation” for business losses, and noted that its own proposals may need to be modified in the light of additional information and experience. These challenges are large. The Review is in the process of developing principles to guide the form, level and timing of support for trade-exposed, emissions intensive industries at risk. These principles will be presented in the March discussion paper on the design of an emissions trading scheme.

Addressing impacts to the non-traded sector

There is also some expectation that “compensation” will be made available to firms in Australia’s non-traded sector, if any such firms’ profitability were exceptionally and adversely affected by the introduction of the emissions trading scheme. Stationary energy is the dominant industry within this category.

Several issues will need to be considered carefully before determining whether scarce resources should be used to compensate such firms.

Typically, producers in the non-traded sectors as a whole will be able to pass on to households most of the costs associated with their direct and indirect emissions. In such instances, the profit impact felt by individual producers will arise from two sources. First, there is an overall (and absolute) reduction in the quantity demanded arising from higher costs of supply. That is, consumers will replace higher-emissions products by lower-emissions products. Second, there will be differences in relative capacity of individual firms to minimise their respective exposures to a carbon price. Firms with less dependence on emission intensive production processes, or which have the ability to switch production process quickly in order to minimise their exposure to a carbon price, may find their market share (and even their profitability) increases. Firms which have less flexible capital structures could be faced with having to choose between passing on the price (and losing market share) or absorbing the price of emissions at the expense of profitability. All things being equal, such firms may face some loss of market value. In reality, it will be difficult or impossible to assess such effects in advance of the operation of the ETS, amongst other things because the effects on profitability will depend crucially on the strength of demand in the years in which the ETS is introduced. Buoyant markets could easily overwhelm the impacts of a price on emissions.

There is no tradition in Australia for compensating capital for losses associated with economic reforms of general application (for example, general tariff reductions—or, for that matter, reductions in tariffs in particular industries—floating of the currency or introduction of the goods and services tax); nor, it should be said, for taking away windfall gains from changes in Government policy (for example, reductions in corporate income taxes).

In the case of this particular reform, the business community has been aware of the risks of carbon pricing for many years, and many businesses have sought to re-engineer their production processes to reduce their reliance on direct and indirect emissions in anticipation of such changes.

Addressing impacts to communities

There is, however, both Australian precedent and a rationale for structural adjustment assistance to workers, communities and firms whose established incomes, employment and patterns of life are disrupted by reforms.

Desirably, and typically, these take the form of assistance in preparation for new employment: retraining of workers (as with textile and steel workers in the 1980s after reduction in protection); grants to communities to support improvements in infrastructure that would be helpful to the attraction of alternative industries (the steel towns in the 1980s); or assistance to parts of the industry that have opportunities for survival and expansion in the new, more competitive circumstances (design and export assistance to the passenger motor industry following reductions in protection in the 1980s and 1990s). Some forms of structural adjustment assistance have been more productive and some more wasteful than others.

The potential for carbon capture and storage

There is no question that, in the absence of commercially successful carbon capture and storage (CCS), some coal-mining and coal-based power-generating firms in Australia would be negatively affected by the introduction of an ETS, and may struggle to operate profitably in a carbon-constrained economy. Reduced operations or decreased profits would have implications for the welfare of workers and regional communities. On the other hand, commercially successful CCS could turn the coal and coal-based electricity generating areas into regions of strong expansion and prosperity. The power requirements of the sequestration process itself would support a large expansion of electricity output to maintain established contributions into the national energy systems.

It would be consistent with Australian policy traditions, and with sound principle, to make substantial commitments to support private research, development and commercialisation activities related to carbon capture and storage by established coal-based electricity producers.

This would be in addition to any general support for innovation in the low-emissions energy industries, for which investments in development and commercialisation of CCS would qualify. This would encourage the timely exploration of the one development — carbon capture and storage — that could generate an expanding future for the coal-based power-generating regions, with large opportunities for established firms in the coal-based domestic energy industries.

Other issues that will be further explored by the Review

On the basis that this major environmental reform, the introduction of the ETS, is not meant to arbitrarily increase the proportion of the economy under the control of the public sector, consideration should be given to identifying the proceeds of the sale of permits for return to the community, either to households, or to business, in one or other of the ways discussed above. Demonstration that revenues from the sale of permits had been returned to the private sector in one way or another, would neutralise what could otherwise become a rallying point for opposition to effective mitigation policies.

The various Australian Mandatory Renewable Energy Targets (MRETs) are soon to be subsumed within a Commonwealth MRET requiring 20 per cent of electricity to be drawn from renewable sources by 2020. A high proportion of the incentive to introduce low-emissions energy in the early years of the ETS, and a higher proportion of the economic cost, may be carried by the MRET scheme. Unless the budget for the ETS is tightly and quickly restrictive, the ETS may result in little additional low-emissions energy contribution in the early years, beyond that which is encouraged by the MRET. In this case, the incremental economic costs of the ETS may be very low in these years. For the big domestic energy companies, the big adjustment costs would derive from MRET, not the ETS. The MRET's current virtue is that it can begin its work earlier than an ETS. The Review will examine in detail the interaction of the MRET with the ETS, and possible paths for phasing out the MRET as the ETS comes to provide sufficient incentives for Australia to meet its emissions targets.

The discussion paper to be released shortly by this Review will independently and openly re-examine ETS design features (including those discussed earlier in this section) considered by the Task Group on Emissions Trading and the National Emissions Trading Taskforce. The discussion paper will inter alia include a discussion of issues such as:

- The appropriate mechanism, timelines and triggers for determining and reviewing the abatement path — including the setting of gateways and the opportunity to review emissions budgets in the light of developments in international agreements or in the science. Reviews should be highly structured, with defined review dates, perhaps every ten years. The factors that may lead to a change in the emissions restriction need to be carefully defined and strictly limited;

- The point in the chain of production and trade at which compliance with permit requirements is imposed. While it would seem that an emissions trading scheme should focus on emitters, in some cases a higher point in the chain will be associated with lower transactions, administration and compliance costs, without detracting from the environmental or economic merits of the scheme;

- The interaction between, and desirability of, the date stamping of permits, limitations on the inter-temporal borrowing of permits and the introduction of a "safety valve" price at which additional permits are issued without limit;

- The economic and environmental efficacy of an Australian cap on emissions that may be increased in response to increased output by trade-exposed, emissions-intensive industries;

- The appropriateness of payments in the form of free permits to the non-traded sector based on prior calculations of possible long-term losses— including analysis in relation to:

    - the precedent this may establish for compensation of capital (as proposed by the Report to the previous Government in the case of the non-traded sector) for policy change and whether this would complicate reform opportunities in future;

    - comparisons with alternative forms of assistance such as structural adjustment assistance that is targeted at the demands of affected workers, communities and the future competitiveness of firms (for example, additional support for accelerated innovation related to carbon capture and storage);

    - difficulties of computation of future losses; and

    - the implications of such policies for short-term macro-economic stabilisation.

- Institutional design, particularly the role of an independent authority that would oversee the emissions market — including the rules by which it would operate and the discretion it could exercise within those rules.

Research, development and commercialisation: public goods and externalities

New technology will play a substantial role in mitigation of and adaptation to climate change. On the mitigation side, new technologies will be needed in energy production, new manufacturing techniques and the development of new product lines.

Establishing a credible and efficient ETS will address the primary market failure of uncapped greenhouse gas emissions and will encourage research and development (R&D) on low-emissions technology. However, the public good nature of basic research and the positive externalities of innovation mean that simply establishing a price on emissions will not generate optimal levels of investment in technological change.

Of particular importance to assisting Australia's transition to an emission-constrained future is the development of low-emissions technology for the energy sector. In 2005, emissions from energy-related sectors accounted for almost 70 per cent of total greenhouse gas emissions. Stationary energy alone accounted for 50 per cent of emissions and was the source of the largest percentage increase in the 15 years from

1990 to 2005. These contributions are much higher (42.6 per cent) than for other developed countries, which have proportionately more stationary energy coming from renewable sources.

For many years, innovation was thought to occur by a simple linear progression from R&D to commercialisation to diffusion. This view implied that the best way to increase the output of useful new technologies was to increase the input of new inventions by putting more resources into R&D, the so-called technology or supply-push. An alternative view was that the demand for services would stimulate inventive activity, so-called market or demand-pull.

Approaches derived from more recent theoretical approaches and empirical research accept the roles of both technology-push and market-pull, but stress the importance of understanding the systems nature of innovation. The innovation systems approach provides a more complex picture of the drivers of the rate and direction of innovation, and of the barriers that can prevent successful innovation.

There are identifiable stages of technology development within the innovation process (Grubb, 2004). The basic drivers of innovation can be seen as technology-push, from the development of new ideas, and market-pull, from the demand for market solutions. A frequently observed phenomenon is the gap between these, the so-called valley of death.

The market-pull end of the innovation chain draws more investment from the business and finance community, while the technology-push end receives significantly less. Government intervention can take various forms and can affect different stages of the innovation chain in different ways. An emissions pricing regime will establish a strong market pull, but other policies will be required to address the market failures along earlier stages of the innovation chain.

The formulation of policies to correct externalities in research, development and commercialisation is complicated by two main trade-offs. First, there is a trade-off between the desirability of providing technology-neutral support in order to avoid distorting the selection of technologies by the market; and the competing desirability of concentrating resources on more promising areas of research and development. Second, there is a trade-off between the potential for increasing returns from economies of scale and learning effects to reduce costs and ease the transition to emissions scarcity; and the option value of maintaining work on a range of potentially competitive ideas.

Policies to assist innovation must find the right balance between providing technology-neutral and technology specific support, and between encouraging options and achieving increasing returns.

Research is a public good

Basic research—at the ideas end of the innovation chain—is a public good in that it is non-rival and non-excludable. It is non-rival because, once it has been created, its use by one agent does not reduce the amount or quality available for use by others. This makes it undesirable to ration access to it. It is non-excludable, as once supplied it is hard to deny access to other users, and hence its benefits cannot be captured by the entity that conducts the research.

These features provide a rationale for government funding and support in the early stages of R&D. The research outcome may have no immediate commercial application, but is widely applicable, easily transferable, and bears public good characteristics. Although a host of measurement and methodological issues makes it impossible to provide any but approximate quantification of the returns to government contributions, there are "widespread and important economic, social and environmental benefits" generated by Australia's public funding of science and innovation (Productivity Commission, 2007).

The total amount of Australia's expenditure on research and development relevant to transition to an emissions-constrained economy should be seen as a contribution to generation of important international public goods. It should be calibrated to represent a proportionate contribution to a global research and development effort by developed countries, focussing on areas of Australian comparative advantage. This, in turn, can play an important part in a wider international agreement on mitigation.

Despite the desire to avoid 'picking winners', there is inevitably a good deal of discretionary judgement in decisions on allocation of public funding for public goods research and development. The important thing is that institutional arrangements for allocating funding apply appropriate expertise in a disciplined manner, and take appropriate account of Australian comparative advantage. This will be discussed at greater length in the full reports.

Positive externalities of demonstration and pre-commercial learning

There are positive externalities in later stage innovation, because innovators can rarely appropriate the full benefits of their investment in knowledge creation. There are some unpriced external benefits from innovative activity (Arrow, 1962). These wider social benefits include:

- The development of skills, including the development of engineering and wider technical capacity;
- The development of support industries and sectors;
- The resolution of issues related to the local application and integration of technologies; and
- The resolution of legal or regulatory issues including linking to existing regulatory structures.

This is especially important in the 'valley of death'. At this stage however, there is neither advantage nor necessity in "picking winners". The Review is exploring more general mechanisms for assistance.

In the intermediate stages of the innovation process, some external benefits have mainly local and national applications, and some are international in character. The accounting of mid-stage innovation within international commitments to an international research, development and commercialisation effort would require some discounting of total public expenditure.

Policy clarity, continuity and coherence are critical to the formulation of expectations about future markets that are crucial to encouraging desirable levels of investment in innovation. In the transition to the low-carbon economy, clarity, continuity and coherence are important in both the system of support for research, development and commercialisation, and the carbon pricing regime (Foxon *et al.*, 2007).

Supply-side infrastructure market failures

Infrastructure will be important in Australia's mitigation of and adaptation to climate change. Private investment in supply-side infrastructure, particularly for electricity transmission and natural gas and carbon dioxide pipeline transportation, faces first mover disincentives. The first firm to build an electricity transmission line from a generator in a new location to the grid, or a CO_2 pipeline from a generator to a suitable storage site, will face a disproportionate part of the total cost of an infrastructure system that later has other users.

These circumstances generate tendencies for each potential user of new infrastructure to delay investment in the hope that another may take the first step. In addition, they may lead to potential investors in low-emissions power generation who would need to use new infrastructure assuming that they would have to meet the full cost of pioneering investment, even if there were some prospect of investment costs being shared by others. These considerations raise the commercial hurdles over which the investment must jump before an investor decides to proceed. The higher hurdle is likely to lead to unnecessary caution and underinvestment. The correction of the resulting tendency to underinvestment would require public contributions to infrastructure investment (as favoured in Britain in the encouragement of renewable energy generation in new locations), or regulatory action to bring together decisions on power generation requiring new technologies (as under current discussion in California). These issues will be even more important in Australia than in other countries, because of the great distances separating new sources of energy and centres of demand, and between sequestration sites and established locations of industrial activity generating significant emissions.

5 Implications of addressing climate change for Australia

5.1 Australia would suffer exceptionally from unmitigated climate change

How Australia fares in a world of climate change will depend above all on the extent of effective global mitigation, on how Australia manages its share of a global effort and on how the global and Australian economies and environments adapt to the impacts of climate change.

Australia would be a big loser—possibly the biggest loser amongst developed countries—from unmitigated climate change. The pace of global emissions growth under "business as usual" is pushing the world rapidly towards critical points, which would impose large costs on Australia directly and also indirectly through the effects on other countries of importance to Australia. The world of business as usual would be deeply problematic for Australia, not least because of the stress that it would place on vulnerable economies, societies and polities in Australia's Asian and Pacific neighbourhood.

The Review is exploring closely the risks associated with climate change in three cases of mitigation, for comparison with "business as usual". One case is continuation, and probably steady intensification, of the partial, *ad hoc* approach to mitigation that characterises current international discussion. A second is firm, effective global mitigation, around an objective of holding emissions concentrations to 550 ppm CO_2-e. A third is ambitious, effective global mitigation, around an objective of stabilisation at 450 ppm CO_2-e, inevitably with overshooting.

The expected costs of climate change would be widely different in the four cases. The differences are currently the subject of close analysis. It is not clear at this stage whether the data will support strong, quantitative analysis of the differences, or whether our judgements will need to be built around qualitative assessments.

The costs of mitigation will also be widely different across the three mitigation scenarios. The Review will work closely with the Australian Treasury on modelling the costs of mitigation under various scenarios.

Australia stands to benefit from an effective international mitigation effort

It is clear from the Review's early analysis that Australia has the human and natural resources to do relatively well within an ambitious international mitigation effort. This reality will surprise some observers, as it contradicts an Australian conventional wisdom that our heavy reliance on fossil fuels for exports, as inputs into export-oriented metals processing industries and for domestic electricity generation mean that Australia faces exceptionally high costs of mitigation.

There are many ways in which Australia is well placed to do well as part of an effective international mitigation effort.

First and most importantly, Australia has an exceptional human resource base in engineering, management and finance related to the resources sector, which places us well for competitive participation in innovation in the emerging, low emissions industries. This strength will reduce the costs of adjustment to the new, low-carbon environment. It is already providing a basis for important new export industries, which will be greatly strengthened by Australia moving from the rear to the middle ranks of developed countries in its domestic mitigation efforts.

Australia is a major exporter of minerals that will receive advantages from a strong international mitigation effort, notably uranium (by far the world's largest reserves of high quality uranium oxide) and natural gas (exceptionally large resources per capita amongst developed countries).

Australia has exceptionally rich resources for renewable energy – for solar, geothermal and wind energy and possibly for tidal and wave power and biofuels – on a per capita basis, amongst the most favoured few in the developed world.

Australia has large deposits of high quality (that is, low emissions per unit of energy) coal, which means that our share of global coal supply would increase in a world of comprehensive mitigation

Australia has exceptionally good sites for carbon capture and storage, which, should the CCS technology be successful commercially (and it is strongly in Australia's interest to see this tested thoroughly on the earliest possible time frame), would support strong expansion of the Australian coal-based energy industry.

Australia's advantages as a location for minerals processing, while diminished by the carbon price in comparison with developing countries which have large underdeveloped resources of renewable and other low-emissions energy, would be enhanced in other ways by comprehensive global mitigation. Higher energy costs would increase the transport cost premium on processing close to the source of minerals. Australia is likely to remain a source of relatively low-cost energy despite the carbon price. And the world's limited resources of competing, low-cost renewable and other low-emissions energy – most importantly, hydro-electric potential and stranded natural gas which have been underutilised because of the geographic distances and political risks associated with location in developing countries – will be in great demand and subject to rising costs of access as a result of competitive pressure.

Australia's large livestock industries are less emissions-intensive than competitors in the Northern Hemisphere, and would gain competitively and considerably if these industries were incorporated into a comprehensive regime of greenhouse gas pricing.

Australia's near neighbours, first of all but not only Papua New Guinea, have exceptional opportunities to reduce carbon emissions and to expand output of renewable energy in various forms, which could be developed to mutual advantage.

Australia's past profligacy in energy use has left an exceptional legacy of opportunities for low-cost energy savings in business and amongst households.

The combination of Australia's exceptional sensitivity, relative to other developed countries, to climate change, and its exceptional opportunities to do relatively well in a world of ambitious, comprehensive mitigation, suggest that Australia should be pressing the international community towards ambitious mitigation.

This suggests two things about Australia's domestic mitigation targets. First, Australia should be committing within the timetable of the Bali roadmap to emissions reductions for 2020 and 2050 that are fully comparable in terms of adjustment effort to commitments being made by other developed countries. The State and Commonwealth Government commitments to 60 per cent reduction in year 2000 emissions by 2050, with corresponding interim targets, may be shown to be appropriate in that context.

Second, the recent developments in the science summarised earlier in this Interim Report, and the work of the Review on current and prospective emissions scenarios in the absence of major policy changes, suggests that ambitions for mitigation will need to rise way beyond those embodied in the Bali roadmap if high probabilities of damaging climate change are to be avoided. Australia should be ready to make firm commitments to specified additional tightening of its own targets for emissions reduction if the international community agrees to effective global action of defined ambition, incorporating appropriately ambitious binding commitments from major developing countries. Australia should, during the course of the Bali roadmap discussions, put on the table an offer embodying the cuts in emissions that it would be prepared to make should the major including developing emitting countries agree on a comprehensive set of commitments that together would reduce risks of dangerous climate change to acceptable levels.

Developing our emissions reduction pathway

One of the major foci of the full reports will be the comprehensive assessment of the relative costs to Australia of inaction on climate change, and of varying degrees of action. Australia's own commitment to mitigation would be calibrated to the international position. The full reports will discuss in detail the level of global ambition, and the corresponding Australian commitment to mitigation, that suits Australia best. The interim judgement is that Australia's national interest lies in strong global action.

Ad hoc, partial mitigation would be associated with substantially lower risks of dangerous climate change than "business as usual". Although the costs of Australia's own mitigation would be lower in this case than with comprehensive, global mitigation, the unevenness in other countries' approaches to mitigation would make this case problematic for Australia in ways that would be quite different from either firm or ambitious effective global mitigation. Amongst much else, this would be a world of trade discrimination and resurgent protectionism, in which protectionist influences interacted with other countries' mitigation policies in ways that were strongly disadvantageous to Australia.

How Australia fares under all but the "business as usual" scenario – and much of the world has already passed beyond "business as usual" – will depend crucially on the efficiency of its own mitigation policies. Costs of mitigation will be much lower, and the extent to which Australia is able to use its considerable advantages in a world of comprehensive global mitigation much higher, if Australia is able to put in place a coherent set of mitigation policies – centred on the ETS but extending well beyond it – that remain stable over long periods.

To achieve this result, the policies will need to promote efficiency in investment and production, and also in distribution. The adjustment required in securing the targets to which Australia will need to commit itself under current circumstances, and the more ambitious targets that would be required alongside a new, effective global approach to mitigation, will make heavy demands on scarce Australian economic and finite political resources. These scarce resources must be used economically if we are to succeed in the task without national trauma.

It is a primary purpose of the Review to assist in the development of, and the marshalling of community understanding and support for, steady policies that can be sustained over long periods, to ensure that scarce economic resources and finite political will are applied economically to Australia's contribution to the global challenge of avoiding unacceptable risks of dangerous climate change.

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Attachment 1 – Terms of Reference

To report to the Governments of the eight States and Territories of Australia, and if invited to do so, to the Prime Minister of Australia, on:

1. The likely effect of human induced climate change on Australia's economy, environment, and water resources in the absence of effective national and international efforts to substantially cut greenhouse gas emissions;

2. The possible ameliorating effects of international policy reform on climate change, and the costs and benefits of various international and Australian policy interventions on Australian economic activity;

3. The role that Australia can play in the development and implementation of effective international policies on climate change; and

4. In the light of 1 to 3, recommend medium to long-term policy options for Australia, and the time path for their implementation which, taking the costs and benefits of domestic and international policies on climate change into account, will produce the best possible outcomes for Australia.

In making these recommendations, the Review will consider policies that: mitigate climate change, reduce the costs of adjustment to climate change (including through the acceleration of technological change in supply and use of energy), and reduce any adverse effects of climate change and mitigating policy responses on Australian incomes.

This Review should take into account the following core factors:

- The regional, sectoral and distributional implications of climate change and policies to mitigate climate change;

- The economic and strategic opportunities for Australia from playing a leading role in our region's shift to a more carbon-efficient economy, including the potential for Australia to become a regional hub for the technologies and industries associated with global movement to low carbon emissions; and

- The costs and benefits of Australia taking significant action to mitigate climate change ahead of competitor nations; and

- The weight of scientific opinion that developed countries need to reduce their greenhouse gas emissions by 60 percent by 2050 against 2000 emission levels, if global greenhouse gas concentrations in the atmosphere are to be stabilised to between 450 and 550 ppm by mid century.

Consult with key stakeholders to understand views and inform analysis. A draft Report is to be distributed for comment by June 30 2008. The final Report is to be completed and published by September 30 2008. Interim draft reports on particular issues may be released before that time for public discussion. The Report will embody the independent judgments of its author.