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Report 100

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Kyoto Protocol to the United Nations Framework Convention on Climate Change

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Foreword

In conducting this inquiry, the Treaties Committee has adopted a science-based, evidence-based approach to the issue of global heating. The report uses the most up to date scientific evidence to make recommendations about how Australia should approach the climate change problem in the post-Kyoto world.

The scientific evidence detailed in this report shows that climate change is happening faster and at lower levels of CO₂ than the Intergovernmental Panel on Climate Change has been predicting. The scientific consensus is that it would be dangerous to allow the amount of carbon in the atmosphere to exceed 450 parts per million.

After examining the evidence, the Committee has concluded that it is in Australia's interests to get global action delivering deep cuts in carbon emissions in order to stabilise greenhouse gases in the atmosphere at 450 parts per million or lower by 2050.

The Committee also concerns itself with emissions targets. It is hard to see how the world can meet the 450 parts per million or lower figure unless developed countries are willing to cut greenhouse gases by 80 per cent by 2050. So the Committee recommends that Australian Government be willing to adopt an 80 percent target and take this as a negotiating position to Copenhagen in December this year.

Generally, greenhouse gas emissions are measured against a 1990 baseline. This is very onerous for Australia, because we were expressly permitted to increase our emissions by eight percent in the first Kyoto period. So it may be that our commitment to an 80 percent cut should be a commitment to cut by 80 percent from now on – this would amount to a cut of two percent every year from 2010 to 2050 – challenging, but achievable. We cannot change our past, but we must change our future.

In January, my home city of Melbourne experienced a very uncomfortable foretaste of things to come under climate change. We had the second driest January ever, with negligible rainfall. To make matters worse, in the last week of January we had day after day of 40-degree-plus temperatures.

Melbourne was not the only city to experience extraordinarily hot and dry weather. Adelaide and much of South Australia, Victoria and the ACT were similarly afflicted. People died in the heat. Power systems failed. Public transport systems failed. This is the shape of things to come in south-eastern Australia, and it underscores the seriousness and urgency of the climate crisis.

To quote the United States' President Barack Obama:

...the time for delay is over. The time for denial is over. We all believe what the scientists have been telling us for years now, that this is a matter of urgency and national security and it has to be dealt with in a serious way. That's what I intend my administration to do.

The majority of the Committee concurs with this view.

Kelvin Thomson MP
Chair



Membership of the Committee

Chair	Mr Kelvin Thomson MP	
Deputy Chair	Senator Julian McGauran	
Members	Hon Kevin Andrews MP (until 10/11/08)	Senator Simon Birmingham
	Mr Jamie Briggs MP (from 11/11/08)	Senator Michaelia Cash
	Mr John Forrest MP	Senator Don Farrell
	Ms Jill Hall MP	Senator Scott Ludlam
	Mrs Julia Irwin MP (from 6/2/09 until 12/3/09)	Senator Louise Pratt
	Hon John Murphy MP (from 13/3/09)	Senator Dana Wortley
	Ms Belinda Neal MP	
	Ms Melissa Parke MP	
	Mr Luke Simpkins MP	
	Mr Chris Trevor MP (until 5/2/09)	
	Ms Maria Vamvakinou MP	

Committee Secretariat

Secretary	Jerome Brown (from 24/11/08)
	Russell Chafer (from 6/9/08 until 23/11/08)
	Siobhán Leyne (until 5/9/08)
Inquiry Secretaries	Kevin Bodel
	Julia Searle
Research Officer	Geoff Wells
Administrative Officers	Heidi Lushtinetz (from 19/1/09)
	Dorota Cooley



Resolution of Appointment

The Resolution of Appointment of the Joint Standing Committee on Treaties allows it to inquire into and report on:

- a) matters arising from treaties and related National Interest Analyses and proposed treaty actions and related Explanatory Statements presented or deemed to be presented to the Parliament;
- b) any question relating to a treaty or other international instrument, whether or not negotiated to completion, referred to the committee by:
 - (i) either House of the Parliament, or
 - (ii) a Minister; and

such other matters as may be referred to the committee by the Minister for Foreign Affairs and on such conditions as the Minister may prescribe.



List of abbreviations

ACE CRC	Antarctic Climate and Ecosystems Cooperative Research Centre
ACF	Australian Conservation Foundation
BCA	Building Code of Australia
BEV	Battery Electric Vehicles
CCS	Carbon Capture and Storage
CPRS	Carbon Pollution Reduction Scheme
CRC GGT	Cooperative Research Centre for Greenhouse Gas Technologies
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GBRMPA	Great Barrier Reef Marine Park Authority
HEV	Hybrid Electric Vehicles
IPCC	Intergovernmental Panel on Climate Change
MRET	Mandatory Renewable Energy Target
NABERS	National Australian Built Environment Rating System
ppm	parts per million
RET	Renewable Energy Target
SRES	Special Report on Emissions Scenarios
WALFA	West Arnhem Land Fire Abatement



List of recommendations

2 Global heating

Recommendation 1

The Committee finds that it is in Australia's interests to secure global agreement to deliver deep cuts in emissions so as to stabilise concentrations of greenhouse gases in the atmosphere at 450 parts per million or lower by 2050.

3 Addressing climate change

Recommendation 2

The Committee recommends that the Australian Government be willing to adopt a policy setting to reduce Australia's emissions of greenhouse gases by 80 percent by 2050 in seeking agreement from other developed countries to also cut emissions by 80 percent by 2050.

Recommendation 3

The Committee recommends that the Australian Government pursue the creation of an international carbon market as the primary mechanism for reducing greenhouse gas emissions.

Recommendation 4

The Committee recommends that the Australian Government take the following position to the 15th Conference of the Parties to the United National Framework Convention on Climate Change in Copenhagen, Denmark:

- that the international community reach an agreement to stabilise greenhouse gas emissions at around 450 parts per million or lower of carbon equivalent;

- that the agreement distribute responsibilities for reducing greenhouse gas emissions across nations by requiring developed nations to reduce emissions by 80 percent by 2050, with the residual reductions distributed fairly between developing and transitional nations; and
- that the agreement establish an international carbon market as the primary mechanism for achieving the necessary reductions.

4 Greenhouse gas reductions in Australia

Recommendation 5

The Committee recommends that the Australian Government work through the Council of Australian Governments to establish a high quality integrated public transport system including light rail technology.

Recommendation 6

The Committee recommends that the Australian Government endeavour to move to 'full carbon accounting' to ensure that emissions resulting from forestry activities as well as biosequestration are accurately accounted for.

Recommendation 7

The Committee recommends that the Australian Government, through both the Council of Australian Governments and ongoing work on the Carbon Pollution Reduction Scheme, and in consultation with relevant indigenous communities, explore ways to reduce greenhouse gas emissions from savannah burning.

Recommendation 8

The Committee recommends that promising renewable energy technologies which are not cost-competitive at the moment, including geothermal, solar thermal, large scale photovoltaic and wave energy, are further supported.

Recommendation 9

The Committee recommends that the Australian Government establish a coordinating mechanism through the Council of Australian Governments to ensure integration and coordination of greenhouse gas reduction actions across all States, Territories and levels of government, including local and State government planning processes.

5 Climate change adaptation in Australia

Recommendation 10

The Committee recommends that the Australian Government direct the Australian Building Codes Board to review the Building Code of Australia to ensure that it better provides for energy efficiency standards suitable for varied climate zones.

Recommendation 11

The Committee recommends that the Australian Government investigate using revegetation as an adaptation mechanism to reduce temperature and increase rainfall in applicable parts of Australia.

Recommendation 12

The Committee recommends that the Australian Government conduct an inquiry into adaptation strategies for climate change. This inquiry should include consideration of projected sea-level rise due to climate change and its impact upon Australian coastal communities and neighbouring countries.

Introduction

Purpose of the Report

- 1.1 This report examines issues arising out of Australia's ratification of the Kyoto Protocol in December 2007 and recommends an approach for Australia to adopt at the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change in Copenhagen, Denmark.

Conduct of the Committee's Review

- 1.2 The review contained in this report was advertised in the national press and on the Committee's website.¹ Invitations to lodge submissions were also sent to all State Premiers, Chief Ministers, Presiding Officers of Parliaments and to individuals who had expressed an interest in being kept informed of proposed Treaty actions. Submissions received and their authors are listed at Appendix A.
- 1.3 Public hearings were conducted by the Committee in Canberra, Brisbane, Darwin and Perth from August to December 2008. In total,

1 The Committee's review of the proposed Treaty action was advertised in *The Australian* on 9 July 2008. Members of the public were advised on how to obtain relevant information both in the advertisement and via the Committee's website, and invited to submit their views to the Committee.

33 witnesses were examined at nine public hearings. The dates and locations of the hearings, including the names of the witnesses who appeared before the Committee, are at Appendix C.

- 1.4 Access to the published submissions to the inquiry, transcripts of evidence taken at public hearings, and an electronic copy of the report are available on the internet from the Committee's website:
<http://www.aph.gov.au/house/committee/jsct/reports.htm>

Approach to this Report

- 1.5 The Committee has taken a conscious decision in this report to adopt a scientific evidence-based approach as it relates to the issue of climate change and greenhouse gas emissions.
- 1.6 Scientific evidence provides a sound basis for policy in this instance because the nature of scientific evidence makes it a uniquely reliable source in describing the behaviour of the physical world, and this report largely addresses how the international community ought to react to that behaviour.
- 1.7 Scientific evidence is based on what is called the 'scientific method'. The scientific method involves scientists testing the findings of their peers' assertions in an attempt to falsify them. The more that attempts to falsify a finding fail, the more reliable that finding is considered to be.
- 1.8 Eventually, should the initial result be repeated often enough, it can come to be considered a general rule that can be relied on in most circumstances.
- 1.9 This process of continuous testing provides for uniquely reliable evidence. The reliability of the scientific method means it is used in everything from testing the effectiveness of new medicines to testing the reliability of aircraft.
- 1.10 The evidence for human caused greenhouse gas emissions increasing the average temperature of the planet has successfully avoided falsification for long enough and by enough scientists in the field to be considered robust and reliable.

Structure of this Report

1.11 This report contains five chapters. Chapter one is this introduction.

Chapter two

- 1.12 Chapter two details the evidence that human caused greenhouse gas emissions are causing climate change, discusses the effects of climate change, and proposes an appropriate stabilisation level for greenhouse gases in the atmosphere.
- 1.13 Evidence from ice cores has shown that the Earth's climate has remained relatively steady for the past 400,000 years. For that period, temperatures and greenhouse gas levels have fluctuated in parallel, with higher concentrations of greenhouse gases coinciding with higher average temperatures. The highest level of greenhouse gases in the atmosphere in the last 400,000 years was 280 parts per million.
- 1.14 However, 150 years ago levels of greenhouse gases in the atmosphere began to rise rapidly. The latest measurement for greenhouse gases in the atmosphere is 380 parts per million, already 100 parts per million higher than it has been for the past 400,000 years. In line with the evidence from ice cores, the increase in greenhouse gases is coinciding with an increase in the average temperature, both in the atmosphere and in the oceans. The average temperature increase over the 100 years prior to 2005 was 0.74 degrees Celsius. Average temperature measures show that the temperature has risen more quickly since 1950.
- 1.15 The concentration of greenhouse gas in the atmosphere is higher than it has been for the last 400,000 years and corresponds to the increased use of fossil fuels and other chemicals to provide power and raw materials to industry and households. The combustion of fossil fuels and other chemical processes produces the greenhouse gases that are now increasing in the atmosphere. These processes are collectively called 'anthropogenic', that is, caused by humans. The quantum of emissions from human caused sources exceeds those from natural sources.
- 1.16 Modelling greenhouse gas emissions and temperature increases into the future shows that, in a business as usual scenario, greenhouse gases could reach a concentration of 1130 parts per million by 2060, with average temperatures increasing between 4.9 and 6.1 degrees Celsius above the pre-industrial average.

- 1.17 A business as usual scenario is likely to result in the extinction of 80 per cent of all species, the destruction of the Greenland ice shelf, with a consequent five metre rise in sea level, and the loss of all coral reefs.
- 1.18 In order to avoid effects of this sort, human caused greenhouse gas emissions need to be reduced.
- 1.19 The degree to which greenhouse gas emissions need to be reduced is calculated on the basis of what is considered an acceptable level of greenhouse gas concentrations in the atmosphere. The calculation of an acceptable level of greenhouse gases in the atmosphere means striking a balance between what reductions are achievable and the level of climate disruption the community is prepared to accept.
- 1.20 Most discussion within the global community about an appropriate level of greenhouse gases in the atmosphere ranges between 370 parts per million and 550 parts per million.
- 1.21 At concentrations of 550 parts per million, Australia risks the loss of a significant number of species, a drier and hotter environment, and the likely loss of national icons such as the Great Barrier Reef. The Committee has found, in line with the conclusions of the Garnaut Inquiry, that it is in Australia's interests to secure global agreement to deliver deep cuts in emissions so as to stabilise concentrations of greenhouse gases in the atmosphere by 450 parts per million or lower by 2050.

Chapter three

- 1.22 Chapter three examines what level of reduction in emissions will be necessary to reach a target of 450 parts per million, and how the necessary reductions can be made.
- 1.23 In 2000, global emissions of greenhouse gases amounted to the equivalent of 42 gigatonnes of carbon dioxide. In a business as usual scenario, this is predicted to grow to 70 gigatonnes by 2050. In order to reach a target of 450 parts per million, annual emissions will need to decline to 12 gigatonnes of carbon dioxide annually by 2050. In percentage terms, this amounts to an international emissions reduction of between 60 and 80 percent by 2050.
- 1.24 No single nation, or group of nations, is capable of reducing emissions sufficiently to meet this target. Emissions reductions of this magnitude can only be achieved through a comprehensive international agreement.

- 1.25 There are two issues that need to be resolved by an international agreement to reduce greenhouse gases:
- how to distribute responsibility for reductions; and
 - what sort of mechanism is used to generate the reductions.
- 1.26 In terms of the mechanism for reducing emissions, the chapter considers two market based mechanisms. Market based mechanisms work by attributing a cost to the emissions used to produce goods and services. The greater the emissions used, the greater the cost. Market based mechanisms encourage consumers to purchase goods and services with lower emissions, and encourage businesses to invest in technologies to reduce emissions in their production process.
- 1.27 The two market based mechanisms considered in the chapter are:
- a carbon tax, where the carbon emitted during the production of a good or service is taxed; and
 - a carbon market, where permits to emit carbon become tradeable instruments.
- 1.28 The Committee recommends that the Australian Government adopt a carbon market mechanism to reduce emissions.

Chapter four

- 1.29 Having determined the level of greenhouse gas reductions Australia is required to make to avoid serious climate disruption, in chapter four the Committee goes on to consider a number of mechanisms that may contribute to the reductions Australia needs to make.
- 1.30 The chapter begins by pointing out that for an 80 percent reduction to occur between 2010 and 2050, a 40 year time frame, this would require emissions to be cut by an achievable two percent a year.
- 1.31 There are three types of mechanisms considered in the chapter. The first is policy settings by the Government. The Committee considers the Australian Government's Carbon Pollution Reduction Scheme (CPRS), and the Mandatory Renewable Energy Target (MRET) for major electricity producers.
- 1.32 The second mechanism considered by the Committee is modifying current practices that result in large greenhouse gas emissions. A number of sources of greenhouse gas emissions in Australia are due

to practices that could be modified with a change in attitude by the community. The practices are:

- use of private vehicles where public transport is a viable option;
- land clearing; and
- savannah burning.

- 1.33 In the Committee's view, there is scope to increase the use of public transport, to reduce emissions from land clearing, and reduce emissions from savannah burning in addition to the emissions reductions to be obtained from the CPRS and MRET.
- 1.34 The third mechanism is much wider deployment of low emissions technologies. The Committee considers the following low emissions technologies:
- wind generation;
 - geothermal energy;
 - ocean power;
 - solar power;
 - cogeneration;
 - carbon capture;
 - alternative fuels for vehicles; and
 - biochar.
- 1.35 A number of these technologies are in the early stages of development and will not contribute to reductions in emissions for some time, possibly up to a decade.
- 1.36 However, others, such as wind electricity generation, solar field electricity generation and hybrid vehicles are technologies available for use now, and are underexploited in Australia.

Chapter five

- 1.37 Chapter five moves on from considering how to reduce emissions to considering how Australia will adapt to the climate changes already in train.
- 1.38 The evidence presented in chapter two indicates that climate change is already occurring, and will continue to occur for some time even if

greenhouse gas emissions were reduced immediately. As the climate changes, it will become more important for the Australian Government to assist the community to adapt.

- 1.39 During the inquiry, the Committee was advised about two mechanisms to assist with adaptation: changing building regulations to encourage the construction of buildings more appropriate to warm climates; and reversing land clearing. These mechanisms are discussed in this chapter.
- 1.40 Currently all construction in the states and territories is regulated by the Building Code of Australia (the BCA). The BCA is administered by the Australian Building Codes Board on behalf of the Australian Government and state and territory governments. The BCA governs a range of factors relating to structure, fire safety, access, equipment, health and sustainability.
- 1.41 One of the objectives of the BCA is to reduce greenhouse gas emissions by ensuring the efficient use of energy in newly constructed buildings. This is achieved through a verification process where all proposed designs for new buildings must achieve an 'efficiency star rating' or equivalent level of efficiency.
- 1.42 The Committee heard that the efficiency star rating is devised for climatic conditions in southern Australia, but has universal application across Australia.
- 1.43 The Committee found that the verification process and star rating do not result in energy efficient buildings in northern Australia. Consequently, the Committee recommends that the BCA be reviewed so that it is flexible enough to recognise that energy efficient design varies depending on the climate.
- 1.44 In relation to land clearing, the Committee was apprised of studies which indicate that land clearing produces significantly higher temperatures than no land clearing. These temperature differences show a correspondence with areas where major clearing of native vegetation has taken place, such as eastern and southwest Western Australia.
- 1.45 Mean summer rainfall in eastern Australia and southwest Western Australia was lower by four to 12 percent and four to eight percent respectively compared to the non-cleared scenario.
- 1.46 In other words, land clearing increased the severity of drought.

- 1.47 The Committee considers that the restoration of cleared vegetation could limit the effect of global heating on temperature and rainfall at a regional level. Restoration of vegetation in certain regions could lead to higher rainfall and lower temperatures.
- 1.48 The Committee recommends that the Australian Government investigate using revegetation as an adaptation mechanism to reduce temperature and increase rainfall in applicable parts of Australia.
- 1.49 Finally, the Committee expresses a view that Australia needs to begin identifying and developing adaptation strategies now.
- 1.50 The Committee recommends that the Australian Government conduct an inquiry into adaptation strategies for climate change.

Global heating

Introduction

- 2.1 This chapter examines the scientific evidence for global heating and its causes, and discusses the predicted effects on Australia's climate, including changes to temperature, rainfall, sea levels and ocean acidification.
- 2.2 Heating of the global climate system has already affected and will continue to have effects across the country into the future, including potentially serious effects upon iconic areas such as the Great Barrier Reef. The chapter considers what level of carbon in the atmosphere is necessary to avoid serious climate disruption.
- 2.3 Participants in the inquiry frequently referred to the scientific assessments of the International Panel on Climate Change (IPCC) and particularly its 2007 Fourth Assessment Report as a primary source for understanding global heating.¹
- 2.4 For emissions scenarios, participants largely used the main emission scenarios described in the IPCC Special Report on Emissions Scenarios

1 The IPCC is a scientific governmental body set up by the World Meteorological Organization and the United Nations Environment Program and is contributed to by scientists from all over the world (www.ipcc.ch/about/index.html).

(SRES)² as a starting point for their analysis. The Committee has also relied upon the IPCC's scientific data for global climate change.

The evidence for global heating

- 2.5 Evidence obtained from ice cores has demonstrated that over the last 400,000 years, global temperatures have varied in alignment with glacial and interglacial periods. Carbon dioxide concentrations in the atmosphere over this period have ranged from 180 parts per million³ to around 280 parts per million, cycling in parallel with temperature changes.⁴
- 2.6 In the last 150 years, the long term trend has been an increase in global temperatures, both on the surface of the planet and in the oceans, and an increase in carbon dioxide (CO₂) concentrations in the atmosphere to currently around 380 parts per million (ppmv).⁵
- 2.7 The CSIRO has explained the change in carbon dioxide concentrations as follows:

The natural sources and sinks for CO₂ have varied widely during past glacial and interglacial cycles but have remained below 300ppmv for at least 420,000 years. With the industrial revolution, humans began transferring carbon that was effectively locked away in the Earth's crust to the atmosphere, upsetting the balance of the carbon cycle. The nature sinks for carbon (primarily terrestrial vegetation and oceans) currently sequester ~40% of emissions from fossil fuel sources. The remaining 60% remains in the atmosphere. As a result, atmospheric CO₂ concentrations have increased from 280ppmv at the start of the industrial revolution to their current concentration of over 370ppmv. The current rate of atmospheric CO₂ accumulation (~1.8 ppmv/year) is approximately 2-3 times that of the early 1960s.⁶

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- 2 More information on these scenarios can be found at <http://www.ipcc.ch/ipccreports/sres/emission/index.htm>. See also Intergovernmental Panel on Climate Change (IPCC), *Climate change 2007: Synthesis report*, 2008, p. 44.
- 3 Parts per million is the ratio of the number of greenhouse gas molecules to the total number of molecules of dry air. For example, 300 parts per million means 300 molecules of greenhouse gas per million molecules of dry air.
- 4 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2.
- 5 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2.
- 6 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p. 11, Exhibit No. 7.

- 2.8 In its Fourth Assessment Report, the IPCC stated that warming of the global climate system is 'unequivocal' as demonstrated by increasing global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.⁷
- 2.9 The IPCC has presented the following evidence for global heating:
- Eleven of the years in the twelve year period of 1995-2006 ranked amongst the warmest years in the instrumental record of global surface temperature (that is, since 1850).
 - The 100 year linear trend in the global average surface temperature to 2005 showed an increase of 0.74 degrees Celsius. Global average surface temperature has particularly increased since about 1950.
 - Observations since 1961 have shown that the average temperature of the global ocean to a depth of at least 3000 metres has increased and that the ocean has been taking up over 80 percent of the heat being added to the climate system. Such warming causes seawater to expand, contributing to sea level rise.
 - Global sea levels rose at an average rate of 1.8mm per year from 1961 to 2003 and at an average rate of about 3.1mm per year from 1993 to 2003.
 - Snow and ice extent have decreased. Satellite data since 1978 showed that the annual average Arctic sea ice extent has shrunk by 2.7 percent per decade. Mountain glaciers and snow cover on average have declined across the globe.
 - Long term changes in rainfall have been observed since 1900 in many regions with both significant increases and decreases.
 - Some extreme weather events have changed in frequency and/or intensity over the last 50 years.⁸

7 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 30.

8 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 30. See also Solomon, S. et. al, 2007, Technical Summary, in *Climate change 2007: The physical science basis*, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, (referred to hereafter as the IPCC Technical Summary) for detailed discussion of this evidence.

The evidence that global heating is the result of human activity

- 2.10 Analysis of the global heating observed since the mid nineteenth century has identified increased concentrations of greenhouse gases and aerosols as the cause.⁹ The IPCC considers that there is a greater than 90 percent probability that most of the warming since the mid twentieth century has been caused by the rapid increase in greenhouse gas concentrations resulting from human activities since the industrial revolution.¹⁰
- 2.11 Changes in atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation alter the energy balance of the climate system by affecting the absorption, scattering and emission of radiation within the atmosphere and at the Earth's surface. The resulting positive or negative changes in energy balance are expressed as radiative forcing. This is then used to compare warming or cooling influences on the global climate.¹¹
- 2.12 It is generally accepted that the warming effect is largely brought about by carbon dioxide, methane and, to a lesser extent, ozone, (collectively part of the family of greenhouse gases). The counteracting cooling influences result from aerosols: particulate matter put into the atmosphere largely as a result of pollution from industrialisation. The warming influences have been found to greatly outweigh the cooling and are considered to be almost entirely attributable to human influence.¹²
- 2.13 The IPCC has stated that human activities are responsible for emissions of four long-lived greenhouse gases: carbon dioxide, methane, nitrous oxide and halocarbons. These gases are chemically stable and persist in the atmosphere for up to centuries or longer. Emission of these gases therefore has a long term influence on climate.¹³ Where emissions are greater than the absorption by sinks, the gases are concentrated in the atmosphere.
- 2.14 The IPCC assessed that global atmospheric concentrations of carbon dioxide, methane and nitrous oxide:

...have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice

9 The term 'aerosol' refers to tiny particles suspended in the atmosphere.

10 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 30, 37.

11 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 37.

12 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2; IPCC, *Climate change 2007: Synthesis report*, 2008, p. 39.

13 IPCC Technical Summary, p. 24.

cores spanning many thousands of years ... The atmospheric concentrations of CO₂ [carbon dioxide] and CH₄ [methane] in 2005 exceed by far the natural range over the last 650,000 years.¹⁴

2.15 Global greenhouse gas emissions increased by 70 percent between 1970 and 2004.¹⁵ The IPCC divided these emissions into the following groups:

- carbon dioxide, fossil fuel use: 56.6 percent;
- carbon dioxide, deforestation, decay of biomass: 17.3 percent;
- carbon dioxide, other: 2.8 percent;
- methane: 14.3 percent;
- nitrous oxide: 7.9 percent; and
- f-gases (hydrofluorocarbons, perfluorocarbons and sulphurhexafluoride): 1.1 percent.¹⁶

2.16 Carbon dioxide is considered to be the most important human caused greenhouse gas, with its annual emissions growing between 1970 and 2004 by about 80 percent from 21 to 38 gigatonnes. As shown in the data above, carbon dioxide represented 77 percent of total human caused greenhouse gas emissions in 2004.¹⁷

2.17 The global atmospheric concentration of carbon dioxide increased from a preindustrial value of about 280 parts per million to 379 parts per million in 2005. Similarly, methane increased from 715 parts per billion to 1774 parts per billion and nitrous oxide increased from 270 parts per billion to 319 parts per billion.¹⁸

2.18 As noted earlier, these changes in the composition of the atmosphere alter the radiative balance of the Earth, that is, the balance between incoming solar radiation and outgoing heat. Greenhouse gases reduce the radiation of heat from the Earth's atmosphere into space, trapping more heat in the atmosphere and thus increasing global temperatures.¹⁹

2.19 The IPCC attribute the largest growth in greenhouse gas emissions between 1970 and 2004 to energy supply, transport and industry. Residential and commercial buildings, forestry (including deforestation)

14 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 37.

15 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 36.

16 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 36.

17 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 36.

18 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 37.

19 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 6-7, Exhibit No. 7.

and agricultural sectors have also grown, but at a slower rate.²⁰ Global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use changes. Increases in methane and nitrous oxide are primarily due to agriculture.²¹

- 2.20 Studies have shown that solar radiation, a natural form of warming, has had a very small impact on temperature compared with human influences.²²

Observed effects of global heating

- 2.21 Based upon studies since 1970, the IPCC concluded in 2007, with either very high (greater than 90 percent) or high (greater than 80 percent) confidence, that global heating has had discernable impacts on physical and biological systems.²³ This includes:
- natural systems related to snow, ice and frozen ground (eg, glacial lakes, permafrost regions and Arctic and Antarctic ecosystems);
 - hydrological systems (eg, runoff and discharge in glacier and snow fed lakes, and warming of lakes and rivers);
 - terrestrial biological systems (eg, the early onset of spring events); and
 - marine and freshwater biological systems (eg, range and abundance of species) associated with rising water temperatures and changes in ice cover, salinity, oxygen levels and circulation.²⁴
- 2.22 While the IPCC concluded that warming had also impacted upon managed and human systems, such as agricultural and forestry management and human health, these impacts were more difficult to distinguish because of adaptation and other non-climatic drivers.²⁵
- 2.23 For Australia, the effects of global heating can be seen through changes to temperature, rainfall, sea levels and ocean acidification. However, the

20 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 36.

21 IPCC, 2007, Summary for Policymakers, in *Climate change 2007: The physical science basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 2.

22 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2.

23 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 31.

24 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 31, 33.

25 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 33.

observed effects of heating differ across the country. Australia's climate is highly variable, particularly in the context of rainfall, which is cyclical and influenced by factors such as El Nino and La Nina. The southern parts of Australia are dominated by a Mediterranean climate with winter rainfall, while northern Australia experiences monsoonal influences and summer dominant rain.²⁶

Temperature, rainfall, run off and drought

- 2.24 The long-term trend for Australia has been an increase in temperature of about 0.9 degrees Celsius over the last 100 years or so.²⁷ Air temperature increases have been accompanied by marked declines in regional rainfall, particularly along the east and west coasts of the continent.²⁸
- 2.25 Warming has been associated with an increase in the frequency of hot days, hot nights and heatwaves, and a decreased frequency of cold days and cold nights, increases in heavy rain events, and decreases in spring-time snow depth in the Snowy Mountains.²⁹
- 2.26 Temperature increases have occurred not only at the surface of the planet but also in the oceans. Substantial warming has occurred in the three oceans surrounding Australia, but most particularly off the south-east coast and in the Indian Ocean.³⁰
- 2.27 The CSIRO provided evidence on annual rainfall trends for the period 1950 to 2007, which illustrated a strong drying trend in south-west Western Australia and a quite strong drying trend through eastern Australia. According to Dr Ash of the CSIRO, the causes of these drying trends are much more complex than the temperature increases:

The drying trend in south-west Western Australia and, to a smaller extent, in south-eastern Australia we believe is attributable to climate change and the way that the frontal systems that go across southern Australia in winter, which bring a fair bit of the rain, have moved southwards as a result of a change in pressure systems from Antarctica up to the middle latitudes.

26 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

27 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2.

28 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 2.

29 Jones D.A., Watkins, A.B. and Hennessy, K., *Humans do contribute to global heating*, Engineers Australia, September 2005, pp. 44-47, www.csiro.au/resources/pfxh.html, viewed on 2 February 2009.

30 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 3.

We are confident that some of the rainfall decreases that we are observing in southern Australia are at least in part attributable to greenhouse gas emissions.³¹

- 2.28 In the same period, rainfall increased in north-western and central Australia and over the western tablelands of New South Wales.³²
- 2.29 The CSIRO indicated that a significant contributor to rainfall increases observed in northern and north-western Australia over the last 30 to 40 years is increased aerosols over Asia as a result of industrialisation.³³
- 2.30 Small changes in rainfall can lead to significant declines in runoff into storage areas and dams. Dr Ash told the Committee that a one percent decrease in rainfall can lead to a three to four percent decrease in runoff. A five percent decrease in rainfall can lead to quite significant declines in runoff into storage areas and dams.³⁴ For example, in relation to the Murray-Darling Basin, runoff is not occurring as the ground is very dry as a result of the current drought and any rainfall is taken up by the ground. The combination of very low rainfalls and higher temperatures is drying out the whole system and without runoff dam levels and water levels are at historic lows.³⁵
- 2.31 In its submission, the Murray Darling Basin Commission highlighted that while average annual inflows to the River Murray system are 11,100 gigalitres³⁶, inflows to the River Murray system in 2006-07 were approximately 1,000 gigalitres – nine percent of average annual inflows.³⁷
- 2.32 With increasing temperatures, the effects of drought are exacerbated because as it gets hotter plants use more water. As a result, even with the same amount of water in the system, ‘you are getting the impact of the drought through increased temperatures’.³⁸
- 2.33 While a lot of the droughts currently being observed are still largely within the bounds of historical natural cycling in terms of rainfall, such as that for the Murray-Darling Basin, the CSIRO considers that they have been

31 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 3.

32 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 2.

33 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 9.

34 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

35 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 6.

36 Estimated over the period 1891 to 2007.

37 Murray Darling Basin Commission, *Submission No. 26*, p. 1.

38 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 5.

exacerbated significantly by the higher temperatures over the last hundred years; that is, by global heating.³⁹

Sea levels

- 2.34 Over a period of thousands of years, there have been large changes in sea level as the Earth's climate has cycled between glacial and inter-glacial periods. These sea level changes were driven predominantly by melting and freezing of ice on land.⁴⁰
- 2.35 From about 1,000 years ago to the late nineteenth century, sea level was relatively stable, with a variation of less than about 0.2 metres over the whole period. This compares with changes of up to four metres in the period from 21,000 to 2,000 years ago.⁴¹
- 2.36 However, in the twentieth century sea level again rose significantly and, according to the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), at a rate that has not been experienced in the past 5,000 years:⁴²

While sea level has varied by more than 120m during ice age cycles, there was little net change in global average sea level from 0 AD to about 1800 AD – the time during which most of the world's coastal development has occurred. Over the last 130 years, the rate of sea-level rise has increased and since the launch of satellites to measure sea-levels in the early 1990s, it is over 3mm/year. This rate is unprecedented in the 20th century.⁴³

- 2.37 The global average rise for the twentieth century is 0.17 metres.⁴⁴ Unlike the sea level changes associated with earlier glacial and interglacial cycles, recent sea-level rise is increasingly the result of a warming ocean and the corresponding thermal expansion.⁴⁵

39 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 6.

40 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 4.

41 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 5.

42 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 5.

43 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment B*, p. 3.

44 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 5.

45 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 6.

- 2.38 The ACE CRC also notes that observed sea level is currently tracking near the upper limit of the IPCC projections from the start date of projections in 1990.⁴⁶

Ocean acidification

- 2.39 Although carbon dioxide emissions start off in the atmosphere, a large proportion is then absorbed by the ocean as part of the natural carbon cycle. Greater carbon dioxide emissions have resulted in more carbon dioxide being dissolved into the world's oceans. Carbon dioxide forms a weak acid (carbonic acid) therefore making the ocean more acidic.⁴⁷
- 2.40 The IPCC assessed that the increase in human caused carbon emissions since 1750 has led to an average decrease in pH⁴⁸ of 0.1 units and therefore an increase in ocean acidification.⁴⁹
- 2.41 According to the ACE CRC, approximately half the fossil fuel carbon dioxide emitted by humans has now dissolved into the ocean. Further:

Ocean acidification is a *direct* consequence of CO₂ emissions, so differs from the overall challenge posed by global heating in that the inevitable and inexorable rise of dissolved CO₂ in the ocean will continue independently of whether the atmosphere is warming.⁵⁰

Predicted effects

- 2.42 While the exact scale and speed of future changes in the global climate are still uncertain, the direction of change is considered to be clear. The IPCC concluded that continuing greenhouse gas emissions at or above current rates would cause further warming and induce larger changes in the global climate system during the twenty first century than those observed during the twentieth century. Further:

46 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment B*, pp. 3, 8.

47 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment C*, p. 4.

48 pH is a measure of acidity.

49 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 52.

50 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment C*, p. 4.

...even if all greenhouse gas emissions ceased today, the Earth would still be committed to an additional warming of 0.2 to 1.0 degrees Celsius by the end of the century.⁵¹

- 2.43 Using SRES scenarios, the IPCC identified a 'best estimate' increase in global average temperature of between 1.8 degrees Celsius and four degrees Celsius at the end of the twenty first century depending upon the scenario. Sea level rise, excluding future rapid dynamical changes in ice flow, using the same scenarios, was projected to be between 0.18 and 0.59 metres.⁵²
- 2.44 Significant effects upon ecosystems, food, coasts, industry and settlements, health and water are considered more than 80 percent likely to occur at a global level.⁵³ For Australia, the CSIRO has assessed that changes to the climate system will result in wide ranging impacts on natural ecosystems, cropping, forestry and livestock, water resources, public health, and infrastructure and settlement.⁵⁴

Temperature

- 2.45 The CSIRO outlined a number of emissions dependent temperature scenarios for Australia for the Committee.⁵⁵ Using a midrange SRES emissions scenario, further warming of around one (0.6 to 1.5)⁵⁶ degree Celsius by 2030 is predicted. Warming will be slightly less in coastal areas and slightly more inland. There is a ten to 20 percent probability that warming will exceed one degree Celsius on the coast, and in inland regions, there was a strong possibility of temperatures exceeding 50 degrees Celsius.⁵⁷
- 2.46 In relation to the projected one degree Celsius increase, the CSIRO pointed out that:
- ... on our current track of emissions we are heading for a higher emissions scenario result for 2030 than that number reflects.⁵⁸

51 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p. 5, Exhibit No. 7.

52 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 45.

53 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 48-51.

54 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 19-31. Exhibit No. 7.

55 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

56 Uncertainty range.

57 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 4.

58 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

- 2.47 By 2070 predicted temperature increases could be between 1.8 (1.0 to 2.5) and 3.4 (2.2 to 5) degrees Celsius, but this is strongly dependent upon the extent to which emissions are reduced over the next 30 to 40 years.⁵⁹ By 2070 in the low emissions case, there is a greater than 90 percent likelihood that warming will exceed 1 degree Celsius throughout Australia, a 20-60 percent chance of exceeding two degrees Celsius over most inland areas, and about a ten percent chance of exceeding three degrees Celsius in more coastal areas.
- 2.48 In the high emissions case, there is around a 30 percent chance of temperature increases exceeding three degrees Celsius in southern and eastern coastal areas and a much greater chance inland, while the chance of exceeding four degrees Celsius is around ten percent in most coastal areas and 20 to 50 percent inland.⁶⁰
- 2.49 It is expected that the number of days over 35 degrees Celsius will substantially increase. For example, in the period 1971-2000, Perth averaged 28 days per year above 35 degrees Celsius. This is predicted to increase to between 35 (33-39)⁶¹ and 54 (44-67) days. In the case of Darwin, which averages 11 days, this is predicted to increase to between 44 (28-69) and 230 (140-308) days.⁶²
- 2.50 The CSIRO has assessed the probable effects that changes in temperature, ranging from less than one degree Celsius to more than five degrees Celsius, are likely to have on the areas identified earlier.⁶³ For example, at warming of one degree Celsius, areas such as the Great Barrier Reef and mountain ecosystems are considered particularly vulnerable. At higher magnitudes of warming, the CSIRO considers that annual damage to the Great Barrier Reef will increase to the point of catastrophic failure, snow cover and duration will decrease substantially, and animal, bird and plant species in northern and southeast Australia will become extinct.⁶⁴

59 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

60 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 4.

61 Uncertainty range.

62 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 5.

63 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 22, 24, 26, 27, 29 and 30. Exhibit No. 7.

64 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 22-23, Exhibit No. 7.

Rainfall

- 2.51 While noting that rainfall is much harder to define, the CSIRO has predicted a large range in annually averaged rainfall for southern parts of Australia by 2030, ranging from no change in rainfall down to a ten percent decline.⁶⁵ In northern areas, the predicted change is around ten percent decline to five percent increase.⁶⁶ These changes will vary across regions and according to season. For example, decreases in rainfall are likely in southern areas in the annual average and in winter, in the southern and eastern areas in spring, and along the west coast in autumn.⁶⁷
- 2.52 The CSIRO pointed out that the effect of greenhouse gases and the climate system on the monsoonal influences (the summer dominant rain of northern Australia) is much less clear, with more work required to understand how emissions will affect rainfall patterns.⁶⁸
- 2.53 The CSIRO considers that projected changes in rainfall and increases in evaporation are likely to result in a decline in soil moisture over much of southern Australia. Simulations show that droughts are likely to increase.⁶⁹
- 2.54 The vulnerability of systems to climate change can be dependant upon a number of climatic variables. For example, the impacts associated with a large temperature increase may be more modest if precipitation also increases. This is the case for agriculture, forestry and livestock, where it is expected that the interaction between temperature and precipitation will influence the impact of climate change. For warming of up to three to four degrees Celsius, wheat yields are projected to increase provided there are sufficient increases in precipitation. However, reductions in precipitation and increases in drought could have severe impacts upon agriculture.⁷⁰

Sea levels

- 2.55 Sea levels are predicted to continue to rise during the twenty first century. According to the Antarctic Climate and Ecosystem Cooperative Research Centre (ACE CRC):

65 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

66 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 5.

67 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 5.

68 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 4.

69 CSIRO and Bureau of Meteorology, *Climate change in Australia: observed changes and projections*, 2007, p. 6.

70 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 20-21, 23, Exhibit No. 7.

Mitigation of greenhouse gas emissions might attenuate sea-level rise in the long-term but we are already locked into significant sea-level rise during this century.⁷¹

- 2.56 This rise is forecast to be around 0.03m in the next decade and 0.2 to 0.8m by the end of the century⁷², although some scientists have suggested that these projections may have been underestimated.⁷³
- 2.57 Thermal expansion of the ocean and glacier and ice cap melt are the two largest contributors to present sea level rise. It is considered that melting ice from Greenland and the West Antarctic Ice Sheet will become increasingly important in the future. Should these melt entirely, they contain enough ice to raise sea levels by seven metres and six metres respectively.⁷⁴
- 2.58 There are significant implications both globally and for Australia from sea level rise given the densities of populations along coastlines. Urbanised coastal areas are particularly vulnerable to climate change because of their exposure to sea level rise and extreme events.
- 2.59 Some of the specific implications of sea level rise for Australia identified by the ACE CRC include:
- More frequent extreme sea level events. It is predicted that events that presently occur every few years may occur every few days in 2100 if mean sea level rises by 0.5m. Sydney, Brisbane and Bass Strait are considered particularly likely to see larger increases in the frequency of these events.⁷⁵ Sea level rise off the east and west coast of Australia has already resulted in extreme sea level events of a given magnitude occurring roughly three times as often in the last half of the twentieth century compared with the first half.⁷⁶
 - Shoreline recession. For a sea level rise of 0.5m, it is predicted that landward erosion of about 50m will occur on sandy beaches. Other high

71 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 7.

72 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 7.

73 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 11.

74 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 8.

75 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, pp. 12-13.

76 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment B*, p. 8.

energy exposed coasts (such as those around much of southern Australia) will experience higher rates of recession while very low energy or embayed coasts (such as those across much of tropical Australia) are likely to experience lower rates.⁷⁷

- Flooding of low lying islands. Many islands are exposed to the risks not only of flooding but also more frequent high sea level events.⁷⁸

2.60 In relation to extreme events, the CSIRO told the Committee that:

One of the big issues with climate change is not some of the slow-moving trends that you see in temperature or rainfall, it is the combination of that trend with extreme events. If there is a combination of some sea level rise and then an extreme weather event, the storm surge that is a result of that has a very large impact, particularly in our coastal areas.⁷⁹

2.61 For example, in this context Kakadu is an area that is particularly vulnerable due to salt water coming into the Kakadu wetlands.⁸⁰

Ocean acidification

2.62 More carbon dioxide in the oceans is lowering the availability of dissolved carbonate ions to calcifying organisms such as shelled sea animals and corals. Calcifying organisms need this carbonate to precipitate their shells.

2.63 According to the ACE CRC, ocean acidification can be considered an impact 'advancing from the south' and one that will affect Australia's marine ecosystems in the Southern Ocean, marine protected areas on the southern margins of the Australian continent (the Great Australian Bight and Tasmanian seamounts) and eventually the Great Barrier Reef.⁸¹ The Southern Ocean, as a cold mass of water, contains a disproportionate amount of human caused carbon dioxide compared with other warmer oceans. The Antarctic polar waters are expected to be the first to experience carbonate ion concentrations low enough that aragonite, one

77 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p.12.

78 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment A*, p. 12.

79 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 5.

80 Dr Andrew Ash, *Transcript of Evidence*, 1 December 2008, p. 5.

81 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment C*, p. 6.

form of calcium carbonate, will no longer be able to be precipitated by shell-forming organisms.⁸²

- 2.64 In its submission, the Great Barrier Reef Marine Park Authority (GBRMPA) cited modelling undertaken by the CSIRO and based on SRES, which forecast that the annual sea surface temperature of the Great Barrier Reef will increase between 1.2 degrees Celsius and 3.9 degrees Celsius by 2080. However, in addition to increased sea surface temperatures, ocean acidification will have far reaching effects.⁸³ It is predicted that ocean pH will decrease between 0.3 to 0.5 units by 2100.⁸⁴ GBRMPA informed the Committee that:

ocean acidification is of concern to coral reefs as calcium carbonate binding organisms (such as corals) are unable to form their skeletons. Scientific evidence suggests that if CO₂ concentrations rise above 500 parts per million, corals will be unable to grow.⁸⁵

- 2.65 GBRMPA also told the Committee that once carbon dioxide level rises above 450 parts per million hard corals will struggle to grow and build skeletons strong enough to withstand storm damage. As a consequence, there will be fewer hard corals and increasingly abundant soft corals, algae and seaweed. This then means that the reef system will:

shift away from the system as we know it now towards a system that has lower productivity in terms of many of the commercial species extracted from the Great Barrier Reef and also lower values in terms of the aesthetics that support the tourism industry.⁸⁶

- 2.66 Coral bleaching is a stress response to high temperatures. Bleaching events of a high magnitude have only been seen in the last ten to 15 years. In the last ten years there have been three bleaching events in the Great Barrier Reef, which is a higher frequency than has ever been seen previously in a ten year timeframe. GBRMPA considers that this is reflective of an increasing trend in baseline temperatures.⁸⁷ In addition, there have been unusually warm sea surface temperatures in the years when bleaching events have occurred.⁸⁸ While these events have affected the quality of the reef, no coral species have yet been lost because of these warm water

82 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment C*, p. 6.

83 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 37.

84 Great Barrier Reef Marine Park Authority, *Submission No. 19*, p. 1.

85 Great Barrier Reef Marine Park Authority, *Submission No. 19*, p. 1.

86 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 31.

87 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 36.

88 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 35.

events.⁸⁹ However, once affected by bleaching, coral reefs are at much greater risk, particularly if they do not have sufficient time between bleaching events to recover.⁹⁰

- 2.67 Ocean acidification is also likely to impact upon the key components of the benthic habitats on which many fisheries in Australian waters are dependent. It will also affect gastropods such as abalone and bivalves including oysters and mussels. In the medium to long term there are likely to be impacts upon fisheries and aquaculture management and practices, including the species produced and areas suitable for production.⁹¹

What is an acceptable level of carbon in the atmosphere?

- 2.68 To maintain a stable level of carbon dioxide in the atmosphere, global emissions of carbon dioxide must be reduced to a level that prevents any net accumulation of carbon dioxide in the atmosphere.

- 2.69 In the IPCC Special Report on Emissions Scenarios (SRES), a range of emissions scenarios were examined based upon different assumptions about future economic, technological and social changes without specific policies to reduce greenhouse gas emissions. All the scenarios suggested that emissions would be at least two to four times 1990 levels by 2050 and may be as high as five times 1990 levels by 2100.⁹² Therefore:

...it is clear that achieving no net growth in atmospheric concentrations requires reversing the current trend of increasing GHG emissions – ultimately reducing emissions to levels well below those of 1990.⁹³

- 2.70 The CSIRO has examined various attempts to define the global mean temperature change and/or stabilisation level consistent with the concept of dangerous human caused interference.⁹⁴ The stabilisation targets

89 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 32.

90 Dr Paul Marshall, *Transcript of Evidence*, 9 December 2008, p. 33.

91 Antarctic Climate and Ecosystems Cooperative Research Centre, *Submission No. 31, Attachment C*, p. 10.

92 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p.12, *Exhibit No. 7*.

93 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p. 12, *Exhibit No. 7*.

94 Article II of the United Nations Framework Convention on Climate Change (UNFCCC) identified the objective of 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human caused interference with the climate system' but did not identify what this level should be.

identified ranged from 375 to 550 parts per million with temperature targets ranging from 0.9 to 2.9 degrees Celsius above 1990 levels.⁹⁵

- 2.71 There is growing support amongst climate scientists and experts that the global average temperature increase should be no more than a maximum of two degrees Celsius. This includes the average temperature increase of 0.6 degrees Celsius which has already occurred since industrialisation.⁹⁶ For example, the 2007 Bali Climate Declaration by Scientists stated in relation to a future global climate treaty:

The prime goal of this new regime must be to limit global heating to no more than 2°C above the pre-industrial temperature, a limit that has already been formally adopted by the European Union and a number of countries.

Based on current scientific understanding, this requires that global greenhouse gas emissions need to be reduced by at least 50% below their 1990 levels by the year 2050. In the long run, greenhouse gas concentrations need to be stabilised at a level well below 450ppm (parts per million; measured in CO₂-equivalent concentration). In order to stay below 2°C, global emissions must peak and decline in the next 10 to 15 years...⁹⁷

- 2.72 In its submission, Greenpeace also argued that to prevent dangerous climate change, global temperature rise must be kept as far below two degrees Celsius as possible, compared with pre-industrial levels. According to Greenpeace, the goal of climate policy must be to ensure that global emissions peak as soon as possible and are substantially reduced in the very near term, with global emissions peaking in 2015 and reduced by more than 50 percent by 2050 with reductions continuing thereafter.⁹⁸
- 2.73 The Climate Institute argued that even a two degree Celsius increase in global temperatures would result in severe impacts for Australia. It considered that concentrations need to peak well below 500 parts per million and then decline to levels below 400 parts per million over the coming centuries.⁹⁹

95 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 10 and 11, *Exhibit No. 7*.

96 NSW Greenhouse Office, *NSW greenhouse plan*, November 2006, p. 11; The Climate Institute, *Submission No. 15*, p. 8.

97 2007 Bali Climate Declaration by Scientists, www.crc.unsw.edu.au/news/2007/Bali.html, viewed on 2 February 2009.

98 Greenpeace, *Submission No. 24*, p. 3.

99 The Climate Institute, *Submission No. 15*, p. 4.

2.74 Figure 2.1 is reproduced from the IPCC's 2007 report and summarises the required emission levels to achieve different stabilisation concentrations and the resulting global average temperature increases. As can be seen from the table, in order to stabilise at a lower concentration and temperature level, emissions will need to peak earlier and greater emission reductions are required by 2050.¹⁰⁰

Figure 2.1 IPCC stabilisation scenarios

Table 5.1. Characteristics of post-TAR stabilisation scenarios and resulting long-term equilibrium global average temperature and the sea level rise component from thermal expansion only.^a (WGI 10.7; WGIII Table TS.2, Table 3.10, Table SPM.5)

Category	CO ₂ concentration at stabilisation (2005 = 379 ppm) ^b	CO ₂ -equivalent concentration at stabilisation including GHGs and aerosols (2005=375 ppm) ^b	Peaking year for CO ₂ emissions ^{a,c}	Change in global CO ₂ emissions in 2050 (percent of 2000 emissions) ^{a,c}	Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity ^{d,e}	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only ^f	Number of assessed scenarios
	ppm	ppm	year	percent	°C	metres	
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4	6
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7	18
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9	21
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4	118
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9	9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7	5

Notes:

- The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks (see also Topic 2.3).
- Atmospheric CO₂ concentrations were 379ppm in 2005. The best estimate of total CO₂-eq concentration in 2005 for all long-lived GHGs is about 455ppm, while the corresponding value including the net effect of all anthropogenic forcing agents is 375ppm CO₂-eq.
- Ranges correspond to the 15th to 85th percentile of the post-TAR scenario distribution. CO₂ emissions are shown so multi-gas scenarios can be compared with CO₂-only scenarios (see Figure 2.1).
- The best estimate of climate sensitivity is 3°C.
- Note that global average temperature at equilibrium is different from expected global average temperature at the time of stabilisation of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150 (see also Footnote 30).
- Equilibrium sea level rise is for the contribution from ocean thermal expansion only and does not reach equilibrium for at least many centuries. These values have been estimated using relatively simple climate models (one low-resolution AOGCM and several EMICs based on the best estimate of 3°C climate sensitivity) and do not include contributions from melting ice sheets, glaciers and ice caps. Long-term thermal expansion is projected to result in 0.2 to 0.6m per degree Celsius of global average warming above pre-industrial. (AOGCM refers to Atmosphere-Ocean General Circulation Model and EMICs to Earth System Models of Intermediate Complexity.)

Source IPCC, *Climate Change 2007: Synthesis Report*, p. 67.

2.75 Global average temperature increase is expected to slow within a few decades of greenhouse gas emissions being stabilised. However, according to the IPCC, small increases in temperature can be expected for several centuries.¹⁰¹

2.76 Figure 2.1 also includes global average sea level rise. Sea level rise from thermal expansion will continue for many centuries after greenhouse gas concentrations are stabilised due to ongoing heat uptake by the oceans. In addition to thermal expansion, the implications of Greenland ice sheet loss, as noted earlier, are potentially several metres and would have major consequences for world coastlines.¹⁰²

100 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 67.

101 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 66.

102 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 66, 67.

- 2.77 The IPCC considered that delaying emission reductions would significantly constrain the opportunity to achieve lower stabilisation levels and increase the risk of more severe climate change. In contrast, it considered that mitigation measures over the next two to three decades 'will have a large impact on opportunities to achieve lower stabilisation levels'.¹⁰³
- 2.78 The stabilisation level that is ultimately adopted will depend upon what climate change impacts governments are prepared to accept. Scientific evidence presented by bodies like the IPCC and CSIRO have outlined the likely impacts that increases in temperature will have.¹⁰⁴ The Garnaut Climate Change Review has also made detailed comparisons of the likely impacts of a 'strong' global mitigation scenario (550 parts per million carbon dioxide equivalent stabilisation) and 'ambitious' global mitigation scenario (450 parts per million carbon dioxide equivalent stabilisation).¹⁰⁵ For example, the world's natural ecosystems are considered particularly vulnerable to climate change with patterns of temperature and precipitation affecting the distribution and abundance of species. The IPCC has assessed that a one to two degrees Celsius increase in global mean temperature would pose a significant risk to many ecosystems.¹⁰⁶ For Australia, the potential impacts upon one significant ecosystem, the Great Barrier Reef, have already been discussed. In its evidence, the GBRMPA informed the Committee that the best possible outcome for the Great Barrier Reef would be for Australia and other countries to rapidly adopt targets that will stabilise atmospheric carbon dioxide well below the critical threshold of 450 parts per million:¹⁰⁷

According to world-class coral reef scientists, a dramatic loss in coral reef biodiversity is inevitable at atmospheric CO₂ concentrations approaching 500 parts per million. Other ecosystems are likely to be extremely impacted at atmospheric CO₂ concentrations between 450 to 500 parts per million. Therefore, it is crucial for coral reefs and other ecosystems that emissions are

103 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 66.

104 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 48-54; Preston, B.L. and R.N. Jones, *Climate Change Impacts on Australia and the Benefits of Early Action to Reduce Global Greenhouse Gas Emissions*, A consultancy report for the Australian Business Roundtable on Climate Change, February 2006, pp. 19-31. *Exhibit No. 7*.

105 Garnaut, R., *The Garnaut climate change review* 2008, p. 279.

106 IPCC, *Climate change 2007: Synthesis report*, 2008, pp. 64-65.

107 Great Barrier Reef Marine Park Authority, *Submission No. 19*, p. 2.

effectively managed to maintain atmospheric CO₂ well below these critical thresholds.¹⁰⁸

2.79 The availability of water resources and water stresses are another critical issue on a global basis.¹⁰⁹ The CSIRO has argued that the current pressures placed on Australian water resources 'are indicative of their general high vulnerability to climate change'.¹¹⁰ With predicted declines in rainfall, particularly across southern Australia, climate change is likely to impact upon:

- important water catchment areas, by impacting on the growth, species composition, frequency and severity of fire and pest incursion of the native forest that covers many of these areas;
- water supply and water quality for irrigation and other uses;
- inflows into reservoirs; and
- wetlands important for bird breeding and other wildlife.¹¹¹

2.80 As an example, a one to two degree Celsius increase in temperature is projected to lead to a 12 to 25 percent decrease in flow in the Murray Darling Basin and a seven to 35 percent decrease in Melbourne's water supply.¹¹²

2.81 While the CSIRO considered that limiting future increases in atmospheric carbon dioxide to 550 parts per million could avoid the more extreme climate changes, a lower stabilisation level, such as 450 parts per million:

...would give natural ecosystems and their associated species greater time to adapt to changing environmental conditions, reduce the likelihood of major adverse consequences for agriculture and forestry, help ensure that Australia's public health infrastructure can keep pace with emerging health challenges, and reduce the chance of large-scale singularities.¹¹³

2.82 In its submission, The Climate Institute argued that:

108 Great Barrier Reef Marine Park Authority, *Submission No. 19*, p. 1.

109 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 49.

110 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p. 25, Exhibit No. 7.

111 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 25-26, Exhibit No. 7.

112 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, p. 26, Exhibit No. 7.

113 Preston, B.L. and Jones, R.N., *Climate change impacts on Australia and the benefits of early action to reduce global greenhouse gas emissions*, 2006, pp. 5-6, Exhibit No. 7.

- A stabilisation level of 400 parts per million or below will reduce the risk of irreversible and potentially catastrophic global impacts, although there will still be risks to natural systems such as coral reefs.
 - An objective of stabilising atmospheric concentrations at 450 parts per million, 'suggests that Australia is prepared to accept the known adaptive capacity of Australian natural ecosystems being exceeded'. It also risks the known adaptive capacity of water security and coastal communities.
 - At 550 parts per million, the risks include severe drought constraining water supplies and farming over large areas, catastrophic events such as collapse of the Greenland and West Antarctic icesheets and exceeding the known adaptive capacity of Australian natural ecosystems, water security, coastal communities, agriculture, forestry, tourism and health systems.¹¹⁴
- 2.83 The projections of the IPCC, CSIRO and other scientists have identified the likely impacts of global heating and clearly illustrate that it is in Australia's national interest to ensure global temperatures peak at the lowest possible level.
- 2.84 While it is no longer possible to avoid all the adverse impacts of global climate change, reductions in greenhouse gas emissions can limit the magnitude and rate of future climate change.
- 2.85 The Committee notes that a stabilisation target of 450 parts per million carbon dioxide equivalent is considered to provide about a 50 percent chance of limiting the global mean temperature increase to two degrees Celsius above pre-industrial levels.
- 2.86 Stabilisation at a higher level, such as 550 parts per million is associated with a real risk of dangerous climate disruption.
- 2.87 On the basis of the evidence available to it, the Committee considers that a stabilisation target for greenhouse gas emissions that provides the best opportunity to protect significantly threatened areas such as the Great Barrier Reef, as well as natural and human environments more broadly, from the effects of climate change, should be adopted.

114 The Climate Institute, *Submission No. 15*, p. 10.

Recommendation 1

The Committee finds that it is in Australia's interests to secure global agreement to deliver deep cuts in emissions so as to stabilise concentrations of greenhouse gases in the atmosphere at 450 parts per million or lower by 2050.

Addressing climate change

Introduction

- 3.1 Having found that we need to stabilise concentrations of greenhouse gases in the atmosphere by 450 parts per million, it is necessary to establish what this means in terms of reductions in greenhouse gas emissions, and how to share the responsibility for reductions across nation states.
- 3.2 This chapter examines mechanisms for reaching the stabilisation target of 450 parts per million of carbon dioxide equivalent greenhouse gases in the atmosphere (referred to as 'parts per million' from here on) which the scientific evidence suggests is necessary to avoid serious climatic disruption.
- 3.3 In particular, this chapter will address:
- the level of emissions reductions necessary to reach the target for greenhouse gas stabilisation at 450 parts per million;
 - the distribution of responsibility for emissions reduction across nation states; and
 - what mechanism should be adopted to reduce greenhouse gas emissions.
- 3.4 The chapter concludes with the Committee's view of the position the Australian Government should take to the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change in Copenhagen, Denmark.

- 3.5 In dealing with greenhouse gas emissions, Australia is faced with a choice, firstly as to the target to work towards for emissions stabilisation, and secondly, the mechanism for reaching that target. The direction taken by Australia will be guided by judgements about how Australia can best influence global attitudes and decisions.¹

Emissions reductions target

- 3.6 In the previous chapter, the Committee concluded that the scientific evidence points to a greenhouse gas stabilisation target of 450 parts per million as necessary to avoid serious climate disruption. The choice of this target for stabilisation shapes much of the rest of the policy analysis and discussion.²
- 3.7 An additional consideration in determining the acceptable flow of greenhouse gas emissions is the evidence for greenhouse gas emissions and climate change that has emerged since the climate modelling on which the discussion in chapter two was based.
- 3.8 The climate modelling in chapter two is based on climate data from the 1990s, published originally in the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios (IPCC SRES). Evidence gathered since this modelling was conducted indicates that both the modelling of greenhouse gas emissions and temperature increases was conservative.
- 3.9 Between 1990 and 1999, greenhouse gas emissions increased at 1.1 percent per year on average. Between 2000 and 2004, emissions of greenhouse gas increased an average three percent a year.³ More recent audits of carbon emissions indicate this higher level of emissions has continued into the second half of the 2000s.⁴ In addition, world average temperatures have increased at a rate higher than the highest temperature increase modelled by SRES.⁵

1 Enting, I. Karoly, D. Falk, J. Clisby, N. Bodman, R. and Settle, D., *The science of stabilising greenhouse gas concentrations: A commissioned report for the Garnaut climate change review*, 2008, pp. 34-35.

2 Stern, N. "The economics of climate change," *American economic review*, 98(2), May 2008, p. 2.

3 Climate Institute, *Evidence of accelerated climate change*, 2007, p. 3.

4 Global Carbon Project, *Carbon trends 2007, 2008*, p. 1.

5 Climate Institute, *Evidence of accelerated climate change*, 2007, p. 3.

- 3.10 The *Stern review on the economics of climate change*, conducted for the UK Treasury, was criticised for using models with a higher range of greenhouse gas emissions to reach a conclusion that the greenhouse gas stabilisation target should be less than 550 parts per million.⁶ However, as Lord Stern has recently pointed out, the modelling used in his review underestimated the actual level of emissions now occurring.⁷
- 3.11 Modelling undertaken by Professor Garnaut on the more recent greenhouse gas emissions evidence indicates that emissions from fossil fuels alone will be eight percent higher than predicted by SRES by 2015, and 34 percent higher by 2030.⁸
- 3.12 In determining what level of emissions reductions is necessary to reach a stabilisation target of 450 parts per million, it is necessary to understand that the carbon cycle discussed in chapter two can take up to 100 years to reach stabilisation. This means that emissions now can have an impact on the level of greenhouse gases in the atmosphere for up to 100 years.⁹
- 3.13 To date, there has been enough greenhouse gases emitted to exceed the stabilisation target of 450 parts per million. In order to reach a stabilisation target of 450 parts per million, the concentration of greenhouse gases in the atmosphere will have to peak and then decline. The lower the desired greenhouse gas stabilisation level, the faster emissions will have to be reduced.¹⁰
- 3.14 Mitigation efforts to 2030 face a shrinking window of opportunity to contain emissions and achieve stabilisation below a level regarded as dangerous.
- 3.15 Having regard to this, the Committee now turns to what level of emissions reduction is necessary to achieve a stabilisation target of 450 parts per million.
- 3.16 In 2000, global emissions of greenhouse gases amounted to the equivalent of 42 gigatonnes of carbon dioxide annually.¹¹ Lord Stern predicted that, with a business as usual scenario, this would increase to the equivalent of

6 Garnaut, G. Howes, S. Jotzo, F. and Sheehan, P., *Emissions in the platinum age: The implications of rapid development for climate change mitigation*, 2008, p. 17.

7 Stern, N., "The economics of climate change," *American economic review*, 98(2), May 2008, p. 2

8 Garnaut, G. Howes, S. Jotzo, F. and Sheehan, P., *Emissions in the platinum age: The implications of rapid development for climate change mitigation*, 2008, p. 17.

9 Garnaut, R., *The Garnaut climate change review*, 2008, p. 42.

10 Enting, I. Karoly, D. Falk, J. Clisby, N. Bodman, R. and Settle, D., *The science of stabilising greenhouse gas concentrations: A commissioned report for the Garnaut climate change review*, 2008, p. 26.

11 A gigatonne is one billion tonnes.

82 gigatonnes of carbon dioxide emissions annually by 2050.¹² An emissions target of 450 parts per million would require emissions to be reduced to the equivalent of 12 gigatonnes of carbon dioxide annually by 2050. This is a reduction of 70 gigatonnes from the business as usual scenario, and a reduction of 30 gigatonnes over current emissions levels.¹³ In percentage terms, this amounts to an international emissions reduction of between 60 and 80 percent by 2050.¹⁴

- 3.17 No single nation, or group of nations, is capable of reducing emissions sufficiently to meet this target. Emissions reductions of this magnitude can only be achieved through a comprehensive international agreement.

Distribution of emissions reduction responsibilities

- 3.18 One of the most significant issues facing the international community is how to distribute responsibility for emissions reductions amongst nation states. How global targets are allocated between nations will determine Australia's national emissions target.¹⁵
- 3.19 The current level of emissions varies considerably between nation states. Two factors determine the level of emissions by nation states – their level of economic activity and their population size. The bulk of greenhouse gas emissions arise from the countries at the centre of global economic activity. The largest emitters are China, the United States and the European Union, which between them are responsible for more than 40 percent of global emissions. The 20 largest emitters are responsible for more than 80 percent of global emissions.¹⁶
- 3.20 Richer countries tend to have much higher per capita emissions than poorer countries. The exceptions are poorer countries with high emissions from land-use change and forestry. Developed and transitional countries produce about half of current global emissions. However, the growth of emissions is much faster in developing countries, and their share of global emissions will grow over time.¹⁷

12 Stern, N., "The economics of climate change," *American economic review*, 98(2), May 2008, p. 3.

13 HM Treasury, *Stern review on the economics of climate change*, 2006, p. 233.

14 IPCC, *Climate change 2007: Synthesis Report*, 2008, p. 67.

15 Enting, I. Karoly, D. Falk, J. Clisby, N. Bodman, R. and Settle, D., *The science of stabilising greenhouse gas concentrations: A commissioned report for the Garnaut climate change review*, 2008, p. 70.

16 Garnaut, R., *The Garnaut climate change review*, 2008, p. 54.

17 Garnaut, R., *The Garnaut climate change review*, 2008, p. 54.

- 3.21 The most recent approach to distributing responsibility between nation states is the Kyoto Protocol. Signatory nations to the Kyoto Protocol could commit to reducing emissions to a certain level above or below that nation's 1990 emissions. Differentiation between emissions targets by countries was negotiated on an ad hoc basis, with little reference to underlying principles for allocation across countries. On average, richer countries agreed to larger reductions.¹⁸

Australia's emissions reductions target

- 3.22 The scientific evidence points to the need for an international agreement in order to reduce greenhouse gas emissions by between 60 and 80 percent by 2050.
- 3.23 Australia's overwhelming interest is in achieving an international agreement. The Committee believes the best approach to achieving an effective international agreement is to work in cooperation with nations that will drive international agreement.
- 3.24 During the United States Presidential election campaign, Barack Obama committed to reduce greenhouse gas emissions in the United States to 80 percent below 1990 levels by 2050.¹⁹
- 3.25 With the aim of achieving stabilisation of greenhouse gases at 450 parts per million, Australia should also be willing to adopt a policy setting to reduce Australia's emissions of greenhouse gases by 80 percent by 2050, in seeking agreement from other developed countries to also cut emissions by 80 percent by 2050.

18 Garnaut, R., *The Garnaut climate change review*, 2008, p. 201.

19 Obama, B. and Biden, J., *Promoting a healthy environment*, 2008, p. 1.

Recommendation 2

The Committee recommends that the Australian Government be willing to adopt a policy setting to reduce Australia's emissions of greenhouse gases by 80 percent by 2050 in seeking agreement from other developed countries to also cut emissions by 80 percent by 2050.

Reducing emissions

- 3.26 It is likely that any international agreement to reduce greenhouse gas emissions will also contain a mechanism to achieve this end. An internationally agreed mechanism for reducing emissions will be essential to the success of the agreement. A range of submissions to the inquiry strongly supported Australia's participation in an international market.²⁰
- 3.27 Two mechanisms are in serious contention. Both are market based mechanisms. Market based mechanisms seek to alter prices in a way that reflects the cost of emissions used to produce a good or service. Emissions can arise during the production and distribution process of a good or service. The more greenhouse gases are emitted, the higher the price of the good or service.
- 3.28 Consumers choose whether, when and how to change from high emission to low emission intensive products. As a consequence, firms begin investing in alternative technologies and new products.²¹
- 3.29 The mechanisms in serious contention are the carbon tax and the carbon market. Both methods have been shown to be effective ways of reducing pollution at a much lower cost than more traditional regulation.²²
- 3.30 Administratively, the simplest pricing mechanism is to impose a tax on emissions, typically known as a carbon tax. A carbon tax is a tax on the carbon content of fuels, effectively a tax on the carbon dioxide emissions from burning fossil fuels.²³
- 3.31 Carbon taxes are straightforward to apply and avoid the need for governments to take discretionary decisions about who ought to be

20 Insurance Council of Australia, *Submission No. 18*, p. 2; Australian Conservation Foundation, *Submission No. 20*, p. 2.

21 Garnaut, R., *The Garnaut climate change review*, 2008, p. 308.

22 Shrum, T., *Greenhouse gas emissions – Policy and economics*, 2007, p. 27.

23 Carbon Tax Centre, <http://www.carbontax.org/introduction/>, viewed on 9 February 2009.

allowed to emit. Carbon taxes also provide certainty about the marginal costs of mitigation.²⁴

- 3.32 Carbon taxes are considered to have a number of advantages. For example, carbon taxes will increase the price of energy by a predictable amount. This has a number of advantages, including price stability for consumers and easy modelling of the effects of its introduction. Unlike a carbon market, a carbon tax avoids the potential of extremely high permit prices causing debilitating compliance costs or extremely low permit prices creating insufficient incentive for emissions reductions.
- 3.33 A stable price signal puts steady pressure on the markets to determine the best pathway towards reduction and alternative energy development. When there is a clear, predictable price for greenhouse gas emissions, businesses can plan prudent investments in energy efficiency and have a transparent, long-term incentive for investments in research and development of new technologies.²⁵
- 3.34 Another advantage of a carbon tax is the immediacy with which it can be applied. A carbon tax would not require the extensive international regulatory framework that a carbon market will require. In an environment where early action will be rewarded, this may prove useful.
- 3.35 Finally, a carbon tax can be more equitable than the carbon market alternative discussed below, particularly if the carbon market is introduced with concessions to emissions intensive industries.²⁶
- 3.36 Nevertheless, a carbon tax cannot guarantee that emissions reductions targets can be met. In addition, with a focus on targets, the tax rate for carbon would have to be continuously monitored and changed to ensure emissions targets were met.²⁷
- 3.37 A carbon market works on the basis of the issue of emissions permits. Each permit represents a tradeable instrument with inherent value that can be exchanged between sellers and buyers in an emissions permit market. This enables the movement of permits within the economy to their most economically efficient use.
- 3.38 The permit enables the holder to emit a specified amount of greenhouse gas. Producers of goods and services are only able to emit the amount of

24 Garnaut, R., *The Garnaut climate change review* 2008, p. 308.

25 Shrum, T., *Greenhouse gas emissions – Policy and economics*, 2007, p. 27.

26 Carbon Tax Centre, <http://www.carbontax.org/introduction/>, viewed on 9 February 2009.

27 Garnaut, R., *The Garnaut climate change review*, 2008, p. 309.

- greenhouse gases they have permits for. The cost of the permit is passed on to the consumer.
- 3.39 The mechanism reduces greenhouse gas emissions in two ways. First of all, the amount of greenhouse gases specified in the permits is less than the amount of greenhouse gases that would be emitted under a business as usual scenario. Producers are therefore encouraged to reduce greenhouse gas emissions in the production process. Secondly, the additional cost of the permits is passed on to the consumer, encouraging the consumer to purchase goods and services produced with a more efficient use of greenhouse gases.²⁸
- 3.40 The principal benefit of the carbon market will be its effectiveness in implementing an international agreement to reduce greenhouse gas emissions. Carbon taxes can only be implemented at a national level. Differences between the tax approaches will mean that the price of carbon will vary across nations. The different carbon prices will reduce the effectiveness of the price signal a carbon tax is supposed to send. By contrast, a carbon market implemented as part of an international agreement will ensure that price signals are uniform world wide.
- 3.41 A further advantage will be that carbon reductions can occur in the most cost effective location. This will be of particular benefit to developing countries.
- 3.42 In a carbon market, there are a number of ways that governments in rich countries can drive flows, either through direct purchase of quotas allocated to developing countries or through the creation of company-level trading where companies have access to credits for emissions reductions created in developing countries. In this case, financial flows between sectors and/or countries can occur automatically as carbon emitters search for the most cost-effective way of reducing emissions.
- 3.43 In theory, both a carbon tax and carbon market could drive financial flows from the developed to developing countries. Under a tax-based system, revenues raised will in the first instance flow to national governments. An additional mechanism would need to be put in place to transfer resources to developing countries.²⁹

28 Garnaut, R., *The Garnaut climate change review*, 2008, p, 322.

29 HM Treasury, *Stern review on the economics of climate change*, 2006, p. 320.

Carbon tax or carbon market?

3.44 Both a carbon tax and a carbon market have advantages as mechanisms for reducing greenhouse gas emissions. Professor Garnaut had the following to say about each of these options:

A well-designed emissions trading scheme has important advantages over other forms of policy intervention. However, a carbon tax would be better than a heavily compromised emissions trading scheme.³⁰

3.45 Once again, the consideration underpinning the Committee's recommendation in relation to this issue is the overwhelming advantage to Australia of reaching an international agreement to reduce greenhouse gas emissions. An international carbon market will hold advantages for developing countries, and may be a crucial aspect to ensure their participation in an international agreement.

Recommendation 3

The Committee recommends that the Australian Government pursue the creation of an international carbon market as the primary mechanism for reducing greenhouse gas emissions.

Australia's position in Copenhagen

3.46 Professor Garnaut argued that, beyond the Kyoto Protocol, the Government should work with the international community to secure a global agreement around a firm emissions concentrations goal. He argued that Australia should commit to a comprehensive global agreement for four reasons:

- international agreement is urgent and essential;
- agreement is possible if Australia and some other countries attach enough importance to it;
- a comprehensive global agreement is the only way to remove the risks, to Australia and to the global trading system, of payments to trade-exposed, emissions-intensive industries; and

30 Garnaut, R., *The Garnaut climate change review*, 2008, p. 299.

- international agreement lowers the cost of Australian mitigation and so allows Australia to be more ambitious about the reduction in emissions.³¹
- 3.47 Professor Garnaut found, as the Committee has found, that Australia's long term interests lie in reaching an agreement to return greenhouse gas levels in the atmosphere to 450 parts per million. However, Professor Garnaut was concerned that the excessive cost of achieving this stabilisation target would make international agreement impossible. In the interests of reaching an international agreement, he argued that Australia should aim for agreement to a more modest target of stabilisation at 550 parts per million.³²
- 3.48 The Committee has approached the issue of climate change using scientific evidence. The advantages of this approach for clear, unambiguous guidance on this issue were discussed in chapter one. This will mean a different series of recommendations to those contained in the Garnaut Review. The scientific evidence indicates that a stabilisation target of 550 parts per million runs a high risk of significant climate disruption. As a consequence, the Committee has recommended that the Government seek an international stabilisation target of 450 parts per million.
- 3.49 The recommendations in chapter three of this report flow from this initial recommendation, including that Australia be willing to set a target of 80 percent reduction of greenhouse gas emissions by 2050, and that Australia pursue the creation of an international carbon market as a mechanism for reducing greenhouse gas emissions.
- 3.50 Above all, it is imperative to reach an international agreement to reduce greenhouse gas emissions.³³ Climate change resulting from human caused greenhouse gas emissions is a global problem of such magnitude that no one country can address it.
- 3.51 Any international agreement will have to take account of the position of developing and transitional nations. Developing and transitional nations have a persuasive argument for not agreeing to a national approach to allocating emissions reductions. Developed nations are responsible for the bulk of greenhouse gasses in the atmosphere at present, having emitted significant amounts of greenhouse gasses in the process of reached developed status. Developing and transitional nations are unlikely to consider shouldering the burden of fixing the problem as equitable when

31 Garnaut, R., *The Garnaut climate change review*, 2008, p. 277.

32 Garnaut, R., *The Garnaut climate change review* 2008, p. 279.

33 The Australian Workers Union, *Submission No. 25*, p. 6.

their citizens still have not achieved the standard of living in developed nations.³⁴

- 3.52 The Committee believes that, having created the global heating problem through emissions since the industrial revolution, the developed nations have a responsibility to take on the bulk of the emission reduction burden. This belief is reflected in the Committee's recommendation that Australia be willing to set a target of an 80 percent reduction in greenhouse gas emissions by 2050. The belief is also reflected in the commitment by the President of the United States to set the same target.
- 3.53 If this target were set by all developed nations, the burden on developing and transitional nations would be light enough to enable them to make a smooth transition to low emission technologies as part of the process of reaching developed status.
- 3.54 Consequently, the Committee makes the following recommendation for the Australian Government's position the 15th Conference of the Parties to the United National Framework Convention on Climate Change in Copenhagen later this year.

Recommendation 4

The Committee recommends that the Australian Government take the following position to the 15th Conference of the Parties to the United National Framework Convention on Climate Change in Copenhagen, Denmark:

- **that the international community reach an agreement to stabilise greenhouse gas emissions at around 450 parts per million or lower of carbon equivalent;**
- **that the agreement distribute responsibilities for reducing greenhouse gas emissions across nations by requiring developed nations to reduce emissions by 80 percent by 2050, with the residual reductions distributed fairly between developing and transitional nations; and**
- **that the agreement establish an international carbon market as the primary mechanism for achieving the necessary reductions.**

34 Carbon Tax Centre, <http://www.carbontax.org/introduction/>, viewed on 9 February 2009.

3.55 In the following chapter, the Committee turns to consider some mechanisms for reducing emissions in Australia.

Greenhouse gas reductions in Australia

A two percent reduction a year

- 4.1 In the previous chapter, the Committee concluded that Australia should be willing to reduce greenhouse gas emissions by 80 percent by 2050, which is commensurate with stabilising greenhouse gases in the atmosphere at 450 parts per million.
- 4.2 While this is a massive reduction in greenhouse gas emissions, the Committee is of the view that it can be achieved. Spread over the 40 years to 2050, the target amounts to a two percent reduction each year.
- 4.3 The key to achieving a reduction of this sort will be consistency of effort and a willingness to employ a wide range of measures to reduce greenhouse gas emissions incrementally.
- 4.4 This chapter explores a number of measures for reducing greenhouse gas emissions. Some of these measures are ready to be implemented now, while others will require research, investment and time before they result in meaningful greenhouse gas reductions.
- 4.5 The measures outlined here provide an example of the incremental process by which significant reductions can be achieved. These include:
 - the adoption of policy frameworks, such as:
 - ⇒ the Carbon Pollution Reduction Scheme (CPRS); and
 - ⇒ the Renewable Energy Target (RET);
 - the effort to change current practices, such as

- ⇒ use of private vehicles where public transport is a viable option;
- ⇒ land clearing; and
- ⇒ savannah burning; and
- low emissions technologies, such as
 - ⇒ wind generation;
 - ⇒ geothermal energy;
 - ⇒ ocean power;
 - ⇒ solar power;
 - ⇒ cogeneration;
 - ⇒ carbon capture;
 - ⇒ alternative fuels for vehicles; and
 - ⇒ biochar.

Policy frameworks

The Carbon Pollution Reduction Scheme (CPRS)

- 4.6 The Carbon Pollution Reduction Scheme (CPRS) is the Federal Government's principal policy response to encourage a reduction in emissions. The CPRS is a national carbon market, with the Australian Government issuing tradable instruments that permit carbon emissions. The advantages of a carbon market have been discussed in some detail in the previous chapter.
- 4.7 The Government estimates that the scheme will result in reductions in greenhouse gas emissions to between five and 15 percent below 2000 levels by 2020 and to 60 percent below 2000 levels by 2050.¹

Renewable Energy Target (RET)

- 4.8 In 2006, stationary energy (that is, energy for industrial, commercial and residential sectors) accounted for 34.4 percent of Australia's greenhouse gas emissions. A move to renewable energy generation in the stationary energy sector could significantly reduce Australia's overall emissions.²

1 Australian Government, *Carbon pollution reduction scheme: Australia's low pollution future*, 2008, p. XX.

2 Department of Climate Change, *National greenhouse gas inventory*, 2006, p. 6.

- 4.9 As part of the Government's strategy to reduce Australia's emissions, it has imposed a Renewable Energy Target (RET) on large wholesale purchasers of electricity. The RET will require that 20 percent of Australia's stationary energy is generated using renewable energy by 2020.³ A range of organisations argue that the RET is an important mechanism in Australia reducing greenhouse gas emissions and should operate in conjunction with the CPRS.⁴
- 4.10 The Obama Administration in the United States has announced a target of 25 percent renewable energy by 2025. In Australia, the Clean Energy Council has expressed concern that Australia's 20 percent by 2020 target will not be met unless investors can see a financial return beyond 2020, given the long time horizon needed to recover large capital investments. It will be important to monitor the implementation of the Renewable Energy Target to ensure that the Government's policy objective is achieved.
- 4.11 During the inquiry the Committee surveyed a range of renewable energy generation technologies with the potential to contribute to the RET, such as wind, solar and ocean electricity generation. These are discussed in some detail below in the technologies section of this chapter.

Changing current practices

- 4.12 A number of large sources of greenhouse gas emissions in Australia are due to practices that could be modified with a change in attitude by the community. The practices are:
- use of private vehicles where public transport is a viable option;
 - land clearing; and
 - savannah burning.

Use of private vehicles

- 4.13 Passenger cars were the biggest contributor to emissions from road transport, with emissions from passenger cars growing by 21 percent

3 Australian Government, *Carbon pollution reduction scheme: Australia's low pollution future*, 2008, p. XL.

4 The Australian Sugar Milling Council, *Submission to the Garnaut Climate Change Review*, p. 3; Environment Business Australia, *Submission to the Carbon Pollution Reduction Scheme*, p. 6.

between 1990 and 2006.⁵ Professor Garnaut identified that there was some scope to reduce emissions from this source.⁶

- 4.14 The Australian Conservation Foundation (ACF) has argued that the formula for fringe benefits tax concessions for private use of company cars creates an incentive for unnecessary travel, as it is based on the number of kilometres travelled. The ACF believes that fringe benefit tax concessions for company cars should be restructured to create positive incentives for efficient vehicles, remove perverse incentives to drive more, and complement efforts to re-tool the Australian car industry for cleaner vehicle production.⁷
- 4.15 In a similar vein, Greenpeace recommended that the Australian Government's *Review of Australia's Future Tax System* address transport subsidies to ensure that climate protection is integrated into public spending.⁸
- 4.16 Evidence to the Committee identified a number of proposals for increasing the use of public transport. The South West Group advocated the development new tram and light rail technology as a pathway to emissions-reduced transport systems.⁹ The Group also suggested that the Australian public would have to adjust to new practices for daily travel.¹⁰
- 4.17 The ACF advocated the need for investment in infrastructure that has low carbon intensity in both its construction and the life of its operation. The ACF called for the development of a high-quality integrated public transport system to combat Australia's growing levels of greenhouse gas emissions.¹¹

5 Department of Climate Change, *National greenhouse gas inventory*, 2006, p. 7.

6 The Garnaut Climate Change Review: *Final Report*, 2008, p. 525.

7 Australian Conservation Foundation, *Submission to Department of the Treasury, Priorities for the Federal Budget 2009-10*, January 2009, pp. 3-4.

8 Greenpeace, *Submission No. 24*, p. 14.

9 Mr Chris Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 19.

10 Mr Chris Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 19.

11 Australian Conservation Foundation, *Submission to Infrastructure Australia: Discussion paper 1: Australia's future infrastructure requirements*, 2008.

Recommendation 5

The Committee recommends that the Australian Government work through the Council of Australian Governments to establish a high quality integrated public transport system including light rail technology.

Reducing emissions from deforestation

- 4.18 Trees sequester carbon from the atmosphere through the process of photosynthesis. This carbon is then stored in the tissue of trees in the form of starch. Once trees die, some of this carbon is transmitted to the soil where it can be stored for thousands of years.¹²
- 4.19 Deforestation plays a dual role in climate change. First, as more trees are removed the effectiveness of forests as carbon sinks is reduced, thus lessening the amount of carbon dioxide being withdrawn from the atmosphere. Second, the process of deforestation actually releases carbon dioxide into the atmosphere through the process of combustion and decomposition.¹³ It is estimated that in 2004 deforestation, along with the decay of biomass, contributed 17.3 percent of the world's man-made greenhouse gas emissions.¹⁴
- 4.20 About 30 percent of the world's land area is covered by forests with the three largest forests located in South America, Central Africa and South East Asia. In other words, forests are largely located in developing and transitional nations. Between 2000 and 2005 the worldwide net rate of deforestation declined¹⁵, however during 2007-2008 deforestation in the Amazon increased by 3.8 percent over the previous year.¹⁶
- 4.21 Deforestation is caused by a range of factors including:

12 Alvarado, L.X.R. and Wertz-Kanounnikoff, S., *Why are we seeing "REDD"? An analysis of the international debate on reducing emissions from deforestation and degradation in developing countries*, 2007, p. 8.

13 Alvarado, L.X.R. and Wertz-Kanounnikoff, S., *Why are we seeing "REDD"? An analysis of the international debate on reducing emissions from deforestation and degradation in developing countries*, 2007, p. 8.

14 IPCC, *Climate change 2007: Synthesis report*, 2008, p. 36.

15 Alvarado, L.X.R. and Wertz-Kanounnikoff, S., *Why are we seeing "REDD"? An analysis of the international debate on reducing emissions from deforestation and degradation in developing countries*, 2007, p. 8.

16 World Wildlife Fund for Nature, *Amazon deforestation on the increase*, 2008, www.panda.org, viewed on 22 January 2009.

- demand for land from agricultural expansion driven by population growth, high prices for agricultural commodities and cheap labour;
- more profitable alternative land use, such as growing crops;
- demand for wood products;
- demand for land to be used for infrastructure such as pipelines, dams and open-pit mines;
- government regulations and poor supervision that reward deforestation; and
- economic factors including wood processing company debt levels and international market prices.¹⁷

4.22 In order to reduce deforestation a range of techniques have been proposed:

- afforestation (planting trees), sequestering carbon from the atmosphere and reducing emissions associated with land clearing;
- improving management of existing forests to increase the density and efficiency of forests; and
- managing the harvest of forests so that the amount of carbon removed annually, through deforestation, is equal to or less than the amount of carbon sequestered and stored by the forest.¹⁸

4.23 The need to reduce emissions from deforestation was formally recognised by the United Nations Framework Convention on Climate Change through the Bali Action Plan in December 2007. The plan advocates the consideration of approaches to reduce emissions from deforestation and to enhance forest carbon stocks in developed and developing countries.¹⁹ The Convention established the Ad Hoc Working Group on Long-term Cooperative Action under the Convention to implement the Bali Action Plan. The Group is expected to present the outcome of its work, including the consideration of mechanisms to combat deforestation in 2009.²⁰

17 Kanninen, M., Murdiyarso, D., Seymour, F., Angelsen, A., Wunder, S. and German, L., *Do trees grow on money: The implications of deforestation research for policies to promote REDD*, 2007, pp. 17-26.

18 IPCC, *Climate change 2007: The physical science basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2008, p. 550.

19 United Nations Framework Convention on Climate Change, *Report of the Conference of the parties on its thirteenth session, held in Bali from 3 to 15 December 2007*, 2008, p. 8.

20 United Nations Framework Convention on Climate Change, 2009, Viewed 22 January 2009 unfccc.int/meetings/items/4381.php.

- 4.24 A range of policy options exist to encourage the uptake of the above mentioned techniques to combat deforestation:
- eliminate subsidies on goods and services that support and protect agriculture, population expansion, and logging sectors;
 - introduce tax breaks for landholders carrying out conservation;
 - influence demand by certifying timber goods that minimise deforestation;
 - deny public and private investment to industries that are not working to combat deforestation;
 - compensate landowners, either through monetary rewards or increased public services, on the condition they preserve and maintain forests;
 - direct regulation where deforestation is prohibited in certain areas; and
 - restrict property rights so that landholders are prohibited from carrying out land clearing.

The most effective policy will vary on a case by case basis and would be largely dependent upon the strength of the institutions involved in their implementation.²¹

- 4.25 A range of submissions to the inquiry advocated a larger role for Australian monetary aid in combating deforestation and forest degradation in developing nations.²²
- 4.26 In July 2008 the United Nations established the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries in order to promote an economic environment that favours the sustainable management of forests. The programme established a \$35 million fund to assist developing countries in constructing deforestation-reduction strategies and solutions. To date, no programmes or projects have been implemented under the scheme.²³
- 4.27 In regards to Australian initiatives, the Government heads the International Forest Carbon Initiative. This is an Australian sponsored programme aimed at demonstrating that reducing emissions from

21 Kanninen, M., Murdiyarso, D., Seymour, F., Angelsen, A., Wunder, S. and German, L., *Do trees grow on money: The implications of deforestation research for policies to promote REDD*, 2007, pp. 32-41.

22 The Australian Conservation Foundation, Submission No. 20, p. 6; Humane Society International, Submission No. 17, p. 2.

23 United Nations Development Group, 2009, www.undp.org, viewed on 22 January 2009.

deforestation can be achieved equitably and effectively through international agreements. Through the initiative Australia has so far pledged tens of millions of dollars to programmes throughout the Asia-Pacific.²⁴

- 4.28 Within Australia, deforestation is not included under the announced CPRS. The CPRS White Paper states that deforestation in Australia has reduced markedly since 1990, and the sporadic nature of current land clearing practices would make its inclusion in the scheme impractical.²⁵
- 4.29 However, as will be discussed in the next chapter, afforestation may help in mitigating climate change in Australia.

Recommendation 6

The Committee recommends that the Australian Government endeavour to move to 'full carbon accounting' to ensure that emissions resulting from forestry activities as well as biosequestration are accurately accounted for.

Savannah burning

- 4.30 The Committee heard evidence of the large contribution of wildfires in regions of northern Australia to Australia's total greenhouse gas emissions. Dr Jeremy Russell-Smith, an expert on savannah burning, argued that the magnitude of these fires, and their effects, are largely unrecognised:

...we are talking about big fires that are often much greater than 10,000 square kilometres and up to 60,000 square kilometres, which is the area of Tasmania. They are not even reported in the local newspaper, let alone in the media generally. It is something that we sort of live with but it is unacceptable.²⁶

- 4.31 Dr Russell-Smith stated that wildfires in pre-European northern Australia were managed by controlled wet-season savannah burning. In the last century, this system broke down to the point where freely burning dry-season wildfires are making significant contributions to Australia's

24 Department of Climate Change, *International forest carbon initiative factsheet*, 2008.

25 Australian Government, *Carbon pollution reduction scheme: Australia's low pollution future*, 2008.

26 Dr Jeremy Russell-Smith, *Transcript of Evidence*, 19 August 2008, p. 25.

greenhouse gas emissions.²⁷ In 2006 savannah burning accounted for almost two percent of Australia's greenhouse gas emissions.²⁸

- 4.32 Dr Russell-Smith advocated reducing the frequency and severity of these fires through a programme of managed savannah burning, referring to the West Arnhem Land Fire Abatement (WALFA) project as an example of how these fires can be effectively managed. This project is a partnership between traditional landholders, industry and government where satellite imaging technology and traditional Indigenous fire management practices are used to plan and carry out strategic savannah burning at appropriate times of year. This burning creates natural firebreaks which diminish the severity of the dry-season wildfires. In turn, the greenhouse gas emissions resulting from savannah burning are greatly reduced.²⁹
- 4.33 Dr Russell-Smith stated that data from the WALFA project indicated a 48 percent reduction in greenhouse gas emissions from savannah burning across the region covered by the project. Dr Russell-Smith stated that similar reductions could be expected if similar strategies were applied across other areas of northern Australia.³⁰ The CSIRO also advocated the implementation of such a strategy across northern Australia.³¹
- 4.34 Savannah burning has not been initially included under the CPRS. However the CPRS does include savannah burning as a source of offsets. The Government has indicated its intention to conduct a national workshop in the first half of 2009 to consider how to overcome a range of issues relating to such projects.³²
- 4.35 If the figures provided by Dr Russell-Smith are accurate, controlled savannah burning could reduce Australian greenhouse gas emissions by one percent.

27 Dr Jeremy Russell-Smith, *Transcript of Evidence*, 19 August 2008, p. 25.

28 Department of Climate Change, *National greenhouse gas inventory*, 2006, p. 7.

29 Dr Jeremy Russell-Smith, *Transcript of Evidence*, 19 August 2008, p. 27.

30 Dr Jeremy Russell-Smith, *Transcript of Evidence*, 19 August 2008, p. 27.

31 Dr Garry Cook, *Transcript of Evidence*, 19 August 2008, p. 43.

32 Australian Government, *Carbon pollution reduction scheme: Australia's low pollution future*, 2008, pp. 6-63.

Recommendation 7

The Committee recommends that the Australian Government, through both the Council of Australian Governments and ongoing work on the Carbon Pollution Reduction Scheme, and in consultation with relevant indigenous communities, explore ways to reduce greenhouse gas emissions from savannah burning.

Low emissions technologies

Wind

- 4.36 Wind turbines convert the energy from a moving airflow to electricity. Wind rotates a turbine which is connected to an energy generator. The energy generator then converts the energy from the rotation of the turbine to electricity, which is then exported to users via an electricity grid.³³
- 4.37 Wind powered electricity generation is a proven technology and is used throughout the world. The efficiency and applicability of electricity generation from wind turbines is increasing due to continued improvements in turbine design and the range of locations where wind turbines can be used. For example, trials are underway throughout Europe of floating wind turbines for use offshore.³⁴
- 4.38 The efficiency of wind generated electricity is being improved by work of the CSIRO on electricity storage batteries attached to wind turbines. For example, the 'Ultrabattery' combines a range of existing technologies to provide a low cost, long life and high performance battery. This battery lasts four times longer and produces 50 percent more energy than conventional batteries.³⁵
- 4.39 Aside from the RET, there are no Federal Government incentives for the development of wind energy generation.³⁶
- 4.40 Worldwide, over forty countries offer feed in tariffs to encourage renewable energy generation. Under such schemes, households and firms are paid a government funded premium rate for electricity that is fed back

33 International Energy Agency, *Renewable energy essentials: Wind*, 2008, p. 4.

34 International Energy Agency, *Renewable energy essentials: Wind*, 2008, p. 2.

35 CSIRO, *CSIRO Project Profile - Ultrabattery: no ordinary battery*, 2008.

36 Clean Energy Council, *Clean energy fact sheets: All about wind energy*, 2007, p. 1.

into the grid from renewable energy sources. The electricity from wind turbines owned by private citizens could be covered under such a scheme.³⁷

- 4.41 A number of state and territory governments currently offer feed in tariffs. Victoria, South Australia, the Australian Capital Territory, Tasmania, the Northern Territory and Queensland all have differing independent feed in tariff schemes. Western Australia and New South Wales have also committed to developing feed in tariff schemes. However wind energy is not necessarily covered under such schemes, and feed in tariffs only encourage the uptake of wind turbines by individuals, rather than by energy generating companies.³⁸
- 4.42 The Clean Energy Council believes that in the short term, the potential exists to more than double the current capacity of wind-powered electricity generation in Australia.³⁹
- 4.43 It is not clear at this stage whether the RET and the state- and territory-based feed in tariffs will be sufficient to ensure that wind turbines are used to their full potential as a renewable energy resource. Environment Business Australia supports the use of feed in tariffs to encourage the uptake of renewable energy sources such as wind energy.⁴⁰
- 4.44 The Committee is of the view that the uptake of wind turbines should be promoted and monitored by the Government. If wind turbines are not used to their full potential, the Government should consider other measures to encourage their use.

Geothermal energy

- 4.45 Geothermal energy converts the subterranean heat generated by the planet's core to electricity. Wells are drilled to a depth of three to five kilometres below the earth's surface. Water is then circulated down these wells to be heated to extremely high temperatures then returned to the surface. The hot water is then converted to electricity, usually through a steam turbine.⁴¹

37 Wind Energy & Solar Power Australia, *Feed-in tariff for grid-connected solar systems*, 2009.

38 Wind Energy & Solar Power Australia, *Feed-in tariff for grid-connected solar systems*, 2009.

39 Clean Energy Council, *Clean energy fact sheets: All about wind energy*, 2007, p. 1.

40 Environment Business Australia, *Submission to the Carbon Pollution Reduction Scheme*, p. 6.

41 Clean Energy Council, *Clean energy fact sheets: All about geothermal energy*, 2007, p. 1.

- 4.46 Geothermal power is an emission neutral source of power. One megawatt of power from a geothermal facility avoids the emission of approximately one tonne of carbon dioxide.⁴²
- 4.47 Geothermal electricity generation relies on existing technologies and is a rapidly emerging technology in Australia. While still in the development stage, it may provide a predictable and reliable renewable energy source.⁴³ In 2008 geothermal energy company Geodynamics Ltd established Australia's first commercial-scale well.⁴⁴
- 4.48 The Government is providing a range of assistance to the geothermal energy industry. During August 2008 the Government announced the *Geothermal Drilling Program* to provide financial assistance for the development of demonstration plants for geothermal energy generation. The programme offers assistance of up to \$7 million per project.⁴⁵
- 4.49 In December 2008, the Government launched the *Geothermal Industry Development Framework*. The framework aims to assist the geothermal industry by encouraging investment, facilitating the exchange of information amongst government and commercial entities, creating an effective research and development network and generating a skilled workforce for the geothermal industry.⁴⁶
- 4.50 Whilst many of the elements of the geothermal energy process such as drilling, pumping and generation have been proven, it is yet to be determined if the process as a whole is viable. If proven to be viable, however, geothermal electricity generation has the potential to become a significant source of stationary energy. The Australian Geothermal Energy Association believes geothermal energy will be a viable source of stationary energy within 12 years.⁴⁷

Ocean power

- 4.51 Ocean power employs the energy from the ocean's tides, currents and waves to produce electricity. A range of technologies exist to harness this energy. The most common generation system uses the energy from
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42 Clean Energy Council, *Clean energy fact sheets: All about geothermal energy*, 2007, p. 1.

43 Clean Energy Council, *Clean energy fact sheets: All about geothermal energy*, 2007, p. 1.

44 Geodynamics Ltd. 2008, Geodynamics Ltd, www.geodynamics.com.au, viewed on 19 January 2009.

45 Department of Resources, Energy and Tourism, *Geothermal drilling program*, 2008.

46 Department of Resources, Energy and Tourism, *Australian geothermal industry development framework*, 2008, p. XI.

47 Australian Geothermal Energy Association, *Installed capacity and generation from geothermal sources by 2020*, 2008, p. 20.

flowing water to turn a turbine. The rotation of this turbine is then used to generate electricity, which is then transmitted to users via an electricity network or grid.⁴⁸

- 4.52 Ocean power is an emerging technology. Developers around the world face a range of challenges in developing and testing ocean power devices due to the variability of ocean conditions, a lack of investment interest and difficulties with the regulation of ocean power installations.⁴⁹
- 4.53 A range of different pilot projects exist internationally. In 2008 Portugal opened the world's first commercial wave-powered energy generation facility.⁵⁰ A similar project is proposed in Scotland.⁵¹
- 4.54 In Australia, companies are involved in the construction of demonstration plants. At Port Kembla, New South Wales, a prototype wave-powered energy generator supplies a small amount of energy to the local grid. Similar projects are proposed for Portland, Victoria, and Fremantle, Western Australia.⁵²
- 4.55 Australia is in a good position to take advantage of wave technology. It is estimated that one million gigawatts of wave energy hits Australia's shores every year.⁵³ The World Energy Council anticipates that in five to ten years time wave energy could be making a contribution to the world's energy supply.⁵⁴
- 4.56 Given the coastal concentration of Australia's population, it appears that tidal and wave generation have the potential to be better utilised in this country. As a source of stationary energy, wave and tidal power is likely to be a longer term proposition for Australia.

Solar power

- 4.57 Solar power is harnessed using two types of generating system; photovoltaic cells and solar thermal generation.
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48 Clean Energy Council, *Clean energy fact sheets: All about ocean energy*, 2007, p. 1.

49 World Energy Council, *Survey of energy resources*, 2009, www.worldenergy.org, viewed on 19 January 2009.

50 Alok, J., *Making waves: UK firm harnesses power of the sea ... in Portugal*, *The Guardian*, 25 September 2008, www.guardian.co.uk, viewed on 19 January 2009.

51 Scottish Power Renewables, 2009, www.scottishpowerrenewables.com, viewed on 19 January 2009.

52 Clean Energy Council, *Clean energy fact sheets: All about ocean energy*, 2007, p. 2.

53 Carnegie Corporation, *Wave energy as a global resource*, 2009, www.carnegiecorp.com.au, viewed on 19 January 2009.

54 World Energy Council, *Survey of energy resources*, 2009, www.worldenergy.org/publications, viewed on 19 January 2009.

- 4.58 In photovoltaic cells, light energy from the sun enters a cell made out of silicon. The light energy excites the electrons contained in the silicon, which in turn generates electricity. This electricity is then used at the site of generation or transmitted to users via a local power grid.⁵⁵
- 4.59 Photovoltaic solar power is an established technology used in around 25,000 homes in Australia. Once installed, photovoltaic solar power creates no emissions. Photovoltaic solar power is a low-maintenance and reliable intermittent power source: it can only generate electricity when exposed to sunlight. Photovoltaic solar power is mainly used to supplement constant base load electricity supplies.⁵⁶
- 4.60 The current solar market is dominated by crystalline silicon solar cells. These cells are expensive due to the large amount of silicon used in their production.
- 4.61 A range of developments are driving down the price of photovoltaic solar power including the development of thin film solar cells. Thin film cells use very little or no silicon at all, thus significantly reducing production costs.⁵⁷ There are many companies putting thin film solar modules into mass production. This promises to further reduce the costs of thin film solar technology to the point where it may compete against fossil-fuel electricity generation.⁵⁸
- 4.62 Solar thermal generation technology is a relatively new form of solar energy that uses a mirror field to concentrate solar energy on a tank of liquid or gas. The liquid or gas is heated, expands, and consequently moves through a turbine to generate electricity.
- 4.63 Solar thermal generation technology requires sufficient space for the mirror field, and so can only be used in industrial, rather than domestic, generation.
- 4.64 Solar thermal generation technology is considered to have a number of advantages over photovoltaic solar generation. Solar thermal generation is much more efficient and has been enhanced by the development of technologies that allow the storage of solar energy, allowing solar thermal generation to continue to generate electricity after dark.⁵⁹

55 Knier, G., *How do photovoltaics work?*, North American Space Agency, 2009, science.nasa.gov, viewed on 19 January 2009.

56 Clean Energy Council, *Clean energy fact sheets: All about solar power*, 2007, p. 1.

57 The Economist, *Bright prospects*, March 2007, Vol. 382, p. 22.

58 Hand, A., *Thin-film photovoltaics*, Semiconductor International, 2008, Vol. 31(8), pp. 26-28.

59 Clean Energy Council, *Clean energy fact sheets: All about solar power*, 2007, p. 3.

- 4.65 Solar thermal generation technology is sufficiently advanced to be already used on a commercial basis. Most notably, the city of Seville in Spain derives the bulk of its power from solar thermal generators.
- 4.66 Solar thermal generation technology is currently being explored by the CSIRO:
- [The project] is a 500-kilowatt solar field which contains about 200 mirrors reflecting the sun's energy up to a central tower. There is a reactor mounted on that tower, and that reactor is basically a solar furnace. It can get up to temperatures of 1,200 degrees if needed, but we are running it at about 800 degrees at the moment. It is reforming natural gas through to what we call 'synthesis gas' with the addition of steam. Synthesis gas contains about 30 percent more energy than the original gases that go in. In other words, we are storing solar energy in the form of a changed gas composition.⁶⁰

Cogeneration

- 4.67 Cogeneration involves harnessing the by-product or excess heat from industrial processes to generate energy. The excess heat is used to power a turbine to create electricity or to heat buildings, reducing the amount of energy used by the buildings. Cogeneration can take place in fossil-fuel based power plants⁶¹ as well as other industrial processes such as sugar mills.⁶²
- 4.68 Because cogeneration is the generation of electricity as a by-product of an industrial process, it has the potential to reduce the amount of power an industrial plant extracts from the electricity grid, and in limited cases, can permit the plant to export the power to the grid.⁶³
- 4.69 Most energy generation takes place in large centralised single process power plants. Energy from these plants must be transmitted significant distances to users, resulting in significant transmission losses. Cogeneration projects have the potential to be located close to users of the

60 Dr John Wright, *Transcript of Evidence*, 1 December 2008, p. 11.

61 Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D., *ABARE Research report 7.16: Technology toward a low emissions future*, September 2007, p. 13; The Australian Petroleum Producers and Exporters Association, *Attachment 2 to Submission No. 32*, p. 65.

62 Baker, T., Bartle, J., Dickson, R., Polglase P., and Schuck, S., *Prospects for bio-energy from short-rotation crops in Australia*, September 1999, p. 3; The Australian Sugar Milling Council, *Submission to the Garnaut Climate Change Review*, p. 4.

63 Sunshine Electricity, *Condong project update*, June 2008, www.sunshineelectricity.com.au, viewed on 8 December 2008.

electricity. Consequently, less energy may be lost during the transmission of the electricity, thus further improving efficiency.⁶⁴

4.70 Cogeneration already exists in Australia, particularly in the sugar milling industry. However, price regulation of transmission networks may form a market barrier to new cogenerators entering the national electricity market.

4.71 The benefits of having many decentralised cogenerators may be nullified by a standard transmission charge which is charged to all users, regardless of the distance the electricity has to be transmitted.⁶⁵

Recommendation 8

The Committee recommends that promising renewable energy technologies which are not cost-competitive at the moment, including geothermal, solar thermal, large scale photovoltaic and wave energy, are further supported.

Carbon capture and storage in coal-fired power plants

4.72 Coal is the primary fuel used for electricity generation in Australia. In 2006, coal was used to generate 86.3 percent of Australia's electricity.⁶⁶

4.73 Carbon capture and storage (CCS) is a process to reduce the amount of carbon dioxide emitted to the atmosphere during the combustion of fossil fuels in power plants. A variety of CCS technologies exist, however the basic concept is the same. Through a chemical process, carbon dioxide is extracted either from fossil fuels prior to combustion (called pre-combustion capture) or from the exhaust after the combustion of fossil fuels (called post-combustion capture). This carbon dioxide is then compressed, transported and injected into naturally occurring, sealed, subterranean geological formations for permanent storage.⁶⁷

64 Pepermans, G., Driesen, J., Haeseldonckx, D., Belmans, R. and D'haeseleer, W., *Distributed generation: definition, benefits and issues*, Energy Policy, 2005, Vol 33(6), p. 789.

65 Productivity Commission, *Report No. 36: The private cost effectiveness of improving energy efficiency*, 2005, p. XLI.

66 Department of Climate Change *National greenhouse gas inventory*, 2006, p. 6.

67 International Energy Agency, *Carbon dioxide capture and storage*, 2009, www.iea.org/Textbase/subjectqueries/cdcs.asp, viewed on 20 January 2009.

- 4.74 According to the Intergovernmental Panel on Climate Change (IPCC), CCS technology could reduce carbon dioxide emissions from power plants by approximately 80 to 90 percent.⁶⁸
- 4.75 CCS technologies are in different stages of development. Some have been proven to be viable at an industrial scale.⁶⁹ Worldwide, there are four commercial-scale carbon dioxide storage projects. These projects have successfully stored millions of tonnes of carbon dioxide without leakage.
- 4.76 However, it is anticipated that CCS technologies, due to the significant costs and construction timeframe, will not be widely deployed in the near-term. This means that CCS will not make a contribution to greenhouse gas reductions until at least 2015.⁷⁰
- 4.77 Within Australia, CCS is being developed by the CSIRO and the Cooperative Research Centre for Greenhouse Gas Technologies (CRC GGT). The CRC GGT is a collaborative research organisation that comprises participants from industry, research organisations and all levels of government.
- 4.78 The CSIRO has participated in the development of three functioning pilot plants with carbon dioxide extraction in New South Wales, Victoria and China.⁷¹
- 4.79 The CRC GGT is focusing on three main areas of research: carbon dioxide capture, carbon dioxide storage and demonstration projects. The CRC GGT has three major demonstration projects in Australia:
- a demonstration of deep geological storage of carbon dioxide in South Western Victoria;
 - a pilot plant built in partnership between the University of Melbourne, Monash University, CSIRO, Loy Yang Power and International Power to seek ways of improving the reliability, safety and efficiency of pre-combustion capture techniques; and
 - a similar pilot plant partnership to investigate post-combustion capture techniques.⁷²

68 IPCC, *IPCC Special report on carbon dioxide capture and storage*, 2005, p. 4.

69 Gurba, L.W., *Clean coal techniques: challenges and opportunities for eastern Australia*, Paper, September 2008, p. 441.

70 International Energy Agency *Carbon dioxide capture and storage*, 2009, www.iea.org/Textbase/subjectqueries/ccs/technology_status.asp, viewed on 20 January 2009.

71 Dr John Wright, *Transcript of Evidence*, 1 December 2008, p. 10.

72 Cooperative Research Centre for Greenhouse Gas Technologies, 2008, www.co2crc.com.au/about/contact.html, viewed on 20 January 2009.

- 4.80 Given Australia's reliance on coal generated power, the Government has implemented, and become party to, a range of measures and programmes to support the research, development and implementation of CCS technologies across Australia and abroad:
- in July 2008 the Government established the National Low Emissions Coal Council to develop a national low emissions coal strategy and to oversee a national research programme into low emissions coal technologies;
 - also in July 2008 the Government established the Carbon Storage Taskforce to drive the development of geological carbon dioxide storage facilities in Australia;
 - in September 2008 the Government established the Global CCS Institute to encourage the international deployment of CCS technologies;
 - since it was founded in 2005, Australia has participated in the Asia Pacific Partnership on Clean Development and Climate, along with many other countries including the US and China. One of the aims of the partnership is to encourage the uptake of CCS technologies in partnership countries;
 - Australia is a member of the Carbon Sequestration Leadership Forum, founded in 2003, which aims to coordinate research and development of CCS on an international level; and
 - in 2007 the Australia-China Joint Coordination Group on Clean Coal Technology was established to facilitate cooperation and the transfer of CCS technologies between Australia and China.⁷³
- 4.81 One of the risks with the subterranean storage of carbon dioxide is that leakage could offset any reductions in carbon dioxide gained through CCS procedures. The IPCC, whilst acknowledging that a persistent leakage may offset the benefits of CCS, found that appropriately selected and managed geological reservoirs can retain more than 99 percent of stored carbon dioxide over 1,000 years of storage.⁷⁴
- 4.82 Concerns have also been raised in regards to the amount of extra energy needed by power plants to operate CCS technologies. The IPCC estimates that a plant equipped with CCS technology would require ten to 40 percent more energy to generate the same amount of electricity as a

73 Australian Coal Association, 2009, www.australiancoal.com.au, viewed on 20 January 2009.

74 IPCC, *IPCC Special report on carbon dioxide capture and storage*, 2005, p. 14.

plant without CCS technology. This would in turn lead to increased resource consumption.⁷⁵

- 4.83 The contribution that CCS technology can make in reducing Australia's greenhouse gas emissions is potentially significant. However, due to the fact that the technology is still in its developmental and demonstration phase, and due to the significant costs and timeframes associated with the installation of the technology, CCS is unlikely to be widely deployed in the short term.

Alternative fuels for vehicles

- 4.84 In 2006, road transport accounted for 12 percent of Australia's national greenhouse gas emissions.⁷⁶ The development of low-emissions vehicles, through the use of alternative fuels, could provide a significant reduction in Australia's total greenhouse gas emissions.

- 4.85 A range of alternatives already exist or are in development:

- electric vehicles;
- hydrogen fuel cells; and
- bio-fuels.

Electric vehicles

- 4.86 Electric vehicles provide a real opportunity to expand the use of renewable energy in our cities.⁷⁷ There are currently two main types of electric vehicles available: hybrid electric and battery electric.

- 4.87 Hybrid electric vehicles (HEVs) combine a conventional internal combustion engine with an electric motor powered by a large battery. HEVs switch between the two sources to power the vehicle, enabling emissions reductions.

- 4.88 The charge on the battery is prolonged through drawing on the energy caused by braking and through the use of the combustion engine to generate electricity. Some HEV batteries can be recharged straight from the grid. The electric motor means that a much smaller combustion engine is needed. The combustion engine is switched off when the car is not

75 IPCC, *IPCC Special report on carbon dioxide capture and storage*, 2005, p. 4.

76 Department of Climate Change, *National greenhouse gas inventory*, 2006, p. 7.

77 Dr Peter Newman, Submission No. 3., p. 1.

moving, and restarts when needed.⁷⁸ HEVs can be up to 50 percent more efficient than conventional combustion engines, with the highest efficiency occurring during stop-and-go traffic.⁷⁹

4.89 The technology associated with hybrid vehicles is already established and widely used today. A range of hybrid vehicles are already available on the market and many new models are in development. Advances in battery technology are expected to increase battery power, performance and life.⁸⁰ For example, the 'UltraBattery', a new form of battery technology recently developed by the CSIRO combines a range of existing technologies to provide a low cost, long life and high performance battery.⁸¹

4.90 The CSIRO gave evidence that the Ultrabattery is already being employed by manufacturers to improve the performance of electric hybrid vehicles and is attracting worldwide interest:

We put [the Ultrabattery] into a Honda Insight in the UK and drove that car for 100,000 miles – 160,000 kilometres, as we would put it – over the test track, and it went perfectly.⁸²

4.91 As part of the Green Car Innovation Fund, the Australian Government has entered into a \$35 million partnership with Toyota to implement the manufacture, and increased use, of Toyota hybrid vehicles in Australia.⁸³

4.92 Battery electric vehicles (BEVs) rely on large batteries to power an electric motor. The batteries are charged from the electricity grid. BEVs operate with zero vehicular emissions, but rely on electricity from a grid which may be powered by fossil fuels. Nonetheless, as base load energy generation decarbonises, fewer emissions will be created when powering BEVs.⁸⁴

4.93 The technology used in manufacturing BEVs is already established and a small number of BEVs are produced by European car manufacturers. However the short drive-range and past issues with battery reliability have hindered demand for BEVs, especially battery electric cars and

78 International Energy Agency *Hybrid electric vehicles*, 2009, www.iea.org/textbase/papers/2005/ETOAltFuels05.pdf, viewed on 23 January 2009.

79 Gielen, D. and Unander, F., *Alternative fuels: An energy technology perspective*, 2005, p. 17.

80 International Energy Agency *Hybrid electric vehicles*, 2009, www.iea.org/textbase/papers/2005/ETOAltFuels05.pdf, viewed on 23 January 2009.

81 CSIRO, *CSIRO Project profile - Ultrabattery: no ordinary battery*, 2008, www.csiro.au, viewed on 2 December 2008.

82 Dr John Wright, *Transcript of Evidence*, 1 December 2008, p. 10.

83 Franklin, M., *Toyota gets \$35m of taxpayers' money to build hybrid in Melbourne*, *The Australian*, 10 June 2008, www.theaustralian.news.com.au, viewed on 23 January 2009.

84 International Energy Agency, *Out look for hybrid and electric vehicles*, 2008, p. 2.

battery electric heavy-duty vehicles. Nonetheless, sales of two-wheeler BEVs, such as electric scooter and electric bicycles, are rising and this may increase the acceptance and demand for battery electric cars and other larger battery electric vehicles.⁸⁵

4.94 A number of disadvantages and limitations apply to electric vehicles:

- the cost of producing and maintaining electric vehicles is much higher than conventional combustion engine vehicles;
- often the batteries required to power electric motors are large and reduce the amount of cargo space in the vehicle;
- electric vehicles have a much slower acceleration and lower top speed than conventional vehicles;
- heating and cooling significantly reduces the performance of the vehicle;
- many electric vehicles have a limited range and cannot be used for long distance travel; and
- the time it takes to recharge the batteries in electric vehicles makes them impractical.⁸⁶

4.95 Overall, and in conjunction with further improvements in alternative fuel technology, electric vehicles could provide a reduction in Australia's greenhouse gas emission in the future.⁸⁷

Hydrogen fuel cell vehicles

4.96 The hydrogen fuel cell is an emerging technology, with major car producers in the testing and demonstration phase of these vehicles. A range of technological and economic hurdles exist that would need to be overcome before the use of the technology could become widespread. For example, prototype models have experienced issues with drive-range, acceleration and durability. Further, hydrogen is technically difficult and expensive to produce and store.⁸⁸

85 International Energy Agency, *Out look for hybrid and electric vehicles*, 2008, p. 2.

86 National Alternative Fuels Training Consortium, *Why Alternative Fuels?*, 2009, www.naftc.wvu.edu/NAFTC/data/indepth/Electric/HybridElectric.HTML, viewed on 23 January 2009.

87 Garnaut, R., *The Garnaut climate change review* 2008, p. 519.

88 International Energy Agency, *Prospects for hydrogen and fuel cells*, 2005, p. 95.

- 4.97 Fuel cells react the hydrogen with oxygen to produce electricity. This electricity is then used to power an electric motor. The only emission from hydrogen fuels cells is water.⁸⁹
- 4.98 In 2006, the CSIRO established the National Hydrogen Materials Alliance as part of its Energy Transformed Research Flagship. The Alliance brings together a range of Australian universities and other research organisations with the aim of improving the efficiency and economics of hydrogen generation and use, including the use of hydrogen in fuel cells.⁹⁰
- 4.99 In 2008 the Department of Resources, Energy and Tourism published its Hydrogen Technology Roadmap. The Roadmap recommends a range of strategies, identifies key responsibilities and proposes a timeframe for the development and application of hydrogen and associated technologies. The Roadmap aims to facilitate industry, government and researches in developing the use of hydrogen as an alternative fuel in Australia.⁹¹

Bio-fuels

- 4.100 A range of methods exist for producing bio-fuels, which are derived from plant material. Some techniques rely on plant matter with a high sugar content (such as sugar cane) to produce ethanol. Other techniques rely on plant matter with high amounts of naturally occurring oils (such as oil palm) to produce a combustible oil similar to diesel. Some processes harness the gases produced during the decomposition of organic matter in the absence of oxygen to produce a form of combustible bio-gas.⁹² These fuels are then used to drive internal combustion engines.
- 4.101 A range of concerns exist about the alleged benefits of bio-fuels:
- bio-fuel feedstocks, such as corn, compete for arable land with food crops, which in turn pushes up global food prices;
 - the demand for land and for high crop yields to produce bio-fuel feedstocks may encourage deforestation, increase the use of scarce water resources and promote unsustainable levels of bio-fuel feedstock production; and

89 International Energy Agency, *Prospects for hydrogen and fuel cells*, 2005, p. 95.

90 CSIRO, *Research cluster aims for breakthrough in hydrogen materials science*, 2009, at www.csiro.au/partnerships/ps2lq.html, viewed on 23 January 2009.

91 Department of Resources, Energy and Tourism, *Hydrogen technology roadmap*, 2008, p. I.

92 International Energy Agency, *From 1st to 2nd generation bio-fuel technologies*, 2008, pp. 19-26.

- developing and producing bio-fuels is expensive and may outweigh the limited greenhouse gas reduction benefits.⁹³
- 4.102 Much research is underway to develop a new wave of bio-fuels where many of the above-mentioned concerns would be addressed. These focus on producing bio-fuels from non-food crop feedstocks such as agricultural and forest residues.⁹⁴ Newly emerging methods focus on breaking down heavier organic feedstocks (such as woodchips) into simpler sugars to produce a form of ethanol.⁹⁵
- 4.103 A range of Government initiatives already exist to encourage the development of different bio-fuel technologies:
- the Cleaner Fuels Grants Scheme, administered by the Australian Tax Office, provides grants to encourage the uptake and manufacture of environmentally friendly bio-fuels;⁹⁶
 - AusIndustry administers the Ethanol Grants Program which provides a per-litre incentive to produce ethanol from bio-mass feedstocks;⁹⁷ and
 - in 2008, the Government launched the Second Generation Biofuels Research and Development Grant Program. The programme aims to stimulate the development and uptake of new bio-fuel technologies.⁹⁸
- 4.104 As this report is being prepared, the Government is undertaking an internal review of bio-fuel programmes and policies.⁹⁹

Soil carbon

- 4.105 The amount of carbon stored in the world's soils exceeds the amount of carbon held in the atmosphere and the world's vegetation combined. Plants convert carbon dioxide into energy in the form of starch through the process of photosynthesis. When plants die, the starch is broken down, primarily by micro-organisms in the soil. As the plant material is broken down, some of the carbon is released back to the atmosphere in the form of carbon dioxide. However a significant amount of carbon remains

93 International Energy Agency, *From 1st to 2nd generation bio-fuel technologies*, 2008, p. 6.

94 International Energy Agency, *From 1st to 2nd generation bio-fuel technologies*, 2008, p. 6.

95 Iogen Corporation, *What is cellulose ethanol?*, 2009, www.iogen.ca, viewed on 27 January 2009.

96 Australian Tax Office, *The cleaner fuels grants scheme*, 2005, p. 1.

97 AusIndustry, *Ethanol production grants*, 2009, www.ausindustry.gov.au, viewed on 27 January 2009

98 Department of Resources, Energy & Tourism, *Second generation biofuels research and development grant program: Program guidelines*, 2008, p. 3.

99 Department of Agriculture, Fisheries and Forestry, *Biofuels/bioenergy*, 2008, www.daff.gov.au/natural-resources/biofuelsbio-energy, viewed on 27 January 2009.

sequestered in the soil in the form of humus, an organic matter with a stable chemical composition which will not break down any further. Humus, and the carbon it contains, can remain in soils for thousands of years.¹⁰⁰

- 4.106 The level of carbon stored in soils in some regions has been declining, thus releasing more carbon into the global carbon cycle. The United Nations Convention to Combat Desertification found that current land use practices, and climate change itself, may be increasing the transmission of carbon from the soil to the atmosphere.¹⁰¹
- 4.107 Land use practices reduce the carbon content of soil in four ways:
- traditional soil tilling practices make soils finer and thus increase the rate at which micro-organisms can break down soils, and in turn the rate at which carbon is released from the soil;
 - burning of crop residues after harvesting releases carbon directly to the atmosphere in the form of carbon dioxide, thus resulting in less carbon being absorbed and stored in the soil;
 - removal of naturally occurring plant residues (such as leaf litter) and field residues (plant material left behind after harvesting) for use in other agricultural processes results in less plant matter being broken down to become part of the soil; and
 - land clearing increases soil salinity, reducing its capacity to support vegetation, in turn reducing the amount of organic matter being decomposed.¹⁰²
- 4.108 Climate change affects soil carbon levels through its impact on the growth of plants. Where climate change reduces the amount of vegetation in an area, less carbon will be transmitted to the soil by decomposing vegetation. Where climate change results in an increase in vegetation, through warmer, more fertile conditions in previously infertile regions, soil carbon content may increase. Thus the effect of climate change on soil carbon content differs depending on the geological position of the region.¹⁰³

100 Rice, C.W., *Storing carbon in soil: Why and how?*, Geotimes, January 2002, www.geotimes.org, viewed on 20 January 2009.

101 United Nations Convention to Combat Desertification, *Submission to the 4th Session of the Ad Hoc Working Group on Long-term Cooperative Action under the UNCCD: Use of biochar (charcoal) to replenish soil carbon pools, restore soil fertility and sequester CO₂*, 2008.

102 Food and Agriculture Organization of the United Nations, *Carbon sequestration in dryland soils*, 2004, ftp.fao.org, viewed on 20 January 2009.

103 Food and Agriculture Organization of the United Nations, *Carbon sequestration in dryland soils*, 2004, ftp.fao.org, viewed on 20 January 2009.

- 4.109 A variety of land use techniques exist in order to stem the falling level of carbon in soils:
- leaving crop fields un-harvested for one or more seasons allows for increased transmission of carbon to the soil;
 - in areas severely affected by salinity and thus with reduced vegetation, plants that thrive in areas of high salinity can be introduced to restore carbon to the soil;
 - afforestation in degraded soils increases the amount of carbon transmitted to the soil;
 - eliminating or reducing the removal of plant residues (both naturally occurring and resulting from harvest) increases the amount of organic matter being broken down and thus the amount of carbon being stored in soils;
 - applying manure, which has high carbon content and a higher resistance to being broken down by micro-organisms than plant residues, increases the long-term carbon content of the soil;
 - introducing tilling techniques that leave higher levels of plant residue, such as mulch-tillage, increase the amount of organic matter being decomposed and thus the amount of carbon being transmitted to the soil; and
 - rotating crops with high carbon transmission and low carbon transmission to improve soil carbon levels.

The effectiveness of these techniques varies significantly depending on the form of vegetation used in mitigation methods and the climate of the region.¹⁰⁴

- 4.110 An emerging technology that could be applied in increasing carbon soil content is a process called slow pyrolysis. This is a process where organic material, such as crop residues, is heated in a vacuum to produce, among other products, a high carbon char known as 'biochar'.¹⁰⁵ Biochar can then be applied to soils to increase the carbon content of the soil and improve soil fertility.¹⁰⁶

104 Food and Agriculture Organization of the United Nations, *Carbon sequestration in dryland soils*, 2004, ftp.fao.org, viewed on 20 January 2009.

105 Best Energies Inc, 2006, www.bestenergies.com, viewed on 21 January 2009.

106 Lehmann, J., Gaunt, J. and Rondon, M., *Biochar sequestration in terrestrial ecosystems – A review*, 2006, Vol. 11.

- 4.111 To drive the uptake of technologies and practices that increase soil carbon content a range of market mechanisms have been proposed. For instance in December 2008 the United Nations Convention to Combat Climate Change advocated including the development of biochar as a Clean Development Mechanism under the Kyoto Protocol in order to encourage the uptake of biochar technology.¹⁰⁷
- 4.112 In Australia, the Northern Agricultural Catchments Council, an agricultural advocacy group from Western Australia, is in the process of implementing a three year pilot project called the Australian Soil Carbon Accreditation Scheme. Under such a scheme, landholders would be able to create certified carbon offsets, to sell as part of an emissions trading scheme, through measured increases in soil carbon content. Landholders would thus be encouraged to take up land use practices that increase soil carbon content.¹⁰⁸
- 4.113 The world's soils already contain a significant amount of the world's carbon, so a small increase in the rate that carbon is sequestered in soil could lead to a significant decrease in the amount of carbon dioxide in the atmosphere. Land use practices and technologies already exist that could facilitate the increased transmission of carbon dioxide into soils. Consequently the benefits of increased soil carbon levels could be realised in the short-term.¹⁰⁹

Waste sector

- 4.114 During 2006, the waste sector contributed three percent of Australia's total greenhouse gas emissions.
- 4.115 The waste sector contributes to greenhouse gas emissions in three main ways:
- the decomposition of organic materials in landfill;
 - emissions from wastewater such as sewage; and
 - the incineration of waste.¹¹⁰

107 United Nations Convention to Combat Desertification, *Submission to the 4th Session of the Ad Hoc Working Group on Long-term Cooperative Action under the UNCCD: Use of biochar (charcoal) to replenish soil carbon pools, restore soil fertility and sequester CO₂*, December 2008.

108 Northern Agricultural Catchments Council, 2009, www2.nacc.com.au, viewed on 21 January 2009.

109 Food and Agriculture Organization of the United Nations, *Carbon sequestration in dryland soils*, 2004, ftp.fao.org, viewed on 20 January 2009.

110 Mr Christopher Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 15.

- 4.116 In 2006, the emissions from landfill contributed 79.2 percent of total waste sector emissions, emissions from wastewater contributed 20.6 percent and emissions from incineration contributed 0.2 percent.¹¹¹
- 4.117 The waste sector in Australia has a good history of reducing emissions. Despite Australia's increased waste generation during the period from 1990 to 2005, the Australian waste sector reduced its emissions by 12.5 percent over the period. This reduction is largely due to a number of water diversion and methane recovery initiatives by the waste sector.¹¹²
- 4.118 The CPRS states that all landfill, wastewater and incineration facilities that emit 25,000 tonnes or more of carbon dioxide equivalent each year will face an assumed carbon price of \$25 per tonne. To avoid the distribution of waste from landfill facilities above the 25,000 tonne threshold to facilities below the threshold, the carbon price will also apply to landfill facilities that emit 10,000 tonnes of carbon dioxide equivalent per year and are in close proximity to other landfill sites.¹¹³
- 4.119 The Committee heard evidence from the South West Group that the inclusion of the waste sector in the CPRS would not reduce, and may in fact increase, the environmental impact of the waste sector. The Committee heard of two main impacts of the CPRS on the waste sector: a reduction in the incentive to recycle and a lack of incentive to reduce emissions in landfill sites.
- 4.120 The Group stated that due to the increased cost of energy under the CPRS, the cost of recycling will increase, causing a decrease in the incentive for waste sector operators to engage in recycling. This may encourage a move back to simple environmentally-damaging landfill facilities. The Group further argued that in order to maintain current levels of recycling under the CPRS, existing community subsidies which support advanced recycling will increase by around \$13 per household per year.¹¹⁴
- 4.121 The Group also gave evidence of the potential effect of the CPRS on the uptake of emission reduction practices in landfill sites, outlining a range of techniques available to contain the emissions from the main waste stream of organic material in landfills such as composting, incineration and methane capture that would be difficult to maintain by applying a carbon price:

111 Department of Climate Change, *National greenhouse gas inventory*, 2006, p. 6.

112 Department of Climate Change *Waste sector greenhouse gas emissions projections 2007*, 2007, p. 3.

113 Australian Government, *Carbon pollution reduction scheme: Australia's low pollution future*, 2008.

114 Mr Christopher Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 15.

At the moment, at a carbon price of \$25 per tonne it is cheaper to put [organic waste] to landfill, and even at \$48 a tonne it is cheaper to put it to landfill.¹¹⁵

- 4.122 The South West Group suggested that the exclusion of the waste sector from the CPRS would provide more benefits than the sector's inclusion in the scheme. Omitting the sector from the scheme would allow the sector to continue to pursue emission reductions in the same way it has over the last 15 years. If excluded, the Group suggested that the waste sector would be driven to produce carbon offsets which could then be sold to sectors covered by the scheme. This would encourage waste operators to move towards further recycling and emission reduction technologies in order to produce carbon offsets.¹¹⁶
- 4.123 It will be important to monitor implementation of the proposed CPRS to ensure that waste recycling efforts are maintained, and that there is no move back to environmentally damaging landfill.

Committee's view

- 4.124 This chapter discusses a number of mechanisms for reducing greenhouse gas emissions. It is the Committee's view that there are opportunities to make emissions reductions now which are worthy of more detailed exploration.
- 4.125 There is scope to increase the use of public transport, to reduce emissions from land clearing, and reduce emissions from savannah burning in addition to the emissions reductions to be obtained from the CPRS and RET.
- 4.126 In addition, a number of the low emissions technologies, such as wind electricity generation, solar photovoltaic, solar thermal generation and hybrid vehicles are technologies available for use now, and are underexploited in Australia.
- 4.127 A number of low emissions technologies are in the early stages of development, and will not contribute to reductions in greenhouse gases for some time, possibly a decade or longer. These technologies will contribute to emissions reductions in the future and should continue to be developed.

115 Mr Christopher Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 20.

116 Mr Christopher Fitzhardinge, *Transcript of Evidence*, 19 December 2008, p. 19.

Recommendation 9

The Committee recommends that the Australian Government establish a coordinating mechanism through the Council of Australian Governments to ensure integration and coordination of greenhouse gas reduction actions across all States, Territories and levels of government, including local and State government planning processes.

4.128 In the next chapter, the Committee turns its attention to methods of adapting to climate change.

Climate change adaptation in Australia

Introduction

- 5.1 In chapter two, the Committee noted that some climate change has already occurred, and that, regardless of the extent and timing of mitigation efforts, climate change will continue to occur for some time.
- 5.2 This chapter focuses on an aspect of the climate change debate that will become increasingly important as the climate change already in train starts to take hold: how to adapt to the effects of climate change.
- 5.3 During the inquiry, the Committee heard evidence about two mechanisms for adapting to climate change. One is the more energy efficient design of buildings, and the other is the moderating effect revegetation can have on climate change at a local level.

Energy efficiency in buildings

- 5.4 The energy used in new and existing buildings forms a significant part of the total energy use in Australia. According to the Australian Bureau of Statistics' *Year Book Australia 2008* Australian households alone account for about 11 percent of total energy use in Australia.¹ Improving energy efficiency in new and existing buildings will thus form an integral part of Australia's response to climate change.

1 Australian Bureau of Statistics, *Year Book Australia 2008*, 2008, cat. no. 1301.0, ABS, Canberra.

Energy efficiency in new buildings

- 5.5 In warmer regions of Australia, a mixture of standardised regulation and an ill-informed consensus as to what constitutes an energy efficient house is driving climatically inappropriate design.
- 5.6 Currently all construction in the states and territories is regulated by the Building Code of Australia (the BCA). The BCA is administered by the Australian Building Codes Board on behalf of the Australian Government and state and territory governments. The BCA governs a range of factors relating to structure, fire safety, access, equipment, health and sustainability.
- 5.7 One of the objectives of the BCA is to reduce greenhouse gas emissions by ensuring the efficient use of energy in newly constructed buildings. This is achieved through a verification process where all proposed designs for new buildings must achieve an 'efficiency star rating' or equivalent level of efficiency.
- 5.8 This efficiency star rating takes into account design features such as geographical location, energy source, heating and cooling, and placement of windows. These factors are then used to model the energy efficiency of the building either through a computer programme or an equivalent modelling method.²
- 5.9 During the inquiry the Committee was informed that the nation-wide character of the BCA, far from encouraging efficient design, may in fact be driving inefficient design in some regions of Australia.
- 5.10 Mr Ross Conolly, from the Darwin Chapter of the Institute of Architects, had the following to say about the effect of BCA regulations on energy efficient design in Darwin:
- The typical thrust has been to use computer based modelling to assess the energy efficiency of, particularly, domestic dwellings. [The modelling] is often based on the effect of sealing small windows, minimisation of heat loss and gain, which can be very good if you live in Melbourne or wherever, but in Darwin you want to get rid of the heat.³
- 5.11 In regards to housing design in Darwin, Mr Connolly advocated housing that is elevated, long and thin with through-ventilation. Mr Connolly stated that this form of housing, whilst significantly more energy efficient
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2 BCA Illustrated, *The Building Code of Australia*, 2009, www.bcaillustrated.com.au, viewed on 21 January 2009.

3 Mr Ross Connolly, *Transcript of Evidence*, 19 August 2008, p. 8.

than the housing designs mandated by the BCA, is discouraged by the current energy efficiency rating system:

...[in a house that is elevated, long and thin with through-ventilation], I can say that there might be 20 days a year where the conditions are so humid and hot that you flick on a room air-conditioner which might sit in the wall. When you put the house on the ground, make it out of heavy weight construction, let the sun bear on the walls and heat up the walls through the day, put in small sliding windows instead of big louvres, you might find that it becomes 200 days a year that you feel that you need to have the air-conditioner on in the building.

While the [BCA] computer models will assess the amount of insulation and the amount of sealing against energy infiltration there is no doubt that, if you are using an air-conditioner for 200 days of the year, you are using a great deal more energy than if you are using it for 20 days a year.⁴

5.12 Mr Gregory McNamara, another Darwin architect, supported this view:

The current direction of regulation is counterproductive and is leading us to an energy-reliant scenario.⁵

5.13 The Committee heard further evidence that, in some areas of Australia, inefficient housing design is also being driven by ill-informed demand. People moving to warmer parts of Australia from the southern states have a pre-existing notion of good housing design. Namely, there is a wide expectation of a ground level brick veneer design with small sealed windows and air-conditioning, which may be appropriate in more temperate regions but is not suitable for a tropical climate. The housing market then responds to this demand leading to the proliferation of energy-inefficient housing designs.⁶

5.14 This issue is exacerbated by the low costs of this housing design and the short term interests of the developers who are contracted to build these houses. Mr McNamara stated that:

The real concern is that these sealed houses are cheaper and faster to build and the mass building market will take on this narrow view of energy efficiency with great vigour...⁷

4 Mr Ross Connolly, *Transcript of Evidence*, 19 August 2008, p. 9.

5 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 4.

6 Mr Ross Connolly, *Transcript of Evidence*, 19 August 2008, p. 15.

7 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 4.

- 5.15 Ensuring energy-efficiency in the design phase of new buildings throughout all regions of Australia would aid in reducing the amount of energy used by buildings and their occupants in Australia.
- 5.16 Mr McNamara concluded that it is imperative for building design regulations, namely the BCA, to be responsive to the local climate and conditions of different regions throughout Australia.⁸
- 5.17 To combat the negative force of market demand, Mr McNamara advocated educating the public about appropriate design and the long-term benefits of such design.⁹
- 5.18 Ms Karen White, from the Northern Territory Branch of the Real Estate Institute, cited a range of mechanisms that could be implemented to encourage the uptake of energy efficient design by developers, including rewarding efficient design with rebates on infrastructure charges and stamp duty or with the relaxing of other design regulations such as height and volume.¹⁰

Recommendation 10

The Committee recommends that the Australian Government direct the Australian Building Codes Board to review the Building Code of Australia to ensure that it better provides for energy efficiency standards suitable for varied climate zones.

Energy efficiency in existing buildings

- 5.19 Energy efficiency in buildings is mainly driven through regulating the design of new constructions. The Committee received evidence that encouraging energy efficiency in pre-existing buildings should also be a priority.
- 5.20 Ms White stated that each year there is an increase of only two percent in Australia's residential building stock, implying that 98 percent of Australia's building stock consists of pre-existing buildings. Encouraging

8 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 10.

9 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 14.

10 Ms Karen White, *Transcript of Evidence*, 19 August 2008, pp. 13-14.

energy efficiency in existing buildings could thus deliver a significant reduction in household emissions.¹¹

- 5.21 A range of options are available to reduce energy usage in existing buildings depending on the regional climate:
- increasing insulation and double glazing windows;
 - installation of energy efficient ventilation systems;
 - installation of energy efficient light bulbs such as fluorescent lamps or LED lighting;
 - installation of energy efficient heating systems such as geothermal and solar heating;
 - installation of energy efficient cooling systems such as evaporative cooling;
 - installation of energy efficient water heating systems such as gas or solar water heaters; and
 - upgrading appliances to modern models with higher energy efficiency.¹²
- 5.22 There is a range of barriers preventing the uptake of energy efficient technologies and practices in existing buildings.
- 5.23 One of the central factors preventing an increase in energy efficiency in buildings is a lack of the necessary experts to advise on and implement energy efficiency measures. In turn, a lack of supply of experts increases the cost of their services, thus increasing the cost of upgrading the energy efficiency of existing buildings.
- 5.24 Business operators may lack incentives to invest in increasing the energy efficiency of existing properties. Operators may be focused on short term profits whereas the benefits of increased energy efficiency are generally only realised in the long-term. Thus operators are not likely to choose to invest significant capital in upgrading their current properties.
- 5.25 In the rental market, any potential benefits from increased energy efficiency will be felt by the tenants through lower energy bills, resulting in

11 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 6.

12 Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D., *ABARE Research report 7.16: Technology toward a low emissions future*, September 2007, pp. 17-25.

little or no benefit to the landlord. Thus, landlords have few incentives to upgrade the energy efficiency of their existing investments.¹³

Star rating programmes

- 5.26 The New South Wales Government currently manages the National Australian Built Environment Rating System (NABERS). This is a voluntary national initiative through which property owners can reliably assess the energy efficiency of their properties and seek ways to improve their energy efficiency.¹⁴
- 5.27 Australian Government agencies, in conjunction with NABERS and subject to the 2006 *Energy Efficiency in Government Operations* policy, must meet mandatory energy efficiency targets, and thus reduce the amount of emissions resulting from Government operations. Part of these efficiencies must be gained through achieving a specific level of efficiency, denoted by a star rating, in existing buildings.¹⁵
- 5.28 Ms White discussed some of the disadvantages of the star rating system in warmer parts of the Australia:
- We need to be careful that any rules that are put in place regarding the building sector do not drive the obsolescence of existing buildings, because that would not be a good environmental outcome. ...When you build a new building it takes at least 30 years to reclaim the annual operating energy that could be saved, so it really is not the best environmental outcome to have any policy that drives the knocking down of existing buildings and a preference for new buildings.¹⁶
- 5.29 Rather, Ms White advocated a system where improvements on current energy ratings should be sought. For example, an improvement of one star during the reporting period as opposed to having to achieve a mandatory 4.5 star rating. Ms White stated that this form of programme would lessen the dangers of building obsolescence whilst maintaining the incentive for land holders to increase efficiency.¹⁷

13 Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D., *ABARE Research report 7.16: Technology toward a low emissions future*, September 2007, p. 41.

14 National Australian Built Environment Rating System, NABERS, 2008, viewed 15 January 2009, www.nabers.com.au, viewed on 15 January 2009.

15 Department of the Environment, Water, Heritage and the Arts, *Energy efficiency in government operations - Fact sheet 1 of 12*, 2006, p. 1.

16 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

17 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

- 5.30 Ms White outlined a range of mechanisms available to governments to reward increased energy efficiency in homes. Ms White advocated a reduction in council rates or accelerated depreciation for homes with high energy efficiency and grants to assist in retrofitting of energy efficient technologies.¹⁸

Land clearing and climate

- 5.31 The Committee has already discussed the impact changes in land use can have on carbon sequestration. However, land use change can also impact the climate more directly. Studies have shown that a reduction in vegetation across a region may affect temperature and rainfall levels in that region.
- 5.32 The impacts of land clearing on climate can be divided into two categories: biogeochemical and biogeophysical.¹⁹
- 5.33 Biogeochemical refers to the transfer between living things and the physical environment.²⁰ A good example is the 'water cycle', which describes the continuous rotation of water between the atmosphere, the land and living things.
- 5.34 The biogeochemical effect of land clearing is already recognised in climate science through the concept of carbon sequestration: as vegetation is cleared, less carbon dioxide is removed from the atmosphere.²¹
- 5.35 Biogeophysical refers to the effect of living things on the physical environment. A common example is the use of plants to prevent erosion.²²
- 5.36 Biophysical effects on the environment are starting to be considered very seriously as part of the climate change debate. There are four principal biophysical effects of concern to climate scientists:

18 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

19 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

20 "biogeochemical adj." *The Australian Oxford Dictionary*, 2nd edition, 2004, www.oxfordreference.com, viewed on 14 January 2009.

21 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

22 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

- a reduction in leaf cover means that less moisture is transmitted to the atmosphere through the process of transpiration resulting in less convective build up;
 - as land cover is altered, so are the reflective properties of that area, which means that land clearing changes the ratio of solar radiation absorbed and reflected by a particular region;
 - the conversion of woody vegetation to low lying crops and pastures decreases aerodynamic drag in the atmosphere which in turn increases the strength of surface winds; and
 - changing the structure of vegetation affects the water runoff patterns across the altered region thus affecting the balance between runoff, evaporation, and surface and sub-soil moisture.²³
- 5.37 Studies by Feddema et al, and, in Australia, McAlpine et al, show that land clearing is affecting temperature and rainfall on a regional scale and may even be influencing global weather patterns.²⁴
- 5.38 The evidence indicates that whether a reduction in vegetation will result in a cooling or warming effect depends on the latitude and geographical nature of the region. For example, snow generally reflects more solar radiation than alpine vegetation. A reduction in vegetation in a region with snow cover may result in a larger amount of solar radiation being reflected, which in turn may cause a cooling effect. However in other areas, with different geographical attributes, land clearing may force a warming effect.²⁵

Effect of land clearing on temperature and rainfall

- 5.39 The Australian landscape has undergone a significant amount of land clearing since European settlement. Land clearing in Australia has primarily taken the form of converting native vegetation to pastures and cropland.

23 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

24 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, pp. 1674-1678; and McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34.

25 Betts, R.A. *Offset of the potential carbon sink from boreal forestation by decreases in surface albedo*, Nature, September 2000, vol. 408, p. 187.

- 5.40 In 2007, researchers from the University of Queensland, Queensland Government, the University of Colorado and the CSIRO completed a study concluding that the clearing of native vegetation has resulted in significant changes in regional climate in Western Australia and eastern Australia.
- 5.41 The study compared two simulations of the Australian climate for the period 1949-2003. One simulation recreated the climate for this period with pre-European land cover characteristics whilst the other simulation reproduced the climate over this period with modern day land cover characteristics.
- 5.42 To accurately carry out these simulations, the study used satellite imagery data on leaf area to build a map, with a resolution of eight kilometres, of vegetation in modern-day Australia, reflecting the significant land clearing that has taken place. The map was then used to extrapolate Australia's pre-European vegetation characteristics where no land clearing had taken place. These two different sets of information were then used to run two climate simulations.²⁶
- 5.43 The simulation showed that modern day land clearing produced significantly higher temperatures than the simulation with no land clearing. These temperature differences showed a correspondence with areas where major clearing of native vegetation had taken place, such as eastern and southwest Western Australia.²⁷
- 5.44 The study further indicated that, in the scenario accounting for modern-day land clearing, the mean summer rainfall in eastern Australia and southwest Western Australia was lower by four to 12 percent and four to eight percent respectively compared to the non-cleared scenario.²⁸
- 5.45 In other words, the study inferred that land clearing increased the severity of drought. In particular, the study concluded that temperatures during

26 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, pp. 4-5.

27 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

28 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

the 2002–2003 El Niño event were 0.75–2.0 degrees Celsius higher than they would have been if the land had not been cleared.²⁹

5.46 Similar climate modelling studies provide additional evidence for the effect of land clearing on temperatures and rainfall:

- Two separate studies from 1989 and 1992 both modelled climate in the Amazon with and without land clearing. The studies found that where forest had been converted to pasture, there was an increase in temperature and decrease in rainfall. Further, the 1992 study found that the length of the dry season increased in areas where deforestation had taken place.³⁰
- A 2002 climate modelling exercise established that changes to the land surface in the Amazon directly affects the circulation patterns of clouds and thus changes the level of rainfall in the Amazon.³¹
- A 2003 study of the Tocantins River in the Amazon demonstrated that deforestation has increased runoff from precipitation in the region, thus altering river flows and soil moisture in the region.³²
- Finally, a global climate modelling study from 2000 demonstrated that land clearing affects temperature differently depending on the latitude and geographical nature of the region. The study suggested that deforestation in high latitude alpine regions results in a cooling effect.³³

5.47 Dr McAlpine, a researcher from the 2007 study on land clearing in Australia, advised the Committee that:

...when we start getting the interaction of a drier climate from increased concentrations of carbon dioxide in the atmosphere and we move into a more drought-prone climate, the land surface is going to dry, the vegetation is going to become more stressed, and our ability to keep the remaining vegetation in the landscape is

29 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

30 Lean, J. and Warrilow, D.A., *Simulation of the regional climatic impact of Amazon deforestation*, Nature, November 1989, Vol 342, pp. 411–413; Shukla, J., Nobre, C. and Sellers, P., *Amazon deforestation and climate change*, Science, March 1990, Vol. 247, pp. 1322–1325.

31 Baidya Roy, S. and Avissar, R., *Impact of land use/land cover change on regional hydrometeorology in Amazonia*, Journal of Geophysical Research, August 2002, Vol. 107, pp. 4–10.

32 Costa, M.H., Botta, A. and Cardille, J.A., *Effects of large-scale changes in land cover on the discharge of the Tocantins River, Southeastern Amazonia*, Journal of Hydrology, July 2003, Vol 283(1), p. 206.

33 Betts, R.A. *Offset of the potential carbon sink from boreal forestation by decreases in surface albedo*, Nature, September 2000, vol. 408, p. 187.

going to become more difficult. Potentially we are going to see a stronger feedback of the land surface on climate, which could actually make our climate change impacts even worse than what is predicted...³⁴

- 5.48 Dr McAlpine further commented on the interconnectedness of the impacts of land clearing across separate regions:

When we change the land use and clear the vegetation, we essentially change the radiative force that is coming off the land surface and also the surface hydrology and the transpiration rates, which then has an impact on the atmosphere – the ability of that atmosphere to produce convective rainfall, which also affects circulation patterns beyond the area where the clearing occurred.³⁵

- 5.49 This proposal is again supported by studies from abroad. A 2004 modelling exercise indicated that land clearing in the Amazonia and Central Africa severely reduces rainfall in the U.S. Midwest during summer and reduces rain fall on the Californian coast in winter.³⁶ A similar study found that land clearing in Australia and Africa may affect the Asian monsoon season.³⁷

- 5.50 In regard to land clearing's importance as a driver of climate change Dr McAlpine concluded:

I am confident that I can say that [land clearing] is part of the problem and that climate change is a multidimensional process.³⁸

- 5.51 A key question is the magnitude of land clearing's effect on climate change. Some studies conclude that whilst the effect of land clearing is perceptible on a regional scale, its overall impact on global average temperatures is minor.³⁹ However, others argue that the spatial scale of land clearing at a global level is comparable to the size of the oceanic drivers that influence the El Niño.⁴⁰ In Dr McAlpine's view:

34 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 14.

35 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 12.

36 Avissar R. and Werth, D., *Global hydroclimatalogical teleconnections resulting from tropical deforestation*, *Journal of Hydrometeorology*, August 2004, Vol 6., p. 134

37 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The Importance of land-cover change in simulating future climates science*, December 2005, Vol. 310, p. 1674.

38 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 16.

39 Bounoua, L., Defries, R. G., Collatz, J., Sellers, P. and Khan, H., *Effects of land cover conversion on surface climate*, *Climatic Change*, January 2002, Vol. 52, p. 1573.

40 Pielke, R.A., *Land use and climate change*, *Science*, December 2005, Vol. 310, p. 1626.

... when we come to Australia ... I would say that [land clearing] is getting up there to being equal with carbon dioxide in terms of some of its effects. I think it is the interaction between the two. As one changes, it is going to accelerate the feedback of the other ones.⁴¹

- 5.52 If Dr McAlpine is correct, then the restoration of cleared vegetation could significantly ameliorate the regional effects on temperature and rainfall of global heating. Dr McAlpine was of the view that the restoration of vegetation in certain regions may lead to higher rainfall and lower temperatures.⁴²
- 5.53 The 2007 Australian climate modelling study, of which Dr McAlpine took part, also recommends that protecting and restoring Australia's vegetation should be a priority in mitigating the effects of climate change.⁴³
- 5.54 It is the view of the Committee that Dr McAlpine may have identified a way of limiting the effects of global heating in certain regions. This is an area that requires further investigation and is too valuable a possibility to be passed up.

Recommendation 11

The Committee recommends that the Australian Government investigate using revegetation as an adaptation mechanism to reduce temperature and increase rainfall in applicable parts of Australia.

- 5.55 This chapter has examined two adaptation strategies for Australia to manage climate change. The Committee has not set out to undertake a thorough review of adaptation strategies, and has limited itself to reporting on those strategies that were presented to it during the course of the inquiry.
- 5.56 As climate change becomes more noticeable, adaptation strategies are likely to become more important for Australia. We need to begin the process of identifying and developing adaptation strategies now.

41 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 16.

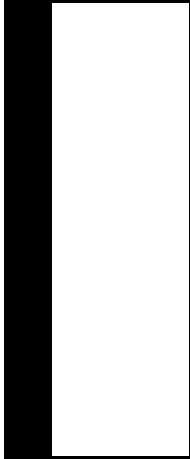
42 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 20.

43 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

Recommendation 12

The Committee recommends that the Australian Government conduct an inquiry into adaptation strategies for climate change. This inquiry should include consideration of projected sea-level rise due to climate change and its impact upon Australian coastal communities and neighbouring countries.

Kelvin Thomson MP
Chair



Dissenting report — Coalition Members and Senators

Introduction

The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change.

It is intended to achieve:

Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system: Article 2 - The United Nations Framework Convention on Climate Change.

The Kyoto Protocol establishes legally binding commitments for the reduction of four greenhouse gases including carbon dioxide, methane, nitrous oxide, sulphur hexafluoride.

Australia signed the Kyoto Protocol on 29 April 1998 and ratified it on 12 December 2007. The Coalition supported the ratification of the Kyoto Protocol.

As set out in the Committee Briefing papers on ratification Australia committed to reducing anthropogenic greenhouse gas emissions to 108% of their 1990 levels. Most parties to the Protocol have committed to reduce greenhouse gas emissions to 95% or less of their 1990 levels.

With the measures introduced by all levels of Government in Australia, the Department of Climate Change estimates that Australia will meet its target in the 2008–2012 period.

Coalition Members and Senators note that the measures put in place to meet these targets were introduced by the former Coalition Government.

Coalition Members and Senators also note that the Department of Climate Change estimates that without these measures in place, Australia's anthropogenic greenhouse gas emissions would be 124% of the 1990 levels for the 2008–2012 period.

Further, Coalition Members and Senators believe this inquiry was an abuse of the Committee process. The Kyoto Protocol has already been considered by JSCOT in Report 38 of April 2001. The act to ratify was made more than six months before the tabling of the ratified treaty in the Parliament yet the Government chose to conduct a nationwide inquiry that broadly ignored the actual treaty ratified. In fact in the nearly 100 page report the actual Kyoto Protocol is only mentioned in passing in just four paragraphs. Clearly this was just a grandstanding exercise on climate change, not an actual inquiry into the Kyoto Protocol.

Dissent from Majority Report

Coalition Members and Senators recognise that there is conflicting science about the cause and extent of climate change.

We believe however that 'the planet should be given the benefit of the doubt' and that responsible action should be taken to reduce our global emissions.

On that basis, Coalition Members and Senators reject the Majority Report.

Fundamentally, the Majority Report is not balanced.

The issue of 'the Kyoto Protocol and beyond' is a significant one. It deserves a full and proper consideration of all aspects of the science.

The Majority Report does not do this. It is selective in the evidence it relies upon. It fails to present or refer to the range of scientific views that were presented during the hearings to the Committee.

While the Majority Report heavily relies on the evidence given by one CSIRO witness, Dr Andrew Ash, it in fact selectively quotes the CSIRO scientist. The Report fails to provide a balanced assessment of Dr Ash's own evidence. The most stark example of this can be found from the Public Hearing transcript of 1 December 2008:

Senator McGAURAN ... all I am trying to do here is bring balance back. You are the CSIRO, the flagship, and you are presenting a tremendous slideshow here. I think the question asked by my

colleague Luke Simpkins was whether the drought along the Murray Darling is climate change related as in man-made related or El Nino related ...

Dr ASH— Our response to that is that in terms of the historical rainfall patterns, as I said, over the Murray-Darling they are still within the natural bounds of variability from El Nino and Indian Ocean influences, so I think we can say that is certainly the case. As I have said before and reiterate again, the temperature increase we have seen even in the last hundred years does exacerbate slightly that natural drought that we see ...

It is clear Dr Ash is venturing his scientific opinion that the Murray Darling drought has more to do with the El Nino effect than man-made climate change. This evidence by Dr Ash seems too much of an inconvenient truth to the majority to consider as worthy to include in the Report.

The Report also fails to acknowledge or comment upon the economic ramifications of climate change mitigation policies such as the Government's proposed carbon pollution reduction scheme and the importance of sustaining a strong economy to ensure that we are able to meet the challenges of climate change.

Not to devote some part of the Report to the effects of varying emission reduction targets upon business and the economy is a serious and bewildering omission. There was a wealth of evidence and modelling available that the Majority Report could have relied on to estimate the effects of emission reduction targets on the economy generally, business and households specifically.

For example, the Allen Consulting Group made a submission entitled *Deep Cuts in Greenhouse Gas Emissions – Economic, Social and Environmental Impacts for Australia* stating that there would be a high (therefore damaging) economic impact on our major export industries of iron ore, black coal and aluminium. Other witnesses to appear that were worthy of note were Chamber of Minerals and Energy of WA, Alcoa of Australia and the Australian Sugar Milling Council. Each gave evidence of the detrimental effect upon their sector of a high emissions reduction trading target.

Nevertheless, the Majority Report failed to factor in such significant evidence when setting their extreme emissions target.

Consequently, the Report makes the extreme recommendation that *'the Australian Government be willing to adopt a policy setting to reduce Australia's emissions of greenhouse gases by 80% by 2050 in seeking agreement from other developed countries to also cut emission by 80% by 2050.'*

This is a target that goes further than the current Government policy and is one that Coalition Members and Senators utterly reject.

Coalition Members and Senators acknowledge that the Report does make some recommendations which have merit including recommendations 5 to 8. However we note that these recommendations have not been subject to economic and budgetary impact statements and have a diminished significance because of the destructive extreme emissions target recommended by the Majority Report.

Unlike the Majority Members and Senators stance on this issue, Coalition Members and Senators believe that effective action to combat climate change demands a policy of both protecting the planet and protecting the Australian economy.

Both in Government and in Opposition the Coalition has supported effective action to combat climate change.

Coalition Members and Senators affirm the Coalition's position that:

- Climate change is best tackled from a position of economic strength.
- Australia must work in concert with the rest of the world (there is no Australian solution to climate change, there is only a global solution).
- Any emissions trading scheme must not result in the export of emissions and jobs.

Coalition Members and Senators affirm that it must not be forgotten that the objective of any action taken to combat climate change must be to reduce emissions, not to just have an Emissions Trading Scheme.

The Kyoto Protocol and beyond

International approach

There is no question that Australia must continue to make a meaningful contribution to the global effort to combat climate change by reducing greenhouse gas emissions.

Coalition Members and Senators believe that our foundation must be an effective international approach to climate change. That is why the global response to climate change must involve:

- All major emitters of greenhouse gases;
- avoid distortions of economic activity and emissions with no environmental benefit; and

- should recognise different national circumstances.

Coalition Members and Senators note that in Bali we endorsed the Bali Road Map for a post Kyoto agreement - well before the Rudd Government was elected.

Also in 2007, under the previous Coalition Government, at the APEC Leaders summit in Sydney, the historic *Sydney Declaration on Climate Change, Energy Security and Clean Development* was signed.

The Declaration was an agreement amongst APEC leaders that an equitable and effective post 2012 climate change arrangement must draw on such principles as:

- goals that are environmentally and economically effective;
- the need to respect different domestic circumstances;
- the importance of promoting open trade and investment; and
- shared aspirational goals.

Therefore, international action that is taken in response to climate change must not put Australian industry at a competitive disadvantage against competitor countries.

Unlike the Majority Report that recommends that Australia should commit to and take to Copenhagen a target of 80% reduction of greenhouse gasses by 2050, Coalition Members and Senators believe that Australia should not finalize the design of any scheme until:

- we know what the major emitters (for example the United States AND China) are going to do; and
- in particular what the rest of the world is going to do at Copenhagen.

Domestic

Coalition Members and Senators recognise that not only must Australia act internationally in responding to climate change, we must also act domestically.

Again, Coalition Members and Senators affirm that the objective of climate change action is to reduce emissions.

In that respect an Emissions Trading Scheme is not the only action available to tackle climate change in an effective and economically responsible manner.

Alternative actions to respond to climate change are set out in the Coalition's Green Carbon Initiative.

They include:

- opportunities in energy efficiency and the vital national interest in rapidly progressing development in clean coal and renewable energy technologies;
- Measures to encourage improved energy efficiency in buildings, where 23% of all greenhouse gas emissions originate;
- A Green Carbon Initiative to offset greenhouse gases by capturing and storing large quantities of carbon in soil and vegetation – ‘biosequestration’.

Alternative energy sources such as solar, wind, wave and geothermal energy also have enormous potential to contribute to a low-emissions economy in Australia, if we can both protect our existing energy supplies by cleaning them up and add to new energy through renewable options.

Due to our climatic conditions, Australia could not be better placed to lead the world in the development and uptake of renewable energy.

Coalition Members and Senators note that Australia is already one of the world’s leading renewable energy producers. The Mandatory Renewable Energy Target introduced under the former Coalition Government built on existing hydro schemes to bring forward additional renewable energy projects with over 1000 megawatts of additional capacity.

Conclusion

Coalition Members and Senators note that whilst the Majority Report makes some recommendations in relation to low emission technologies we believe that it has neglected to give proper weight to alternative actions that will contribute to a low carbon economy.

The Emissions Trading Scheme is put forward by the Majority Report as the major force to reduce carbon emissions.

Given that the Majority Report recommends that Australia reduce its emission of greenhouse gases by 80% by 2050, Coalition Senators and Members note that this would result in the price of carbon being so high as to have a ruinous impact on the Australian economy.

This reckless recommendation is not only rejected by Coalition Members and Senators but is noted as a clear indication of the inflexible ideological approach that dominates the Majority Report.

Senator Julian McGauran

Deputy Chair

Senator Simon Birmingham

Senator Michaelia Cash

Mr John Forrest MP

Mr Luke Simpkins MP

Mr Jamie Briggs MP

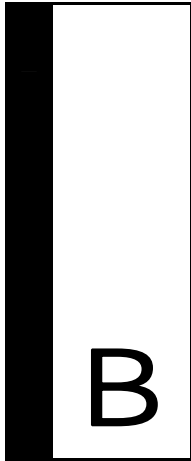


Appendix A - Submissions

Treaties tabled on 25 June 2008

- 1 Australian Patriot Movement
- 3 Prof. Peter Newman
- 5 Mr David Stimson
- 6 Great Barrier Reef Foundation
- 7 National Farmers' Federation
- 8 Growcom
- 9 Australian Bahá'í Community
- 10 Tropical Savannas Management Cooperative Research Centre
- 11 Ms Maria Cugnetto
- 12 VISY
- 13 Mr Rod Gobbey
- 14 Hydroelectric Corporation
- 15 The Climate Institute
- 16 Make Poverty History
- 17 Humane Society International
- 18 Insurance Council of Australia
- 19 Great Barrier Reef Marine Park Authority

- 20 Australian Conservation Foundation
- 21 Australian Industry Greenhouse Network
- 22 Wentworth Group of Concerned Scientists
- 23 Climate Action Network Australia
- 24 Greenpeace Australia Pacific
- 25 The Australian Workers Union
- 26 Murray Darling Basin Commission
- 27 ACT Government
- 28 Growcom
- 29 Mr Chris Lalor
- 30 Northern Territory Legislative Assembly
- 31 Antarctic Climate and Ecosystems Cooperative Research Centre
- 32 The Australian Petroleum Production & Exploration Association
APPEA

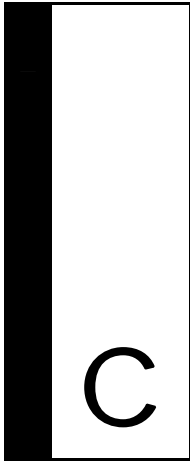


Appendix B - Exhibits

- 1 Prof. Peter Newman
(Related to Submission No. 3)
- 2 Australian Institute of Architects
Tabled Diagrams
- 3 Darwin City Council
Greenhouse Action Plan 2001-2010
- 3.1 Prof. Peter Newman and Darwin City Council
Costal Erosion Issues in the East Point and Nightcliff of Darwin – Report
(Related to Submission No. 3)
- 4 Property Council of Australia
- 5 Australian Antarctic Division, Department of the Environment and
Heritage
Preliminary Tracks from GLS DAT
- 6 Humane Society International
Terrestrial Landscapes, Biodiversity and Climate Change (Related to
Submission No. 17)
- 6.1 Humane Society International
Garnaut Climate Change Review (Related to Submission No. 17)
- 6.2 Humane Society International
Garnaut Climate Change Review Scheme Discussion Paper March 2008
(Related to Submission No. 17)

- 6.3 Humane Society International
Letter to Department of Climate Change regarding National Greenhouse and Energy Reporting System from HIS (Related to Submission No. 17)
- 6.4 Humane Society International
Letter to Hon. Peter Garrett MP and Hon. Penny Wong regarding the Priority areas for carbon (Related to Submission No. 17)
- 6.5 Humane Society International
Letter to Senator Penny Wong from HIS (Related to Submission No. 17)
- 7 Australian Conservation Foundation
CSRIO - Climate Change Impacts on Australia and Benefits of Early Action to Reduce Global Greenhouse Gas Emissions (Related to Submission No. 20)
- 7.1 Australian Conservation Foundation
The Business Case for Early Action (Related to Submission No. 20)
- 8 Wentworth Group of Concerned Scientists
How to include Terrestrial Carbon in Developing Nations in the Overall Climate Change Solution (Related to Submission No. 22)
- 9 Greenpeace Australia Pacific
Budget 08 - Time to stop subsidising climate change (Related to Submission No. 24)
- 9.1 Greenpeace Australia Pacific
Greenpeace - Options for LULUCF in the post- 2012 process briefing (Related to Submission No. 24)
- 9.2 Greenpeace Australia Pacific
Science of Climate Change - Bill Hare (Related to Submission No. 24)
- 9.3 Greenpeace Australia Pacific
Carbon dioxide capture and storage in geological formations as clean development mechanism project activities (Related to Submission No. 24)
- 9.4 Greenpeace Australia Pacific
Forest for Climate (Related to Submission No. 24)
- 9.5 Greenpeace Australia Pacific
Energy (r)evolution (Related to Submission No. 24)
- 9.6 Greenpeace Australia Pacific
False Hope (Related to Submission No. 24)

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- 9.7 Greenpeace Australia Pacific
Tropical Deforestation Emission Reduction Mechanism - A discussion paper
(Related to Submission No. 24)
- 9.8 Greenpeace Australia Pacific
Turning Up the Heat (Related to Submission No. 24)
- 10 Growcom
Principles for REDD Methodologies (Related to Submission No. 8)
- 10.1 Growcom
LULUCF principles for ensuring environmental integrity of the Kyoto Protocol in Annex 1 accounting rules and modalities (Related to Submission No. 8)
- 10.2 Growcom
GREEN CARBON - The role of natural forests in carbon storage (Related to Submission No. 8)
- 10.3 Growcom
GREEN CARBON - The role of natural forests in carbon storage (Related to Submission No. 8)
- 11 Alcoa of Australia
A CALL FOR ACTION - Consensus Principles and Recommendations from the U.S. Climate Action Partnership: A Business and NGO Partnership
- 11.1 Alcoa of Australia
Summary Overview: USCAP Blueprint for Legislative Action
- 11.2 Alcoa of Australia
Sustainability 07 - Unlocking the solutions to sustainability



Appendix C - Witnesses

Monday, 25 August 2008 - Canberra

Australian Antarctic Division, Department of the Environment and Heritage

Mr Ian John Hay, Senior Policy Officer, Antarctic Territories and Environment Protection Section

Department of Foreign Affairs and Trade

Mr Damian White, Executive Officer, Malaysia, Brunei, Singapore Section

Monday, 1 September 2008 - Canberra

Department of Climate Change

Ms Jan Adams, First Assistant Secretary, International Division and Ambassador for Climate Change

Mr Howard Bamsey, Deputy Secretary and Special Envoy on Climate Change

Ms Bridget Brill, Assistant Secretary, Emissions Reporting Branch

Ms Geraldine Capp, Public Affairs Unit

Miss Tamara Curl, Kyoto Protocol Section, International Division

Mrs Julieanne McIntyre, Kyoto Protocol Section, International Division

Mr Rob Sturgiss, Director, Emissions Analysis Inventory Team

Monday, 22 September 2008 - Canberra

Australian Industry Greenhouse Network

Mr Michael Hitchens, Chief Executive Officer

Ms Emma Watts, Research Officer

Department of Foreign Affairs and Trade

Mr David Mason, Executive Director, Treaties Secretariat,
International Legal Branch

Monday, 10 November 2008 - Canberra

Australian National University

Mr Andrew MacIntosh, Associate Director, Centre for Climate Law &
Policy

Department of Foreign Affairs and Trade

Mr David Mason, Executive Director, Treaties Secretariat,
International Legal Branch

National Association of Forest Industries

Mr Shane Gilbert

Mr Allan Hansard, Chief Executive Officer

Monday, 24 November 2008 - Canberra

ABARE

Ms Melanie Ford, EL2

Dr Don Gunasekera, Chief Economist

Bureau of Rural Services

Ms Karen Schneider, Executive

Department of Foreign Affairs and Trade

Mr David Mason, Executive Director, Treaties Secretariat,
International Legal Branch

Environment Business Australia

Ms Fiona Wain, Chief Executive Officer

Monday, 1 December 2008 - Canberra**Individuals**

Dr Gregory Ayers, Chief of the CSIRO Division of Marine and Atmospheric Research, CSIRO - Vic

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Dr Katherine Harle, Senior Advisor

CSIRO

Dr Andrew Ash, Director, Climate Adaptation Flagship

CSIRO - NSW

Dr John Wright, Director, Energy Transformed Flagship

Tuesday, 9 December 2008 - Brisbane**Australian Sugar Milling Council**

Mrs Sharon Denny, Manager, Industry Development & Government Relations

Great Barrier Reef Marine Park Authority

Dr Paul Marshall, Director

Mr Peter McGinnity, General Manager

Insurance Council of Australia

Mr Karl Sullivan, General Manager, Policy Risk & Disaster Planning Directorate

The University of Queensland

Dr Clive McAlpine, Senior Research Fellow, School of Geography, Planning & Environment Management

Friday, 19 December 2008 - Perth

Alcoa of Australia

Ms Libby Lyons, Manager, Government Relations and Public Policy

Mr Timothy McAuliffe, Manager, Environment and Business
Sustainability

Chamber of Minerals and Energy of Western Australia

Mrs Aileen Murrell, Assistant Director

South West Group

Mr Christopher Fitzhardinge, Director