CLIMATE INSTITUTE POLICY BRIEF

CLIMATE IMPACTS AND EMISSION TARGETS

The prime goal of this new [post-2012 climate] regime must be to limit global warming to no more than 2 ºC above the pre-industrial temperature… In the long run, greenhouse gas concentrations need to be stabilised at a level well below 450 ppm (parts per million; measured in CO2-equivalent concentration).

2007 Bali Climate Declaration by Scientists, endorsed by many of Australia's leading climate change researchers

As Professor Garnaut and the Australian Government have noted , it is in Australia's national interest to ensure atmospheric greenhouse gas concentrations are stabilised at the lowest possible level (Garnaut 2008a, Government of Australia 2008). Even a 2^{o}C increase in global temperature above pre-industrial levels is risky and would severely impact Australia, its neighbours, and key trading partners in the region. In the lead up to the last Federal Election the Prime Minister stated:

> "*the IPCC* [Intergovernmental Panel on Climate Change] *found that the level of greenhouse gases in the atmosphere will need to be kept between 445 – 490 parts per million, in order to avoid the most dangerous impacts of climate change.*"[1]

Avoiding warming of more than 2^{o}C or achieving levels around or below 450ppm-e depends entirely on the world's ability to stop emissions increasing and begin significant reductions of carbon pollution before 2020. Action will be required by all major emitters. Developed countries, responsible for 75 per cent of the carbon pollution in the atmosphere, will need to lead and peak emissions earlier. Strong targets and financing to engage developing countries will be critical. Time for a soft start has run out.

If Australia is to be a positive player in the global negotiations vital to our interest, our 2020 carbon pollution reduction target will need to be credible scientifically and in the real world of global negotiations. Anything less will strengthen the hand of those that are resisting strong 2020 obligations and reduce the chance of achieving an effective global climate agreement.

Based on the latest available science from groups such as CSIRO and the scientific experts commissioned by the Garnaut Climate Change Review, this policy brief summarises the implications of different carbon pollution reduction targets and projected global, national and state-level impacts.

Main conclusions that can be drawn from this analysis are (see Table 1 and 2):

- On current emission trends, unmitigated climate change is likely to have catastrophic global impacts. Under this scenario current estimates suggest that the world's coral reefs would be lost and irreversible melting of the world's great ice sheets would lock in several metres of sea level rise. There is also a very high risk that many forests, grasslands and other natural 'sinks' (or stores) of carbon pollution will, through stress, fire and desertification, become big new sources of emissions. In Australia, irrigated agricultural production in Murray-Darling Basin would all but disappear, 2,700 additional temperature related deaths are projected annually and the Great Barrier Reef would suffer "catastrophic" impacts.

- Stabilising greenhouse gas concentrations at or below 450 ppm-e needs a global response, where industrialised countries as a group need to reduce emissions by 25-40% below 1990 levels by 2020. A 440 ppm-e target would substantially reduces the risk of large scale global and Australian impacts. For example, only 1-5% of species are at risk of extinction and there is only a 1-5% risk of initiating irreversible melt of the Greenland Ice Sheet. Stabilising at 450 ppm-e and not below would be risky in that it is only a 50/50 chance of avoiding a 2^{o}C increase.

[1] Kevin Rudd, "An Action Agenda for Climate Change", Annual Fraser Lecture, 30/5/07

- If we choose to stabilise greenhouse gases at concentrations of 550 ppm-e we would leave future generations a legacy of very high climate risks. Greenhouse gas concentrations at this level would mean about an 80% chance of exceeding a 2^{o}C increase in global temperatures. The world's coral reefs would be unable carry out important functions such as maintaining biodiversity and protecting coastlines, and there would be up to a 40% chance of initiating irreversible melt of the Greenland Ice Sheet. There would be a 50-95% chance of exceeding the estimated lower threshold above which land based carbon sinks could become carbon sources and push climate change out of control. For example this could mean the temperatures rising to a point high enough to cause the collapse of the Amazon rainforest, traditionally a carbon sink, which would then unleash billions of tonnes of carbon into the atmosphere, speeding up global warming.

THE GLOBAL IMPACTS OF CLIMATE CHANGE

There is an emerging consensus among prominent scientists that a 2^{o}C increase in global temperatures above pre-industrial levels would constitute a threshold above which dangerous, irreversible and potentially catastrophic global impacts may occur (Preston, Jones, 2006; Bali Climate Declaration by Scientists, 2007). It is estimated that there has been a 0.8^{o}C increase to date.

Table 1 compares scenarios to stabilise atmospheric greenhouse gas concentrations at 400, 450 and 550 ppm by 2100 with the chance of exceeding a 2^{o}C increase (above pre-industrial levels) in global temperature. Emission reductions required by 2020 to stabilise concentrations and the risks of irreversible and/or catastrophic global impacts are also included. Global impact risks are based on CSIRO/Garnaut Review estimates (Garnaut, 2008b):[2]

- **Percent of species at risk of extinction**: Percentage of all species "committed to extinction" due to shifts in habitat caused by temperature and climate changes.

- **Chance of initiating irreversible melt of the Greenland ice sheet**: The melting of Greenland would raise global sea level by 2-7 m, change coastlines worldwide, and lead to flooding of low-lying areas, particularly river Deltas.

- **Death of slow growing, reef building corals**: Percentage of reef area in which there is widespread mortality in slow-growing, tolerant reef species on a frequency of less than 25 years. How frequently high temperatures cause widespread mortality of heat tolerant, slow growing coral species is important as very frequent impacts will reduce the ability of coral communities to recover to a state of ecological viability. Coral reefs support the lives and wellbeing of hundreds of millions people globally. Major impacts on coral reefs would lead to major biodiversity loss, severe regional economic impacts (e.g. Caribbean, far north Queensland), and decreased regional food security (e.g. Pacific and South-East Asia).

- **Estimated chance of lower threshold for initiating accelerated disintegration of the West Antarctic ice sheet being exceeded:** The melting of West Antarctic Ice Sheet would raise global sea level by 5-6m, reconfiguration of coastlines worldwide, and lead to the inundation of low-lying areas, particularly river Deltas.

- **Estimated chance of lower threshold where terrestrial, or land based, sinks could become carbon sources being exceeded:** Terrestrial sinks could be damaged to the extent that they become carbon sources not carbon sinks. This could comprise the ability of human activities to reduce global greenhouse gas concentrations and lead to runaway climate impacts. Estimates include the threshold for extensive damage to the Amazon rainforest and northern boreal forest systems, and desertification leading to widespread loss of forests and grasslands.

[2] Note that some leading climate scientists say these estimates and risks may be conservative and current levels of atmospheric concentrations may already threaten accelerating mass losses from Greenland and West Antarctica, the complete loss of Arctic summer sea ice, and severe impacts on the world's coral reefs (Hansen et al. 2008).

Table 1: Greenhouse concentrations, emission reductions and climate risks (SOURCE: IPCC)

Concentration (CO_2-e)	Chance of exceeding 2°C (mid range)	2020 emission reductions required		Global impact risks
<400 ppm	27%	Industrialised countries (overall)	> -30% below 1990	• 1-5% of species at risk of extinction • 1-5% chance of initiating irreversible melt of the Greenland ice sheet • 0–10% death of heat tolerant coral species • 0-1% chance of estimated lower threshold for initiating accelerated disintegration of the West Antarctic ice sheet exceeded
		Developing countries	Emissions peak and begin decline in Latin America, Middle East, East Asia and Cen-trally-Planned Asia by 2020	
450 ppm	54%	Industrialised countries (overall)	-25% to -40% below 1990	• 5-10% of species at risk of extinction • 6–19% chance of initiating irreversible melt of the Greenland ice sheet • 0–56% death of heat tolerant coral species • 0-1% chance of estimated lower threshold for initiating accelerated disintegration of the West Antarctic ice sheet exceeded • 33-66% chance of estimated lower threshold where terrestrial sinks could become carbon sources exceeded
		Developing countries	Substantial reduction in emissions growth in Latin America, Middle East, East Asia and Centrally-Planned Asia	
550 ppm	82%	Industrialised countries (overall)	-10% to -30% below 1990	• 10-17% of species at risk of extinction • 19-40% of initiating irreversible melt of the Greenland ice sheet • 56-73% death of heat tolerant coral species • 0-10% chance of estimated lower threshold for initiating accelerated disintegration of the West Antarctic ice sheet exceeded • 50-95% chance of estimated lower threshold where terrestrial sinks could become carbon sources exceeded
		Developing countries	Reduction in emissions growth in Latin America and Middle East, East Asia	
Unmitigated	>99%	-	-	• 98-100% of initiating irreversible melt of the Greenland ice sheet • 97-100% death of heat tolerant coral species • 95-99% chance of estimated lower threshold for initiating accelerated disintegration of the West Antarctic ice sheet exceeded • >99% chance of estimated lower threshold where terrestrial sinks could become carbon sources exceeded

AUSTRALIAN IMPACTS OF CLIMATE CHANGE

Australia's high vulnerability to climate change among developed countries is largely due to the dryness of the continent, the proximity of major population centres to the coast and our unique and highly adapted natural ecosystems.

Australia's climate has been changing over the last century. For example, overall temperatures have increased, recent droughts have been hotter than average and the southern and eastern regions of the country have seen declines in rainfall (Figure 1) (Hennessy et al. 2007). The 2002-2003 drought wiped an entire percentage point of Australia's GDP (US$7.6 billion) as well as reducing agricultural employment, mainly in rural and regional areas, by about 100,000 people. The impact of the drought was also felt outside of rural Australia. Food prices increased on average by 4.4 per cent over 2002-03 compared with a general increase in the Consumer Price Index of 2.7 per cent.

Figure 1: Trend in annual total rainfall: 1950-2007

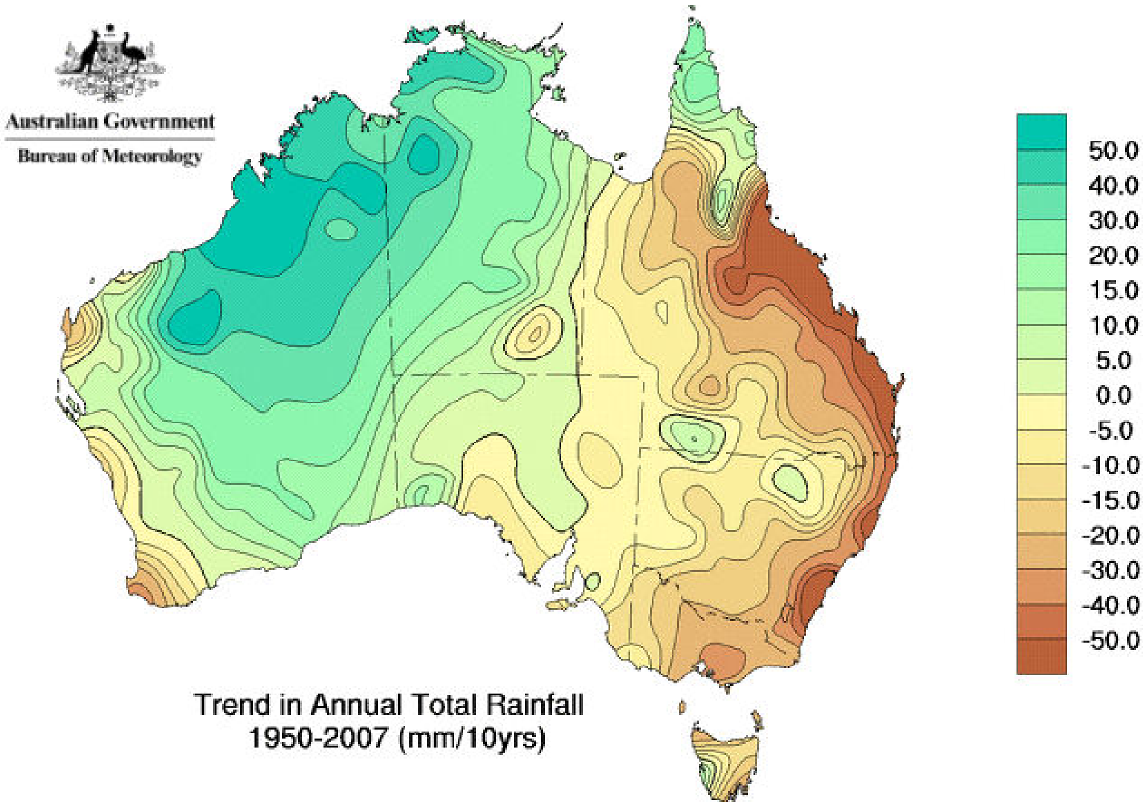

Table 2 compares national climate change impacts of unmitigated climate change scenario verses the impacts under different greenhouse gas stabilisation scenarios. Tables 3-7 give state-based summaries.[3] All are based on Garnaut, 2008b and The Climate Institute (2007a, b; 2008).

[3] The definitions of "Extreme", "High", "Moderate" and "Low" in state-based tables are based on definitions used in the Garnaut Review. For example, an extreme impact is defined as a major change to cost structure of industry with an extreme increase in operational and maintenance expenditure, or extreme productivity loss. Examples of the cost changes in industries examined are provided in the tables. The Garnaut Review's Draft Report 'bad-end story' uses more extreme temperature and drying projections of the climate models. This is described as a 1 in 10, 10 per cent ,chance (p167).

Table 2: National impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3oC 2100)	Hot, dry extreme case (the "bad end Story")
• 92% decline in value of irrigated agricultural production in Murray-Darling Basin	• 20% decline in value of irrigated agricultural production in Murray-Darling Basin	• 6% decline in value of irrigated agricultural production in Murray-Darling Basin	• 97% decline in value of irrigated agricultural production in Murray-Darling Basin
• -20% (-50 to -4) change in runoff in Murray-Riverina in 2070	• 100-300% increase in extreme fire weather	• 720 thousand at risk from dengue fever	• 8,600 additional temperature related deaths
• 2,700 additional temperature related deaths	• -16% (-38 to -3) change in runoff in Murray-Riverina in 2070	• Mass bleaching of the Great Barrier Reef twice as common as today	• Additional 7.9 million at risk from dengue fever
• Additional 5.5 million at risk from dengue fever	• 720 thousand at risk from dengue fever	• Increase in artificial snow making	• Catastrophic destruction of the Great Barrier Reef
• Catastrophic destruction of the Great Barrier Reef	• Disappearance of the Great Barrier Reef as we know it, with high impact to reef-based tourism	• Significant species extinction risk in Australia's internationally significant environments in north Queensland and Western Australia	• Snow-based tourism in Australia is likely to have disappeared
• Snow-based tourism in Australia is likely to have disappeared	• Increase in artificial snow making	• -14% (-31 to -3) change in runoff in Murray-Riverina in 2070	
• Beginning of major dislocation in coastal megacities of south Asia, south-east Asia and China and displacement of people in islands adjacent to Australia	• Tropical cyclone rainfall increase 20-30%, as wind speed increases 5-10%	• Fewer temperature related deaths	
	• 80% of Kakadu wetlands lost to sea level rise		
	• Fewer temperature related deaths		

Note: All temperature increases shown in tables are above pre-industrial levels

Table 3: Queensland impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3°C 2100)	Hot, dry extreme case (the "bad end Story")
• Catastrophic destruction of the Great Barrier Reef	• Disappearance of the Great Barrier Reef as we know it, with high impact to reef-based tourism	• Mass bleaching of the coral reef twice as common as today	• "Extreme" impacts to water supply infrastructure (24% increase in capital expenditure on supply)
• "Extreme" impacts to water supply infrastructure (19% increase in capital expenditure on supply)	• Number of extreme fire days doubles	• (Vertebrates) animals in Wet Tropics lose 90% of habitat "	• "Extreme" impact on buildings in coastal settlements (28% increase operational expenditure of buildings)
• "Extreme" impact on buildings in coastal settlements (25% increase operational expenditure of buildings)	• Small increase in additional temperature related deaths per year	• "Moderate" impact on buildings in coastal settlements (5% increase operational expenditure of buildings)	• 9,500 additional temperature related deaths
• 4,100 additional temperature related deaths per year	• "Low" impact to water supply infrastructure (3% increase in capital expenditure on supply)	• Fewer temperature related deaths	
	• "Moderate" impact on buildings in coastal settlements (6% increase operational expenditure of buildings)	• Low" impact to water supply infrastructure (2% increase in capital expenditure on supply)	

Table 4: Victorian impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3°C 2100)	Hot, dry extreme case (the "bad end Story")
• "Extreme" impacts to water supply infrastructure (28% increase in capital expenditure on supply)	• Number of extreme fire days doubles to triples	• -14% (-31 to -3) change in runoff in Murray-Riverina in 2070	• "Extreme" impacts to water supply infrastructure (28% increase in capital expenditure on supply)
• "High" impact on buildings in coastal settlements (13% increase operational expenditure of buildings)	• -16% (-38 to -3) change in runoff in Murray-Riverina in 2070	• "Low" impact to water supply infrastructure (3% increase in capital expenditure on supply)	• "High" impact on buildings in coastal settlements (15% increase operational expenditure of buildings)
• Fewer temperature related deaths	• "Moderate" impacts to water supply infrastructure (3% increase in capital expenditure on supply)	• "Low" impact on buildings in coastal settlements (4% increase operational expenditure of buildings)	• Fewer temperature related deaths
• Snow-based tourism in Australia is likely to have disappeared	• "Moderate" impact on buildings in coastal settlements (5% increase operational expenditure of buildings)	• Fewer temperature related deaths	
• -20% (-50 to -4) change in runoff in Murray-Riverina	• Fewer temperature related deaths	• Increase in artificial snow making	
	• Increase in artificial snow making		

Table 5: NSW impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3°C 2100)	Hot, dry extreme case (the "bad end Story")
• "Extreme" impacts to water supply infrastructure (19% increase in capital expenditure on supply)	• Number of extreme fire days doubles to triples	• -14% (-31 to -3) change in runoff in Murray-Riverina in 2070	• "Extreme" impacts to water supply infrastructure (24% increase in capital expenditure on supply)
• "High" impact on buildings in coastal settlements (14% increase operational expenditure of buildings)	• -16% (-38 to -3) change in runoff in Murray-Riverina in 2070	• "Moderate" impact on buildings in coastal settlements (4% increase operational expenditure of buildings)	• "Extreme" impact on buildings in coastal settlements (16% increase operational expenditure of buildings)
• Fewer temperature related deaths	• "Moderate" impact on buildings in coastal settlements (5% increase operational expenditure of buildings)	• Fewer temperature related deaths	• Fewer temperature related deaths
• Snow-based tourism in Australia is likely to have disappeared	• Fewer temperature related deaths	• Increase in artificial snow making	
• -20% (-50 to -4) change in runoff in Murray-Riverina in 2070	• Increase in artificial snow making	• "Low" impact to water supply infrastructure (3% increase in capital expenditure on supply)	
	• "Low" impact to water supply infrastructure (3% increase in capital expenditure on supply)		

Table 6: South Australian impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3°C 2100)	Hot, dry extreme case (the "bad end Story")
• "Extreme" impacts to water supply infrastructure (28% increase in capital expenditure on supply)	• Number of extreme fire days doubles to triples	• -14% (-31 to -3) change in runoff in Murray-Riverina in 2070	• "Extreme" impacts to water supply infrastructure (32% increase in capital expenditure on supply)
• -20% (-50 to -4) change in runoff in Murray-Riverina	• -16% (-38 to -3) change in runoff in Murray-Riverina in 2070	• "Moderate" impacts to water supply infrastructure (3% increase in capital expenditure on supply)	• "High" impact on buildings in coastal settlements (16% increase operational expenditure of buildings)
• "High" impact on buildings in coastal settlements (14% increase operational expenditure of buildings)	• "Moderate" impacts to water supply infrastructure (4% increase in capital expenditure on supply)	• "Low" impact on buildings in coastal settlements (4% increase operational expenditure of buildings)	• Fewer temperature related deaths
• Fewer temperature related deaths	• "Moderate" impact on buildings in coastal settlements (5% increase operational expenditure of buildings)	• Fewer temperature related deaths	
	• Fewer temperature related deaths		

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Table 7: Western Australian impacts of unmitigated and mitigated climate change

Unmitigated (Global temperature increase of 5-6.3°C 2100)	550ppm-e (Global temperature increase of 2.3-2.8°C 2100)	450ppm-e (Global temperature increase of 1.8-2.3°C 2100)	Hot, dry extreme case (the "bad end Story")
• "Extreme" impacts to water supply Infrastructure (34% increase in capital expenditure on supply)	• "Moderate" impacts to water supply infrastructure (5% increase in capital expenditure on supply)	• "Moderate" impacts to water supply infrastructure (4% increase in capital expenditure on supply)	• "Extreme" impacts to water supply infrastructure (37% increase in capital expenditure on supply)
• "Moderate" impact on buildings in coastal settlements (13% increase operational expenditure of buildings)	• "Moderate" impact on buildings in coastal settlements (4% increase operational expenditure of buildings)	• "Low" impact on buildings in coastal settlements (3% increase operational expenditure of buildings)	• "High" impact on buildings in coastal settlements (15% increase operational expenditure of buildings)
• 170 additional temperature related deaths per year	• Small increase in additional temperature related deaths	• Small increase in additional temperature related deaths	• 320 additional temperature related deaths

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