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Australian Greenhouse Office

Australia's Fourth National Communication on Climate Change

A Report under the United Nations Framework Convention on Climate Change

2005

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Contents

Foreword v

Chapter 1: Executive summary 1

National circumstances 1
National Greenhouse Gas Inventory 2
Policies and measures 3
Projections 5
Vulnerability assessment, climate change impacts and adaptation 6
Financial resources and technology transfer 7
Research and systematic observation 7
Education, training and public awareness 8

Chapter 2: National circumstances—Australia in context 10

Government structure 10
Population 11
Geography 11
Climate 12
Climate change projections 13
Economy 14
Energy 15
Transport 18
Industry 19
Waste 21
Building stock and urban structure 21
Agriculture 21
Forestry 22
Summary 22

Chapter 3: National Greenhouse Gas Inventory 23

Development of the National Greenhouse Gas Inventory 23
Overview of national emissions 24
Emissions by greenhouse gas type (UNFCCC accounting) 26
Methodology 29
Methodology documentation 30

Chapter 4: Policies and measures 36

Policy-making process 36
Policies and measures and their effects 39
Energy—stationary 42
Energy—transport 49
Energy—fugitive emissions from fuels 52

CONTENTS

Industrial Processes 53
Agriculture 55
Waste 56
Land use, land use change and forestry 57

Chapter 5: Projections 67

Australia's approach to emissions projections 67
Assessment of aggnegate effects of policies and measures 68
Projections–sector by sector 69
Projections methodology 80

Chapter 6: Vulnerability assessment, climate change impacts and adaptation 83

Vulnerability assessment 84
Impacts and adaptation responses 85

Chapter 7: Financial resources and transfer of technology 90

Provision of financial resources 90
Assistance to developing countries that are particularly vulnerable to climate change 93
Activities related to transfer of technology 93

Chapter 8: Research and systematic observation 108

Research capacity 109
Research focus 111
Some illustrative research projects 111
Systematic observation 113

Chapter 9: Education, training and public awareness 118

Formal education and training 118
Programme based education 120
Public awareness raising 121
Contribution of non-governmental organisations 124
Public consultation 124
International activities 125

Appendices 127

Appendix A 127
Appendix B 137
Appendix C 143

List of Abbreviations 144

Index 147

Foreword

I am pleased to present Australia's *Fourth National Communication* to the United Nations Framework Convention on Climate Change. This report summarises Australia's domestic and international actions to meet its obligations under the Convention and its Kyoto greenhouse gas emissions target.

Climate change is a serious global challenge that will require sustained action by all greenhouse gas emitting nations over many generations. Australia is certainly vulnerable to its impacts, both economically and environmentally, and is taking comprehensive action to reduce its greenhouse gas emissions for the Kyoto period and beyond.

The Australian Government's Climate Change Strategy sets out clear, practical steps to reduce emissions across all sectors of the economy and community. Importantly, the Strategy successfully integrates emissions management with Australia's unique economic circumstances in relation to energy.

The Climate Change Strategy also provides the foundations for a long-term response to climate change, including investing in the development of low emissions technologies, and understanding the science, addressing the risks, capturing the opportunities and preparing for the unavoidable consequences of climate change.

The Australian Government has already committed $1.8 billion to address climate change. This, together with additional funding and complementary initiatives by state and territory governments and the efforts of business and the community, underlines Australia's commitment to an effective domestic greenhouse response.

Australia is also pursuing a comprehensive global response to climate change through active participation in the United Nations Framework Convention on Climate Change and other international forums. We are also engaging directly with our international partners and neighbours, such as through the Asia–Pacific Partnership on Clean Development and Climate, launched in July 2005.

Australia is proud of its climate change management record and we remain committed to working with our international partners in responding to this global challenge.

Senator the Hon Ian Campbell
Minister for the Environment and Heritage
28 November 2005

CHAPTER 1

EXECUTIVE SUMMARY

Australia's *Fourth National Communication* under the United Nations Framework Convention on Climate Change (UNFCCC) sets out Australia's progress on implementation of its international obligations to address climate change since submitting its *Third National Communication* in 2002.

Building on past successes, the Australian Government, in consultation with state and territory governments, local government and industry, has developed a strategic framework of greenhouse action that reflects its particular national circumstances and recognises Australia's vulnerability to climate change. Through the Department of the Environment and Heritage's Australian Greenhouse Office and related organisations, significant progress has been made in implementing a range of policies and measures to place Australia's greenhouse response efforts at the forefront of global action, in proportion to its size. Projections of Australia's future emissions profile assess the impact of these policies and measures on reducing Australia's emissions, while a summary of Australia's 1990–2003 National Greenhouse Gas Inventory provides an estimate of Australia's net greenhouse gas emissions.

The *Fourth National Communication* also gives details of the likely impacts of climate change on Australia, an assessment of Australia's vulnerability and a range of adaptation measures being introduced. Research and systematic observation activities are identified, and an outline of Australia's financial commitment to assist developing countries to respond and adapt to climate change is given. The steps Australia has taken in climate change education, training and public awareness are also highlighted.

Despite Australia's national efforts, global greenhouse emissions will continue to rise unsustainably without renewed and concerted global action and cooperation, particularly by the major emitters. Australia strongly supports the forging of an inclusive and effective agreement on climate change mitigation in the UNFCCC. Australia also places a high priority on cooperation in the development and deployment of clean development technologies, including low-emission fossil-fuel technologies and renewables. The Asia–Pacific Partnership on Clean Development and Climate, whose members are Australia, China, India, Japan, the Republic of Korea and the United States, recognises that climate change actions should complement economic development and energy security goals.

Australia's long-term focus has been combined with short-term goals. Domestic policies and programmes are being implemented to meet Australia's target under the Kyoto Protocol of limiting greenhouse emissions to 108% of 1990 emissions levels over the period 2008–12, even though Australia has decided not to ratify the Kyoto Protocol. Through the Council of Australian Governments' Senior Officials' Group on Climate Change, other ministerial councils and cross-jurisdictional groups, the Australian Government will continue to work closely with states and territories and local government to achieve a national approach.

National circumstances

Australia is the sixth largest country in the world (769 million hectares). It is estimated that its population of over 20 million people will grow by 36.8% between 1990 and 2021. Australia is the fourteenth largest world economy, with a gross domestic product in 2004 of $821 billion[1] (around US$616 billion).

Australia is, in many respects, unique among the countries listed in Annex I to the United Nations Framework Convention on Climate Change. Australia's size, diverse environments and above Organisation for Economic Co-operation and Development (OECD)-average population growth, concentrated along an extensive coastline, expose it to a wide range of potential impacts and costs arising from climate change. Energy generation in Australia continues to be dominated by low-cost fossil fuels, and exports (particularly primary products, energy and energy-intensive products) play a major role in the economy.

Along with the national government, Australia has eight self-governing states and territories (the Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania, Victoria and Western Australia) and more than 700 local governments. As the Australian Government and state and territory and local governments share responsibility for reducing greenhouse gas emissions and protecting and enhancing greenhouse sinks, coordinated action is required to implement climate change policy effectively.

The structure of Australia's economy has a major impact on its greenhouse gas emissions profile and its consequent approach to reducing emissions. Energy-intensive and export-oriented industries, such as aluminium smelting,

[1] All monetary values are in Australian dollars unless otherwise specified.

alumina refining, and liquefied natural gas (LNG), coal and steel production are significant contributors to Australia's economy. Fossil fuels are the dominant energy source for these, primarily because vast reserves of low-cost fossil fuels are available, hydro-electric resources are limited by available water in one of the world's most arid continents and nuclear power is not utilised. In contrast to most other OECD countries, Australia is a significant energy exporter, with nearly 68% of its total energy production exported in 2003–04 (excluding uranium). By providing the world market with energy-intensive products and energy sources that are less greenhouse-intensive than coal, such as LNG, Australia displaces emissions that would otherwise occur in these markets.

Agriculture accounts for around 23% of total Australian merchandise exports, with exports worth $26.8 billion in 2004, providing substantial quantities of food and fibre to the world. At 30 June 2003, agricultural and pastoral properties in Australia covered an estimated 439.5 million hectares. Unlike most other industrialised countries, land-use patterns in Australia are still changing and the Land Use, Land Use Change and Forestry sector is a net source of greenhouse gas emissions.

Australian native forests cover about 163 million hectares (or about 21% of the continent). Most of this is woodland and scrub. Australia also has more than 1.7 million hectares of forest plantations, of which 59% are introduced pines and 41% are native species, mostly eucalypts.

National Greenhouse Gas Inventory

The National Greenhouse Gas Inventory is an important tool in the development of Australia's climate change policy and is a key means of appraising progress in implementing greenhouse response measures. The inventory is compiled annually, reflecting international and national commitments. The results in the *Fourth National Communication* are taken from the most recent inventory, for the period 1990 to 2003.

Consistent with its unique national circumstances, including the continuing importance of natural resource development to the economy, Australia has a distinctive profile of greenhouse gas emissions:

- energy-intensive primary energy production, minerals processing and transport continue to drive growth in Energy sector emissions
- emissions associated with agriculture are a significant component of the inventory.

Australia's 2003 inventory provides a comprehensive record of human-induced greenhouse gas emissions and sinks. There are some different international rules for compiling inventories under the UNFCCC and for Australia's 108% Kyoto target, resulting in differences in the level of emissions and trends in emissions reported under these two accounting regimes. Table 1.1 summarises Australia's emissions using the UNFCCC rules.

According to the accounting rules relevant to Australia's progress towards its 108% Kyoto target, Australia's net emissions of greenhouse gases amounted to 544.1 million tonnes (Mt) of carbon dioxide equivalent (CO_2-e) in 1990 and 550.0 Mt CO_2-e in 2003, an increase of 1.1%. The main difference in the inventory accounting rules for the 108% Kyoto target is in the way forest sinks are treated.

Table 1.1 Net greenhouse gas emissions and removals (Mt CO_2-e) by sector, 1990 and 2003 (UNFCCC accounting method)

Sector	1990	2003	Change (Mt CO_2-e)
Energy	**286.1**	**374.3**	**88.2**
Stationary Energy	195.4	268.1	72.7
Transport	61.9	79.8	17.9
Fugitive Emissions from Fuels	28.8	26.4	–2.4
Industrial Processes	**28.0**	**32.3**	**4.3**
Agriculture	**93.6**	**97.3**	**3.7**
Land Use, Land Use Change and Forestry	**93.6**	**6.1**	**–87.5**
Waste	**10.2**	**11.4**	**1.1**
Total net national emissions	**511.5**	**521.4**	**9.9**

Using the UNFCCC inventory rules as a basis for analysis, the largest percentage increases in emissions were in the Stationary Energy (37.2%) and Transport (28.8%) subsectors, and the Industrial Processes (15.2%) sector. Smaller increases occurred in the Waste and Agriculture sectors, while emissions from Fugitive Emissions from Fuels and net Land Use, Land Use Change and Forestry emissions fell by 8.2% and 93.5%, respectively, between 1990 and 2003.

In terms of emissions by gas type (see Table 1.2), CO_2 makes the largest contribution to Australia's total emissions, accounting for 71.7% of all emissions in 2003, compared with 72.1% in 1990. Methane (CH_4) accounted for 21.2% of CO_2-e emissions in 2003, reflecting Australia's substantial agricultural industry, although its share has declined slightly since 1990. The share of nitrous oxide (N_2O) was 6.0% in 2003, 1.6% higher than in 1990.

Emissions of perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) declined between 1990 and 2003, due to improved process control and monitoring in the aluminium production process. Hydrofluorocarbon (HFC) emissions from industrial processes increased by 282.6%, but these represent less than 0.8% of Australia's total emissions.

Table 1.2 Net greenhouse gas emissions and changes (Mt CO_2-e) by gas, 1990 and 2003 (UNFCCC accounting method)

Greenhouse gas	1990	2003	1990 Percentage of total	2003 Percentage of total	Change (Mt CO_2-e)
Carbon dioxide (CO_2)	369.0	373.6	72.1	71.7	4.6
Methane(CH_4)	114.6	110.3	22.4	21.2	–4.3
Nitrous oxide (N_2O)	22.3	31.2	4.4	6.0	8.9
Hydrofluorocarbons (HFCs)	1.1	4.3	0.2	0.8	3.2
Perfluorocarbons and sulphur hexafluoride (PFCs and SF_6)	4.5	2.0	0.9	0.4	–2.5
Total CO_2-e	**511.5**	**521.4**	**100.0**	**100.0**	**9.9**

As part of the continuous improvement process for the inventory, the Australian Greenhouse Office launched the Australian Greenhouse Emissions Information System (AGEIS) in May 2005. The AGEIS integrates emissions estimation, reporting and data storage processes into a single system. The system is also designed to enhance the accessibility and transparency of Australia's national and state greenhouse gas inventories, with emissions data from the AGEIS database publicly accessible through a dynamic web interface.

Policies and measures

The Australian Government's Climate Change Strategy builds on past successes, such as the 1998 National Greenhouse Strategy, and incorporates a mix of policy instruments, including voluntary action, strategic investment, government regulation and market measures, to enable Australia to meet its Kyoto target and provide a framework for climate change action over the longer term.

The Climate Change Strategy is articulated through measures contained in the 2004–05 Federal Budget and the Australian Government's new energy policy, the 2004 Energy White Paper *Securing Australia's Energy Future*. It focuses action in three areas:

- international engagement—pursuing an effective global response to climate change
- emissions management—leading action on Australia's commitment to its Kyoto Protocol target and a lower greenhouse signature in the longer term
- foundation—providing the foundations for Australia's climate change response, including understanding and preparing for the impacts of climate change.

The strategy is underpinned by Australian Government commitments of approximately $1.2 billion, bringing investment in climate change since 1997 to almost $1.8 billion.

Given Australia's federal system of government, state and territory governments are also an important part of Australia's climate change response. States and territories have responsibility for a range of issues with a bearing on climate change, such as: waste management strategies; planning and development of power plants; promoting the take-up of renewable energy; land use and transport planning; and vegetation management. They also work in conjunction with the Australian Government to deliver a range of Australian Government climate change policies and measures, such as the Mandatory Renewable Energy Target, energy market reform and the Renewable Remote Power Generation Programme. All Australian states and territories have either implemented, are reviewing, or are developing a greenhouse strategy, to address the climate change issues that fall under their jurisdiction.

Similarly, through Local Greenhouse Action and other Australian Government programmes, in addition to policies and measures developed by individual councils, Australian local governments are working to manage the potential effects of climate change within their communities.

Through a range of key policies and measures, and a series of sector, industry, and community based programmes, Australia's combined commitment to climate change programmes is projected to reduce annual greenhouse gas emissions by 85 Mt CO_2-e in 2010.

Key policies and measures include:

Cross-sectoral

- The $31.6 million Greenhouse Challenge Plus Programme builds on the success of Greenhouse Challenge and incorporates two existing initiatives—Greenhouse Friendly and Generator Efficiency Standards—into a single industry partnership programme. The programme is expected to provide 15.8 Mt CO_2-e of abatement in 2010.

- The Greenhouse Gas Abatement Programme (GGAP) is designed to leverage private sector investment in activities or technologies that will result in substantial reductions in greenhouse gas emissions or sink enhancement, particularly in the period 2008–12. It is projected that GGAP will abate an estimated 6.1 Mt CO_2-e in 2010.

- Also designed to leverage private sector investment, the $500 million Low Emissions Technology Demonstration Fund will support industry-led projects to demonstrate the commercial viability of new technologies or processes, or the application of overseas technologies or processes to Australian circumstances. This programme will deliver large, long-term greenhouse gas emission reductions in the Australian energy sector.

Sectoral

Energy—stationary

- Projected to reduce greenhouse gas emissions by an estimated 6.6 Mt CO_2-e in 2010, the Mandatory Renewable Energy Target seeks to increase the contribution of renewable energy sources to Australia's electricity mix by 9,500 gigawatt hours per year by 2010, at which time renewable energy generation is expected to have increased by more than 50% above 1997 levels.

- The National Appliance and Equipment Energy Efficiency Programme (NAEEEP) mandates comparative energy labelling and minimum energy performance standards for both electrical and gas domestic appliances, commercial products and industrial equipment. It is estimated that NAEEEP will reduce greenhouse gas emissions by 7.9 Mt CO_2-e in 2010.

- The Low Emissions Technology and Abatement programme was announced in the 2004–05 Federal Budget as a $26.9 million measure designed to encourage technologies that reduce energy demand and emission intensity in business, industry and local communities.

- The $75 million Solar Cities initiative aims to create more energy-sustainable communities where market barriers are overcome and consumers are encouraged to use energy wisely through trialling a combination of photovoltaic and smart meter technologies, innovative market arrangements—including responsive pricing, and energy efficiency and load management options.

- In 2003, the New South Wales Government established a mandatory Greenhouse Gas Abatement Scheme (GGAS), requiring liable parties (electricity retailers and large electricity users choosing to participate) to meet mandatory annual targets for greenhouse emissions, or pay a financial penalty. In 2005, the Australian Capital Territory introduced a similar scheme, which compels electricity retailers to source an increasing percentage of their product from cleaner and/or renewable energy sources.

- The Queensland Government's 13% Gas Scheme, a proactive regulatory measure of the Queensland Cleaner Energy Strategy, is designed to foster greater use of gas by requiring electricity retailers and some other liable parties, such as self-generators and power stations selling electricity to end-users, to source at least 13% of the electricity they sell or use in Queensland from gas-fired generation.

- The Victorian Government's $106 million Energy Technology and Innovation Strategy will facilitate a coordinated approach to the advancement of greenhouse gas abatement energy technologies to commercial-ready stage, while the Queensland collaboration, the Centre for Low Emission Technology, facilitates research, development and demonstration of low emission technologies.

Energy—transport

- The Australian Government's Environmental Strategy for the Motor Vehicle Industry aims to improve motor vehicle efficiency to deliver a range of environmental benefits, including reducing greenhouse gas emissions from the Transport sector. Programmes under the Strategy include the National Average CO_2 Emissions target, the Fuel Consumption Labelling Scheme, and the Australian Government Fleet Target.

- State and territory governments have adopted a range of measures to reduce transport-related greenhouse gas emissions. These include the Queensland Government's integrated regional transport plans, the Western Australian MetroRail project and the collaborative development of the Alice Springs to Darwin railway extension.

Industrial processes

- In December 2003, legislative amendments were made to the *Ozone Protection Act 1989*, expanding it into the *Ozone Protection and Synthetic Greenhouse Management Act 1989*. The amendments extend import, export and manufacturing controls to include those synthetic greenhouse gases used to replace ozone-depleting substances; extend import controls to include refrigeration and air conditioning equipment containing a hydrofluorocarbon or hydrochlorofluorocarbon refrigerant charge; and provide for introduction of consistent national standards for the handling, storage and disposal of ozone-depleting substances and their synthetic greenhouse gas replacements.

Agriculture

- The $20.5 million Greenhouse Action in Regional Australia programme aims to coordinate greenhouse action across the land sectors and build the capacity of the agriculture and land management sectors to reduce greenhouse gas emissions by promoting forest sink enhancement and the integration of forest sinks and greenhouse issues with natural resource management. Programme activities span the Land Use, Land Use Change and Forestry and Agriculture sectors.

Waste

- Most state and territory governments and local councils have waste minimisation and re-use strategies in place, including the reduction and capture of CH_4 emissions from the Waste sector. It is estimated that the cumulative effect of Australian Government and state, territory and local government measures across the Waste sector will reduce greenhouse gas emissions by 9.0 Mt CO_2-e in 2010.

Land use, land use change and forestry

- Legislative reforms introduced by the Queensland and New South Wales governments in 2003 and 2004 are expected to result in substantial reductions in broad-scale clearing of remnant native vegetation, leading to greenhouse gas emission reductions of an estimated 17.9 Mt CO_2-e in 2010.

Projections

Emissions projections across all sectors have undergone a process of continuous improvement since Australia's *Third National Communication*. Australia's projections are principally made in accordance with the provisions of the UNFCCC and were prepared in 2004 and 2005.

Australia reports a 'with measures' projection for each National Greenhouse Gas Inventory sector, with a focus on 2010 and 2020, whilst 'business as usual' emissions projections are currently developed for the Energy, Agriculture, Industrial Processes and Waste sectors and the Land Use Change subsector.

As the accounting methodologies for emissions projections under the Kyoto Protocol differ from the UNFCCC accounting rules there are differences in the emissions projections under each of these accounting regimes.

According to the UNFCCC accounting rules, Australia's total emissions are projected to be 565 Mt CO_2-e in 2010, with all sectors and greenhouse gas abatement measures included.

Australia is on track to meet its target under Kyoto Protocol accounting rules. Using Kyoto accounting, the projections indicate that between 2008-12, emissions would be, on average, 108% of 1990 levels.

Currently implemented measures combine to total 85 Mt CO_2-e of abatement in 2010, across all UNFCCC sectors (Energy, Agriculture, Industrial Processes, Waste and Land Use, Land Use Change and Forestry) (see Table 1.3).

Table 1.3 Greenhouse gas emissions projections (Mt CO_2-e), 1990 and 2010 (UNFCCC accounting method)

Sector	1990	2010 Business as usual	Measures	2010 With measures
Energy	286	461	47	414
Stationary	195	322	38	285
Transport	62	97	2	94
Fugitive Emissions from Fuels	29	42	7	35
Industrial Processes	27	51	9	42
Agriculture	94	99	1	99
Waste	10	19	9	10
Unallocated abatement from policies and measures			1	-1
Sub Total	**417**	**630**	**67**	**563**
Land Use, Land Use Change and Forestry	92	19	18	1
Forest Lands	-33	-42[a]	ne	-42
Land Use Change	126	61	18	43
Total Net National Emissions	**511**	**649**	**85**	**565**

Note: Columns may not add up to total due to rounding
ne: not estimated

[a] The Business as usual figure provided for the Forest Lands subsector is notional, as projections for this subsector are calculated on a 'with measures' basis only.

Sectoral contributions to total emissions are dominated by Energy, Agriculture and Land Use, Land Use Change and Forestry.

- It is projected that the Energy sector (comprising the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors) will continue to be the most significant source of greenhouse gas emissions in 2010 (approximately 70% of total emissions on a Kyoto accounting basis).
- Emissions from Industrial Processes are expected to grow rapidly from a relatively small base. They are projected to contribute approximately 7% of emissions in 2010.
- Agriculture emissions are not projected to grow significantly, but are still expected to contribute approximately 18% of emissions in 2010.
- The contribution of the Waste sector is projected to shrink slightly, contributing 2% of emissions in 2010.
- On a UNFCCC accounting basis, the Forest Lands subsector is expected to sequester approximately 42 Mt CO_2-e in 2010, or 8% of total net emissions. The subsector is estimated to have sequestered approximately 33 Mt CO_2-e in 1990.
- Emissions from the Land Use Change subsector are projected to be 43 Mt CO_2-e in 2010. The subsector is estimated to have emitted approximately 126 Mt CO_2-e in 1990.

A notable feature of the Australian process of developing emissions projections is that multiple models are used to determine projections in a number of sectors. Drawing on a range of different expertise in these sectors, the sectoral projection is an average of the individual model projections.

Developments since the *Third National Communication* include an increased focus on the key drivers of sectoral projections, increased reconciliation of results from the different models within sectors, and improvements to the estimation of measures impacts.

Vulnerability assessment, climate change impacts and adaptation

Australia's diverse and unique range of climate regimes, ecosystems and socio-economic factors make it particularly susceptible to climate change and vulnerable to its impacts.

In July 2005, the Australian Government released the report of a major study into climate change risks. The first high-level strategic risk and vulnerability assessment of climate change impacts across Australia, *Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*, used a risk management framework to identify sectors and regions requiring the formulation of urgent adaptation responses. High-priority sectors were found to include agriculture, biodiversity, buildings and settlements, water supply and energy, with the health, tourism, fishing and forestry sectors requiring a less immediate response. Similarly, high priority regions were identified as being the Cairns and Great Barrier Reef region, the Murray–Darling Basin and the south-west of Western Australia.

Over the past two years, governments in Australia have made significant efforts to lay the groundwork for adaptation planning. The introduction of the $14.2 million National Climate Change Adaptation Programme began preparing Australian governments, and vulnerable industries and communities, for the unavoidable consequences of climate change. The programme will support policy analysis of the cross-sectoral implications of climate change, partnerships to address climate change in regions of national priority, and the development of tools and information to assist in the development of adaptation plans. In addition, the $20.5 million Greenhouse

Action in Regional Australia Programme is being implemented in close collaboration with rural industry groups to coordinate greenhouse action across land sectors, fill knowledge gaps, implement improved practices and integrate climate change action in natural resource management sectors.

State and territory governments have also started to plan for adaptation to climate change. The Victorian Government, for example, recently released a revised Greenhouse Strategy Action Plan which included a range of adaptation measures. Similarly, the Queensland Government's Greenhouse Strategy contains adaptation strategies for water supply, agriculture and biodiversity, as well as a focus on modelling of climate change projections and local planning. The Western Australian Government's Greenhouse Strategy includes actions for adapting to climate change, particularly in the areas of agriculture, health and water. The Tasmanian Government has completed a state-wide coastal vulnerability study.

Financial resources and technology transfer

The Australian Government, through its overseas aid programme, provides assistance for activities in developing countries in support of the UNFCCC, particularly in the Asia–Pacific region.

Since 1996–97, Australia has contributed over $279 million to bilateral and regional development assistance for climate change-related activities that contribute to sustainable development while reducing net greenhouse gas emissions, or that help developing countries adapt to climate change. Australia's focus is on the provision of both hardware and 'soft' technologies through capacity building, information networks, and training and research. The primary targets of this bilateral funding are forestry, land management and renewable energy. The Australian Government has committed an additional $5.1 million over 2004–08 for developing and implementing bilateral partnerships and projects that deliver mutual practical benefits for Australia and partner countries, and help build the capacity of developing countries to take action on climate change.

Australia has continued to make financial contributions to multilateral institutions and programmes with significant climate change programmes, including the Global Environment Facility (GEF), the World Bank, the Asian Development Bank, and the United Nations Development Programme (UNDP).

In addition, Australia has funded a significant programme of assistance to help vulnerable Pacific small island developing states to monitor and adapt to climate change. For example, Australia is the largest financial supporter of the South Pacific Regional Environment Programme, which is bringing a strategic and coherent approach to climate issues in the region. Australia also supports the Enhanced Application of Climate Predictions in Pacific Islands Countries project, to strengthen Pacific island countries' capacity in climate prediction.

Australia's aid programme helps partner countries to build capacity, develop enabling environments and to gain access to innovative and environmentally sound sustainable energy and pollution-control technologies. Similarly, projects under Australia's Bilateral Climate Change Partnerships Programme have supported the transfer of climate-related technologies to assist developing countries in the Asia–Pacific region to address climate change more effectively. Australia recognises the importance of capacity building to address climate change. Improving governance and institutional capacity, particularly in the public sector is a focus of the Australian aid programme.

Research and systematic observation

Australian scientists continue to play an active role in climate, climate change and climate variability research. This commitment to research means that Australia has the most comprehensive research and monitoring activities related to climate change in the Southern Hemisphere. Australia is regarded as a leading contributor to international research in this area.

Climate research in Australia is conducted at both Australian and state government level and by many other organisations and institutions. Research topics include climate processes, modelling, impacts, mitigation and adaptation strategies.

The Australian Climate Change Science Programme is the Australian Government's primary focus for climate change research. Managed by the Australian Greenhouse Office, the Programme provides strategic research funding to improve understanding of the causes, nature, timing and consequences of climate change, so that industry, community and government decisions can be better informed. Science providers and co-investors in the programme are the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Meteorology.

Australian researchers also contribute significantly to international climate research by participating in the activities of the World Climate Research Programme, the World Climate Impacts and Response Strategies Programme, and other climate-related programmes, such as the International Geosphere–Biosphere Programme and the International Human Dimensions Programme.

The 1997 plan for an Australian Climate Observing System (ACOS) provides the framework for Australia's systematic observation of climate. Australia contributes to the systematic observation of the global climate under the Global Climate Observing System through the provision of meteorological and oceanographic observations and through participation in international terrestrial and space-based observing programmes. These networks work in partnership with other international observing systems such as the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS), the Global Observing System (GOS) and the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO).

Australia's meteorological observing network is operated and maintained by the Bureau of Meteorology. Marine and ocean observation programmes are operated by organisations including the Bureau of Meteorology, CSIRO Marine and Atmospheric Research (CMAR), the Royal Australian Navy and the Australian Institute of Marine Science (AIMS), while the terrestrial observing network is managed by the CSIRO and a range of Australian universities.

Education, training and public awareness

Public awareness and educational activity specifically related to climate change has continued to play a significant role in Australia's response to climate change.

Through its National Action Plan for Environmental Education, the Australian Government is working with state and territory governments and associated bodies and councils to achieve systemic change in key education sectors, moving beyond awareness raising to the promotion of long-lasting attitudinal and behavioural change. Through programmes such as the Sustainable Schools Initiative, which integrates sustainability education into a holistic programme with measurable environmental, economic, educational and social outcomes, and the Renewable Energy Industry Development programme, the Australian Government and state and territory governments continue to incorporate education on greenhouse gases, climate change and climate change adaptation into these formal processes. A significant amount of educational activity has occurred in the context of achieving the aims of major greenhouse gas programmes.

Australia continues to use a range of approaches to raise community awareness of climate change issues. The Australian Government's climate change public awareness strategy aims to ensure broad understanding of human-induced climate change, inform key stakeholders and the general community of government policies and programmes, and encourage industry, community and individual action in greenhouse gas reduction initiatives. The Australian Greenhouse Office is currently developing a new, climate change communications strategy and is conducting market research to gain greater understanding of community perceptions.

All Australian Government policies and programmes include public awareness goals and are supported by comprehensive programme websites as well as a telephone service operated by the Australian Greenhouse Office which provides access to information on Australian Government climate change publications, actions to reduce greenhouse gas emissions and policy and programme initiatives.

Australia has a broad range of non-governmental organisations that are actively involved in promoting public awareness and understanding of greenhouse issues through lobbying, education and training, and media activities.

Australia also contributes to education, training and public awareness at an international level though its bilateral and regional activities that strengthen climate change capacity building, information networks, training and research in developing countries, predominantly in the Asia–Pacific region.

The United Nations Framework Convention on Climate Change (UNFCCC) recognises that all parties have a common, but differentiated, responsibility to address climate change. The convention further recognises that each party is unique and therefore its climate change response strategy must be tailored to suit its particular circumstances.

A range of factors is important in understanding the opportunities and constraints that Australia faces in engaging in emission mitigation and sink augmentation, such as the country's climate, geography, demographic trends, natural resource base, political structures and institutions, economic composition, trading relationships, and energy production and consumption profile. Identifying Australia's environmental and economic vulnerability to, as well as opportunities from, the effects of climate change requires a thorough examination of all these factors.

Australia is one of the most arid continents in the world and the fragility of its diverse ecosystems and tendency to extremes of drought and flooding render it vulnerable to the effects of climate change. The population growth rate is above the Organisation for Economic Co-operation and Development (OECD) average, and people are concentrated along an extensive coastline, further exposing Australia to a wide range of potential impacts and costs arising from climate change. These effects could include disruption to water supply to cities, farming and livestock, an increase in the severity of storms, floods and droughts, heightened erosion of coasts due to sea level rise, and risks for human health, including an increase in the range and spread of tropical diseases and pests. They may include adverse impacts on a multitude of human, industrial and environmental habitats, affecting agriculture, energy supply, mining and manufacturing industries, as well as biodiversity, social and essential infrastructure. Further information on these impacts is given in Chapter 6—Vulnerability assessment, climate change impacts and adaptation.

Although response to climate change is necessary, Australia is also likely to be affected economically by international and domestic actions to reduce greenhouse gas emissions. This is due to factors such as Australia's reliance on export-based industries such as aluminium, alumina, coal, gas and agriculture, its dependence on long-haul transport over large land areas, its widely dispersed natural resources and remoteness from overseas markets, and its reliance on fossil fuels, in particular large reserves of low-cost black and brown coal.

Australia has few economically viable alternatives to sourcing most of its energy from fossil fuels, with no nuclear energy and limited hydro-electricity capacity. Ongoing market reform, improved business energy efficiency, continued fuel substitution and increasing capacity from cogeneration, gas and renewables will all provide future sources of energy.

Australia is the world's leading exporter of coal, as well as a rapidly growing exporter of liquefied natural gas (LNG). It has a large and relatively inexpensive supply of fossil fuels upon which energy-intensive industries such as aluminium smelting, alumina refining and other mineral processing have been built. These industries make a significant contribution to economic growth, employment and regional development in Australia.

These national circumstances have been considered in formulating Australia's response to climate change, recognising that effective climate change policies must accommodate environmental protection, conservation, economic growth and social justice.

This chapter provides the framework within which Australia's response to climate change can be better understood. It outlines Australia's particular national circumstances and their implications for climate change issues and policy making.

Government structure

Australia consists of a federation of a central government (the Commonwealth or Australian Government) and eight self-governing states and territories (the Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania, Victoria and Western Australia). In addition, there are approximately 700 local governments in Australia.

As the Australian, state and local governments share responsibility for mitigating greenhouse gas emissions, protecting and enhancing greenhouse sinks and implementing strategies to adapt to climate change, coordinated action is required to effectively implement a national climate change policy. State and territory governments and local governments are implementing a range of measures, some building upon Australian Government initiatives while others are additional to the Australian Government's Climate Change Strategy.

The Australian Government is able to provide a whole-of-government approach to greenhouse matters. The Australian Greenhouse Office (AGO), part of the Australian Government's Department of the Environment and Heritage, is responsible for the coordination of domestic climate change policy and provides a central point of contact for stakeholder groups. It also seeks to influence the international agenda by engaging in international developments and coordinating Australia's domestic policy basis for international negotiations.

Population

Although Australia's population is relatively small, it is increasing rapidly when compared with the growth rates of other OECD countries. From 1960 to 1990, Australia's population increased by 64.3%. In the years 1990–2003, Australia's population grew by 17.1%. The Australian population passed the 20 million mark in December 2003. Projections for 1990–2021 show a similar trend, with Australia's population projected to grow by 36.8%. This will exert increasing pressure on resources and energy use well into the twenty-first century.

Most of Australia's population is concentrated in two widely separated coastal regions. By far the larger of these in terms of area and population, lies in the south-east and east. The smaller of the two regions is in the south-west of the continent. In both coastal regions, the population is concentrated in urban centres, particularly the state and territory capital cities. Half the area of the continent contains only 0.3% of the population, and the most densely populated 1% of the continent contains 86.2% of the population.

While New South Wales remains the most populous state, with 6.7 million people in December 2003, the fastest growth has occurred in Queensland and the Northern Territory, with increases of 22.1% and 16.2%, respectively, in the 10 years to 2003. In contrast, the population of South Australia grew by just 4.5% and that of Tasmania by only 1.1% over the same period.

Geography

Australia has a land area of 7,692,024 square kilometres (km^2), excluding external territories, making it the sixth largest country in the world. The Australian continent extends from approximately 10° south to 43° south of the equator, including the island state of Tasmania. Australia is also the only country that has sole occupancy of a continent, providing Australians with unique circumstances relative to other developed countries.

Australia is one of the oldest, lowest and flattest continents. The coastline extends for 36,700 kilometres (km), providing a diverse marine environment including tropical mangrove and coral reef habitats. Oceans also have a major influence on the continental climate.

Australia was part of a former giant land mass, Gondwana, which connected the southern continents of Africa, Antarctica, Australia, India and South America, and broke up more than 100 million years ago. It has been geographically isolated from other continents for 35 million years. As a result, a unique biota has evolved. Australia's national reserve system recognises the need to preserve the natural heritage of that historic connection. The Wet Tropics of Queensland, for example, contain 13 of the 19 families of the most ancient flowering plants known to survive from Gondwana. They have now been declared a World Heritage Area by the United Nations. Australia is recognised as one of 17 countries that are megadiverse. It has the planet's second highest number of reptile species (686), is fifth in flowering plant species (23,000) and tenth in amphibian species (more than 180). Many Australian soils are derived from ancient material and tend to be shallow and infertile.

Australia's diverse climate and landscapes, ranging from tropical rainforest to sandy desert, support a wide variety of land uses that contribute to its unique greenhouse profile. Unlike most other industrialised countries, land use patterns in Australia are still changing. The Land Use, Land Use Change and Forestry sector is a net source of greenhouse gas emissions. Land clearing, in particular, results in the emissions of greenhouse gases through the burning of cleared vegetation, decay of unburnt vegetation and disturbance of soil as part of the clearing process. This is offset to some extent through carbon sequestration due to regrowth of cleared vegetation. These features of Australia's land management practices are further discussed in Chapter 3—National Greenhouse Gas Inventory.

Conservation of the natural environment is a vital issue for Australia's wellbeing. Considerable importance is placed on identification and conservation of Australia's biodiversity through a scientifically based system of nature conservation areas. As at June 2002, more than 77 million hectares (ha) of protected areas covered 10.1% of Australia's continental land area. In addition to the protected areas on the mainland and Tasmania, there are others located on Australia's oceanic islands and external territories, comprising Norfolk Island (695 ha), Lord Howe Island (1,247 ha), Christmas Island (8,726 ha), Macquarie Island (13,182 ha) and Antarctic Special Protection Areas (1,362 ha) in the Australian Antarctic

Territories. In June 2002, 547 national parks covered 4% of the land surface (30.9 million ha) and were registered under national and state legislation. In addition, more than 6,000 other designated conservation areas were found all over Australia and covered 6.1% of the land surface (46.6 million ha). They include Indigenous-protected areas, fauna and flora reserves and conservation parks as well as national parks. These too are protected by national or state legislation.

Australia's protected areas are not restricted to dry land—with significant natural treasures such as the Great Barrier Reef, there is a need to extend protection into the sea as well. There are 195 marine protected areas, which cover almost 65 million ha (as at June 2002). They range from Commonwealth Marine Parks, such as the Great Barrier Reef Marine Park, to fish habitat reserves, fish sanctuaries, aquatic reserves, conservation areas, marine parks and marine and coastal parks. Of these, the Australian Government has responsibility for 31 areas, Queensland 101, South Australia 19, New South Wales 18, Victoria 11, Western Australia 7, Tasmania 5 and the Northern Territory 3.

The Australian Government is strongly aware of the potential threat of climate change to these natural ecosystems. The vulnerability of these areas to potential climate change impacts is discussed in Chapter 6.

Climate

Australia has a wide range of climate zones—from the tropical regions in the north through the arid expanses of the interior, to the temperate regions in the south. Droughts and floods are common. Few other countries listed in Annex I to the UNFCCC are subject to such great year-to-year rainfall variability. This means that the threat of potential climate change impacts takes on a special dimension for Australia.

Australia is the driest of all inhabited continents. More than three-quarters of its land area has an average rainfall of less than 600 millimetres (mm) annually and about half the country receives less than 300 mm. Figure 2.1 shows the average annual rainfall distribution. The World Meteorological Organization (WMO) takes its reference period to be 1961–90, so more recent anomalies in weather patterns, deviating from the WMO reference data, are provided separately.

The most notable feature of the climate is the extreme rainfall variability, which affects much of the continent and is illustrated in Figure 2.2. Australia's geographical location in the Southern Hemisphere on the western rim of the Pacific Ocean places it under the influence of the El Niño–Southern Oscillation (ENSO) phenomenon. ENSO has a significant impact on the climate and is a major contributor to the annual rainfall variability. It has a cycle that varies between two and eight years, which exposes Australia to relatively frequent floods and droughts and high variability in frequency of extreme events such as tropical cyclones, severe storms and bushfires.

Figure 2.1 Average annual rainfall distribution in Australia, 1961–90

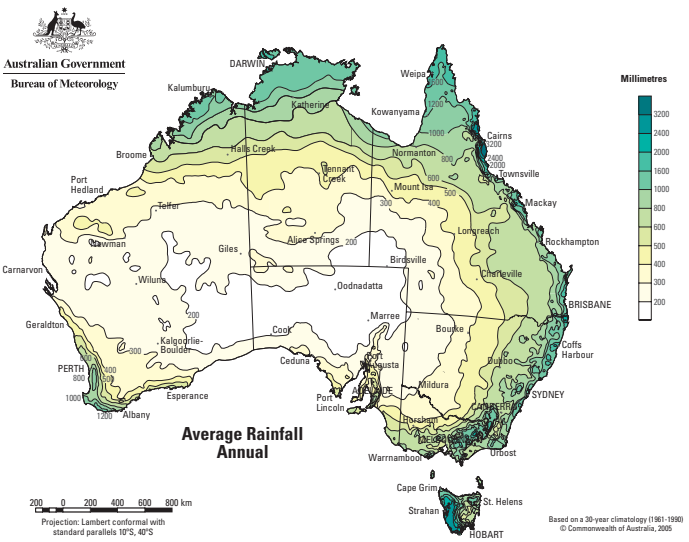
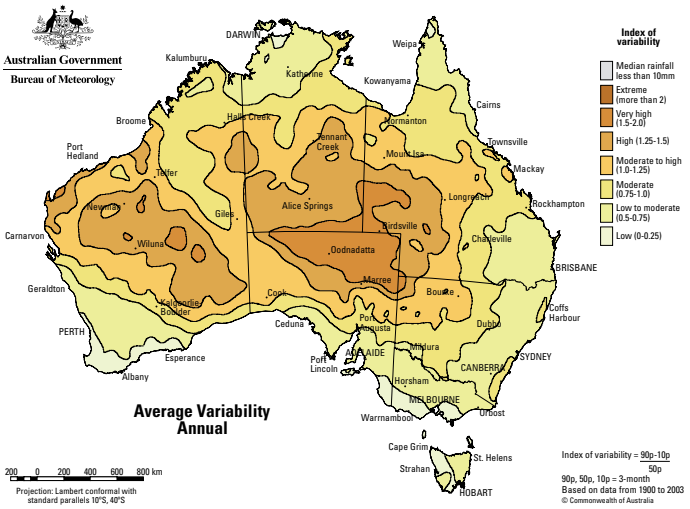


Figure 2.2 Annual rainfall variability (based on the period 1900 to 2002)



High temperatures over large areas of the continent, particularly in summer, can exacerbate the impact of the relatively frequent droughts. The distribution of maximum temperatures across Australia is shown in Figure 2.3. The first six months of 2005 have been amongst the warmest on record, with the anomalies from average shown in Figure 2.4.

Figure 2.3 Maximum temperatures across Australia between 1 July 2004 and 30 June 2005

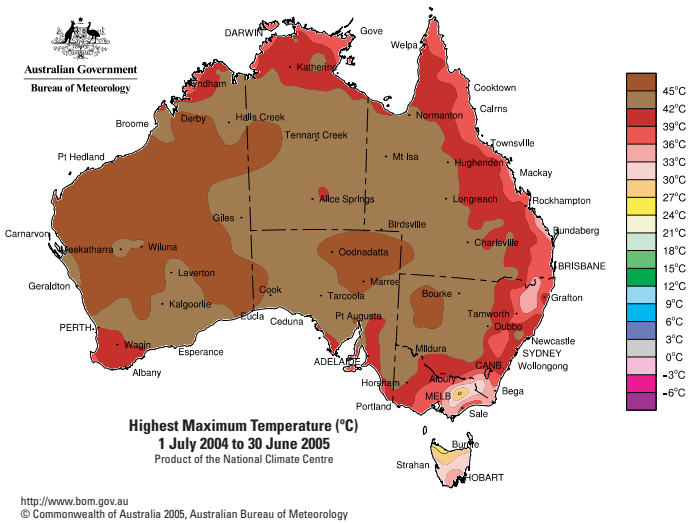
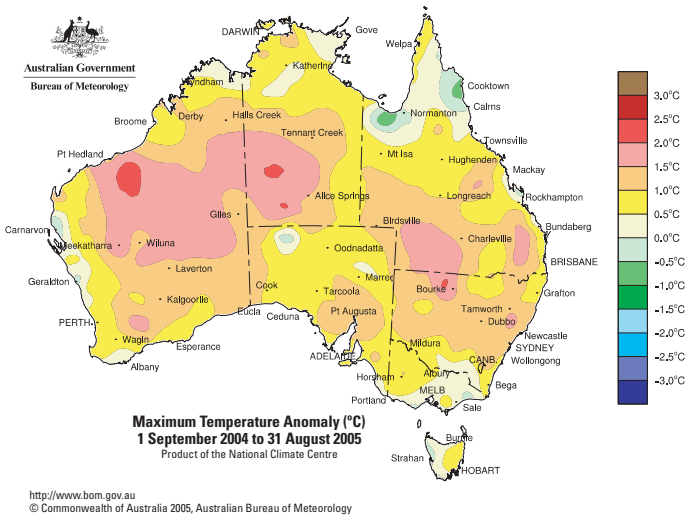


Figure 2.4 Maximum temperature anomalies across Australia between 1 January and 30 June 2005 (relative to the 30-year 1961–90 long-term average)



Along the narrow coastal strip, where the majority of the population centres are located, sea breezes moderate maximum temperatures during warmer months. The coastal regions also experience smaller daily temperature ranges than inland areas because of the influence of the sea. Frosts are a regular occurrence during winter in inland areas in the southern half of the continent and can cause serious losses to some agricultural crops. Snowfall in Australia is highly variable in area of coverage, depth and duration from year to year, and is usually restricted to south-eastern Australia at elevations above about 1,500 metres. High levels of solar radiation are a feature of most of the continent. High winds are common in some areas.

Climate change projections

In 2001, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) produced climate change projections for the Australian region using global climate model (GCM) simulations. Based on the *Special Report on Emissions Scenarios* released in 2000 by the Intergovernmental Panel on Climate Change (IPCC), this set of national projections presents climate averages for 2030 and 2070 relative to the average climate of 1990. The range in projections reflects the uncertainty in the amount of emissions and uncertainty in the climate system's response to enhanced greenhouse gases, and provides a starting point for most climate impacts studies undertaken in Australia. Most states and territories have commissioned the CSIRO to provide regional-scale climate change projections.

Temperatures

By 2030, annual average temperatures could be 0.4–2.0°C higher over most of Australia, with slightly less warming in some coastal areas and Tasmania, and somewhat more warming in the north-west of the country. By 2070, average annual temperatures could be 1.0–6.0°C higher with spatial variations similar to those for 2030.

Rainfall

Projected annual average rainfall ranges tend to decrease in the south-west of Australia (–20% to +5% in 2030 and –60% to +10% in 2070, rounded to the nearest 5%), and in parts of south-eastern Australia and Queensland (–10% to +5% by 2030 and –35% to +10% by 2070). In some other areas, including much of eastern Australia, projected ranges are –10% to +10% in 2030 and –35% to +35% by 2070. The ranges for the tropical north of Australia (–5% to +5% by 2030 and –10% to +10% in 2070) represent little change from current conditions.

In summer and autumn, projected rainfall ranges for most locations are –10% to +10% in 2030 and –35% to +35% by 2070, or tend towards increase (–10% to +20% in 2030 and –35% to +60% in 2070). The latter occur mainly in parts of southern inland Australia in summer and inland areas in autumn. In some parts of northern and eastern Australia in summer, and inland Australia in autumn, the tendency for wetter conditions is –5% to +10% by 2030 and –10% to +35% by 2070. However, for the far south-east of the continent and Tasmania, projected rainfall tends to decrease in both seasons (–10% to +5% by 2030 and –35% to +10% by 2070).

In winter and spring, decreased rainfall is projected for most regions (or the locations are seasonally dry). Ranges are typically –10% to +5% by 2030 and –35% to +10% in 2070. Projected reductions are stronger in the south-west (–20% to +5% by 2030 and –60% to +10% by 2070) while Tasmania shows increases in winter (–5% to +20% by 2030 and –10% to +60% by 2070).

Where average rainfall increases, more extremely wet years are projected, and where average rainfall decreases more dry spells are projected. Most models indicate an increase in extreme daily rainfall leading to more-frequent heavy rainfall events. This can occur even where average rainfall decreases. Reductions in extreme rainfall occur where average rainfall declines significantly. Increases in extreme daily rainfall are likely to be associated with increased flooding.

Evaporation and moisture balance

Changes in potential evaporation are included in the CSIRO (2001) projections. These show increases annually and for all seasons in the range 0–8% per degree of global warming over most of Australia, and up to 12% over Australia's eastern highlands and Tasmania. The increases tend to be higher where there is a corresponding decrease in rainfall.

The net atmospheric moisture balance is the difference between potential evaporation and rainfall. Australia has an annual net moisture balance deficit, and the environment is largely moisture limited. Average decreases in annual water balance range from about 40 to 120 mm per degree of global warming. This represents decreases in the range 15–160 mm by 2030 and 40–500 mm by 2070.

The greatest consistency in the simulated changes is in spring, when the decreases are greatest over eastern Australia.

Tropical cyclones

Projections of changes in cyclone activity are difficult to make, since tropical cyclones are not well resolved by global or regional climate models. The present indications outlined in the CSIRO regional scenarios are that:

- the regions of origin are likely to remain the same
- maximum wind speeds may increase by 5–20% in some parts of the globe by 2100
- preferred paths and poleward extent may alter, but changes remain uncertain
- future changes in frequency will be modulated by changes in the ENSO.

El Niño Southern Oscillation

The strong influence of ENSO on many parts of Australia will continue. The climate models do not give a consistent indication of future changes in ENSO events. It is likely, however, that global warming will enhance the drying associated with warm phase (El Niño) events, and enhance intense rainfall and run-off associated with cool phase (La Niña) events.

Economy

The structure of Australia's economy has a major impact on its greenhouse gas emissions profile and its consequent approach to reducing emissions. Australia's gross domestic product (GDP) in 2004 was $821 billion (or around US$616 billion). The GDP per capita for 2004 was $40,604.

With substantial mineral and resource wealth and abundant low-cost coal reserves, Australia is also a major producer of a range of processed and semi-processed metals. Australia is one of the world's leading exporters of coal, bauxite, alumina, lead, gold, iron ore, aluminium, nickel, zinc and uranium. Mineral resources and resource-processing industries generate more than 8.5% of Australia's GDP and more than 400,000 jobs, approximately 5% of all employment in Australia.

Australia's emissions profile is atypical among OECD countries, and other countries listed in Annex I to the UNFCCC. Agriculture was a significantly more important emission source for Australia than for other countries, with much of agricultural produce being exported. Australia is one of only two Annex I countries whose Land Use, Land Use Change and Forestry sector is a net source of emissions.

An important feature of Australia's trade profile is the strong trading links with developing countries—particularly in the Asia–Pacific region, partly reflecting Australia's proximity to the economies of the Asia–Pacific region and the region's energy-intensive imports. Australia is one of the world's leading suppliers of energy-intense materials. No other OECD country shares Australia's position as the dominant exporter of emission-intensive goods to the fast-growing Asia region. Further trade liberalisation and economic integration in the region is likely to further increase Australia's production of energy and greenhouse gas-intensive activities to service growing Asia–Pacific markets.

Energy

Australia has vast reserves of low-cost energy. The reserves that can currently be recovered at least cost include brown and black coal, uranium, natural gas, crude oil and condensate, and naturally occurring liquefied petroleum gas (LPG). Total primary energy production (excluding uranium) in 2003–04 was over 11,160 petajoules (PJ) (refer Table 2.1).

In contrast to most other OECD countries, Australia is a significant energy exporter. Over the 2003–04 period, nearly 68% of total energy production (excluding uranium) was exported (valued at $20.4 billion or about 19% of Australia's total merchandise export earnings).

Energy consumption in Australia is dominated by fossil fuels with major consumers being the electricity generation sector (30%), the transport sector (24%) and the manufacturing sector (24%). Combined, these sectors account for almost 80% of Australia's total energy consumption.

The Transport sector is the second largest sector in terms of energy use—a share that has remained static over the last 30 years. The sector is dominated by road transport, with petroleum products accounting for around 98% of the sector's energy needs.

Table 2.1 Australian energy supply, trade and consumption, by fuel in energy units (petajoules), actual 2003–04

Energy product	Production	Consumption	Net exports
	2003–04	2003–04	2003–04
Black coal[1]	7,615	1,558	6,208[5]
Brown coal[2]	659	696	0
Renewable[3]	265	265	0
Petroleum[4]	1,154	1,789	–394
Natural gas	1,468	1,038	431
Total	**11,160**	**5,346**	**6,245**

Notes

[1] Includes coke and coal by-products.

[2] Includes brown coal briquettes.

[3] Includes wood, wood waste, bagasse, hydro-electricity and solar.

[4] Includes crude oil, condensate and LPG. Consumption refers to petroleum products. Exports include refined petroleum products.

[5] Consumption amount may vary from Production – Exports + Imports because of stock change and statistical discrepancies.

Source: Donaldson K *Australian Energy Statistics 2005*, ABARE, Canberra.

Fuel types

Coal

Australia has a very substantial coal resource, with significant reserves of both black and brown coal. As of December 2003, Australia had demonstrated black coal resources of around 75 billion tonnes, of which around 40 billion tonnes is considered economically recoverable. Inferred resources account for a further 85 billion tonnes of which 52 billion is considered recoverable. Economically recoverable brown coal resources are currently estimated at 37.5 billion tonnes or 20% of the world's economically demonstrated resources.

Oil

Australia has significant petroleum reserves. Proven reserves (i.e. both economic and uneconomic fields at current prices) at 1 January 2004 were 1.6 billion barrels of crude oil, 2.3 billion barrels of condensate and 1.8 billion barrels of LPG.

Natural gas

Australia had an estimated 3,921 billion cubic metres of natural gas reserves, (both economic and uneconomic at current prices) as at 1 January 2004. Exploration for gas is normally undertaken in conjunction with exploration for other petroleum products, with crude oil the primary target.

Electricity

The electricity generation sector was the largest consumer of energy in 2003–04, at 1,629 PJ and historically has been one of the fastest growing sectors. This trend reflects increased electrification in all end-use sectors, in addition to the continued strong growth in a number of industries in which electricity is the primary fuel source, such as the commercial services and nonferrous metals sectors. Electricity generation in Australia is dominated by coal-fired generation. In 2003–04, 77% of electricity was sourced from black and brown coal and their by-products, while renewable energy sources, such as hydroelectricity, wind, solar, bagasse (that is, sugar cane residue), wood and biogas accounted for 8%, natural gas 14% and petroleum products less than 1%. Ongoing energy market reform and a reduction in surplus coal-fired capacity is projected to see, in the medium to long-term, future additions to capacity coming from a mixture of coal, cogeneration, gas and renewables.

Renewable energy

Renewable energy currently contributes 5% of Australia's total energy supply and represents 8% of Australia's electricity generation. Combustible renewables, which contribute 3.4% of total energy, are made up of bagasse used to generate electricity and steam, and wood for home heating and to raise steam in the industrial sector, predominately the pulp and paper sector. Cited quantities of these renewable primary energy products produced in 2003–04 are 10,100 kilotonnes (kt) of bagasse, 5,980 kilotonnes kt of wood, 16,300 gigawatt hours (GWh) of hydro-electricity and 1,100 GWh of wind energy.

The consumption of renewable primary energy forms (biofuels and hydro) was 12% higher in 2003–04 than in 1989–90. However, as total primary energy consumption increased by 35.5% over the period, the renewable share of primary energy declined from 6% in 1989–90 to 5% in 2003–04 (after reaching a peak of 6.2% in 1996–97).

As the most arid inhabited continent in the world, Australia has little further large-scale hydro-electric generation potential and most of the commercially favourable sites have already been exploited. There is some potential for the development of small-scale hydro, although there are short-term fluctuations in water availability and market factors influencing hydro production. Australia has good access to solar and wind energy resources. There may also be some potential for the development of wave power generation in some areas.

Market structure

State and territory governments are responsible for the management of coal reserves in their jurisdictions and regulate the procedures for coal exploration and development. They make the reserves available for private companies to develop, and the companies pay royalties for access to the resource. With around 75% of saleable black coal production exported, the industry is export oriented and subject to international competition.

Commercial exploration and development of oil and gas is undertaken entirely by the private sector. The Commonwealth, states and territories are responsible for regulating exploration, development, safety, environmental assessment and royalties in their respective jurisdictions. Furthermore, exploration is actively promoted through government sponsored production and dissemination of basic geo-scientific information.

The same government regulations apply to the extraction of natural gas, as to other petroleum product producers. The market for natural gas in Australia is characterised by a highly concentrated supply market with a small number of producers. Producers either sell their gas into the domestic market, or produce for export in the form of LNG.

The competitive National Electricity Market (NEM) was set up in 1998 and currently supplies electricity to 7.7 million Australian customers on an interconnected national grid that links Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia, and shortly Tasmania. The NEM is structured around a common pool, or spot market, for trading wholesale electricity. All electricity produced by market generators must be traded through the pool. Approximately $8 billion of energy is currently traded through the NEM per year. As well as the NEM, there are three independent systems, which are owned by the different state governments.

Electricity generated by renewable sources either feeds into the NEM, smaller remote area grids or is used on site. A voluntary, industry owned Green Electricity Market is being developed to trade in 'green electricity rights'.

Production

Table 2.1 contains the production volumes of coal, oil (petroleum), natural gas and renewable energy. In 2003–04 Australia produced 11,160 PJ of primary energy products (excluding uranium) and imported 1,290 PJ of energy products, mainly crude oil and finished petroleum products.

Consumption

Table 2.1 presents the consumption volumes of coal, oil (petroleum), natural gas and renewable energy. As Australia does not export electricity, total consumption equals total production.

In 2003–04 total energy use in Australia, comprising both primary and derived energy, was 5,346 PJ, of which around two-thirds (3,545 PJ) was delivered to end-users (households, commercial activities, transport and industry) and the remaining third was lost in conversion processes, transmission and distribution. Of the energy delivered to end-users, 148,000 GWh of electricity were supplied to industrial and commercial customers and 56,900 GWh were supplied to residential customers.

Trade

Most of the energy produced in Australia is exported (7,535 PJ in 2003–04, excluding uranium), the bulk of which is black coal and LNG. In addition Australia exported 4,277 PJ of uranium.

Australia is the world's largest exporter of black coal, with over 218 million tonnes exported in 2003–04, earning $10.9 billion. In 2005–06 this is projected to grow to 240 million tonnes exported and to be worth around $25.7 billion due to high energy prices. This commodity is Australia's leading mineral export, generating 10% of the country's total merchandise export revenue in 2003–04. Japan is the leading destination for Australian coal, taking 59 million tonnes of steaming coal and 41 million tonnes of coking coal (62% and 37% respectively of total Australian exports for these commodities).

In 2003–04, Australia exported 17.5 billion litres (110 million barrels) of crude oil and other refinery feedstock (condensate), 2.5 billion litres (1.6 million barrels) of finished petroleum products and almost 3 billion litres (18 million barrels) of LPG. However, crude oil and refinery feedstock imports of over 23.5 billion litres (148 million barrels) and 10.5 billion litres (6.6 million barrels) of finished petroleum products mean that Australia is a net importer of oil products.

In 2003–04 Australia exported about 29% of its natural gas, in the form of LNG. All exports are currently from the North West Shelf production facility off the coast of Western Australia, which exports about 7.9 million tonnes (430 PJ) of LNG annually, earning around $3 billion annually. Australia has the potential to produce more LNG for export. Australia does not import natural gas.

No electricity is either imported or exported. Australia does not trade in renewable energy. However, Australian companies actively market renewable energy generating products in overseas markets.

Australia has 701,000 tonnes of uranium in Reasonably Assured Resources recoverable at costs of less than US$40/kilogram (kg) U—this is the world's largest resource and represents 40% of world resources in this category. Australia, with approximately 23% of world uranium production in 2004, is the world's second largest producer after Canada (29%). Exports of uranium oxide in 2003–04 were 9,099 tonnes, valued at $364 million. Australia has no significant national demand for uranium and all production is exported under very stringent conditions to ensure it is used only for peaceful purposes.

Royalties and taxes

Royalties paid by mining businesses are collected by state and territory governments for mining of minerals and petroleum onshore and in coastal waters to three miles offshore. Royalty systems and levels vary between jurisdictions and commodities. The systems include specific rate royalties (a fixed amount per unit), ad valorem royalties (a fixed percentage of the value of production) and profit-related royalties (or profit rent). For example, companies pay royalties for coal extraction on a fixed amount per tonne for non-exported coal in Western Australia, on a fixed amount per gigajoule in Victoria and South Australia, on a percentage of value in New South Wales, Queensland and on exported coal in Western Australia, and on a profit basis in the Northern Territory and Tasmania. The Australian Government applies a resource rent tax to petroleum produced in Australia's offshore areas beyond coastal waters, with the exception of the North West Shelf production area to which royalties and crude oil excise apply. Natural gas producers face the same royalties and taxes as other petroleum producers.

Australian energy producers are also subject to Australian taxes, such as company tax and goods and services tax (GST), as well as a range of state taxes, such as payroll tax. Companies receive tax credits on GST paid on all business inputs, including fuel and energy.

Subsidies

No direct subsidies apply to energy production from coal, oil, natural gas or electricity. The Australian Government has introduced a number of programmes to promote renewable energy. These are discussed in detail in Chapter 4—Policies and measures.

Emissions intensity

Australia's emissions profile is heavily influenced by its large energy-intensive industries such as aluminium, iron and steel production, and its large greenhouse intensive agriculture sector. Australia supplies a considerable proportion of the world's demand for these products. Australian industry and consumers also depend heavily on long-haul transport, due to the wide dispersal of natural resources and remoteness from overseas markets.

Despite the continuing importance of these features of the economy, Australia has reduced its emissions intensity compared to its overall economic performance. Macro greenhouse indicators are 'total emissions', 'emissions per capita' and 'emissions per dollar of GDP'. Measured according to UNFCCC accounting standards, emissions per dollar of gross domestic product (GDP) declined by 32.9% between 1990 and 2003. Measured according to Kyoto accounting, emissions per dollar of GDP declined by 33.4% over the same period. Energy-related emissions per dollar of GDP declined by 13.9% between 1990 and 2003, under both systems of accounting. Australia has reduced its emissions when expressed in per capita terms by 12.6% (by 13.3% under Kyoto accounting), from 30.2 tonnes CO_2-e (Kyoto: 32.1 tonnes CO_2-e) in 1990 to 26.4 tonnes CO_2-e (Kyoto: 27.8 tonnes CO_2-e) in 2003.

Transport

Travel plays a large part in the national economy and in the everyday lives of most Australians. This is a consequence of the increasing affordability of travel and the demand for travel due to Australia's geographic size and dispersed population, as well as the distances between natural resources and manufacturing and market centres, and distances between Australia and its trading partners.

Australia's population is heavily concentrated around its coastal cities, especially coastal state and territory capitals. Large distances separate these cities: by road, Brisbane is 982 km north of Sydney, which is 872 km by road from Melbourne. Adelaide is another 731 km from Melbourne, and road transport from Adelaide to Perth requires a trip of approximately 2,781 km, while Adelaide to Darwin is 3,020 km. Hobart is separated from the other capitals by both distance and the waters of Bass Strait.

Passenger transport

Australian cities have comparatively low average urban population densities and are characterised by extensive suburban land use patterns that result in significant distances between locations. As a consequence, the decentralised land use patterns of Australian cities require greater intra-city travel and reliance on private vehicle use.

The average gross vehicle mass of new passenger cars has increased by around 8% over the past 20 years (currently about 2,150 kg). Significant advances in technical fuel efficiency have enabled consumers to acquire vehicles with improved performance, size and comfort while still achieving overall gains in fuel efficiency.

Table 2.2 provides summary statistics on the growth, between 1990 and 2003, in the Australian passenger vehicle fleet, the total fuel consumed by these vehicles and the total vehicle km and passenger km travelled.

Table 2.2 Aggregate passenger vehicles, fuel consumption and distance travelled in Australia, 1990 and 2003

Year	Passenger vehicles	Fuel consumed (million litres – petrol equivalent)	Total vehicle distance travelled (billion km)	Total passenger distance travelled (billion km)
1990	7,797,300	14,951	124.4	198.5
2003	10,404,279	17,282	165.2	257.3

Over the decade to 2003, passenger vehicle numbers increased 33%, vehicle km travelled by 32.8% and fuel consumption (measured in terms of petrol equivalent) increased by 15.6%.

Although the overall rail task has grown, rail has lost market share, having accounted for approximately half of the total passenger transport task in the mid-twentieth century but declining to less than 2.3% in 2003. Since 1994–95, the rail passenger transport task has increased by 14.6%.

The number of passengers on coastal shipping vessels, mainly ferries, increased by 26% from 14,833,900 in 1991 to 18,637,900 in 2002–03.

Domestic freight transport

Freight transport—domestic and international—is an important component in the cost structure of Australian industry and the Australian economy. About two-thirds of the total domestic freight task by weight (excluding pipelines) is in bulk commodities. Much of this is the long-haul movement of iron ore, oil and coal for secondary industry by coastal ships and of primary products from inland mines and farms to coastal city markets and export ports by railway.

The road freight task undertaken by commercial vehicles grew by over 70% from 1990–1991 to 2002–2003 reaching an estimated 188.1 billion tonne-km. Freight carried by domestic shipping increased from 96.5 billion tonne-km in 1991 to 114.9 billion in 2002–03.

Industry

Australia's economy is increasingly made up of services. These accounted for approximately 74% (just under $597 billion including electricity, gas and water supply) of GDP in 2003–04. Of the other sectors, manufacturing produced 11% of gross value added (GVA) (around $83 billion), mining produced 4% (about $30 billion) and agriculture, forestry and fishing produced 3% (or nearly $24 billion).

Gross value added from the services sector was more than 50% higher in 2002 than in 1990, whereas GVA from the more energy-intensive manufacturing sector was about 20% higher than in 1990. The increasing importance of the services sector to the economy is not unique to Australia, as this sector has increasingly dominated the industrial profile of most developed economies over recent decades.

Nevertheless, Australia's trade patterns do not reflect the structure of its economic output. The mining sector provided the greatest amount of exports by value (31.5%) in 2004, followed by the services sector with 21.9%. The manufacturing sector was also a significant exporter, at 16.8% of export value.

Short profiles of key Australian industries follow. It is important to note that these industries are, for the most part, both energy and greenhouse gas intensive.

Mineral resources

Australia continues to rank as one of the world's leading mining nations. In 2003 it had the world's largest demonstrated economic resources of lead (25%), mineral sands (ilmenite (33%), rutile (43%) and zircon (42%)), nickel (36.3%), tantalum (94%), uranium (39%) and zinc (17%), while bauxite, black coal, copper, gold, lithium, manganese ore, niobium, silver and industrial diamond rank in the top six worldwide. It is the largest producer of mineral sands and lead in the world, and is also one of the largest producers of iron ore, nickel, uranium and zinc, contributing respectively 18%, 14%, 21% and 17% of world production in 2003.

The contribution of the mining industry to Australia's GDP has remained around 5% over the past 10 years. From an industry of origin perspective, the mining industry is the nation's second-largest export earner (after manufacturing), accounting for 29.6% of the total value of exports in 2003–04, principally from the coal, oil and gas extraction industries. Australian mining and mineral processing (excluding petroleum) accounted for $33.6 billion in exports of minerals and metals in 2003–04, representing 23% of Australia's total exports of goods and services. These extraction and production industries are discussed further under 'Energy' in this chapter.

Mineral exploration expenditures in Australia rose by $75 million to $732.6 million in 2002–03. Spending for the calendar year 2003 rose by just over $57 million to $735.3 million. These modest rises follow a fall of 51% (from $1340.3 million to $657.6 million) during the period 1996–97 to 2001–02. In April 2005, there were 74 minerals and energy projects at advanced stages of development; that is, projects that were either committed or under construction. The announced capital expenditure of these 74 projects equals $22.6 billion.

As of June 2004, the mining industry employed more than 321,000 people (directly and indirectly) particularly in remote and regional areas of Australia.

Aluminium industry

Australia is the world's largest producer of bauxite and alumina, and the fifth-largest producer of aluminium. In 2004, bauxite, alumina and aluminium production generated export earnings of $7.4 billion. Ninety per cent of Australia's bauxite is processed into alumina domestically; around 80% of alumina production is exported, with the balance consumed in the Australian aluminium smelting sector. The aluminium industry currently employs over 16,000 people and uses about 16% of all electricity and 12% of all natural gas in Australia. Australia is one of the world's leading exporters of bauxite and alumina and significant growth in these sectors is expected.

Automotive industry

The Australian automotive industry consists of four motor-vehicle producers, which in 2004 produced 400,000 units. In addition, there are over 200 motor vehicle component manufacturers. Production of vehicles in Australia is concentrated in the large car segment (non-luxury passenger vehicles of 6 and 8 cylinders). Australian-made vehicles dominate this segment, while imports prevail in the others.

The Australian market has shown strong demand for vehicles, with total sales of all vehicles reaching a record 955,229 units in 2004. Businesses engaged in component manufacture are highly internationalised. Many firms are wholly or partially foreign-owned and components are exported to many countries. The automotive sector's industry value added (IVA) was nearly $4.7 billion in 2000–01, accounting for over 6% of total manufacturing activity and nearly 0.7% of total economic activity. The largest sector within the industry is motor vehicle manufacturing, which accounts for 47% of the automotive sector's IVA, closely followed by automotive component classification (36% of IVA).

At 30 June 2001, there were approximately 62,600 people employed in the automotive sector, accounting for 6.6% of total manufacturing employment and 1.2% of total employment.

The sector remains Australia's leading exporter of manufactured goods and Australia's sixth largest export performer overall. Automotive exports exceed more traditional exports such as wheat, wool and wine. In 2002–03, exports of vehicles were valued at nearly $3 billion, and exports of components and parts at nearly $2 billion. Major export markets for vehicles were Saudi Arabia, the Unites States and New Zealand, and major markets for components were the United States, South Korea and New Zealand.

Chemicals and plastics industry

Export earnings from the Australian plastics and chemicals industry in 2003–04 amounted to $3.2 billion. In 2002–03, turnover for the chemicals and plastics sectors was $32.5 billion, and value added was $9.6 billion. The industry is a significant part of the manufacturing sector, employing around 81,000 people. It is a key supplier to industries such as agriculture, automotive, food processing, packaging and telecommunications.

Wood, pulp and paper industry

The wood, pulp and paper industry is one of the largest segments of Australian manufacturing and is particularly important to many rural areas and regional centres. The industry incorporates sawmilling and timber dressing, manufactured wood products, and pulp, paper and paper products. The industry produced about $4.9 billion in industry gross product for 2002–03. The value of exports of forest products in 2002–03 totalled $2.1 billion, of which 38% were woodchips and 34% paper and paperboard products. The woodchip export industry uses sawmill residues and timber that is unsuitable for sawmilling and not required by the pulp, paper and reconstituted wood products industries. Australia's forest and wood products industries, based on native and plantation forests, employed approximately 92,700 people in 2003–04. The value of exports and imports of forest products was substantial, at about $2.1 billion and $4.0 billion, respectively, in 2002–03. Currently, Australia has a trade deficit in forest products of $1.9 billion, due to imports predominantly in paper, paperboard products and sawn timber.

Heavy engineering industry

Structurally, the heavy engineering sector is divided into several segments: iron and steel casting and forging, railway equipment, mining, steel fabrication, construction and agricultural machinery, and industrial machinery manufacturing. In 2003–04, the manufacturing of general industrial machinery, equipment and machine parts generated $1.2 billion in exports, while specialised machinery generated $1.1 billion in exports. Machinery and equipment manufacturing had a GVA of $16.5 billion and an IVA of $13.5 billion, while metal product manufacturing had a GVA of about $10.8 billion and an IVA of $13.7 billion.

Despite the traditional domestic focus of the industry in Australia, there are a number of well-established firms responding to new export opportunities through joint ventures and innovation, especially among the mining and construction machinery companies.

Waste

Around 21 million tonnes of waste is disposed of to landfill in Australia annually. This generally comprises 35% municipal solid waste (including household waste), 38% construction and demolition waste, and 27% commercial and industrial waste.

Some 95% of Australian households recycle waste. Estimates indicate Australia is annually recycling 73.7% of paper and cardboard, including 73.5% of newspapers (over 1 billion newspapers), 63.4% of aluminium cans (2 billion), 29.8% of glass packaging and 44% of steel cans. It is estimated that over 100,000 people are employed by recycling-related industries, while the recycling of millions of tonnes of steel each year delivers significant energy savings to the Australian steel industry.

Building stock and urban structure

Since 1911 there has been a slow but steady increase in the size of Australian dwellings, accompanied by a steady decline in the average number of persons per dwelling, from 3.5 persons in 1961 to 2.4 persons in 2001. The average size of new homes has tended to increase. From 1984–85 to 2002–03, the average size increased 40.3% to 227.6 square metres.

The trend away from separate houses towards medium and higher density housing is related to a number of factors, including the desire of government planners and private developers to meet the demand for lower priced accommodation and housing closer to employment centres. Higher density housing may lead to greater cost-effectiveness in the establishment of urban infrastructure and services, such as roads, lighting and waste removal. This in turn could lead to reduced emission of greenhouse gases through such measures as reduced demand for street lighting and greater reliance on public transport.

Agriculture

Agriculture has traditionally been a significant component of the Australian economy. It currently accounts for less than 4% of GDP, but is more important in trade terms, accounting for around 23% of total Australian merchandise exports. In real terms agricultural exports were worth $26.8 billion in 2004. Australia is the world's largest exporter of wool and beef, the second largest exporter of cotton, sheep meats and wheat, the third largest exporter of canola and barley, and a significant exporter of wine.

In spite of Australia's harsh environment, agriculture is the most extensive form of land use. At 30 June 2003, the estimated total area of establishments with agricultural activity was 439.5 million ha, representing about 57% of the total land area. The remainder of the land area consists of unoccupied land (mainly desert in western and central Australia), Aboriginal land reserves (located mainly in the Northern Territory and Western Australia), forests, mining leases, national parks and urban areas. Livestock grazing accounts for the largest area of land use in agriculture, with approximately 340 million ha, or over 75% of all agricultural land, being used for this activity. At 30 June 2003, approximately 5% of total agricultural land was under crops, with a further 5% under sown pastures and grasses. In 2003–04 the national sheep flock was 101 million and the beef cattle herd 27.5 million. Agricultural emissions are a relatively more important emission source for Australia than for most other OECD countries.

The agriculture sector is an important source of employment in regional and rural Australia. The number of people employed in agriculture and related services decreased slightly in 2004 to 345,700 persons, following a significant drop in 2003. The significant reduction in 2003 was largely the result of the drought experienced across Australia during that period, which severely affected the sector. Severe drought conditions across Australia more than halved wheat production, to 10.1 million tonnes in 2002–03.

Degradation problems persist in large areas of rural and regional Australia, limiting agricultural productivity in some regions and requiring costly management responses. Scientific evidence suggests that a number of degradation problems will probably become worse. A high proportion of Australian agricultural land is or will be in the relatively short term (the next 50 years) affected by at least one form of land degradation. Many of these forms of degradation—among them salinity and soil acidity—are insidious, having thresholds beyond which there is ecosystem collapse. A National Action Plan on Salinity and Water Quality in

Australia has been established to deal with these problems, while considerable work is also being undertaken on environmental management systems as a tool for reducing the environmental impacts of agriculture by improving farm management practices.

Forestry

Australia's forests are strikingly different from those of the rest of the world, ranging from tropical rainforests to mulga scrub. They are very diverse in their species composition, structure and the fauna they support. Many forest species are unique to Australia with more than 2,800 of the 3,000 tree species being endemic. Eucalypts dominate most forests, with more than 700 species found principally in Australia.

The total area of Australian native forest is about 163 million hectares (or about 21% of the continent). Most of this (122 million hectares) is woodland and mallee. Australia also has 1.7 million hectares of plantations, of which about 59% are introduced pines and 41% are native hardwood species, mostly eucalypts, with the proportion of native hardwood species in the national estate continuing to increase. Less than 1% of available area in native forests is harvested annually, while total plantation area increases each year.

Summary

Australia is extremely unusual among industrialised countries in its rapid population and economic growth, its changing land-use patterns and its reliance as a country on long-haul transport across vast distances, with its population concentrated in a small percentage of its overall territory. As an arid continent with very limited hydro-electric resources and no nuclear energy industry, it is reliant on its large, inexpensive fossil-fuel reserves for power generation. One of the world's leading mining nations, Australia has huge export demand for its energy commodities and energy-intensive materials. At the same time, its dependence on agriculture and the fragility of its environmental systems renders it vulnerable to the effects of climate change.

CHAPTER 3

NATIONAL GREENHOUSE GAS INVENTORY

The National Greenhouse Gas Inventory is an important tool in the development of climate change policy and a key means of appraising progress in implementing greenhouse response measures. It serves the dual purpose of providing greenhouse gas emission estimates for the United Nations Framework Convention on Climate Change (UNFCCC) and for tracking Australia's progress towards its internationally agreed target of limiting emissions to 108% of 1990 levels over the period 2008–12.

Consistent with its unique national circumstances, including the continuing importance of natural resource development to the economy, Australia has a distinctive profile of greenhouse gas emissions:

- energy-intensive primary energy production, minerals processing and transport continue to drive rapid growth in energy emissions
- emissions associated with agriculture are a significant component of the inventory.

Australia's inventory is compiled annually, reflecting international and national commitments. The most recent inventory covers the year 2003 and has been lodged with the UNFCCC Secretariat. This chapter provides a summary of the inventory results for the period 1990–2003.

Development of the National Greenhouse Gas Inventory

Australia has made, and will continue to make, a significant contribution to the Intergovernmental Panel on Climate Change (IPCC) in developing methodologies and good practice in preparing standardised inventories of greenhouse gas emissions. For example, in December 2005 Australia will host the final IPCC expert meeting for the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

The *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories* (IPCC 1997), the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Inventories* (IPCC 2000) and *Good Practice Guidance on Land Use, Land Use Change and Forestry* (IPCC 2003) provide the basis for the preparation of Australia's inventory. Australia has invested significant resources in developing country-specific inventory methodologies, which build upon and are fully consistent with the IPCC approach and reflect Australia's national circumstances.

The Australian sectoral methodologies have been developed and reviewed by a wide range of professional experts in research institutions, government agencies and industry, and by community interests. Development of the methodologies and preparation of the Inventory are overseen by an intergovernmental inventory committee.

The methodologies used to compile the 2003 inventory are published in a set of workbooks to ensure transparency. Full bibliographic details of Australia's methodology documentation are provided at the end of this chapter.

As part of the continuous improvement process for the inventory, the Australian Greenhouse Office (AGO), part of the Department of the Environment and Heritage, launched the Australian Greenhouse Emissions Information System (AGEIS) in May 2005. The AGEIS consolidates emissions estimation, reporting and data storage processes into a single system. It has consolidated Australia's emissions estimation methodologies and fully integrated quality control procedures into the compilation process. The system is also designed to enhance the accessibility and transparency of Australia's national and state greenhouse gas inventories, with emissions data from the AGEIS database publicly accessible through a dynamic web interface at http://www.ageis.greenhouse.gov.au.

The National Carbon Accounting Toolbox was also launched in 2005. The toolbox will assist land managers to monitor emissions effectively and to identify more sustainable (less emissions-intensive) land management practices. The toolbox provides access to the Full Carbon Accounting Model (FullCAM) that is used to construct Australia's national greenhouse gas emissions account for land-based activities (via the National Carbon Accounting System). For land managers, this will ensure that their project or regional emissions accounts are determined on a similar basis to Australia's official recording of emissions for the land sector.

Case study: Australian Greenhouse Emissions Information System—making Australia's inventory accessible

In 2005, Australia launched a publicly accessible dynamic web interface—the Australian Greenhouse Emissions Information System (AGEIS)—to enhance the transparency of its national and state greenhouse gas inventories.

The AGEIS can display emission estimates in the common unit of measurement—carbon dioxide equivalent (CO_2-e)—or for individual greenhouse gases. The user can also view emissions data compiled under both of the internationally accepted accounting standards for greenhouse gases—the Kyoto accounting standard and the United Nations Framework Convention on Climate Change accounting standard.

A series of drop-down menus enables users to answer general questions such as 'what are the emissions from fossil fuel combustion?', or more specific questions such as 'what are the emissions from the combustion of brown coal in the electricity industry?' The search tool can also be used to look for more detailed information.

The AGEIS is more than a database of emissions. Used to compile Australia's national emission inventories, the AGEIS integrates Australia's emissions estimation, quality control, documentation, and reporting systems.

Future development of the AGEIS will accommodate an extended series of national emission inventories, providing access to emissions data by both IPCC and industry classifications, and at the national and state level.

For further information go to http://www.ageis.greenhouse.gov.au.

Overview of national emissions

Australia's inventory provides a comprehensive inventory of human induced greenhouse gas emissions and sinks from the following sectors and subsectors:

- Energy (including Stationary Energy, Transport and Fugitive Emissions from Fuels)
- Industrial Processes
- Agriculture
- Land Use, Land Use Change and Forestry
- Waste.

According to the accounting rules for the 108% Kyoto target provisions, Australia's net emissions of greenhouse gases amounted to 544.1 million tonnes (Mt) carbon dioxide equivalent (CO_2-e) in 1990 and 550.0 Mt CO_2-e in 2003, an increase of 1.1%.

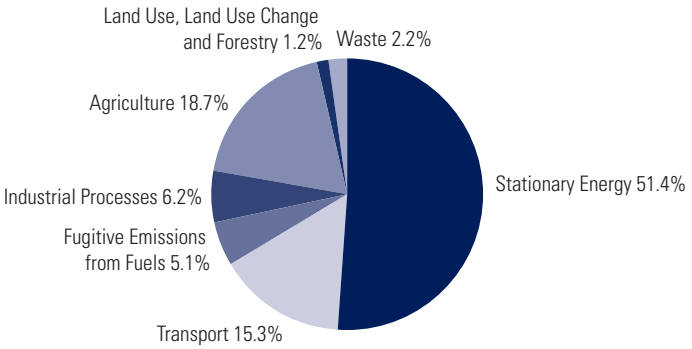
Following the international guidelines for preparation of national communications, this chapter on Australia's National Greenhouse Gas Inventory has been prepared in accordance with the inventory accounting rules that apply for the UNFCCC. However, there are some major differences between UNFCCC rules and the rules used for Kyoto targets, notably those for forestry sinks. This means that the emissions trends differ between the UNFCCC and the Kyoto target accounting methods.

Emissions estimates derived using Kyoto accounting provisions are given in Appendix A.

Emissions profile (UNFCCC accounting)

Energy related emissions (Stationary Energy, Transport and Fugitive Emissions from Fuels) dominate Australia's emissions profile, contributing 72% of total emissions in 2003. The Agriculture and Industrial Processes sectors also make a significant contribution to net greenhouse gas emissions, totalling about 25% (Figure 3.1).

Figure 3.1 Contribution to total CO_2-equivalent emissions by sector in Australia, 2003 (UNFCCC accounting)



Between 1990 and 2003 all sectors were net emitters. Table 3.1 summarises emissions and changes since 1990. Greater detail of subsectors is given in Table 3.8.

Table 3.1 Net greenhouse gas emissions and removals (Mt CO_2-e) by sector in Australia, 1990 and 2003 (UNFCCC accounting)

Sector	1990	2003	Change (Mt CO_2-e)
Energy	286.1	374.3	88.2
Stationary Energy	195.4	268.1	72.7
Transport	61.9	79.8	17.9
Fugitive Emissions from Fuels	28.8	26.4	–2.4
Industrial Processes	28.0	32.3	4.3
Agriculture	93.6	97.3	3.7
Land Use, Land Use Change and Forestry	93.6	6.1	-87.5
Waste	10.2	11.4	1.1
Total net national emissions	**511.5**	**521.4**	**9.9**

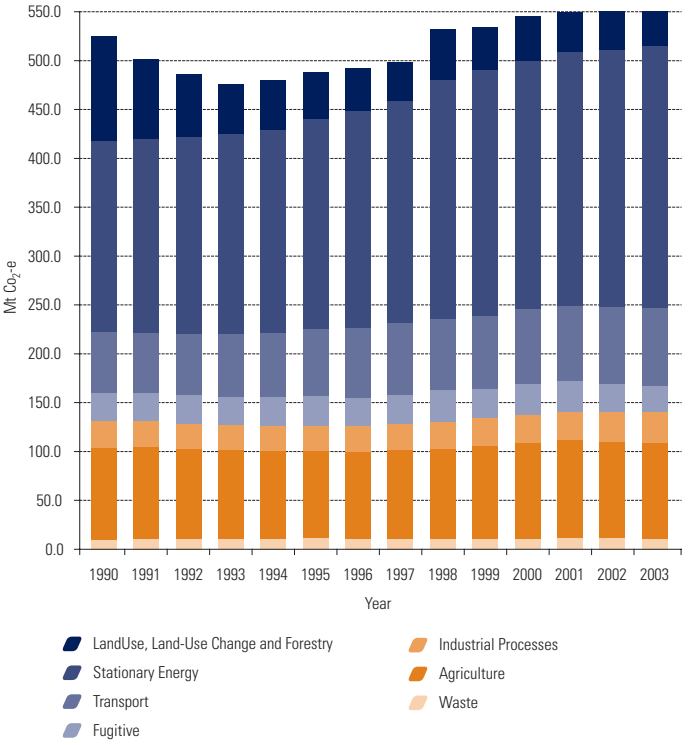
Following the IPCC guidelines, fuels used for international transport (international aviation and marine bunkers) are reported separately from the national inventory. In 2003, bunker fuels supplied in Australia for international transport generated 8.8 Mt CO_2-e.

The UNFCCC inventory estimates provided in the *Fourth National Communication* employ a new methodology for harvested wood products that has been incorporated into the 2005 emissions projections. This ensures alignment between the inventory and projections in this document. Although this methodology was not incorporated in the *2003 National Greenhouse Gas Inventory*, it will be reflected for the first time in the *2004 National Greenhouse Gas Inventory*.

Changes in emissions since 1990 (UNFCCC accounting)

According to the inventory accounting provisions of the UNFCCC, Australia's greenhouse gas emissions amounted to 511.5 Mt CO_2-e in 1990 and 521.4 Mt CO_2-e in 2003 (Figure 3.2).

Figure 3.2 Net greenhouse gas emissions (Mt CO_2-e) by sector in Australia, 1990 to 2003 (UNFCCC accounting



The largest increases in net emissions since 1990 have been in the Stationary Energy (37.2%) and Transport (28.8%) subsectors. Electricity generation comprises the majority of the increase in Stationary Energy subsector emissions, whilst within the Transport subsector, emissions from passenger vehicles, trucks and light commercial vehicles account for most of the increase.

Smaller increases occurred in the Waste (11.1%), Industrial Processes (15.2%) and Agriculture (4.0%) sectors. In the Industrial Processes sector, increases in emissions from the chemical industry and from hydrofluorocarbons (HFCs) were largely offset by reductions in perfluorocarbon (PFC) emissions from aluminium production and lower emissions from iron and steel production. Similarly, in the Agriculture sector an increase in emissions from crop production was partly offset by a decline in livestock emissions caused by

reductions in livestock numbers. The increase in Waste sector emissions, which can be related to an increase in population and per capita waste disposal, was somewhat less than the increase in population from 1990 to 2003, largely because of the effect of recovery of waste gas from landfills and wastewater facilities.

Fugitive Emissions from Fuels fell by 8.2% because the growth in emissions from coal, oil and natural gas production was more than offset by a decline in leakage from natural gas distribution and by the capture of coal mine waste gas.

Net emissions from Land Use, Land Use Change and Forestry fell by 93.5% between 1990 and 2003.

These changes reflect a 16.6% increase in Australia's population and a 51.9% increase in gross domestic product (GDP) during the same period. Emissions per dollar of real GDP declined by 32.9% during the same period. This falling trend in emissions per unit of GDP reflects both the result of specific emissions management actions across sectors and structural changes in the economy.

Australia has also reduced its per capita emissions, by 12.6%, or from 30.2 tonnes CO_2-e per capita in 1990 to 26.4 tonnes CO_2-e per capita in 2003. Australia's per capita emission level reflects a number of factors:

- the dominance of coal as a fuel in the electricity industry
- net emissions from the Land Use, Land Use Change and Forestry sector
- the impact of international trade patterns, which result in the production in Australia of many goods with high associated emissions levels—that is, resources and agricultural products—that are destined for export and consumption in other countries.

Emissions by greenhouse gas type (UNFCCC accounting)

Carbon dioxide (CO_2) makes the largest contribution to Australia's net emissions, accounting for 71.7% of all emissions in 2003 compared with 72.1% in 1990.

Methane (CH_4) accounted for 21.2% of total (CO_2-e) emissions in 2003, 1.2% less than its share in 1990.

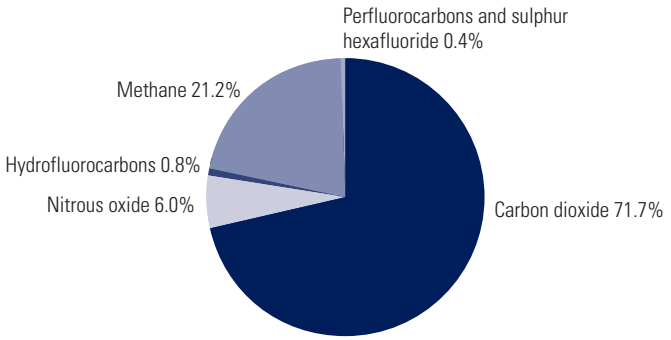
The share of nitrous oxide (N_2O) was 6.0% in 2003, 1.6% higher than in 1990.

Emissions of PFCs and sulphur hexafluoride (SF_6) declined by more than 55.3% between 1990 and 2003. Whilst emissions of HFCs increased by 282.6%, they represent less than 0.8% of Australia's greenhouse gas emissions. A detailed breakdown of the emissions contributions of the direct greenhouse gases for 1990 and 2003 is provided in Table 3.2 and Figure 3.3.

Table 3.2 Australia's net greenhouse gas emissions and changes (Mt CO_2-e), by gas, 1990 and 2003 (UNFCCC accounting)

Greenhouse gas	1990	2003	1990 Percentage of total	2003 Percentage of total	Change (Mt CO_2-e)
Carbon dioxide (CO_2)	369.0	373.6	72.1	71.7	4.6
Methane (CH_4)	114.6	110.3	22.4	21.2	–4.3
Nitrous oxide (N_2O)	22.3	31.2	4.4	6.0	8.9
Hydrofluorocarbons (HFCs)	1.1	4.3	0.2	0.8	3.2
Perfluorocarbons and sulphur hexafluoride (PFCs and SF_6)	4.5	2.0	0.9	0.4	–2.5
Total CO_2-e	**511.5**	**521.4**	**100.0**	**100.0**	**9.9**

Figure 3.3 Contribution to total net CO_2-equivalent emissions by gas in Australia, 2003 (UNFCCC accounting)



Carbon dioxide

The majority of CO_2 emissions in Australia (Table 3.3) arise from the combustion of fossil fuels. CO_2 emissions from energy-related sources totalled 345.8 Mt in 2003, of which Stationary Energy accounted for about 77% and Transport around 21%.

The largest single contributor to CO_2 emissions was electricity generation (which relies mainly on coal), followed by road transport.

In 2003, CO_2 emissions from Land Use, Land Use Change and Forestry were 47.7 Mt. This was partially offset by the uptake of carbon through the growth of forests. These net sinks accounted for about 45.8 Mt in 2003. This resulted in net CO_2 emissions of 1.8 Mt.

The overall increase in net CO_2 emissions from 1990 to 2003 was just over 1%. CO_2 emissions from the Energy sector were more than 33% higher in 2003 than in 1990.

Emissions from Stationary Energy were approximately 38% higher in 2003 than in 1990 due to increased demand for energy. Emissions from the Transport subsector increased by 24% over the same period. In contrast, Land Use, Land Use Change and Forestry emissions were 98% lower in 2003 than in 1990.

Table 3.3 Total CO_2 emissions and removals (Mt) by sector in Australia, 1990 and 2003 (UNFCCC accounting)

Sector[a]	1990	2003	Change (Mt)	Percentage change
Energy	258.5	345.8	87.3	33.8
Stationary Energy	192.8	266.0	73.1	37.9
Transport	59.7	74.0	14.3	24.0
Fugitive Emissions from Fuels	6.0	5.8	–0.2	–3.3
Industrial Processes	22.4	25.9	3.6	15.9
Land Use, Land Use Change and Forestry	88.1	1.8[b]	-86.3	-98.0
Total net emissions	**369.0**	**373.5**	**4.5**	**1.2**

[a] Carbon dioxide emissions are not recorded in the Agriculture sector and are negligible in the Waste sector.

[b] Net value: 47.7 Mt – 45.8 Mt to net sinks.

Methane

Australia's CH_4 emissions (Table 3.4) amounted to 5.3 Mt in 2003, equivalent to 110.3 Mt CO_2. This is a decrease of 4.3% since 1990.

The Agriculture sector accounted for around 66.8% of national CH_4 emissions in 2003. Livestock contributed 88% of Agriculture sector CH_4 emissions through enteric fermentation and the decomposition of animal wastes. Smaller quantities of CH_4 were generated through rice cultivation, burning of savannas to increase grass production and field burning of crop residues.

Livestock emissions were about 6% lower in 2003 than in 1990. This decline was the result of a reduction in sheep numbers due largely to a downturn in the wool industry. There have been some offsetting increases in cattle numbers and the area of cropping.

Fugitive Emissions from Fuels accounted for about 18.7% of national CH_4 emissions. About 80% of these fugitive emissions came from the mining of coal for domestic use and export. Fugitive emissions from coal mining have increased by 4.5% between 1990 and 2003. Notably, emissions have not increased as fast as coal production as there has been a shift to the less CH_4 intensive open-cut mines and an increase in gas recovery.

Another significant contributor to CH_4 emissions is the Waste sector, which accounted for 9.8% of the national total. More than 75% of the CH_4 emissions from the Waste sector were generated from anaerobic decomposition of organic matter in landfills. There was a 2.7% increase in Waste sector CH_4 emissions between 1990 and 2003.

Table 3.4 Total CH_4 emissions (Mt) by sector in Australia, 1990 and 2003 (UNFCCC accounting)

Sector	1990	2003	Change (Mt)	Percentage change
Energy	1.2	1.1	–0.13	–10.7
Stationary Energy	0.09	0.06	–0.03	–34.4
Transport	0.03	0.03	0.00	15.1
Fugitive Emissions from Fuels	1.1	1.0	–0.10	–9.5
Industrial Processes	0.003	0.003	0.000	0.7
Agriculture	3.6	3.5	–0.08	–2.3
Land Use, Land Use Change and Forestry	0.2	0.2	–0.04	–20.2
Waste	0.5	0.5	0.01	2.7
Total emissions	**5.5**	**5.3**	**–0.24**	**–4.3**

Nitrous oxide

Australia's N_2O emissions (Table 3.5) were 0.1 Mt in 2003, equivalent to 31.2 Mt CO_2. This was about 40% more than in 1990.

Agriculture accounted for 75.8% of national N_2O emissions. Most of this N_2O was produced from the application of fertiliser and animal wastes to agricultural soils. Burning of savannas to increase grass production, field burning of agricultural residues and manure management accounted for the balance. Agriculture sector N_2O emissions have increased by 29.8% between 1990 and 2003 due to increasing intensification of the livestock industries and increased application of fertilisers.

The Transport subsector accounted for 16.3% of the N_2O inventory. Emissions of N_2O from transport have more than doubled between 1990 and 2003 with additional vehicles using three-way catalytic converters.

Table 3.5 Total N_2O emissions (Mt) by sector in Australia, 1990 and 2003 (UNFCCC accounting)

Sector	1990	2003	Change (Mt)	Percentage change
Energy	0.008	0.020	0.012	153.6
Stationary Energy	0.002	0.003	0.0007	29.2
Transport	0.005	0.016	0.011	212.6
Fugitive Emissions from Fuels	0.0001	0.0001	0.0000	–38.1
Industrial Processes	0.0001	0.0001	0.0000	–24.3
Agriculture	0.059	0.076	0.018	29.8
Land Use, Land Use Change and Forestry	0.004	0.003	–0.0009	–22.5
Waste	0.002	0.002	0.0003	16.6
Total emissions	**0.072**	**0.101**	**0.029**	**40.0**

Synthetic gases

Most emissions of PFCs in Australia are generated during aluminium production. Better management of the aluminium smelting process and a production shift to smelters with lower PFC emission rates has resulted in emissions declining from about 3.9 Mt CO_2-e in 1990 to 1.5 Mt CO_2-e in 2003, a fall of about 63%, despite an increase in aluminium production of 65% (1.2 Mt of aluminium in 1990 to 1.9 Mt in 2003).

Emissions of HFCs have increased by 283% between 1990 and 2003. HCFC-22 was produced in Australia from 1990 to 1995 and by-product emissions of HFC-23 resulting from that production peaked at 1.5 Mt CO_2-e in 1993. The use of HFCs in Montreal Protocol Industries commenced in 1994, and estimated emissions from this source increased to 4.3 Mt in 2003.

Emissions of SF_6 from the electricity supply industry are estimated to be constant at 0.5 Mt CO_2-e. Between 1996 and 2000 a small quantity SF_6 was used as a cover gas in experimental work on magnesium casting.

Indirect greenhouse gases

Emissions of the indirect greenhouse gases—carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2)—are reported under UNFCCC guidelines, but as they have not been allocated global warming potentials they are not included within Australia's aggregate emissions. Emissions of indirect greenhouse gases are summarised in Table 3.6. Compared with 1990, there has been an increase in the emissions of NO_x, CO and SO_2 (0.5 Mt (24.0%), 2.2 Mt (9.9%) and 1.1 Mt (68.2%), respectively) while NMVOC emissions have changed negligibly. These gases are emitted from some industrial processes and during the burning of fossil fuels and biomass.

Table 3.6 Total emissions (Mt) of indirect greenhouse gases in Australia, 1990 and 2003 (UNFCCC accounting)

	1990	2003	Percentage change
Nitrous oxides (NO_x)	2.0	2.5	24.0
Carbon monoxide (CO)	22.2	24.4	9.9
Non-methane volatile organic compounds (NMVOC)	2.45	2.45	0.2
Sulphur dioxide (SO_2)	1.7	2.8	68.2

Case study: National Carbon Accounting System Toolbox and Data Viewer—assistance for land managers

Building on the success of the National Carbon Accounting System (NCAS), the NCAS Toolbox and Data Viewer provides greenhouse gas emissions and land management information for natural resource management planning.

The toolbox assists land managers to effectively monitor emissions and identify less emissions intensive land management practices through access to a complete set of tools that track greenhouse gas emissions and carbon stock changes.

Coupled with the toolbox is a data viewer that contains satellite images providing a unique visual record of landscape and vegetation change in Australia since 1972.

With the data viewer, users can zoom into any area of the continent and compare satellite images and climatic data between different years, as well as climate statistics for each region.

Further information about the NCAS Toolbox and Data Viewer can be found at: http://www.greenhouse.gov.au/ncas.

Methodology

Changes since the *Third National Communication*

There have been a number of changes to the Australian National Greenhouse Gas Inventory methodology and improvements in input data since Australia's *Third National Communication*, submitted in 2002. The emissions calculated for 1990, for example, are about 2% higher than those previously reported.

The reasons for the emissions recalculations are as follows:

- inclusion of synthetic gases
- addition of new source categories
- improvements in methodology
- revision of data values (i.e. better data have been obtained, or estimated values have been over-written with actual data)
- revision of data series
- the correction of previous computational errors.

These have been described in detail in the *2003 National Inventory Report*.

Reporting, averaging and adjustments

The majority of the Australian inventory is compiled on an Australian financial (statistical) year basis, which runs from July to June. For example, 2003 refers the period from 1 July 2002 to 30 June 2003.

Emissions estimates from the Agriculture, Land Use, Land Use Change and Forestry, and Waste sectors embody some data for more than a single year, either through algorithms that relate emissions in a given year to activity in previous years or through the averaging of annual inventory data. For example, emission estimates for the Agriculture sector represent a three-year average. In the 2003 inventory, agricultural emissions are based on two-year averages only, since data for 2004 are not yet available.

There are no adjustments to sectoral emissions estimates for climate or any other factors.

Quality assurance and quality control

Quality assurance processes for the national inventory are broadly based. A key element of the arrangements is the National Greenhouse Gas Inventory Committee, which comprises representatives of the Australian Government and state and territory governments and has been in place since the early 1990s. The committee is the principal mechanism of review for the inventory before its release. Before it is submitted, the inventory is also circulated to other Australian Government departments and agencies and relevant state experts through the National Greenhouse Gas Inventory Committee.

The role of the AGEIS in the inventory preparation process is central to Australia's quality assurance/quality control (QA/QC) plan. Key Tier 1 QA/QC procedures for the inventory compilation process have been systematically built into the operation of the AGEIS. Systematic and auditable checks are undertaken inter alia to reduce the risks or errors associated

with the input of activity data, missing data, the implementation of estimation methodologies, recalculations and the time series consistency of generated emissions estimates.

Tier 2 QA/QC checks are also implemented, and quality control of activity data is managed by the source agencies.

The estimates of uncertainty surrounding emission data are also reported as part of the Australian Greenhouse Gas Inventory. Consistent with required IPCC Tier 1 QC checks, these estimates are currently reviewed under a protocol developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research (CMAR) division.

Uncertainty

Uncertainties in estimation of greenhouse gas emissions in some areas of the inventory arise from three main sources:

- uncertainties surrounding basic input data
- imperfect understanding of the basic processes resulting in greenhouse gas emissions and sinks
- the application of average conditions across very different environments.

Uncertainties at the sectoral level are estimated using a mix of expert judgement and more rigorous quantitative analysis (Monte Carlo techniques). These have been combined to present an estimate of the overall uncertainty for the inventory as a whole using the IPCC Tier 1 approach.

Uncertainty in the emissions estimates for each sector or subsector can be summarised as follows:

- Stationary Energy and Transport—less than 10% for estimates of CO_2 and more than 20% for other gases
- Fugitive Emissions from Fuels—5–20%
- Industrial Processes—10–30%
- Agriculture—10–more than 80%
- Land Use, Land Use Change and Forestry—20–60%
- Waste—50%.

The estimated uncertainty surrounding the aggregate inventory estimate for 2003 is ±5%.

Methodology documentation

National Greenhouse Gas Inventory Committee (NGGIC), 2005a, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Energy (Stationary Energy)*, Canberra.

2005b, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Energy (Transport)*, Canberra.

2005c, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Energy (Fugitive Emissions)*, Canberra.

2005d *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Industrial Processes*, Canberra.

2005e *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Solvents*, Canberra.

2005f *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Agriculture*, Canberra.

2005g *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use Change and Forestry*, Canberra.

2005h *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry (Plantations)*, Canberra.

2005i, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: National Carbon Accounting System (NCAS)*, Canberra.

2005j, *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Waste*, Canberra.

Table 3.7 Greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 2003

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (net emissions)	**373,575.59**	**110,294.50**	**31,198.65**	**4,309.02**	**1,472.05**	**521.02**	**521,370.83**
1. Energy	**345,770.51**	**22,462.86**	**6,049.71**				**374,283.09**
A. Fuel combustion (sectoral approach)	340,004.36	1,845.10	6,027.44				347,876.89
1. Energy industries	208,302.60	219.38	654.92				209,176.90
2. Manufacturing industries and construction	39,117.20	41.71	202.47				39,361.38
3. Transport	74,033.42	639.97	5,098.77				79,772.15
4. Other sectors	17,280.43	943.07	65.82				18,289.32
5. Other	1,270.71	0.97	5.46				1,277.14
B. Fugitive Emissions from Fuels	5,766.16	20,617.77	22.27				26,406.19
1. Solid fuels	NE	16,534.08	0.00				16,534.08
2. Oil and natural gas	5,766.16	4,083.69	22.27				9,872.12
2. Industrial Processes	**25,913.69**	**69.63**	**20.27**	**4,309.02**	**1,472.05**	**521.02**	**32,305.69**
A. Mineral products	5,384.17	NA	NA				5,384.17
B. Chemical industry	952.11	9.17	IE	NA	NA	NA	961.28
C. Metal production	13,866.07	60.46	20.27		1,472.05	NE	15,418.85
D. Other production	NE						NE
E. Production of halocarbons and sulphur hexafluoride				NO	NO	NO	NO
F. Consumption of halocarbons and sulphur hexafluoride				4,309.02	NE	521.02	4,830.04
G. Other	5,711.34	NA	NA	NA	NA	NA	5,711.34
3. Solvent and other product use	**NA**		**NE**				**NE**
4. Agriculture	**NA**	**73,624.87**	**23,655.77**				**97,280.64**
A. Enteric fermentation		62,748.00					62,748.00
B. Manure management		2,047.53	1,286.11				3,333.64
C. Rice cultivation		400.09					400.09
D. Agricultural soils	NA	NE	18,716.27				18,716.27
E. Prescribed burning of savannas		8,220.15	3,564.33				11,784.48
F. Field burning of agricultural residues		209.10	89.07				298.17
G. Other		NA	NA				NA
5. Land Use, Land Use Change and Forestry[a]	**1,875.09**	**3,351.40**	**914.26**				**6,140.74**
A. Forest Lands	-45,799.98	1,826.47	497.46				-43,476.05
B. Cropland	0.00	0.00	0.00				0.00
C. Grassland	47,675.07	1,524.93	416.80				49,616.80
D. Wetlands	0.00	0.00	0.00				0.00
E. Settlements	0.00	0.00	0.00				0.00
F. Other Land	0.00	0.00	0.00				0.00
6. Waste	**16.30**	**10,785.74**	**558.64**				**11,360.68**
A. Solid waste disposal on land	NE	8,141.48					8,141.48
B. Wastewater handling		2,644.26	558.64				3,202.89
C. Waste incineration	16.30	NE	NE				16.30
D. Other	NA	NA	NA				NA

Table 3.7 Greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 2003 (continued)

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
7. Other (please specify)	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
Memo items:							
International bunkers	8,837.18	2.90	80.17				8,920.25
Aviation	6,615.32	0.56	61.10				6,676.97
Marine	2,221.86	2.35	19.07				2,243.27
Multilateral operations	NE	NE	NE				NE
Carbon dioxide (CO_2) emissions from biomass	15,947.94						15,947.94

a The data presented in Table 3.7 differs from that presented in the *2003 National Inventory Report* due to the implementation of a refined methodology for Forest Lands, see *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry (Plantations)*

Table 3.8 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 1990 to 2003

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	286,067.71	286,067.71	287,933.10	293,997.96	296,884.21	301,909.52	313,279.77	322,958.21	330,742.66	349,150.70	356,307.23	363,563.15	368,010.77	370,069.48	374,283.09
A. Fuel combustion (sectoral approach)	257,294.72	257,294.72	259,922.70	264,871.19	268,594.00	273,044.17	283,020.14	293,457.09	300,801.47	317,283.17	326,188.13	331,575.20	336,756.10	340,892.86	347,876.89
1. Energy industries	142,282.25	142,282.25	145,790.84	149,018.63	150,295.05	151,336.13	157,334.23	163,933.98	170,096.62	185,562.12	189,970.63	193,332.46	199,174.45	202,851.56	209,176.90
2. Manufacturing industries and construction	37,590.47	37,590.47	36,948.68	36,887.76	37,345.62	38,799.48	39,392.64	40,582.33	39,699.95	40,522.21	43,898.56	43,174.67	42,310.01	39,607.42	39,361.38
3. Transport	61,911.31	61,911.31	61,582.90	62,936.89	64,402.68	66,226.14	69,090.68	71,602.80	73,154.84	73,492.19	74,658.71	77,021.09	77,051.12	79,069.58	79,772.15
4. Other sectors	14,324.53	14,324.53	14,442.60	14,826.98	15,320.49	15,385.98	15,790.01	15,812.39	16,303.10	16,380.05	16,420.99	16,764.25	16,860.15	18,018.02	18,289.32
5. Other	1,186.16	1,186.16	1,157.68	1,200.93	1,230.16	1,296.44	1,412.58	1,525.59	1,546.95	1,326.60	1,239.23	1,282.74	1,360.37	1,346.28	1,277.14
B. Fugitive Emissions from Fuels	28,773.00	28,773.00	28,010.40	29,126.77	28,290.21	28,865.35	30,259.64	29,501.11	29,941.19	31,867.54	30,119.10	31,987.95	31,254.67	29,176.62	26,406.19
1. Solid fuel	15,816.36	15,816.36	15,979.04	16,604.39	16,611.41	17,392.34	17,480.17	17,786.50	18,176.44	20,048.78	18,969.85	19,638.07	18,445.52	17,456.28	16,534.08
2. Oil and natural gas	12,956.64	12,956.64	12,031.36	12,522.38	11,678.80	11,473.01	12,779.46	11,714.61	11,764.75	11,818.76	11,149.24	12,349.87	12,809.16	11,720.34	9,872.12
2. Industrial Processes	28,040.78	28,040.78	27,502.32	25,495.02	25,822.01	26,196.85	25,936.24	25,900.56	26,074.64	27,743.21	28,004.00	28,134.64	29,726.18	29,999.83	32,305.69
A. Mineral products	4,825.64	4,825.64	4,508.72	4,329.46	4,538.74	5,237.80	5,047.73	5,091.60	5,023.59	5,438.55	5,353.54	5,155.38	5,146.66	5,215.57	5,384.17
B. Chemical industry	512.89	512.89	486.24	642.40	670.65	680.87	806.50	846.73	886.30	1,089.40	785.00	897.24	1,025.27	943.50	961.28
C. Metal production	18,690.86	18,690.86	18,626.64	16,555.81	15,301.67	15,435.75	15,179.62	15,255.45	15,009.67	15,267.02	15,474.30	14,948.10	14,965.85	14,320.86	15,418.86
D. Other production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of halocarbons and sulphur hexafluoride	1,126.27	1,126.27	1,126.27	1,053.94	1,446.59	811.70	718.85	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and sulphur hexafluoride	521.02	521.02	521.02	521.02	521.02	528.51	726.04	1,075.80	1,553.48	2,147.48	2,710.34	3,239.74	3,778.81	4,283.49	4,830.04
G. Other	2,364.10	2,364.10	2,233.42	2,392.39	3,343.34	3,502.23	3,457.50	3,630.99	3,601.60	3,800.76	3,680.81	3,894.19	4,809.58	5,236.40	5,711.34
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	93,555.11	93,555.11	93,803.34	92,286.74	91,107.88	90,013.32	89,614.41	89,366.89	91,614.61	92,833.60	95,317.76	98,198.79	100,114.32	98,611.86	97,280.64
A. Enteric fermentation	67,512.63	67,512.63	67,736.04	66,465.79	65,026.00	63,489.39	62,995.06	62,746.53	63,259.13	63,234.89	64,024.23	64,356.06	64,811.65	63,298.87	62,748.00
B. Manure management	2,061.13	2,061.13	2,119.21	2,235.01	2,390.42	2,527.21	2,655.17	2,643.10	2,819.19	2,978.71	3,185.92	3,291.28	3,347.22	3,361.86	3,333.64
C. Rice cultivation	490.50	490.50	523.78	540.22	602.42	606.24	648.74	704.74	723.17	724.59	670.74	741.36	737.83	589.29	400.09
D. Agricultural soils	15,178.92	15,178.92	15,311.99	15,204.68	15,495.16	15,616.59	15,446.58	15,267.65	16,282.47	17,150.11	18,155.68	19,030.14	19,412.31	19,223.66	18,716.27
E. Prescribed burning of savannas	8,040.04	8,040.04	7,849.82	7,573.97	7,307.12	7,487.91	7,571.96	7,686.10	8,174.04	8,374.74	8,915.48	10,405.50	11,422.18	11,812.02	11,784.48
F. Field burning of agricultural residues	271.90	271.90	262.49	267.08	286.76	285.98	296.90	318.76	356.62	370.56	365.72	374.44	383.13	326.17	298.17
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA

Table 3.8 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 1990 to 2003 (continued)

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
5. Land Use, Land Use Change and Forestry [a]	93,627.91	93,627.91	68,306.71	50,309.01	36,587.45	33,705.06	30,328.45	25,679.34	20,138.97	31,529.78	17,261.82	19,483.50	13,800.21	20,610.97	6,140.74
A. Forest Lands	-32,547.87	-32,547.87	-32,999.00	-34,189.65	-34,516.37	-34,287.92	-34,105.76	-35,857.68	-37,579.09	-39,790.99	-40,568.73	-40,071.71	-39,563.53	-39,950.17	-43,476.07
B. Cropland	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
C. Grassland	126,175.78	126,175.78	101,305.72	84,498.66	71,103.81	67,992.98	64,434.21	61,537.01	57,718.06	71,320.77	57,830.55	59,555.21	53,363.73	60,561.14	49,616.80
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	10,229.88	10,229.88	10,569.70	10,709.08	10,977.19	10,838.37	11,235.35	10,483.80	10,670.54	10,464.95	10,896.40	11,076.85	11,345.10	11,708.93	11,360.68
A. Solid waste disposal on land	7,472.31	7,472.31	7,774.35	7,878.50	8,115.11	7,947.33	8,308.01	7,520.11	7,667.07	7,430.69	7,828.52	7,973.82	8,204.09	8,526.30	8,141.48
B. Waste-water handling	2,745.99	2,745.99	2,783.77	2,818.99	2,850.49	2,879.46	2,910.51	2,950.16	2,986.52	3,017.13	3,050.40	3,086.72	3,124.71	3,166.32	3,202.89
C. Waste incineration	11.58	11.58	11.58	11.58	11.58	11.58	16.83	13.53	16.94	17.13	17.49	16.30	16.30	16.30	16.30
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA
7. Other (please specify)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total emissions/removals with land use, land use change and forestry	511,521.39	511,521.39	488,115.17	472,797.80	461,378.74	462,663.13	470,394.22	474,388.79	479,241.42	511,722.25	507,787.21	520,456.93	522,996.58	531,001.07	521,370.83
Total emissions without land use, land use change and forestry	417,893.48	417,893.48	419,808.46	422,488.79	424,791.29	428,958.07	440,065.77	448,709.45	459,102.45	480,192.47	490,525.39	500,973.43	509,196.37	510,390.09	515,230.10
Memo items:															
International bunkers	6,400.97	6,400.97	6,378.80	6,584.40	6,987.84	7,361.83	8,532.60	9,030.65	9,059.30	9,449.69	9,718.28	10,099.67	10,625.28	8,603.39	8,837.12
Aviation	4,345.12	4,345.12	4,520.39	4,795.71	5,199.38	5,349.80	5,857.66	6,311.70	6,540.10	7,232.89	7,268.09	7,330.88	8,151.32	6,392.44	6,615.32
Marine	2,055.85	2,055.85	1,858.42	1,788.69	1,788.46	2,012.03	2,674.93	2,718.95	2,519.20	2,216.80	2,450.19	2,768.79	2,473.96	2,210.95	2,221.80
Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Carbon dioxide emissions from biomass	15,112.99	15,112.99	14,964.91	13,664.99	15,317.65	16,227.76	17,071.01	17,114.32	18,998.78	19,321.49	19,580.00	19,263.31	18,254.75	15,465.63	15,947.94

a The data presented in Table 3.8 differs from that presented in the *2003 National Inventory Report* due to the implementation of a refined methodology for Forest Lands, see *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry (Plantations)*

Table 3.9 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2) -equivslent) by gas in Australia, 1990 to 2003

Greenhouse gas emissions	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net carbon dioxide (CO_2) emissions/removals	369,011.31	369,011.31	345,604.72	331,105.57	322,184.78	325,223.20	332,198.02	337,801.12	338,907.79	367,498.16	362,568.63	370,352.22	370,870.85	379,920.40	373,575.59
CO_2 emissions (without land use, land use change and forestry)	280,885.87	280,885.87	282,401.24	285,217.36	289,676.04	295,564.31	305,606.00	315,788.22	322,492.48	339,715.63	348,954.84	354,372.98	360,632.54	363,810.08	371,700.52
Methane (CH_4)	114,633.00	114,633.00	114,253.08	113,512.90	111,204.85	110,511.88	111,523.75	110,302.60	112,182.93	113,784.07	113,049.68	115,625.86	115,821.90	113,716.89	110,294.50
Nitrous oxide (N_2O)	22,291.51	22,291.51	22,668.61	22,669.27	23,188.43	23,740.28	23,918.50	24,003.88	25,546.56	26,895.55	28,476.56	30,135.90	30,969.05	31,573.11	31,198.65
Hydrofluorocarbons (HFCs)	1,126.27	1,126.27	1,126.27	1,053.94	1,446.59	819.19	923.87	546.17	1,026.48	1,622.81	2,185.74	2,716.33	3,257.79	3,762.47	4,309.02
Perfluorocarbons (PFCs)	3,938.28	3,938.28	3,941.47	3,935.10	2,833.07	1,847.57	1,309.06	1,205.39	1,050.67	1,396.99	981.99	1,103.21	1,555.97	1,507.17	1,472.05
Sulphur hexafluoride (SF_6)	521.02	521.02	521.02	521.02	521.02	521.02	521.02	529.62	527.00	524.68	524.61	523.41	521.02	521.02	521.02
Total (with net CO_2 emissions/removals)	**511,521.39**	**511,521.39**	**488,115.17**	**472,797.80**	**461,378.74**	**462,663.13**	**470,394.22**	**474,388.79**	**479,241.42**	**511,722.25**	**507,787.21**	**520,456.93**	**522,996.58**	**531,001.07**	**521,370.83**
Total (without CO_2 from land use, land use change and forestry)	**423,395.95**	**423,395.95**	**424,911.69**	**426,909.59**	**428,870.00**	**433,004.24**	**443,802.20**	**452,375.89**	**462,826.12**	**483,939.73**	**494,173.42**	**504,477.68**	**512,758.27**	**514,890.74**	**519,495.76**

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	286,067.71	286,067.71	287,933.10	293,997.96	296,884.21	301,909.52	313,279.77	322,958.21	330,742.66	349,150.70	356,307.23	363,563.15	368,010.77	370,069.48	374,283.09
2. Industrial Processes	28,040.78	28,040.78	27,502.32	25,495.02	25,822.01	26,196.85	25,936.24	25,900.56	26,074.64	27,743.21	28,004.00	28,134.64	29,726.18	29,999.83	32,305.69
3. Solvent and other product use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4. Agriculture	93,555.11	93,555.11	93,803.34	92,286.74	91,107.88	90,013.32	89,614.41	89,366.89	91,614.61	92,833.60	95,317.76	98,198.79	100,114.32	98,611.86	97,280.64
5. Land Use, Land Use Change and Forestry [a]	93,627.91	93,627.91	68,306.71	50,309.01	36,587.45	33,705.06	30,328.45	25,679.34	20,138.97	31,529.78	17,261.82	19,483.50	13,800.21	20,610.97	6,140.74
6. Waste	10,229.88	10,229.88	10,569.70	10,709.08	10,977.19	10,838.37	11,235.35	10,483.80	10,670.54	10,464.95	10,896.40	11,076.85	11,345.10	11,708.93	11,360.68
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

a The data presented in Table 3.9 differs from that presented in the *2003 National Inventory Report* due to the implementation of a refined methodology for Forest Lands, see *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Land Use, Land Use Change and Forestry (Plantations)*

Policy-making process

Australia's *Third National Communication* under the United Nations Framework Convention on Climate Change (UNFCCC) set out progress on the implementation of policies and measures to reduce greenhouse gas emissions between 1997 and 2002. It addressed measures set out in the Commonwealth, and state and territory governments' National Greenhouse Strategy. In 2004, the Australian Government announced its new Climate Change Strategy to build on those past achievements and provide a framework for action over the longer term. The Australian Government has now committed almost $1.8 billion to policies and measures to address climate change, which, along with additional funding and initiatives by the state and territory governments, reaffirms Australia's commitment to an effective greenhouse response.

The Climate Change Strategy provides the strategic framework for advancing Australia's greenhouse response to meet the Kyoto emissions target and beyond 2012. It is a comprehensive strategy, covering all sectors of the Australian economy, including Australia's important and growing energy sector, and it uses a mix of complementary policy instruments. The strategy provides a range of integrated measures that streamline and strengthen the Australian Government's approach to climate change, drawing on lessons learned from implementation of earlier initiatives.

These measures focus action in three strategic areas:

- international engagement—pursuing an effective global response to climate change
- emissions management—leading Australia's commitment to its Kyoto Protocol target and a lower greenhouse signature in the longer term
- foundation—providing the foundations for Australia's climate change response, including understanding and preparing for the impacts of climate change.

Internationally, the Australian Government is pursuing a multi-pronged strategy, including action at the multilateral, regional and bilateral levels to both influence the broader global policy agenda, and to support practical action to address climate change. Australia is engaged actively in multilateral climate change negotiations and processes, such as the UNFCCC and the Intergovernmental Panel on Climate Change (IPCC), helping to build the capacity of developing countries to take effective climate change action, and expanding bilateral partnerships with countries such as the United States, China, New Zealand and Japan, and with the European Union. At the regional level, Australia has joined China, India, Japan, the Republic of Korea and the United States to form the new Asia–Pacific Partnership on Clean Development and Climate, to develop, deploy and transfer the cleaner, more efficient technologies that the world will need to make the required deep cuts in global greenhouse gas emissions.

The Australian Government has not ratified the Kyoto Protocol, as it considers that the Protocol will not be environmentally effective and will not meet Australia's long-term interests given that it does not provide for engagement in emissions reductions in all countries where substantial greenhouse gas emissions occur. Nevertheless, the Australian Government recognises that Australia is exposed to the potential impacts of climate change, and remains committed to meeting its emissions target agreed in the Kyoto Protocol negotiations of 108% of net 1990 emissions levels over the period 2008–12. The Australian Government continues to play a leading role within the international community to develop a global response to climate change that is environmentally effective, economically efficient and equitable, involves all major emitters, and takes into account different national circumstances.

Most of the funding under the recently developed Climate Change Strategy is for policies and measures aimed at limiting and reducing greenhouse gas emissions. This chapter sets out these emissions reduction measures, along with those of state and territory governments. At this time, Australian Government activity is focused on completing established measures, and implementing new policies and measures contained under the strategy; as such, this document does not report on any *planned* policies or measures.

The Australian Government's Climate Change Strategy is also providing the foundations for a long-term response to climate change through actions that include building Australia's understanding of the science of climate change, and managing the risks, capturing the opportunities and preparing for the impacts of climate change. Under the strategy, the Australian Government is investing in measures to identify, assess and adapt to the unavoidable consequences of climate change. Further information about these initiatives is set out in Chapter 6—Vulnerability assessment, climate change impacts and adaptation, Chapter 8—Research and systematic observation, and Chapter 9—Education, training and public awareness.

The Climate Change Strategy is articulated through measures contained in the 2004–05 Federal Budget and the Australian Government's new energy policy, the 2004 Energy White Paper *Securing Australia's Energy Future*, reflecting the close integration of policy on energy and greenhouse issues. It includes:

- $463 million over four years for 11 new measures and a number of continuing emissions management programmes (2004–05 Federal Budget)
- $749 million in funding for low emissions and renewable energy technologies (Energy White Paper).

The Climate Change Strategy was developed in consultation with the Australian community, including industry. The Australian Government also consults widely in the implementation of individual policies and measures. More information about this process is included in Chapter 9—Education, training and public awareness.

Given Australia's federal system of government, state and territory governments are also an important part of Australia's climate change response. States and territories are responsible for addressing a range of climate change issues, such as: waste management strategies; planning and development of power plants; promoting the uptake of renewable energy; land use and transport planning; and vegetation management. All Australian states and territories have either implemented or are currently reviewing or developing greenhouse strategies that cover the climate change issues that fall under their jurisdiction. State and territory governments have made a substantial investment in programmes to reduce greenhouse gas emissions.

For example, in 2002, the Victorian Government launched the Victorian Greenhouse Strategy and began implementing a three-year programme of action to reduce greenhouse gas emissions across a range of sectors in that state. In 2005, the Victorian Government released an Action Plan Update, which acknowledges recent developments in state, national and international policy settings; builds on the actions and commitments initiated by the state greenhouse strategy; and advances action on both emissions abatement and adaptation. The Action Plan Update includes specific policies and programmes to: position Victoria's economy for a low carbon future; enable communities to shape their future through action on abatement and adaptation; transform urban areas for sustainability; and reduce net emissions from land management in rural Victoria. It also complements action being taken at the Australian Government level, extending elements of the Cities for Climate Protection™ Australia programme (CCP™ Australia) and TravelSmart initiatives under the Australian Government's Local Greenhouse Action measure.

Implementation of national, state and territory strategies requires a coordinated approach within and between all jurisdictions. Within the national government, the Sustainable Environment Committee of Cabinet, chaired by the Prime Minister, ensures that environmental considerations are central to decisions on economic growth and development. Implementation of the Climate Change Strategy is a whole-of-government task managed by the Australian Greenhouse Office (AGO), within the Department of the Environment and Heritage, and involving extensive coordination of relevant Australian Government portfolios, notably the Industry, Tourism and Resources, and the Agriculture, Fisheries and Forestry portfolios.

There is also considerable coordination between the Australian Government and state and territory governments on measures addressing climate change, although policy differences between jurisdictions are significant in some areas. Previously, as reported in Australia's *Third National Communication*, a High Level Group on Greenhouse of senior officials from all levels of government managed the implementation, monitoring, and review of the National Greenhouse Strategy, reporting to the Council of Australian Governments (COAG). In June 2005, COAG agreed to establish a new Senior Officials Group to consider ways to further improve investment certainty for business, encourage renewable energy and enhance cooperation in areas such as technology development, energy efficiency and adaptation.

Climate change issues requiring national coordination are also managed through a number of inter-governmental ministerial councils, including:

- the Ministerial Council on Energy
- the Ministerial Council on Natural Resource Management
- the Australian Transport Council
- the Environment Protection and Heritage Council
- the Primary Industries Ministerial Council.

A variety of mechanisms are used to review the performance of Australian Government policies and measures to reduce greenhouse gas emissions. For example, the AGO analyses the performance of all emissions reduction policies and measures. Greenhouse gas emissions projections are updated annually, each sector being revised once every 2 years. This review is overseen and endorsed by an interdepartmental committee comprising Australian Government agencies such as the Department of Industry, Tourism and Resources, the Department of the Treasury, and the Department of the Prime Minister and Cabinet. Through this process, the AGO derives an estimate of the total abatement that will be achieved from all relevant policies and measures.

The performance of Australian Government policies and measures is also assessed regularly through a programme evaluation process (typically every 3–4 years). It is also standard practice that the performance of all Australian Government agencies is reviewed regularly. This occurs through a range of existing mechanisms, including those overseen by the Australian National Audit Office.

The Australian Government, and state and territory governments, use a variety of monitoring and evaluation tools for reviews. To enable effective assessment of progress against outputs and achievement of the Australian Government's overarching climate change outcomes, a new set of performance indicators and a new business reporting framework have been implemented. This will enable consistent analysis and reporting against performance targets.

The latest emissions projections released in 2004 indicate that Australia is on track to meet its Kyoto Protocol target, with climate change policies and measures projected to reduce greenhouse gas emissions by 85 million tonnes (Mt) of carbon dioxide equivalent (CO_2-e) in 2010. The Australian Government will continue to review its climate change policies and measures and to develop new measures in the future as appropriate.

Case study: 2004 Energy White Paper *Securing Australia's Energy Future*— integrating energy and greenhouse policy

Australia's Energy White Paper, *Securing Australia's Energy Future*, comprehensively reviews Australia's energy policies and approaches, and provides a framework for a sustainable energy future.

Reflecting the close integration of policy on energy and greenhouse issues, *Securing Australia's Energy Future* provides a framework for the management of Australia's energy resources and energy markets, and identifies new policies and measures to improve the performance of the energy sector. This framework is supported by $749 million for low emissions and renewable energy technologies, which, together with $463 million for new and continuing emissions management programmes announced in the 2004–05 Federal Budget, underpins Australia's Climate Change Strategy.

The Australian Government places a high priority on improving energy efficiency in Australia and, through the White Paper, acknowledges that this is the most cost-effective way to lower Australia's greenhouse gas emissions. The White Paper also provides substantial support for new technology development, including renewable energy technologies and demonstration activities, that will reduce Australia's greenhouse gas emissions over the longer term.

Securing Australia's Energy Future sets out policies and principles that will guide the production and use of energy in Australia well into the 21st century.

For further information, go to http://www.dpmc.gov.au/publications/energy_future/index.htm .

Policies and measures and their effects

The overview of policies and measures is organised according to sector and subsector, with specific references to the individual greenhouse gases limited or reduced by a policy or measure, or a collection of policies and measures, and the expected abatement in 2010 from some of the more significant policies and measures. In some cases the estimated abatement in 2010 is calculated as the average annual abatement for the measure over the period 2008–2012. A summary of Australia's policies and measures, including quantitative estimates of abatement from all policies and measures, is presented in Table 4.1 at the end of this chapter. Abatement for a number of new measures in the Stationary Energy subsector has not been estimated as the projections for this subsector were last updated in 2004. A summary of policies and measures is also presented according to greenhouse gases mitigated in Appendix B.

Cross-sectoral

A number of strategic partnerships between the various levels of government, industry and the wider community underpin many policies and measures contained in the Climate Change Strategy. These partnerships are particularly important for the success of policies and measures that cut across a number of greenhouse sectors. These Cross-sectoral policies and measures are described below.

The implementation of Cross-sectoral policies and measures to limit greenhouse gas emissions continues to involve collaboration between governments and industry (through measures such as Greenhouse Challenge Plus and the Greenhouse Gas Abatement Programme), the fostering of broader community engagement (through local government initiatives such as Local Greenhouse Action), and the promotion of international greenhouse partnerships (through the Australian Government's international climate change partnerships).

Low Emissions Technology Demonstration Fund

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government has established a $500 million Low Emissions Technology Demonstration Fund to support industry-led projects to demonstrate the commercial viability of new technologies or processes or the application of overseas technologies or processes to Australian circumstances to deliver long-term, large-scale greenhouse gas emission reductions. The fund is technology neutral and will encompass renewable and fossil fuel supply technologies as well as energy efficiency, and can be for either stationary or transport energy projects. To be eligible for support under the fund, technologies will have to be commercially available by 2020–30 and able to reduce greenhouse gas emissions from the energy sector by at least 2% per annum from 2030.

The fund was announced through the release of the Australian Government's 2004 Energy White Paper *Securing Australia's Energy Future*, and has been designed to leverage at least $1 billion dollars in private-sector investment. The fund will play a major role in reducing Australia's greenhouse signature over the longer term while maintaining the viability of its energy and energy-dependent industries. In light of the longer term focus of this programme, projects will deliver emissions abatement beyond 2010.

Greenhouse Gas Abatement Programme

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs

The Greenhouse Gas Abatement Programme (GGAP) was established as part of the 1999 Measures for a Better Environment package. As reported in Australia's *Third National Communication*, the programme leverages private sector investment in activities or technologies that are likely to result in substantial reductions in greenhouse gas emissions or sink enhancement particularly in the period 2008–12.

GGAP projects approved to date include co-generation, energy efficiency, travel demand management, alternative fuels, coal mine gas technologies and fuel conversion. As of mid-2004, 12 projects approved by ministers are on track to deliver abatement in the Kyoto target period. In the 2004–05 Federal Budget, the Australian Government announced that the third funding round of GGAP would be the last, and re-allocated uncommitted GGAP funds to Climate Change Strategy initiatives that include a strong focus on strategic, long-term abatement and innovative technologies.

GGAP is expected to generate cost-effective emissions reductions during the Kyoto Protocol target period 2008–12. The estimated average abatement cost (from government funding) is $5.5 per tonne of CO_2 for the first two funding rounds of GGAP based on 2003 projections. It is projected that GGAP will abate an estimated 6.1 Mt CO_2-e in 2010.

Greenhouse Challenge Plus Programme

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs / SF_6

The Australian Government's $31.6 million Greenhouse Challenge Plus Programme was announced in 2004. It builds upon the success of the Greenhouse Challenge Programme (reported in Australia's *Third National Communication*), to strengthen the partnership between the Australian Government and industry to abate greenhouse gas emissions.

The programme is designed to help companies reduce their emissions, integrate greenhouse issues into business decision making and accelerate the uptake of energy efficiency. The new Greenhouse Challenge Plus Programme recognises businesses' different levels of response to managing greenhouse gas emissions through a tiered approach to programme membership, incorporating partnerships on a voluntary, incentive-based and compulsory basis. All existing members of the Greenhouse Challenge programmes became members of Greenhouse Challenge Plus.

Greenhouse Challenge Plus has around 800 participants, representing almost 50% of greenhouse gas emissions from industry. In particular, it has excellent coverage of companies in key sectors, including electricity supply, oil and gas, aluminium, cement, mining and manufacturing.

Most member companies participate voluntarily, but from July 2006, companies that receive more than $3 million per year of business fuel credits will be required to join the programme. In addition, a new requirement for proponents of major energy resource developments to join Greenhouse Challenge Plus is being developed.

Under Greenhouse Challenge Plus, businesses measure and monitor greenhouse gas emissions and deliver maximum practical greenhouse gas abatement by working towards specific milestones set out under individual agreements. The Australian Government provides administrative and technical support for the programme.

The programme also allows companies that wish to go further in reducing their greenhouse gas emissions to be identified as Greenhouse Leaders by agreeing to achieve a greenhouse gas abatement goal and report publicly on the outcomes.

Greenhouse Challenge Plus also integrates the Generator Efficiency Standards (GES) and the Greenhouse Friendly programmes (as reported in Australia's *Third National Communication*) into a single streamlined programme. This integration is being achieved through common verification and reporting arrangements and through a new online reporting tool.

By May 2004, 17 companies, representing 85% of Australian electricity generation capacity, had signed up to the GES, and some have already started implementing their action plans.

The Greenhouse Challenge, GES, and Greenhouse Friendly components of Greenhouse Challenge Plus together are expected to lead to abatement of an estimated 15.8 Mt CO_2-e in 2010.

Local Greenhouse Action

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government's Local Greenhouse Action measure was announced in the 2004–05 Federal Budget. It integrates the following previously separate programmes: Cities for Climate Protection™ Australia (CCP™ Australia); Travel Demand Management; Household Greenhouse Action; and Cool Communities. These programmes have been streamlined in order to engage a larger number of Australian households and communities in greenhouse action over the long term, and on a more cost-effective basis.

Funding of $13.6 million over four years to 2007–08 has been committed to this measure to encourage and facilitate greenhouse gas abatement by local governments and the community through:

- maintaining and increasing abatement from the operations of local government through CCP™ Australia
- using local government as the key conduit to the community by providing incentives for local government to take action with local households, transport systems and businesses
- leveraging the complementary role of local government in planning and infrastructure provision
- increasing the information and resources available to encourage community greenhouse gas abatement.

Abatement and capacity building will be achieved through targeted grant programmes, partnership projects with various levels of government, the provision of information, the commissioning of research, and the provision of programme support through the International Council for Local Environmental Initiatives.

The Travel Demand Management Programme complements TravelSmart activities already underway, as reported in Australia's *Third National Communication*. Under the initiative, the Australian Government is engaging with state, territory and local governments and communities to support various approaches to reduce greenhouse gas emissions from passenger transport, particularly in urban centres.

CCP™ Australia now has 205 participating local governments representing nearly 80% of the Australian population, making it the world's largest and most effective CCP™ campaign.

Emissions trading

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs / SF_6

Following examination of the feasibility and implications of introducing an emissions trading system, the Australian Government concluded that the introduction of emissions trading at present would impose unnecessary economy-wide costs.

Due to the success of its current measures, Australia is on track to meet its Kyoto target. The introduction of additional measures such as an emissions trading regime is therefore not required at this stage.

Should a comprehensive and environmentally effective global response to climate change be in prospect, the Australian Government will consider least-cost mechanisms for constraining emissions. This could include consideration of emissions trading or other market-based mechanisms.

In April 2005, the state and territory governments announced an intention to develop a sub-national emissions trading scheme. An inter-jurisdictional working group has been established to examine the feasibility of this and to develop design principles. The group issued a public discussion paper in mid 2005.

International climate change partnerships to reduce greenhouse gas emissions

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs / SF_6

Multilateral partnerships

In July 2005, the Australian Government, along with the governments of China, India, the Republic of Korea, Japan and the United States, launched the Asia–Pacific Partnership on Clean Development and Climate. This Partnership is an important new step in the global climate change response, bringing together key countries in the Asia–Pacific region to develop, deploy and transfer the cleaner, more efficient technologies that the world will need to make the required deep cuts in global greenhouse gas emissions.

As these countries account for 48% of global greenhouse gas emissions, compared to only 32% from countries with binding commitments under the Kyoto Protocol, the Partnership has the potential to make a significant contribution to resolving climate change issues.

The Partnership recognises that it is only with the participation of the world's major emitters—including the United States, China, India, Japan and the Republic of Korea—that it is possible to make any significant progress in meeting this major global challenge. It also recognises that climate change cannot be managed in isolation from other global needs and challenges. The partners will therefore work together to address energy security, climate change and air pollution issues in practical ways that minimise economic costs. The Partnership will also help build human and institutional capacity to strengthen cooperative efforts, and will seek opportunities to engage the private sector.

The Partnership will be consistent with and contribute to Australia's and other partner countries' efforts under the UNFCCC and will complement the Kyoto Protocol. Participants will regularly review the Partnership to ensure its effectiveness.

The Australian Government also supports the outcomes from the July 2005 G8 summit, including the Gleneagles Plan of Action. The range of activities contained in the plan of action, particularly those that focus on energy efficiency and the development and deployment of lower-emitting energy technologies, is entirely consistent with the Australian Government's $1.8 billion Climate Change Strategy. Australia welcomes the Dialogue on Climate Change, Clean Energy

and Sustainable Development, launched at the G8 summit, which will progress the plan of action and facilitate the sharing of best practice between participating governments. Australia is looking forward to playing an active, ongoing part in this important dialogue.

Australia is participating in a range of international technology-based partnerships, including the Methane to Markets Partnership, the Renewable Energy and Energy Efficiency Partnership, the Carbon Sequestration Leadership Forum and the International Partnership for the Hydrogen Economy. These initiatives are aimed at strengthening information networks, training, research and practical collaboration on climate change actions.

Bilateral partnerships

Australia's multi-pronged international climate change strategy also includes the development of several bilateral relationships. These partnerships provide a framework to both engage at a high level on climate change policy issues and focus on practical and measurable outcomes that benefit both countries and contribute to the global climate change response. Australia has five bilateral climate change partners—China, the United States, Japan, New Zealand and the European Union.

Energy—stationary

Total Stationary Energy emissions for 2003 were estimated to be 268.1 Mt CO_2-e, equal to 51.4% of Australia's total net emissions. This includes emissions from energy industries, such as electricity production and petroleum refining, the manufacturing and construction industries, as well as emissions from direct fuel combustion in the residential and commercial sectors.

The 2004 energy policy *Securing Australia's Energy Future* recognises the contribution of energy to Australia's growth in greenhouse gas emissions and provides the framework for the transition to a low-emissions future for this expanding sector. As a critical element of the Climate Change Strategy, the new energy policy represents the refinement of strategic themes pursued in relation to energy under the National Greenhouse Strategy, including energy market reform, the development of low-emissions and renewable technologies, and improvements to end-use energy efficiency. Policies and measures have been targeted to maximise emission reductions across the Stationary Energy sector.

Energy market reform

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government is committed to a long-term national leadership role in ongoing energy market reform (EMR). The Australian Government will continue to work collaboratively with the state and territory governments to develop an open, efficient and competitive energy market that is attractive to investors, encourages a greater focus on energy efficiency, and will lead to a decrease in the greenhouse intensity of Australia's energy supply.

The Australian Government's Climate Change Strategy outlines the current priorities and mechanisms for continued EMR that will build on the successes of previous reform measures, such as the formation of the National Electricity Market in 1998. The reform agenda includes increasing the interconnection of regional electricity markets, and measures to increase demand-side participation across a number of markets.

In December 2003, COAG announced its commitment to a renewed programme of reform for the period to 2006 involving, as a first step, the establishment of a single energy regulator, the Australian Energy Regulator, and a single rule-making and market development body, the Australian Energy Market Commission, replacing 17 existing bodies and providing certainty and stability to energy markets. Current reform policies focus on the areas of transmission planning, energy user participation and removal of impediments to natural gas use.

Ongoing EMR will be complemented by a detailed suite of measures designed to increase the uptake of commercial opportunities to improve energy efficiency. The Australian Government will also work with states and territories to identify and overcome energy market rules that provide impediments to the uptake of smaller-scale local generation (distributed generation), including renewable energy sources.

State governments have also taken specific measures in relation to EMR. In July 2003, full retail contestability was introduced into the energy markets of New South Wales, Victoria, South Australia and the Australian Capital Territory. Households and small businesses in these jurisdictions are now able to choose the supplier from whom they buy their energy. The aim is to allow all electricity and gas customers to have greater choice in their energy supply, and to compare prices and services.

With the passage of time, it has become increasingly difficult for energy modellers to separate the effects of EMR on greenhouse gas emissions from business as usual base cases, because of the difficulty of specifying what would have happened in the absence of EMR. Consequently, the effects of EMR policies and measures on greenhouse gas emissions are no longer estimated.

Low Emissions Technology and Abatement Programme

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Low Emissions Technology and Abatement (LETA) Programme was announced by the Australian Government in the 2004–05 Federal Budget as a $26.9 million measure designed to encourage technologies that reduce energy demand and emission intensity, in business, industry and local communities. The Australian Government agreed on the following four LETA themes through which funds will be allocated and the programme evaluated:

- strategic abatement
- renewables
- fossil fuels
- geosequestration—monitoring pilot project.

LETA is designed to complement other climate change programmes as a comprehensive approach to meeting the emissions management objectives of the Australian Government's Climate Change Strategy. Assessment, approval and implementation of proposals is expected to begin in the latter part of 2005.

State and territory regulatory measures

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Queensland Government's 13% Gas Scheme came into effect on 1 January 2005. It is a major regulatory measure of the Queensland Government's Cleaner Energy Strategy and is designed to foster greater use of gas in that state by requiring electricity retailers and some other liable parties, such as self-generators and power stations selling electricity to end-users, to source at least 13% of the electricity they sell or use in Queensland from gas fired generation.

On 1 January 2003 the New South Wales Government established a mandatory Greenhouse Gas Abatement Scheme (GGAS), which requires liable parties (electricity retailers and large electricity users choosing to participate) to meet mandatory annual targets for greenhouse emissions, or pay a financial penalty. Annual targets for the scheme are based on per capita greenhouse emissions in New South Wales. Electricity retailers can meet their benchmark through purchasing increased amounts of electricity from less greenhouse-intensive sources, reduced consumer demand and the purchase of carbon sinks to offset emissions.

The Australian Capital Territory introduced its GGAS on 1 January 2005, compelling electricity retailers to source, over time, an increasing percentage of their product from cleaner or renewable energy sources.

State and territory low emissions technology measures

Greenhouse gases affected
CO_2 / CH_4 / N_2O

In 2003, the Queensland Government committed $9 million over five years to the Centre for Low Emission Technology, in conjunction with the Commonwealth Science and Industrial Research Organisation, Australian Coal Research, industry partners and the University of Queensland. The Centre facilitates research, development and demonstration of the key technologies that have the potential to significantly improve the environmental performance of coal-fired power stations, by reducing greenhouse gas emissions to near zero levels. The Centre will also conduct research into the policy issues surrounding low emission coal technologies.

The Victorian Government's $106 million Energy Technology and Innovation Strategy (ETIS) was launched in May 2005. Developed to facilitate a coordinated approach to the advancement of low emissions energy technologies to commercial-ready stage, the ETIS supports the progression of new technologies through their innovation processes, particularly where a market gap has been identified. Current projects include:

- the large-scale demonstration of clean brown coal technology power plants
- investment in research, development and early stage demonstration projects as a base for later commercialisation

- a trial of geo-sequestration
- investment to support construction of a pre-commercial plant demonstrating a coal drying technology known as mechanical thermal expression.

Action on energy efficiency

Greenhouse gases affected
CO_2 / CH_4 / N_2O

National Framework for Energy Efficiency

In August 2004, the Ministerial Council on Energy announced a comprehensive package of measures comprising Stage One of the National Framework for Energy Efficiency (NFEE). The NFEE package integrates existing energy efficiency measures (as reported in Australia's *Third National Communication*) with a range of new measures under the Climate Change Strategy. Together, the Australian Government and state and territory governments have committed $33 million to the NFEE package.

Stage One of NFEE includes eight integrated policy packages with objectives as follows:

- *residential and commercial buildings*—to set improving levels of minimum energy efficiency design standards for new construction of residential and commercial buildings, and to provide information to consumers about the relative energy performance of buildings
- *commercial/industrial energy efficiency*—to bring energy efficiency opportunities to the attention of key decision-makers in large energy consumers, to motivate action by businesses, and to improve the skill base to identify energy efficiency opportunities
- *commercial and industrial sector capacity building*—to demonstrate the benefits of energy efficient technology, build industry capacity to deliver energy efficient solutions, promote innovation, and reduce energy efficiency investment risks
- *appliance and equipment energy efficiency*—to drive ongoing improvements to the energy efficiency of major energy using appliances and equipment
- *government energy efficiency*—to demonstrate government leadership in the adoption of energy efficient practices, and to develop standardised monitoring and reporting processes to evaluate energy efficiency initiatives
- *trade and professional training and accreditation*—to ensure key trades and professions have the skills to deliver efficiency outcomes, to establish consumer confidence and reduce the risks for investors in energy efficiency projects by ensuring work is undertaken by competent and independently accredited professionals, and to assist trades and professions to recognise and promote new market opportunities associated with energy efficiency
- *general consumer capacity building*—to raise the awareness of consumers about the benefits of energy efficiency, to enable consumers to make better informed decisions about actions to reduce energy consumption, and to motivate consumers to save energy
- *finance sector awareness*—to increase the understanding of the benefits of energy efficiency by financial institutions and financial decision makers, and to stimulate the development of innovative financing options to realise energy efficiency opportunities.

Energy efficiency standards for residential and commercial buildings

In January 2003, minimum energy efficiency standards for housing became mandatory through the Building Code of Australia. From May 2006, all classes of buildings are expected to have minimum energy performance requirements and those for houses are expected to be enhanced.

Programmes encouraging performance standards above mandatory minimum standards are being rolled out by the Australian Government and various state and territory governments. For example, Victoria's 5 Star Housing initiative, which commenced in 2004, is improving the energy efficiency of residential buildings by requiring all new homes to meet a five-star energy rating.

Since July 2004, the New South Wales Government has required all new residential developments in that state to achieve a 40% reduction in water consumption and a 25% reduction in greenhouse gas emissions, based on the average home in that state. The initiative, known as the Building Sustainability Index (BASIX), will incorporate a 40% reduction target for greenhouse gas emissions from July 2006.

Other state and territory governments are implementing or reviewing similar initiatives, with a view to further improving the energy efficiency of residential buildings.

Energy Efficiency Opportunities

The Australian Government is introducing a new programme, Energy Efficiency Opportunities (EEO), to encourage large energy using businesses to improve their energy efficiency. It has committed $16.9 million over five years from 2004–05 to the initiative, which is due to commence in early 2006.

The programme aims to stimulate large energy using businesses to take a more rigorous approach to energy management by requiring them to undertake an assessment to identify energy efficiency opportunities and to report publicly on the outcomes. EEO is designed to lead to: identification and uptake of cost-effective energy efficiency opportunities; improved productivity and reduced greenhouse gas emissions; and greater scrutiny of energy use by large energy consumers.

National Appliance and Equipment Energy Efficiency Programme

The National Appliance and Equipment Energy Efficiency Programme (NAEEEP) mandates comparative energy labelling and minimum energy performance standards (MEPS) for electrical and gas-powered domestic appliances, commercial products and industrial equipment. State and territory regulatory agencies administer mandatory energy efficiency labelling and MEPS within their jurisdictions.

NAEEEP is estimated to reduce greenhouse gas emissions by 7.9 Mt CO_2-e in 2010.

Case study: Minimum Energy Performance Standards (MEPS)—airconditioners

Australia's action on airconditioner standards demonstrates how effective partnerships between industry and government, together with high quality analysis and flexible processes, can deliver enhanced energy efficiency, with resulting economic and greenhouse benefits.

Airconditioners contribute significantly to peak load electricity demand in many locations throughout Australia. Australian governments and industry have worked together since 2002 to complete all the steps in the regulatory process to include single-phase airconditioners within minimum energy performance standards (MEPS).

In May 2004, energy ministers agreed to a two-stage implementation process. The first stage involved the introduction of MEPS in October 2004 for the least effective 20–25% of models (depending on product type and size) on the Australian market at that time. The second stage involved the introduction of MEPS in October 2007 for a further 60–70% of current models. Under this plan, the total impact would transform the efficiency of domestic/residential airconditioners sold in Australia in little more than three years.

The AGO commissioned a survey in 2004 of the single-phase products sold in China, the Republic of Korea, Malaysia and Thailand, which together supply almost 90% of consumer products sold in Australia. The results showed that airconditioner efficiencies in those countries were improving even more quickly than anticipated by Australian Government officials, energy efficiency experts and Australian-based suppliers. The Australian Government is now considering bringing forward the second stage of MEPS by 18 months.

Improving energy efficiency in government operations

The Australian Government's Energy Efficiency in Government Operations Programme aims to reduce the energy use in, and greenhouse gas emissions from Australian Government operations by setting energy intensity targets in a number of end-use categories and requiring government office buildings to be designed to meet energy efficiency performance criteria. Since the first reporting period in 1997–98 there has been a significant reduction in reported energy intensity. For example, energy intensity for tenant light and power has fallen by more than one-third, resulting in energy cost savings of more than $15 million in this category alone.

The programme is being reviewed to consider updated targets, improved metering and reporting, benchmarking for non-office building energy uses and improved mechanisms to deliver energy efficiency in government office buildings.

State and territory governments have also introduced energy efficiency programmes for government operations. For example, the Victorian Government has set a target to reduce energy use in government buildings by 15% by 2006. Most Victorian Government departments have now reached, if not exceeded, the target, while the remainder are on track to do so by the scheduled deadline.

Energy Efficiency Best Practice and Benchmarking Programme

Through its Energy Efficiency Best Practice Programme, the Australian Government worked in partnership with industry, consultants, and research agencies to demonstrate that managing energy can lead to significant cost reductions, improvements in overall productivity, and positive staff involvement in business operations. Key lessons from the programme are being incorporated into the design of new energy efficiency measures for Australian companies in the industrial and commercial sectors.

An independent full term review of the initiative conducted in November 2002 found that the programme would deliver cumulative savings of $74 million in industry energy costs by 2010, if all planned projects went ahead. Funding for the programme concluded on 30 June 2003.

State and territory action on energy efficiency

State and territory governments are implementing a number of energy efficiency measures that reflect individual state and territory greenhouse strategies. These include, for example, additional state and territory targets for government and residential buildings and efforts to increase the market penetration of low emissions hot water heaters.

Another such initiative is the Queensland Government's ecoBiz Programme which supports businesses (specialising in agribusiness, engineering, foundries, manufacturing, and hospitality) through the process of establishing energy use baselines and targets, and offers financial incentives to encourage uptake of actions to meet energy efficiency targets. There are currently 89 companies involved in the programme.

The Queensland Government's $4.4 million Queensland Sustainable Energy Innovation Fund, which provides financial incentives to support organisations in their efforts to commercialise energy-efficient or renewable energy technologies.

Renewable Energy Policies and Measures

The Australian Government's Climate Change Strategy is providing a major boost to the commercialisation and uptake of renewable energy. The Australian Government has committed more than $500 million to measures to support the renewable energy industry, including the measures outlined below. Renewable technologies are also eligible for funding under the $500 million Low Emissions Technology Demonstration Fund.

Mandatory Renewable Energy Target

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Prime Minister announced in 1997 the introduction of a Mandatory Renewable Energy Target (MRET) for the uptake of additional renewable energy in power supplies. The MRET scheme sought to increase the contribution of renewable energy sources to Australia's electricity mix by 9,500 GWh per year by 2010, at which time, renewable energy generation is expected to have increased by more than 50% above 1997 levels.

Under the applicable legislation, wholesale electricity purchasers are required to purchase increasing amounts of electricity generated from renewable sources.

Following a review of the *Renewable Energy (Electricity) Act 2000* in 2003, the Australian Government agreed to improve the operational and administrative efficiency of the measure and increase opportunities for solar and biomass energy. The scheme is projected to reduce greenhouse gas emissions by an estimated 6.6 Mt CO_2-e in 2010.

Renewable Energy Development Initiative

Greenhouse gases affected
CO_2 / CH_4 / N_2O

Under the Renewable Energy Development Initiative (REDI), the Australian Government will provide $100 million over seven years from 2004–05 to support the development of renewable energy technology products, processes and services that have strong early-stage commercialisation and greenhouse gas abatement potential.

The programme aims to support the international competitiveness of Australian industry by encouraging innovation through increasing the level of research and development, proof-of-concept and early-stage commercialisation activities undertaken by Australian companies. The assessment of project proposals commenced in August 2005. Emissions reductions have not been estimated as this measure is focused on longer-term abatement beyond 2012.

Solar Cities

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government's $75 million Solar Cities initiative aims to encourage businesses and communities to explore new sustainable models of electricity supply and use in order to better manage peak electricity demand.

Announced by the Prime Minister in 2004 as part of the Energy White Paper *Securing Australia's Energy Future*, Solar Cities will develop innovative approaches to electricity pricing that deliver more effective signals to energy users. These will be integrated with the concentrated uptake of solar technology, energy efficiency, smart meter and load management measures.

Solar Cities will help deliver a future where consumers are rewarded for using energy more wisely, industry is able to test new sustainable energy options in a low-risk environment, and electricity utilities are able to better manage supply and demand. Robust market data will be collected to assess future widespread commercialisation.

The AGO aims to support at least four Solar Cities in grid-connected urban centres across Australia. Solar cities will leverage at least $67 million over the life of the programme from private sector and state government partners.

Solar Cities will run until 2013, with the focus to date upon programme design and site selection. Twenty three consortia from across Australia have expressed interest in hosting a Solar City. Following the preparation of detailed business cases and a rigorous selection process, an announcement on the final locations is expected in the first half of 2006, with implementation of the first Solar Cities expected to commence later that year. Emissions reductions have not been estimated as project proposals have not yet been assessed, and as this measure is focused on longer-term abatement beyond 2012.

More details are at http://www.greenhouse.gov.au/solarcities.

Advanced Energy Storage Technologies

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government is providing funding of $20.4 million over four years to identify, support the development and demonstration of, and promote advanced storage technologies that have strong potential to significantly increase the penetration of electricity generated by intermittent renewable energy sources into Australia's energy supply. Announced as part of measures contained in *Securing Australia's Energy Future*, the initiative is designed to take advantage of Australia's technological leadership in a number of storage technologies that have the potential to reduce greenhouse gas emissions over the medium to long term.

It is expected that proposals under this initiative will be assessed in 2006. Emissions reductions have not been estimated as this measure is focused on longer-term abatement beyond 2012.

Wind Energy Forecasting Capability

Greenhouse gases affected
CO_2 / CH_4 / N_2O

In response to an emerging challenge to the effective management of increasing amounts of wind power on electricity networks, the Australian Government has committed $14 million over five years from 2004–05 to the development and installation of systems to provide accurate forecasts of wind output. This capability will facilitate greater penetration of wind into energy markets, increasing the value of wind energy to electricity retailers, and allow for more strategic planning of new wind farms.

The forecasting capability is expected to be implemented in 2006, and will be expanded over the following three years to improve performance and maximise accuracy. Emissions reductions have not been estimated separately from MRET.

National Green Power Accreditation Programme

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The National Green Power Accreditation Programme (Green Power) is offered through joint collaboration by participating state and territory government agencies in New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory. Green Power aims to facilitate the installation of new renewable energy generators across Australia, beyond mandatory renewable requirements.

Under the programme, customers can elect to pay a premium to their energy retailers for the supply of electricity generated from renewable sources (solar, wind, biomass, hydro and geothermal). Accredited energy suppliers then agree to buy an amount of energy from renewable sources equivalent to the amount nominated by participating consumers and businesses.

The programme has similar objectives to MRET—to reduce greenhouse gas emissions from the electricity generation sector and drive investment in renewable energy projects—but whereas MRET is a mandatory (legislated) requirement, Green Power relies on consumers voluntarily paying a premium. Green Power provided by retailers to meet customer demand cannot be 'double counted' to contribute to meeting their MRET obligations.

Ongoing compliance of products is checked regularly via financial and technical status reports provided by the energy supplier. Independent audits are carried out by the New South Wales Department of Energy Utilities and Sustainability, as programme manager. Participating state and territory governments promote and help energy suppliers to promote Green Power accredited programmes to increase participation and therefore demand. Several of the state governments also provide financial assistance for the development of new generators, and have policies for government bodies to purchase Green Power.

Strategic development of renewable energy

Greenhouse gases affected
CO_2 / CH_4 / N_2O

As reported in Australia's *Third National Communication*, the Australian Government announced in 1997 and 1999 a suite of measures with the following aims: to boost the commercialisation of renewable energy technologies; to reduce costs and improve the quality and reliability of renewable technologies; to deploy renewable energy technologies; and to help build the capacity of the renewable energy industry to meet the expected high growth in demand for its goods and services.

The Australian Government has invested $343 million for the following renewable energy grant and equity programmes that are either complete or are continuing to be implemented: the Renewable Energy Commercialisation Programme (RECP); the Renewable Remote Power Generation Programme (RRPGP); the Renewable Energy Showcase; the Renewable Energy Equity Fund; and the Photovoltaic Rebate Programme.

A significant proportion of the greenhouse gas reductions expected to result from these initiatives in 2010 is contained in the estimate provided elsewhere in this chapter for MRET.

Several states and territories are also implementing programmes to boost the commercialisation of renewable energy technology and the uptake of renewable energy. For example, the Victorian Government's Renewable Energy Support Fund is designed to leverage maximum private sector funding for the development of small-scale renewable energy generation projects in that state. Since 2002, the fund has provided $6.7 million in grants towards the capital costs of these projects and has leveraged a further $63 million in private sector investment.

Low Emissions Technology Demonstration Fund – stationary energy elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Low Emissions Technology Demonstration Fund is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Gas Abatement Programme – stationary energy elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Gas Abatement Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Challenge Plus Programme – stationary energy elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Challenge Plus Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes, Waste and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Local Greenhouse Action – stationary energy elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Local Greenhouse Action measure is Cross-sectoral in nature, targeting the Stationary Energy and Transport subsectors, and the Waste sector. It is fully described earlier under Cross-sectoral policies and measures.

Energy—transport

The Transport subsector produced an estimated 79.8 Mt CO_2-e, or 15.3% of Australia's total net emissions in 2003. Road transportation is the major source within this subsector, contributing 90.1% (or 71.9 Mt CO_2-e), of which 62.2% (or 44.8 Mt CO_2-e) was from passenger cars.

The policies and measures described in this section reflect key actions to reduce greenhouse gas emissions from passenger and freight transportation. Many of these actions represent a substantial refinement of initiatives that were described in Australia's *Third National Communication*. In addition, a number of new initiatives were introduced as part of the 2004–05 Federal Budget and the Energy White Paper *Securing Australia's Energy Future*.

Environmental Strategy for the Motor Vehicle Industry

Greenhouse gases affected
CO_2

The Australian Government's Environmental Strategy for the Motor Vehicle Industry aims to improve motor vehicle efficiency to deliver a range of environmental benefits, including reducing greenhouse gas emissions from the Transport subsector.

National Average CO_2 Emissions Target

The Australian Government reached agreement with the automotive industry on a voluntary target to improve the fuel efficiency of new passenger motor vehicles by 18% between 2002 and 2010. The target will be converted to a National Average CO_2 Emissions (NACE) target to reflect both fuel and carbon efficiency, and will be expressed in grams of CO_2 per kilometre (km). NACE will also expand the previous target area to cover cars, vans, four-wheel drive and light commercial vehicles up to 3.5 tonnes, and will also include diesel and liquefied petroleum gas (LPG)-powered vehicles.

Fuel Consumption Labelling Scheme

Since 1 January 2001, all new cars under 2.7 tonnes sold in Australia have been required by law to carry a fuel consumption label on the windscreen at the point of sale. The label shows how many litres of fuel the car uses to travel 100 km under standard test conditions. The fuel consumption label was revised in 2002 to extend fuel consumption labelling to all vehicles up to 3.5 tonnes and to introduce CO_2 emissions labelling to these vehicles. The new label became mandatory for all new vehicles from 1 January 2004. The fuel consumption label aims to raise consumer awareness of fuel efficient cars and their role in helping to reduce greenhouse gas emissions. It will help consumers to make informed choices about new car purchases that will help reduce greenhouse emissions while returning an economic benefit through lower fuel running costs.

Green Vehicle Guide

The Australian Government launched its Green Vehicle Guide in August 2004. The guide is a web-based tool that provides information to consumers on the comparative fuel consumption, greenhouse emissions and regulated air pollutant emissions performance of current light duty motor vehicles (vehicles up to 3.5 tonnes).

The Green Vehicle Guide allows for easy comparison and ranking of vehicles and currently receives around 10,000 to 15,000 user sessions per month. This initiative is jointly managed by the departments of Transport and Regional Services, and the Environment and Heritage and can be accessed at http://www.greenvehicleguide.gov.au.

Australian Government Fleet Target

Australian Government agencies are working to increase the environmental performance of the Australian Government vehicle fleet. A target has been set to increase the proportion of vehicles with scores in the top half of the Green Vehicle Guide from 18% to 28% by December 2005, while maintaining the Australian-made proportion of the fleet.

Alternative fuels programmes

Greenhouse gases affected CO_2 / CH_4

Alternative Fuels Conversion Programme

The Australian Government's $37.5 million Alternative Fuels Conversion Programme commenced in January 2000, with the objective of providing assistance to the operators of heavy commercial vehicles and buses (weighing 3.5 tonnes gross vehicle mass or more) to convert their vehicles to operate on either natural gas or LPG, or to purchase new vehicles running on these fuels. To date, applications covering the conversion of over 1,080 vehicles have been approved. The programme has been successful in stimulating significant uptake of compressed natural gas (CNG) buses (718 by February 2005) and investment of more than $200 million by Australian transport authorities in these buses.

However, in 2002, the AGO identified that the uptake of CNG and LPG trucks was below initial expectations and commissioned a review, consulted with industry, and refined the programme to overcome barriers identified. As a result of this review, the current focus of the programme is to work with leading truck fleet operators to trial and demonstrate alternative-fuelled truck engines that show both greenhouse and air quality improvements. Agreements are now in place with five major truck fleet operators to evaluate the business case for alternative fuels.

The programme has focused significant attention on the technical solutions required to deliver greenhouse benefits from natural gas engines, given that this fuel is itself a potent greenhouse gas. The programme has now been expanded to include a scoping study into the feasibility of a wide-scale rollout of hydrogen buses in Australia. Note that the primary objective of the programme is to test commercial viability of new technologies, rather than achieve significant greenhouse gas abatement.

State and territory alternative fuels programmes

Several states and territories are also encouraging the conversion of buses from diesel to cleaner burning gas. The Western Australian Government is currently undertaking a $15 million hydrogen fuel cell bus trial in Perth, while 214 (or 26.5%) of buses in the South Australian Government's bus fleet are fuelled by CNG.

Compressed Natural Gas Infrastructure Programme

The Australian Government's $7.6 million Compressed Natural Gas Infrastructure Programme (as reported in Australia's *Third National Communication*) provided financial assistance for three additional publicly accessible CNG refuelling sites in New South Wales and Victoria, as well as assisting with other technical developments that supported CNG refuelling programme experience. The objectives of the programme are now more appropriately achieved through the heavy vehicle fleet trial arrangements described earlier under the Alternative Fuels Conversion Programme.

Energy Grants (Credits) Scheme

The Diesel and Alternative Fuels Grants Scheme (as reported in Australia's *Third National Communication*) was formally abolished on 1 July 2003, but most of its functions have passed into the 'on-road' component of the current Energy Grants (Credits) Scheme (EGCS). The EGCS will, in turn, largely be abolished on 1 July 2006, with most of its functions evolving into the Fuel Tax Credits regime on that date. However, grants under the EGCS for the use of alternative fuels will continue until 1 July 2011. From 1 July 2011 alternative fuels will begin to incur fuel tax, but, if used in business activities, will be eligible for a partial or full credit of tax paid. As greenhouse gas abatement is not the primary objective of the EGCS, projected emissions reductions have not been estimated at this stage.

Government biofuels initiatives

Greenhouse gases affected
CO_2

The following Australian Government initiatives aim to boost the development of a commercially viable domestic biofuels industry by addressing market barriers to the production and use of biofuels.

Biofuels Capital Grants Program

The Australian Government's Biofuels Capital Grants Program, announced in 2003, is providing $37.6 million to fund one-off capital grants for projects that provide new or expanded biofuels production capacity. The Program aims to increase the availability of biofuels for the domestic transport market. Grants are being provided at a rate of 16 cents per litre for new or expanded projects producing a minimum of 5 million litres of biofuel per annum and have been limited to $10 million per project.

350 ML Biofuels Target

In 2001, the Australian Government set an objective that biofuels would contribute at least 350 million litres (ML) to the total fuel supply by 2010. The Australian Government restated its commitment to this target in 2005 and is working with oil companies, petrol retailers, consumer groups, the biofuels industry and car manufacturers to ensure the target is achieved.

In August 2005, the Prime Minister's Biofuels Taskforce made a number of recommendations to increase the uptake of biofuels in Australia. The Australian Government is implementing these recommendations.

Production grants for ethanol and biodiesel

The Australian Government encourages the production of biofuels through the payment of production grants of 38.143 cents per litre for fuel ethanol and biodiesel. Production grants for fuel ethanol commenced in September 2002 and were extended in 2004 for a further eight years to June 2011. In the 2003-04 Federal Budget, the Australian Government announced broadly similar treatment for biodiesel commencing from September 2003. These arrangements ensure that the effective rate of excise for biofuels is zero until 1 July 2011.

Strategic transport planning

Greenhouse gases affected
CO_2

All levels of government in Australia are committed to reducing greenhouse gas emissions from all parts of the Transport subsector. Policies and measures focus on low-emissions transport options, in particular, public transport.

The Australian Government, state and territory governments, and the Australian Local Government Association collaborated to develop, and in 2003 endorse, the National Charter of Integrated Land Use and Transport Planning. The national charter is a high-level agreement between transport and planning ministers providing a national commitment to a framework for responsive planning, consistent decision-making and good design and management. The objective of the national charter is to achieve greater integration of land use planning and transport planning across agencies, jurisdictions and levels of government to facilitate effective and sustainable urban and regional development across Australia. This considered and integrated approach to

transport and land use planning, especially in urban areas, will improve the sustainability of passenger and freight transport. A positive impact on transport-related greenhouse gas emissions over the longer term will be one of the many benefits of the national charter.

In 2004, the Australian Capital Territory Government launched its Sustainable Transport Plan, setting the framework to achieve a more sustainable transport system in the territory over the next 25 years. The plan sets out to increase the use of sustainable transport modes from 13% of work trips to 20% in 2011 and 30% in 2026.

Similarly, the Northern Territory Government is currently developing the Northern Territory Transport Plan, a framework for sustainable transport systems in that territory.

As reported in Australia's *Third National Communication*, the Northern Territory and South Australian governments and the Australian Government, along with a private consortium, invested significantly in the extension of the railway line from Alice Springs to Darwin in the Northern Territory. The railway line commenced operation in February 2004, representing a significant modal shift for freight between Darwin and southern Australian states from long haul road transport to rail, resulting in reductions in greenhouse gas emissions.

State and territory governments have adopted a number of measures to reduce transport-related greenhouse gas emissions, such as the Western Australian Government's New MetroRail project, and the Queensland Government's range of integrated regional transport plans, which include the South East Queensland Integrated Regional Transport Plan, targeting mode share increases of 50% for public transport, 15% for walking and 300% for cycling.

Low Emissions Technology Demonstration Fund – transport energy elements

Greenhouse gases affected
CO_2 / CH_4

The Low Emissions Technology Demonstration Fund is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Gas Abatement Programme – transport energy elements

Greenhouse gases affected
CO_2

The Greenhouse Gas Abatement Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Local Greenhouse Action – transport energy elements

Greenhouse gases affected
CO_2

The Local Greenhouse Action measure is Cross-sectoral in nature, targeting the Stationary Energy and Transport subsectors, and the Waste sector. It is fully described earlier under Cross-sectoral policies and measures.

Energy—fugitive emissions from fuels

Fugitive emissions result from the production, processing, transport, storage, transmission and distribution of raw fossil fuels, but do not include emissions from fuel burnt for process energy. Total estimated fugitive emissions for 2003 were 26.4 Mt CO_2-e, or 5.1% of Australia's total net emissions. Of these, 62.6% (or 16.5 Mt CO_2-e) were associated with coal mining and handling, while oil and natural gas production, processing and distribution accounted for the remaining 37.4% (or 9.9 Mt CO_2-e).

Low Emissions Technology Demonstration Fund – fugitive emissions elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Low Emissions Technology Demonstration Fund is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Gas Abatement Programme – fugitive emissions elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Gas Abatement Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors, and the Industrial Processes and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Challenge Plus Programme – fugitive emissions elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

Through Greenhouse Challenge Plus, which has wide coverage of emissions from oil, gas and coal mining, companies have, either voluntarily or as required by law, entered into agreements to reduce emissions, including fugitive emissions. Oil and gas companies, for example, are working to develop flaring policies and implement flaring-reduction strategies, while oil and gas industry bodies, through facilitative agreements, have committed to work with their members to reduce fugitive emissions by examining potentially cost-effective measures such as the collection and utilisation of flared and vented gas.

In addition to the Fugitive Emissions from Fuels subsector, the Greenhouse Challenge Plus Programme targets the Stationary Energy and Transport subsectors and the Industrial Processes, Waste and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

State and territory action to reduce fugitive emissions from fuels

Greenhouse gases affected
CO_2 / CH_4 / N_2O

As reported in Australia's *Third National Communication*, the Queensland Government, under its Cleaner Energy Strategy, has committed $1.5 million over five years to assist the coal industry to install equipment to capture and use waste mine gas from coal mines. The Queensland Government has set a target to reduce waste gas emissions from coal mines by 2.5 Mt CO_2-e over four years.

The New South Wales Government has provided a market for waste coal mine gas under its Greenhouse Gas Abatement Scheme.

Industrial processes

Emissions from industry and commercial activities are predominantly generated through energy use in manufacturing and industrial processes (primarily in the form of electricity), but also from transportation and fugitive emissions. Activities to abate these emissions are discussed in the section on energy in this chapter and, given their cross-sectoral nature, are also included in the Cross-sectoral section of this chapter. Programmes like Greenhouse Challenge Plus and GGAP are examples of government partnering with industry to reduce their greenhouse gas emissions.

This section relates to measures that abate emissions from specific industrial processes. These emissions result from the physical or chemical transformation of materials in industrial processes. They also include the loss or leakage of raw materials, intermediates and products to the atmosphere, such as synthetic greenhouse gases.

Emissions from these industrial processes account for only a small percentage of Australia's total net emissions and cover the full range of greenhouse gases. Total emissions from industrial processes were 32.3 Mt CO_2-e in 2003, or 6.2% of Australia's total net emissions. This total does not fully reflect the greenhouse impact of industry, however, given that emissions from energy consumption by industry are included in the Stationary Energy subsector.

Ozone-depleting substances and synthetic greenhouse gas replacements from Montreal Protocol industries

Greenhouse gases affected
HFCs / PFCs

Synthetic greenhouse gases are used and emitted by a wide range of Australian industries, including the refrigeration and air conditioning, foam blowing, fire prevention, aerosols and solvents industries. Emissions of synthetic greenhouse gases do not currently contribute significantly to Australia's total net emissions. However, these gases have comparatively high global warming potentials and given the expected increase in their use, driven largely by industries covered by the *Montreal Protocol on Substances that Deplete the Ozone Layer* (Montreal Protocol) that are replacing ozone depleting substances with synthetic greenhouse gases, there is significant potential for emissions of synthetic gases to grow.

In December 2003, the Australian Parliament passed legislative amendments to the *Ozone Protection Act 1989*, expanding it to the *Ozone Protection and Synthetic Greenhouse Management Act 1989*. The amendments:

- extend import, export and manufacture controls to include synthetic greenhouse gases (hydrofluorocarbons and perfluorocarbons) that are used to replace ozone depleting substances
- extend import controls to include refrigeration and air conditioning equipment containing a hydrofluorocarbon or hydrochlorofluorocarbon refrigerant charge
- provide for introduction of consistent national standards for the handling, storage and disposal of ozone depleting substances and their synthetic greenhouse gas replacements.

In July 2005, Australia implemented end-use controls in the fire protection, refrigeration and air conditioning sectors. These controls establish consistent minimum standards for all people who work with gases in these industry sectors. They will ensure that only technicians who have the appropriate qualifications and skills to minimise emissions handle the gases. Businesses will be able to purchase the gases only when they can demonstrate they have the appropriate equipment and employ only appropriately licensed staff.

End-use controls will be progressively developed for the foam, aerosol, solvent and laboratory and analytical research sectors.

Best practice management of SF_6

Greenhouse gases affected
SF_6

The Department of the Environment and Heritage is working with the electricity supply industry, which uses sulphur hexaflouride (SF_6) in equipment such as switchgear and circuit breakers, and wholesalers of SF_6, to develop handling guidelines to reduce emissions of SF_6. Electricity suppliers are also reporting emissions of SF_6 through Greenhouse Challenge Plus.

At present, SF_6 is widely used as a cover gas in the production of magnesium. With an interest in reducing global SF_6 emissions, a cooperative study was initiated in June 2002 as part of the Australia–United States Climate Action Partnership, to evaluate two alternative cover gases for the protection of molten magnesium. This study found that both alternative cover gases have a greenhouse gas emissions impact that is more than 95% lower than when SF_6 is used.

Other initiatives to reduce emissions from industrial processes

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs / SF_6

Australia's state and territory governments are implementing a number of initiatives that are projected to reduce greenhouse emissions from industrial processes.

Under the Victorian Government's State Environment Protection Policy (Air Quality Management), businesses subject to works approval and licensing by the Victorian Environment Protection Authority are required to: implement best practice with respect to energy efficiency and greenhouse gas emissions for new investments; and conduct energy audits for existing licensed premises and implement actions for which the implementation cost will be recovered through efficiency savings within three years. Under the Victorian Government's $4.3 million Business Energy Innovation Initiative, Sustainability Victoria (formerly SEAV), in conjunction with the Australian Industry Group and the Business Council for Sustainable Energy, is supporting the design and implementation of new innovative applications of energy efficient technologies in Victorian businesses.

Case study: Victorian State Environment Protection Policy

In December 2001, the Victorian Government implemented a comprehensive, leading edge regulatory programme targeting greenhouse gas emissions from industry. Under the State Environment Protection Policy (Air Quality Management), to which the Victorian Government has committed a total of $3.25 million to date, all businesses subject to works licensing are required to:

- implement best practice with respect to energy efficiency and greenhouse gas emissions for new investments
- conduct energy audits for existing licensed premises and implement actions that have a financial payback of up to three years.

Approximately 500 licensees have conducted energy audits and delivered significant energy efficiency savings to date. Typical activities in action plans include installing variable speed drives on equipment, installing more efficient motors and pumps, eliminating steam and compressed air leaks, and improving boiler efficiency.

The programme has been well received by licensees who have been provided with an energy management toolkit that helps to identify and implement energy efficiency actions.

Greenhouse Gas Abatement Programme – industrial processes elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Gas Abatement Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Greenhouse Challenge Plus Programme – industrial processes elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O / HFCs / PFCs

In addition to activities relating to best practice management of SF_6 described earlier, Greenhouse Challenge Plus includes other activities to reduce greenhouse gas emissions from the Industrial Processes sector. The Greenhouse Challenge Plus Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes, Waste and Land Use, Land Use Change and Forestry sectors. The programme is fully described earlier under Cross-sectoral policies and measures.

Agriculture

Agriculture produced an estimated 97.3 Mt CO_2-e emissions or 18.7% of Australia's total net emissions in 2003. These emissions consisted principally of methane (CH_4) from the digestive processes of cattle and sheep, and nitrous oxide (N_2O) from agricultural soils.

Reducing emissions from livestock and agricultural soils presents real opportunities to achieve multiple benefits. Methane emissions from livestock are a loss of valuable energy from livestock production. Between 10-20% of all ingested energy is lost as CH_4. Reduction measures therefore are expected to also lead to improved livestock productivity. Similarly, N_2O emissions from soils represent a loss of valuable nutrients. Farming practices, such as improved fertiliser management, that deliver lower emissions from agricultural soils, will also lead to productivity improvements.

Greenhouse Action in Regional Australia

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Action in Regional Australia (GARA) programme, announced in the 2004–05 Federal Budget, aims to coordinate greenhouse action across the land sectors and build the capacity of the agriculture and land management sectors to reduce greenhouse gas emissions through investment in research and development, agriculture industry partnerships and support for forest sink activities, and integration of greenhouse issues with regional natural resource management. The Australian Government has

committed $20.5 million over four years to the programme. Programme activities span the Agriculture and the Land Use, Land Use Change and Forestry sectors.

Programme activities applicable to the Agriculture sector include:

- targeted research and development to manage and reduce greenhouse gases from livestock production systems and agricultural soils
- Government-industry partnerships at various levels within the Australian agriculture sector (farm enterprises, industry associations, agribusiness corporations), aimed at encouraging the development and implementation of management tools and practices that reduce greenhouse gas emissions, and incorporating these activities into Environmental Management System and Best Management Practice initiatives.

The GARA programme incorporates or extends aspects of a number of activities reported in Australia's *Third National Communication*, including:

- the Greenhouse Challenge Agricultural Strategy
- the Agriculture Sector Work Programme
- research on a broad range of possible options for reducing CH_4 emissions from livestock
- initiatives to improve the efficiency of nitrogen use in agriculture, including targeting nitrogen management to crop requirements and strategic placement of nitrogen fertilisers.

Programmes supporting environmental management systems

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government is supporting voluntary industry and community-led adoption of environmental management systems (EMS) to help primary producers achieve profitable and sustainable production and improve environmental and natural resource management outcomes. An EMS is an integrated business management tool that uses a 'plan-do-check-review/act' cycle that leads to continuous improvement in environmental, business and marketing performance.

The Australian Government has established three national programmes to help producers implement EMS, namely the EMS Incentives Programme, the EMS National Pilot Programme and the Pathways to Industry EMS Programme. Through these programmes, producers are conserving and restoring habitat for native flora and fauna, enhancing Australia's greenhouse sink capacity and reducing greenhouse gas emissions from land-based sources. Total Australian Government funding for these initiatives is $31.2 million from 2002–03 to 2006–07.

Waste

The Waste sector comprises predominantly CH_4 emissions from municipal solid waste disposal on land, and wastewater disposal. The total sector emissions for 2003 were estimated at 11.4 Mt CO_2-e, or 2.2% of Australia's total net emissions.

Waste management strategies

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government, state and territory governments and local governments are developing and implementing policies and measures that are focused on reducing and capturing CH_4 emissions from the Waste sector. Most state and territory governments, as well as the majority of local councils, have waste minimisation and re-use strategies in place.

The Australian Capital Territory Government is implementing its No Waste by 2010 Strategy. One of the priorities under this strategy is a programme to capture CH_4 from landfill for the generation of electricity. Two power stations are feeding methane-based energy into the electricity grid to make up a portion of the territory's green energy, thereby displacing electricity currently generated from coal fired power stations.

The Victorian Government, in conjunction with local government and industry groups, is currently developing its Towards Zero Waste Strategy, which seeks to reduce solid waste by 65% in 2013. The strategy will involve community education, and promote high levels of community participation in kerbside recycling as well as industry and business initiatives.

The South Australian Government's Zero Waste SA strategy includes funding of $3.4 million over three years from 2004–05 for projects to establish or upgrade resource recovery and recycling facilities and infrastructure in that state.

The New South Wales Greenhouse Gas Abatement Scheme, described earlier also affects activity in the Waste sector.

It is estimated that the cumulative effect of Australian Government and state and territory government measures across the Waste sector will reduce greenhouse gas emissions by 9.0 Mt CO_2-e in 2010.

Greenhouse Challenge Plus Programme – waste elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Challenge Plus Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes, Waste and Land Use, Land Use Change and Forestry sectors. It is fully described earlier under Cross-sectoral policies and measures.

Land use, land use change and forestry

In 2003, forestry comprised a net sink of around 43.5 Mt CO_2-e. It is estimated that land use, land use change and forestry activities in 2003 produced 6.1 Mt CO_2-e, or 1.2% of Australia's total net emissions.

Land use change and forestry practices that increase and protect vegetation cover play important roles in enhancing Australia's greenhouse gas sink capacity. Increasing the area of production forests, particularly through reforestation and farm forestry, and increasing vegetation cover provide important opportunities for carbon sequestration, in addition to other environmental benefits such as salinity mitigation and biodiversity conservation.

Greenhouse Action in Regional Australia

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government's $20.5 million GARA programme includes activities that span the Land Use, Land Use Change and Forestry and Agriculture sectors.

Programme activities applicable to the Land Use, Land Use Change and Forestry sector include:

- supporting research and development to enhance carbon sequestration, manage greenhouse gas emissions, and integrate greenhouse and natural resource management outcomes
- facilitating enhanced forest sink activity and integrated greenhouse and natural resource management outcomes through the production and distribution of information and tools and the provision of training and advice to forest growers and other natural resource managers.

The National Carbon Accounting Toolbox and Data Viewer were launched in 2005 as tools to provide natural resource managers with free public access to National Carbon Accounting System modelling and data. These tools allow users to track emissions and carbon stock changes from land use and management and access satellite images and regional climate data to plan and monitor vegetation and land management. (Further information about the Toolbox is in Chapter 3—National Greenhouse Gas Inventory.) Information on legal, financial and organisational issues concerning the creation and transaction of carbon sequestration rights has also been produced to assist forest growers and investors.

Natural Heritage Trust—land and vegetation programmes

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Australian Government established the Natural Heritage Trust (NHT) in 1997 to help restore and conserve Australia's environment and natural resources. Since the submission of Australia's *Third National Communication*, the Australian Government has worked with state and territory governments to make the NHT more effective. The 23 programmes previously funded through the NHT have been consolidated into four.

One of these programmes—the Landcare Programme—invests in activities that contribute to reversing land degradation and promote sustainable agriculture. Another programme—the Bushcare Programme—invests in activities that contribute to conserving and restoring habitat for the native flora and fauna that underpin the health of the landscape. Both Landcare and Bushcare aim to reduce greenhouse gas emissions in the Land Use, Land Use Change and Forestry sector through the enhancement of Australia's greenhouse sink capacity, and by contributing to the reduction of greenhouse gas emissions from land-based sources. The Rivercare and Coastcare programmes also contribute to conservation and productivity goals and deliver a range of greenhouse benefits.

The Australian Government boosted its funding for the NHT by $300 million in the 2004–05 Federal Budget. This will extend the operation of the NHT until 2007–08, bringing total investment under the trust to $3 billion. The environmental activities funded by the NHT are delivered at three levels: national investments, regional investments, and a local action component known as the Australian Government Envirofund.

National Landcare Program

Greenhouse gases affected
CO_2 / CH_4 / N_2O

As detailed in Australia's *Third National Communication*, the National Landcare Program supports community-based action to achieve sustainable agricultural production systems. This programme is distinct from the NHT Landcare Programme described earlier.

National Landcare Programme projects include those that contribute to the sustainable management of land and vegetation, thereby enhancing Australia's greenhouse sink capacity and contributing to the reduction of greenhouse gas emissions from land-based sources.

Australian Government funding for the National Landcare Program is $109.8 million over the period 2005–06 to 2007–08.

Plantations for Australia: The 2020 Vision

Greenhouse gases affected
CO_2

Plantations for Australia: The 2020 Vision outlines the vision shared for Australia's plantations by the Australian Government, state and territory governments, and industry. As reported in Australia's *Third National Communication*, the objectives of the programme are to remove impediments to sustainable plantation establishment in Australia. The target is to treble the area of Australia's plantations between 1996 and 2020 by planting an average of 80,000 hectares per year. The rate of plantation expansion has increased from 30,300 hectares in 1995 to an average of about 75,000 hectares per year for the period 2000–2005. Up to $3 billion (of mainly private capital) could be invested to establish new plantations by 2020.

National Action Plan for Salinity and Water Quality

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The National Action Plan for Salinity and Water Quality (NAP) is focused on investment in catchment and regional management plans for improved salinity and water quality in 21 priority regions. It provides scope for investment in specific actions that enhance the contribution of vegetation to greenhouse sinks, including maintaining and improving the condition of existing native vegetation, and establishing multiple purpose perennial vegetation (focused on agriculture, forests, biodiversity and carbon) in targeted areas. It also provides for sustainable land management practices that may contribute to reducing greenhouse gas emissions from land-based sources. The Australian Government and state and territory governments have committed to a joint investment of $1.4 billion over seven years to 2007-08.

As an example of a NAP initiative, the Australian Government will partner with the Western Australian Government to jointly invest up to $64 million to establish integrated tree plantings over 18,000 hectares across four regional catchment areas in that state between 2005 and 2008. This revegetation project is designed to provide both commercial and environmental benefits, primarily in areas affected by dryland salinity in the south-west of Western Australia.

Other land and vegetation programmes

Greenhouse gases affected
CO_2

State and territory governments have responsibility for regulating land and vegetation management. Legislative reforms introduced by the Queensland and New South Wales governments in 2003 and 2004 are expected to result in substantial reductions in broadscale clearing of remnant native vegetation. The Queensland Government is investing $150 million to support implementation of its recently introduced land clearing controls which will phase out broadscale clearing of remnant vegetation by 2006, resulting in greenhouse gas emission reductions of an estimated 17.5 Mt CO_2-e in 2010. The New South Wales Government's reforms are expected to reduce greenhouse gas emissions by 3.4 Mt CO_2-e in 2010.

The Northern Territory Government, in conjunction with industry and the community, is minimising greenhouse gas emissions through policies and measures to improve fire and vegetation management.

States and territories have also implemented land and vegetation programmes that, through revegetation and vegetation protection, are expected to substantially enhance Australia's greenhouse sink capacity. The Victorian Government, through its $3.4 million Carbon Tender initiative and its $1.9 million Plantations for Greenhouse project, is supporting establishment of new permanent, native vegetation and new sawlog plantations on private land.

The Western Australian Government's Greenhouse Strategy provides for government investment, and promotion of investment from other sources, to expand forest carbon sinks in that state.

In 2004, the South Australian Government established the legislative framework for sustainable management of natural resources in the state, which provides for a range of activities that are expected to enhance sink capacity over time.

In 1998, the New South Wales Government introduced the world's first carbon rights legislation, which recognises carbon sequestration by forests in law, and allows the ownership, sale and management of these carbon rights as a kind of forestry right. In 2004, the Queensland Government introduced legislation to provide legal certainty for contractual arrangements regarding property rights to carbon sequestration.

Greenhouse Gas Abatement Programme – land use, land use change and forestry elements

Greenhouse gases affected
CO_2 / CH_4 / N_2O

The Greenhouse Gas Abatement Programme is a Cross-sectoral measure that targets the Stationary Energy, Transport and Fugitive Emissions from Fuels subsectors and the Industrial Processes and Land Use, Land Use Change and Forestry Sectors. It is fully described earlier under Cross-sectoral policies and measures.

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a]

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Cross-sectoral policies and measures							
Low Emissions Technology Demonstration Fund	Support for the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	$500 million over up to 15 years from 2005	0.0
Greenhouse Gas Abatement Programme (GGAP)	Market-based allocation of grants to cost effective abatement opportunities	$CO_2/CH_4/N_2O$/ PFCs/HFCs	Economic	Implemented	Australian Government	$232.2 million from 1999–2013[c]	6.1
Greenhouse Challenge Plus	Voluntary, incentive-based and compulsory partnerships between the Australian Government and industry to abate greenhouse gas emissions	$CO_2/CH_4/N_2O$/ PFCs/HFCs/SF_6	Regulatory/ Economic/ Voluntary	Implemented	Australian Government	$31.6 million over 4 years	15.8
Local Greenhouse Action	Increasing abatement from local government and increasing capacity of local government to respond to impacts and adaptation.	$CO_2/CH_4/N_2O$	Voluntary/ Negotiated agreements/ Education	Implemented	Australian Government; states and territories; local governments	$13.6 million from 2004–08	0.4
International climate change partnerships	International action at the multilateral, regional and bilateral levels to support the development of an environmentally effective and economically efficient global response to climate change, and support for practical action to reduce greenhouse gas emissions	$CO_2/CH_4/N_2O$/ PFCs/HFCs/SF_6	Economic/ Voluntary/ Information/ Education/ Research	Implemented	Australian Government	$20.1 million	Actions do not target domestic abatement
Total Cross-sectoral	Note: The estimated mitigation impact of these policies and measures has been apportioned to entries in relevant sectors of this table.						
Energy–Stationary							
Energy market reform	Accelerating and monitoring energy market reform	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Australian Government; states and territories	Not able to be determined	Can no longer be separated from 'business as usual' projection
Low Emissions Technology and Abatement Programme	Supporting technologies that reduce energy demand and emission intensity in four theme areas: strategic abatement; renewables; fossil fuels; and geosequestration	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	$26.9 million over 4 years	0.2[d]
Queensland Government 13% Gas Scheme	Scheme requiring electricity retailers to source 13% of electricity from gas-fired generation	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Queensland Government	Not available	1.1
New South Wales Greenhouse Gas Abatement Scheme	Scheme requiring electricity retailers to meet mandatory annual targets for greenhouse emissions	$CO_2/CH_4/N_2O$	Regulatory	Implemented	New South Wales Government	Not available	18.1[e]
Australian Capital Territory Greenhouse Gas Abatement Scheme	Scheme requiring electricity retailers to source an increasing percentage of electricity from cleaner or renewable energy sources	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Australian Capital Territory Government	$0.3 million from 2005–12	Not estimated – sufficient information not available
Queensland Centre for Low Emission Technology	Research, development and demonstration into the key technologies that will lower greenhouse gas emissions from coal-based power generation	$CO_2/CH_4/N_2O$	Research	Implemented	Australian Government; Queensland Government	$9 million over 5 years from 2003	Not estimated – the primary focus of this measure is technology demonstration
Victorian Government Energy Technology and Innovation Strategy	To facilitate a coordinated approach to the advancement of low emissions energy technologies to commercial-ready stage	$CO_2/CH_4/N_2O$	Research/ Economic	Implemented	Victorian Government	$106 million	Not estimated – sufficient information not available in 2004

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
National Framework for Energy Efficiency	Whole-of-Government platform to improve energy efficiency performance nationally	$CO_2/CH_4/N_2O$	Regulatory/ Information/ Education	Implemented	Australian Government; states and territories	$33 million from 2004–07	Accounted for under other energy efficiency measures in this table
Energy efficiency standards for residential and commercial buildings	Introduction of minimum energy performance requirements for residential and commercial buildings	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Australian Government; states and territories	$6.4 million from 1998–2006	3.5
Energy Efficiency Opportunities	To stimulate large energy using businesses to take a more rigorous approach to energy management	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Australian Government	$16.9 million from 2004–05	0.8
National Appliance and Equipment Energy Efficiency Programme	Introduction of energy performance codes and standards (including labelling) for domestic appliances and commercial and industrial equipment	$CO_2/CH_4/N_2O$	Regulatory/ Voluntary	Implemented	Australian Government; states and territories	Funded through National Framework for Energy Efficiency (refer to figure above)	7.9
Improving energy efficiency in government operations	Reducing greenhouse gas emissions from government operations	$CO_2/CH_4/N_2O$	Regulatory/ Voluntary/ Negotiated agreements	Implemented	Australian Government; states and territories	$4.5 million from 2004–08	0.6
Energy Efficiency Best Practice and Benchmarking Programme	Assist industry in the efficient use of energy through innovation and capacity building	$CO_2/CH_4/N_2O$	Voluntary/ Negotiated agreements	Completed	Australian Government	$10.3 million over 5 years	0.2
State and territory action on energy efficiency	State and territory action to improve energy efficiency	$CO_2/CH_4/N_2O$	Various	Implemented	States and territories	Not able to be determined	2.9[f]
ecoBiz	Provision of financial incentives to encourage uptake of actions to meet energy efficiency targets	$CO_2/CH_4/N_2O$	Voluntary/ Economic/ Education	Implemented	Queensland Government	$2.8 million for 2005–06	Not estimated – sufficient information not available
Queensland Sustainable Energy Innovation Fund	Provision of financial incentives to support organisations in their efforts to commercialise energy-efficient or renewable energy technologies.	$CO_2/CH_4/N_2O$	Voluntary/ Economic/ Education	Implemented	Queensland Government	Up to $4.4 million from 2005–09	Not estimated – sufficient information not available
Mandatory Renewable Energy Target (MRET)	Mandatory targets for the uptake of renewable energy in power supplies	$CO_2/CH_4/N_2O$	Regulatory	Implemented	Australian Government	$6 million (in administration costs)	6.6
Renewable Energy Development Initiative	Research and development, proof-of-concept, and early-stage commercialisation of renewable energy projects	$CO_2/CH_4/N_2O$	Economic/ Research	Implemented	Australian Government	$100 million over 7 years	Not estimated – focused on longer-term abatement beyond 2012
Solar Cities	Trialling new sustainable energy models for electricity supply and use	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	$75 million over 9 years	Not estimated – proposals not yet assessed; focused on longer-term abatement beyond 2012
Advanced Energy Storage Technologies	Development of advanced storage systems for electricity from intermittent generation	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	$20.4 million over 4 years	Not estimated – focused on longer-term abatement beyond 2012

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Wind Energy Forecasting Capability	Addressing barriers to take-up of wind energy in electricity networks/markets	$CO_2/CH_4/N_2O$	Research	Implemented	Australian Government	$14 million over 5 years	Not estimated separately from MRET
National Green Power Accreditation Programme	Facilitate installation of new renewable energy generators and encourage consumer demand for electricity generated from renewable sources	$CO_2/CH_4/N_2O$	Voluntary/ Negotiated agreements	Implemented	States and territories	Not able to be determined	0.9
Strategic development of renewable energy	Renewable Energy Commercialisation Programme; Renewable Energy Showcase Programme; Renewable Remote Power Generation Programme; Renewable Energy Equity Fund; Photovoltaic Rebate Programme.	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	$343 million	0.5[g]
Renewable Energy Support Fund	Develop small-scale renewable energy generation projects in Victoria	CO_2	Economic	Implemented	Victorian Government	$6.7 million since 2002	Not estimated separately from MRET
Low Emissions Technology Demonstration Fund–stationary energy elements	Support for the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.0
Greenhouse Gas Abatement Programme (GGAP)–stationary energy elements	Market-based allocation of grants to cost effective abatement opportunities	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	1.9
Greenhouse Challenge Plus–stationary energy elements	Voluntary, incentive-based and compulsory partnerships between the Australian Government and industry to abate greenhouse gas emissions	$CO_2/CH_4/N_2O$	Regulatory/ Economic/ Voluntary	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	5.6
Local Greenhouse Action–stationary energy elements	Increasing abatement from local government and increasing capacity of local government to respond to impacts and adaptation.	$CO_2/CH_4/N_2O$	Voluntary/ Negotiated agreements/ Education	Implemented	Australian Government; states and territories; local governments	Shown above in Cross-sectoral policies and measures	0.4
Estimated mitigation overlap	Estimated overlap of 0.1 Mt CO_2-e between projected abatement from the Queensland Government Cleaner Energy Strategy and abatement projected to arise from other state and territory action on energy efficiency referred to in this table	$CO_2/CH_4/N_2O$	-	-	-	-	-0.1
Estimated mitigation overlap	Estimated overlap of 13.5 Mt CO_2-e between projected abatement from the New South Wales Greenhouse Gas Abatement Scheme and abatement projected to arise from other actions referred to in this table	$CO_2/CH_4/N_2O$	-	-	-	-	-13.5[e]
Total Energy–Stationary[h]							37.6
Energy–Transport							
Environmental Strategy for the Motor Vehicle Industry	National Average CO_2 Emissions Target; Fuel Consumption Labelling Scheme; Green Vehicle Guide; Australian Government Fleet Target	CO_2	Regulatory/ Voluntary/ Information	Implemented	Australian Government	Not able to be determined	0.5
Alternative Fuels Conversion Programme	Subsidy for conversion of vehicles to use alternative fuel	CO_2/CH_4	Economic	Implemented	Australian Government	$37.5 million from 2000–08	0.04[i]

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
State and territory alternative fuels programmes	State and territory alternative fuels programmes such as the Western Australian Government's hydrogen fuel cell bus trial and the South Australian Government's use of CNG buses	CO_2/CH_4	Economic	Implemented	States and territories	Not able to be determined	Not estimated separately
Compressed Natural Gas Infrastructure Programme	Subsidy of compressed natural gas refuelling stations	CO_2/CH_4	Economic	Completed	Australian Government	$1.5 million	Included in Alternative Fuels Conversion Programme above
Energy Grants (Credits) Scheme	Reducing the incentive to switch from using alternative fuels to diesel	CO_2/CH_4	Economic	Implemented	Australian Government	Not able to be determined	Not estimated
Biofuels Capital Grants Program	Capital grants for projects that provide new or expanded biofuels production capacity	CO_2	Economic	Implemented	Australian Government	$37.6 million	Included in abatement from 350ML Biofuels Target below
350 ML Biofuels Target	The contribution of at least 350 million litres of biofuels to the total fuel supply by 2010	CO_2	Economic	Implemented	Australian Government	Not able to be determined	0.3[j]
Production grants for ethanol and biodiesel	Grants to encourage the production of biofuels	CO_2	Economic	Implemented	Australian Government	Not able to be determined	Included in abatement from 350ML Biofuels Target above
Strategic transport planning	Initiatives to improve the sustainability of passenger and freight transport	CO_2	Various	Implemented	Australian Government; states and territories; local governments	Not able to be determined	Not estimated separately
State and territory transport measures	State and territory initiatives to reduce emissions from the transport sector	CO_2	Various	Implemented	States and territories	Not able to be determined	0.8
Low Emissions Technology Demonstration Fund – transport energy elements	Support for the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector	CO_2/CH_4	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.0
Greenhouse Gas Abatement Programme (GGAP) – transport energy elements	Market-based allocation of grants to cost effective abatement opportunities	CO_2	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.6
Local Greenhouse Action – transport energy elements	Increasing abatement from local government and increasing capacity of local government to respond to impacts and adaptation.	CO_2	Voluntary/ Negotiated agreements/ Education	Implemented	Australian Government; states and territories; local governments	Shown above in Cross-sectoral policies and measures	0.02
Total Energy–Transport[h]							2.2
Energy–Fugitive Emissions from Fuels							
Low Emissions Technology Demonstration Fund–fugitive emissions elements	Support for the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.0
Greenhouse Gas Abatement Programme (GGAP)–fugitive emissions elements	Market-based allocation of grants to cost effective abatement opportunities	$CO_2/CH_4/N_2O$	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	2.3

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Greenhouse Challenge Plus – fugitive emissions elements	Capture of waste coal mine gas and reduction in oil and gas venting and flaring through Greenhouse Challenge and other activities under Greenhouse Friendly	$CO_2/CH_4/N_2O$	Regulatory/ Voluntary/ Negotiated agreements	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	4.9
Queensland Government coal mine gas capture	Capture and use of waste mine gas from coal mines	$CO_2/CH_4/N_2O$	Regulatory/ Economic	Implemented	Queensland Government	$1.5 million over 5 years	Not estimated separately
New South Wales Greenhouse Gas Abatement Scheme	Provision of a market for waste coal mine gas	$CO_2/CH_4/N_2O$	Regulatory	Implemented	New South Wales Government	Refer to figure in Stationary Energy subsector above	Abatement included in entry under Stationary Energy subsector above
Total Energy–Fugitive Emissions from Fuels[h]							7.2
Industrial Processes							
Ozone depleting substances and synthetic greenhouse gas replacements from Montreal Protocol industries	Minimise synthetic greenhouse gas emissions, while providing long-term certainty for industry	HFCs/PFCs	Regulatory	Implemented	Australian Government	Not able to be determined	4.7
Best Practice Management of SF_6	Development of handling guidelines to reduce emissions of SF_6	SF_6	Regulatory/ Voluntary	Implemented	Australian Government	Funded through Greenhouse Challenge Plus (refer to figure in Cross-sectoral policies and measures above)	0.3
Other initiatives to reduce emissions from industrial processes	Victorian Government's State Environment Protection Policy (Air Quality Management) and Business Energy Innovation Initiative	$CO_2/CH_4/N_2O$/ PFCs/HFCs/SF_6	Regulatory/ Economic	Implemented	Victorian Government	$7.5 million from 2002–06	Not estimated – sufficient information not available
Greenhouse Gas Abatement Programme (GGAP)–industrial processes elements	Market-based allocation of grants to cost effective abatement opportunities	$CO_2/CH_4/N_2O$/ PFCs/HFCs	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.7
Greenhouse Challenge Plus–industrial processes elements	Voluntary, incentive-based and compulsory partnerships between the Australian Government and industry to abate greenhouse gas emissions	$CO_2/CH_4/N_2O$/ PFCs/HFCs	Regulatory/ Economic/ Voluntary	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	4.1
Estimated mitigation overlap	Estimated mitigation overlap of 0.7 Mt CO_2-e between projected abatement from actions targeting industrial processes under the Greenhouse Gas Abatement Programme (GGAP) and abatement projected to result from the introduction of synthetic gas legislation affecting ozone depleting substances and synthetic greenhouse gas replacements from Montreal Protocol industries referred to in this table	PFCs/HFCs	-	-	-	-	-0.7
Total Industrial Processes[h]							9.2

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Agriculture							
Greenhouse Action in Regional Australia	Build capacity to enhance forest sinks and build capacity to reduce emissions from agriculture	$CO_2/CH_4/N_2O$	Information/ Research	Implemented	Australian Government	$20.5 million	0.6[k]
Environmental Management Systems (EMS) Programmes	Support to primary producers for improved environmental and natural resource management outcomes	$CO_2/CH_4/N_2O$	Economic/ Voluntary	Implemented	Australian Government	$31.2 million from 2002–07	Not estimated separately
Total Agriculture[h]							**0.6**
Waste							
Australian Government, state, territory, and local government waste management strategies	Policies and measures to reduce and capture methane emissions from the waste sector	$CO_2/CH_4/N_2O$	Voluntary/ Regulatory/ Economic	Implemented	Australian Government; states and territories; local government	Not able to be determined	9.0
Greenhouse Challenge Plus–waste elements	Voluntary, incentive-based and compulsory partnerships between the Australian Government and industry to abate greenhouse gas emissions under the Greenhouse Friendly programme	CH_4	Regulatory/ Economic/ Voluntary	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.2
Estimated mitigation overlap	Estimated overlap of 0.2 Mt CO_2-e between projected abatement from Greenhouse Challenge Plus and abatement projected to arise from Australian Government, state, territory, and local government waste management strategies referred to in this table	CH_4	-	-	-	-	-0.2
Total Waste[h]							**9.0**
Land Use, Land Use Change and Forestry							
Greenhouse Action in Regional Australia	Build capacity to enhance forest sinks and build capacity to reduce emissions from agriculture	$CO_2/CH_4/N_2O$	Information/ Research	Implemented	Australian Government	Refer to figure in Agriculture sector	Not estimated separately[k]
Natural Heritage Trust—land and vegetation programmes (Landcare and Bushcare)	Environmental plantings	$CO_2/CH_4/N_2O$	Economic/ Information	Implemented	Australian Government; states and territories	Not able to be determined	Not estimated separately in the 'with measures' projection
National Landcare Programme	Environmental plantings	$CO_2/CH_4/N_2O$	Economic/ Information	Implemented	Australian Government; states and territories	$109.8 million from 2005–08	Not estimated separately in the 'with measures' projection
Plantations for Australia: The 2020 Vision	Remove impediments to plantation establishment	CO_2	Economic/ Information	Implemented	Australian Government; states and territories; industry	Not able to be determined	Not estimated separately in the 'with measures' projection
National Action Plan for Salinity and Water Quality	Enhance sink capacity by preventing, stabilising and reversing trends in dryland salinity	CO_2	Economic/ Information	Implemented	Australian Government; states and territories	$1.4 billion from 2001–08	Not estimated separately in the 'with measures' projection
Queensland Government legislation for the management of native vegetation	Reduce land use change emissions from clearing of native vegetation in Queensland	CO_2	Regulatory	Implemented	Queensland Government	$150 million	17.5

Table 4.1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, by sector[a] (continued)

Name of policy or measure	Objective and/or activity affected	Greenhouse gas affected[b]	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
New South Wales Government legislation for the management of native vegetation	Reduce land use change emissions from clearing of native vegetation in New South Wales	CO_2	Regulatory	Implemented	New South Wales Government	Not able to be determined	3.4
Other land and vegetation programmes	Various activities to improve vegetation management and enhance forest carbon sinks, including legislation covering carbon sequestration	CO_2	Regulatory/ Economic	Implemented	States and territories	Not able to be determined	Not estimated – sufficient information not available
Greenhouse Gas Abatement Programme (GGAP)–land use, land use change and forestry elements	Market-based allocation of grants to cost effective abatement opportunities	CO_2	Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.1
Mitigation adjustment	Adjustment to estimated mitigation projected to result from initiatives to reduce clearing of native vegetation	CO_2	-	-	-	-	-3.0[l]
Total Land Use, Land Use Change and Forestry[h]							18.0
Policies and measures not allocated to a specific sector							
Greenhouse Gas Abatement Programme (GGAP) – unallocated elements	Market-based allocation of grants to cost effective abatement opportunities – Round 3		Economic	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.4
Greenhouse Challenge Plus – unallocated elements	Further abatement from Greenhouse Friendly programme not already included in Stationary Energy and Fugitive Emissions from Fuels subsectors		Regulatory/ Economic/ Voluntary	Implemented	Australian Government	Shown above in Cross-sectoral policies and measures	0.7
Total Policies and measures not allocated to a specific sector[h]							1.1
Total National Abatement[h]							**85**

[a] This table summarises policies and measures set out in this chapter, including official Australian Government estimates of abatement in 2010. In some cases the estimated abatement in 2010 is calculated as the average annual abatement for the measure over the period 2008–2012. Abatement has not been estimated for programmes that are either broadly related to information dissemination rather than specific actions, or for which information is not yet available to provide an estimate. The term 'not estimated' is used in both cases.

[b] CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; PFCs = perfluorocarbon compounds; HFCs = hydrofluorocarbon compounds; SF_6 = sulphur hexafluoride.

[c] Additional funding originally allocated to the Greenhouse Gas Abatement Programme in 1999 has since been reallocated to other measures with strategic abatement potential.

[d] The estimated mitigation impact shown for the Low Emissions Technology and Abatement Programme is a preliminary estimate only. Assessment, approval and implementation of proposals under the Programme is expected to begin in the latter part of 2005. Until such time, it is not possible to estimate the full abatement impact of this initiative.

[e] Projected abatement from the New South Wales Greenhouse Gas Abatement Scheme includes estimated mitigation overlap of 13.5 Mt CO_2-e with abatement projected to arise from other actions referred to In this table

[f] This estimated abatement is in addition to that expected through programmes implemented jointly by the Australian Government and state and territory governments, such as building efficiency initiatives and MEPS as described in this chapter.

[g] Figure shown relates to the estimated mitigation impact of the Renewable Energy Commercialisation Programme and Renewable Remote Power Generation Programme, in addition to that reported against the Mandatory Renewable Energy Target above. Greenhouse gas reductions from the Renewable Energy Showcase, the Renewable Energy Equity Fund, and the Photovoltaic Rebate Programme have not been estimated, because they focus primarily on technology development and commercialisation as opposed to greenhouse gas abatement, and because the potential greenhouse gas abatement depends on the degree of commercial uptake and application of the technologies developed.

[h] Unless shown otherwise, estimated mitigation figures for individual policies and measures have been rounded to one decimal place. The sectoral and subsectoral totals do not always match the sum of the measures due to rounding. The estimated Total National Abatement has been calculated as the sum of the sectoral and subsectoral mitigation totals after rounding these figures to the nearest whole number.

[i] Figure shown relates to the total estimated mitigation impact of all elements of the Alternative Fuels Conversion Programme, including mitigation resulting from the CNG Infrastructure Programme included below in this table.

[j] The estimated mitigation impact of the 350 ML Biofuels Target is a net estimate, which includes some increase in emissions from the Stationary Energy subsector resulting from the production of biofuels.

[k] The Greenhouse Action in Regional Australia measure appears in this table as a measure that targets both the Agriculture sector and the Land Use, Land Use Change and Forestry sector, however the estimated mitigation impact of this measure relates only to initiatives that target the Agriculture sector only

[l] The Australian Greenhouse Office has introduced an adjustment of 3.0 Mt CO_2-e in 2010 to the total projected abatement expected to result from initiatives to reduce clearing of native vegetation to reflect the high levels of uncertainty associated with estimating abatement from the Land Use, Land Use Change and Forestry sector.

CHAPTER 5

PROJECTIONS

This chapter presents projections for Australia's greenhouse gas emissions. 'With measures' projections are reported for each National Greenhouse Gas Inventory sector, focussing on 2010 and 2020. These sectoral projections were prepared in 2004 and 2005.

Projections of emissions presented in this chapter are principally made in accordance with the provisions of the United Nations Framework Convention on Climate Change (UNFCCC), in line with the international guidelines for national communications.

This chapter also reports emissions projections under Kyoto accounting rules, in order to report Australia's progress towards meeting its Kyoto target of limiting emissions in 2008–12 to 108% of 1990 levels.

The rules for preparing inventories and emissions projections under the Kyoto Protocol differ from the UNFCCC accounting approach in relation to forestry. Using the UNFCCC comprehensive definition of forestry, the 1990 baseline is lower than that which applies for analysing progress towards Australia's Kyoto target. This difference in the accounting rules means that the emissions projections for UNFCCC accounting and for the Kyoto target are different.

This chapter presents a summary of Australia's approach to emissions projections, an assessment of the aggregate effects of policies and measures, and a discussion of the uncertainties associated with those projections. A sector by sector explanation of the projections is also provided; describing the approach adopted, key assumptions and results. The sectors are defined to be generally consistent with the National Greenhouse Gas Inventory. The final section describes Australia's emissions projections methodology in more detail.

Australia's approach to emissions projections

Australia produces a 'with measures' emissions projection, together with a 'business as usual' (BAU) projection (otherwise referred to in the guidelines as 'without measures') of emissions for a majority of sectors. The 'with measures' projection reflects the likely net level of emissions, including the impact of policies and measures. The BAU projection refers to the level of emissions that would have occurred in the absence of specific action to reduce greenhouse gas emissions through policies and measures. The optional 'with additional measures' projection is not produced.

'With measures' and BAU projections are currently developed for the Energy, Agriculture, Industrial Processes, Waste sectors and the Land Use Change subsector. Projections for the Forest Lands subsector have only been developed on a 'with measures' basis.

A notable feature of the Australian approach is that multiple models are used in a number of sectors, in particular in the Stationary Energy, Transport and Agriculture sectors. Australia's emissions projections draw on a range of different expertise in these key sectors. In these sectors, the sectoral projection is an average of the individual model projections.

In Stationary Energy, four different model projections are used, two from top-down models and two from bottom-up models. Two model projections are used in both the Transport and Agriculture sectors.

This approach draws on the range of expertise and views that exists in Australia in economic modelling and emissions activity in these sectors, as part of reflecting and managing the uncertainty associated with emissions projections.

The method of averaging results from the different individual sectoral projections reflects a 'consensus forecasting' approach to the projections. Consensus forecasting assumes that the average of a range of expert projections is more accurate than the individual forecasts that constitute the consensus.

Australia's emissions projections approach also incorporates significant interaction between the different modelling experts, business groups and individual companies within each sector through the projections process. This has led to significant testing of and refinements to individual projections, and to greater consensus among the projections.

For the Stationary Energy sector, the range between the highest and lowest of the individual model results for the 2010 annual projections has fallen from around 23 million tonnes (Mt) of carbon dioxide equivalent (CO_2-e) difference in the *Third National Communication* (about 8% of the mean projection) to around 4 Mt CO_2-e (1.5%) in the current projections.

Emissions projections reported in the *Third National Communication*, were initially estimated on a BAU basis, in the absence of policies and measures that reduce growth in projected emissions. Separate assessments were made of the impact of policies and measures, and the 'with measures' projection was produced by deducting the impact of the policies and measures from the BAU projection.

Since then, estimation of the impacts of policies and measures has been increasingly incorporated directly into the projections modelling, especially for the Stationary Energy sector. This means that the emphasis of the modelling is directly focussed on the 'with measures' projection, together with internally consistent individual modellers' BAU projections and measures estimates.

Australia's greenhouse gas emissions projections are published annually, with each sector being reviewed every two years. The projections contained in the *Fourth National Communication* were released in 2005, with the Transport, Agriculture, Waste, and Land Use, Land Use Change and Forestry sector projections updated in 2005. The Stationary Energy, Fugitive Emissions from Fuels and Industrial Processes sector projections were completed in 2004, and will next be reviewed in 2006.

The Australian Greenhouse Office (AGO) within the Department of the Environment and Heritage has an ongoing programme to update and improve sectoral projections. This continuous improvement process has included an increased focus on the key drivers of sectoral projections, increased reconciliation of results from the different models within sectors, and improvements to the estimation of measures impacts.

Assessment of aggregate effects of policies and measures

According to UNFCCC accounting rules, Australia's total emissions are projected to be 565 Mt CO_2-e in 2010 (see Table 5.1), with all sectors and greenhouse gas abatement measures included.

Australia is also on track to meet its Kyoto target under Kyoto Protocol accounting rules. Using Kyoto accounting, the projections indicate that between 2008 and 2012, emissions would be 108% of 1990 levels on average. Details of the overall Kyoto projections are shown in Appendix C.

Policies and measures currently being implemented are projected to deliver abatement of 85 Mt CO_2-e in 2010, across all UNFCCC sectors (Energy, Industrial Processes, Waste, Agriculture, Land Use, Land Use Change and Forestry).

Table 5.1 Greenhouse gas emissions projections (Mt CO_2-e), 1990 and 2010 (UNFCCC accounting method)

	1990	2010 Business as usual	Measures	2010 With measures
Energy	**286**	**461**	**47**	**414**
Stationary	195	322	38	285
Transport	62	97	2	94
Fugitive	29	42	7	35
Industrial Processes	**27**	**51**	**9**	**42**
Agriculture	**94**	**99**	**1**	**99**
Waste	**10**	**19**	**9**	**10**
Unallocated Abatement from Policies and Measures			1	-1
Sub Total	**417**	**630**	**67**	**563**
Land Use, Land Use Change and Forestry	92	19	18	1
Forest Lands	-33	-42[a]	ne	-42
Land Use Change	126	61	18	43
TOTAL	**511**	**649**	**85**	**565**

Note: Columns may not add up to total due to rounding
ne Not estimated
[a] The BAU figure provided for the Forest Lands subsector is notional, as projections for this subsector are calculated on a 'with measures' basis only

Main sectoral contributions

Sectoral contributions to total emissions are dominated by Energy, Agriculture and Land Use, Land Use Change and Forestry.

- It is projected that the Energy sector (comprising the Stationary Energy, Transport and Fugitive Emissions from Fuels sectors) will continue to be the most significant source of greenhouse gas emissions in 2010 (approximately 70% of total emissions on a Kyoto accounting basis).
- Agriculture emissions are not projected to grow significantly, but are still expected to contribute approximately 18% of emissions in 2010.
- Emissions from Industrial Processes are expected to grow rapidly from a relatively small base. They are projected to contribute approximately 7% of emissions in 2010.
- The contribution of the Waste sector is projected to shrink slightly, contributing approximately 2% of emissions in 2010.

- On a UNFCCC accounting basis, the Forest Lands subsector is expected to sequester approximately 42 Mt CO_2-e in 2010. On the same basis, Forest Lands is estimated to have sequestered approximately 33 Mt CO_2-e in 1990. The Kyoto target implementation provisions are different. On this basis new forest plantations provide around 21 Mt CO_2-e removals in 2010 from a 1990 base of zero.

- Emissions from the Land Use Change subsector are projected to be 43 Mt CO_2-e in 2010. The subsector is estimated to have emitted approximately 126 Mt CO_2-e in 1990.

Reconciliation with previous projections

The projections included in Australia's *Third National Communication* submitted in 2002 projected an 11% increase in emissions between 1990 and 2010 using Kyoto accounting rules and a 16% increase using UNFCCC accounting rules.

Since the *Third National Communication*, changes in sectoral projections together with the impact of new measures such as those contained in the Australian Government's Climate Change Strategy mean that Australia is now on track to meet its Kyoto target of limiting emissions to 108% of 1990 levels.

A comparison of current projections with emissions projections as reported in the *Third National Communication,* on a UNFCCC accounting basis, are shown in Table 5.2.

Table 5.2 Comparison of Third National Communication and current projections (Mt CO_2-e) (UNFCCC accounting method)

Projection	1990	2010			
		Business as usual	Measures	With Measures	% of 1990
Third National Communication	498	639	59	580	116%
Current Projections	511	649	85	565	111%

Projections – sector by sector

The following section discusses the best estimate 'with measures' projections for each sector, together with the BAU and the impact of measures. In most cases a range is provided to indicate the level of uncertainty of the projections. This is shown in the corresponding figures for each sector as high and low estimates for the 'with measures' projections. The high and low 'with measures' projections reflect scenarios in which some key assumptions vary from those in the best estimate projection.

Significant detail on each sectoral projection is available in individual papers which are published on the AGO website at http://www.greenhouse.gov.au/projections. A brief overview of projections for each sector follows.

Projections for the Stationary Energy sector

Stationary Energy includes emissions from the generation of electricity and from direct combustion of solid, liquid, gaseous, biomass and other fuels for purposes other than electricity generation. Electricity generation is the most significant contributor to emissions from this sector. Emissions associated with the use of reducing agents such as coke by the steel industry, which were previously allocated to the Stationary Energy sector, are now reported in the Industrial Processes sector.

Factors influencing sectoral emissions projections

Growth in emissions from this sector is attributable to a range of factors including:

- gross domestic product (GDP)
- population growth
- sectoral activity and structural change
- major resource projects
- ongoing improvements in energy efficiency
- fuel mix, including greater use of less carbon intensive fuels such as natural gas and renewable energy.

Analytical approach followed

The Stationary Energy projection uses a combination of top-down and bottom-up economic models. The 2004 projection for the Stationary Energy sector used four different models. The models were selected to represent both economy-wide general equilibrium approaches and more detailed bottom-up approaches where individual electricity generators and energy intensive projects could be specified. Two models from the Australian Bureau of Agriculture and Resource Economics (ABARE) were used (GTEM and E4CAST) together with two models from the private sector (Centre of Policy Studies' MMRF-Green model and McLennan Magasanik Associates' suite of models).

The projection is a composite of the projections from all modelling groups. Projections from top-down and bottom-up models were averaged within their classes and the two resulting projections were then averaged to form the composite projection. With two models in each class for the 2004 projections, the four models have equal weight.

The composite projection has been based on full 'with measures' projections provided by the modellers, to the extent possible. The AGO adjusted these individual projections to allow for estimates of measures that were announced in the 2004-05 Federal Budget and the Australian Government's Energy White Paper as information on these new measures was not available when the projections were modelled in 2004.

Assumptions

The assumptions used for the Stationary Energy projection are shown in Table 5.3. These include GDP, population estimates, energy use estimates and projected share of energy generated from gas.

Table 5.3 Summary of key assumptions

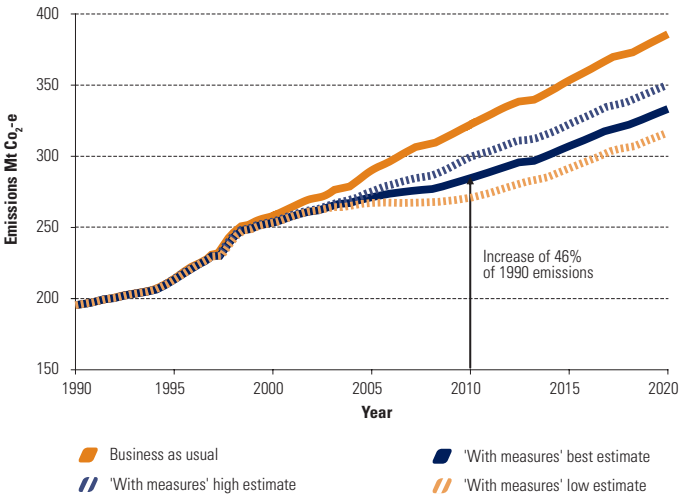
Variable	Unit	Modellers range	
		2002-10	2010-20
Real GDP	Annual % growth	3.0 to 3.5	2.6 to 3.3
Population	Annual % growth	1.2	0.8
End-use energy efficiency	Annual % improvement	0.5 to 0.6	0.3 to 0.5
Energy sector efficiency	Annual % improvement	0.5 to 0.8	0.1 to 0.4
Share of electricity generated from gas	Total % change over the period	3.5 to 5.5	2.5 to 4.7

'With measures' projections

Emissions from the Stationary Energy sector in 2010 are projected to be 285 Mt CO_2-e. This represents a 46% increase over 1990 levels. For 2020 the 'with measures' projection is 333 Mt CO_2-e. This is an increase of 70% over 1990 levels.

The emissions projection for this sector is shown in Figure 5.1.

Figure 5.1 Emissions from the Stationary Energy sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

The impact of measures affecting the Stationary Energy sector is projected to be 37.6 Mt CO_2-e in 2010, increasing to 52.6 Mt CO_2-e in 2020. A list of current measures is provided in Table 5.4.

Table 5.4 Impact of current measures in the Stationary Energy sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Action on Energy Efficiency	12.0	23.0
Mandatory Renewable Energy Target	6.6	6.7
Greenhouse Challenge (supply and end-use)	5.6	6.0
Greenhouse Gas Abatement Programme	1.9	1.9
Energy Efficiency Opportunities	0.8	2.5
Additional State and Territory Actions	8.5	9.2
Other Actions	2.2	3.2
Total Stationary Energy	**37.6**	**52.6**

Note: Columns may not add up to total due to rounding

New measures were announced by the Australian Government in 2004. Projections for these new measures were estimated separately from the projections modelling process and include the Energy Efficiency Opportunities programme, Solar Cities, the Low Emissions Technology Demonstration Fund, the Low Emission Technology and Abatement Programme and the Renewable Energy Development Initiative. A preliminary estimate of these measures is included in the 'with measures' projection for the Stationary Energy sector.

Projections for the Transport sector

Greenhouse gas emissions from the Transport sector include emissions from the direct combustion (or end–use) of fuels by road, rail, domestic air transport and domestic shipping but do not include full fuel cycle emissions. Road transport is by far the most significant source of transport emissions. Passenger motor vehicles together with trucks and light commercial vehicles have been responsible for the majority of the growth in transport emissions.

Factors influencing sectoral emissions projections

Transport sector emissions are driven primarily by projected GDP and population growth. Other significant factors include improvements in vehicle technology; such as fuel efficiency and design standards; the future travel behaviour of individuals in response to rising personal incomes; and the impact of greenhouse gas abatement measures introduced by governments.

Emissions from commercial vehicles are closely linked to demand for the goods and services they provide, which in turn is linked to the general level of growth in the broader economy. Economic growth and increasing per capita income levels also influence emissions from passenger cars, however not as directly as emissions from commercial vehicles and other modes of freight.

Analytical approach followed

The Transport sector projection is based on two bottom-up models (from the Bureau of Transport and Regional Economics (BTRE) and the Apelbaum Consulting Group (ACG)). Both modellers provided 'with measures' projections, excluding the biofuels measure estimate, which was not available at that time. The AGO adjusted the modellers' results for the impact of the biofuels measure. The two resulting projections were then averaged to derive a best estimate.

Assumptions

The main assumptions for transport emissions are economic and population growth. Assumptions adopted by the BTRE and ACG for these variables are within the range specified in Table 5.3.

While assumptions between the ACG and BTRE models are broadly similar at the aggregate level, it should be noted that the models differ in structure and rely on different levels of input assumptions. The ACG suite of models consists of regionally based modelling structures and functions and thus depends on indicators such as growth in Gross State Product, population, industrial production and housing investment on a state basis. By comparison, the BTRE modelling relies on more aggregate indicators such as GDP and national population growth.

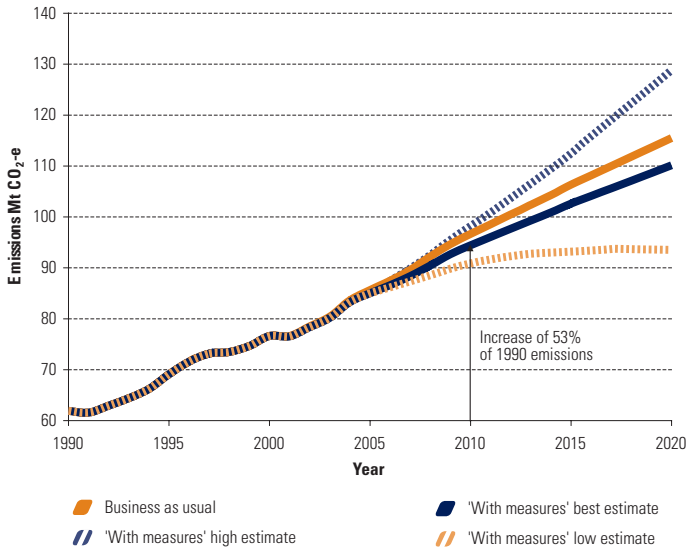
The ACG and BTRE models also contain significantly different structural relationships between road transport demand and these variables. In particular, the BTRE predict that emissions growth will become increasingly decoupled from income growth into the future, while ACG project this relationship to remain strong. The central 'with measures' projection takes this diversity into account through the averaging of the two projections to arrive at the composite 'with measures' projection.

'With measures' projections

Emissions from the Transport sector in 2010 are projected to be 94 Mt CO_2-e. This represents a 53% increase over 1990 levels. 'With measures' emissions for 2020 are projected to be 110 Mt CO_2-e, which is an increase of 78% over the 1990 levels.

The emissions projection for this sector is shown in Figure 5.2.

Figure 5.2 Emissions from the Transport sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

In 2010, impact of measures affecting the Transport sector is estimated to be 2.2 Mt CO_2-e increasing to 5.3 Mt CO_2-e in 2020. A list of these measures and their impacts is provided in Table 5.5.

Table 5.5 Impact of current measures in the Transport sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Environmental Strategy for the Motor Vehicle Industry	0.5	2.5
Government Biofuels Initiatives	0.3	0.3
Greenhouse Gas Abatement Programme	0.6	0.5
Additional State and Territory Actions	0.8	2.0
Other Actions	0.1	0.1
Total Transport	**2.2**	**5.3**

Note: Columns may not add up to total due to rounding.

Projections for the Fugitive Emissions from Fuels sector

The Fugitive Emissions from Fuels sector covers methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions from the production, processing, transport, storage, transmission and distribution of fossil fuels, but does not cover the emissions from fuel burnt for process energy, which are counted in the Stationary Energy and the Industrial Processes sectors.

Factors influencing sectoral emissions projections

The two key components of the Fugitive Emissions from Fuels sector are emissions from coal mines and from major oil and gas projects. Fugitive emissions are determined in part by the total production of coal, oil and natural gas, but more importantly by the emissions intensity of that production. For example, underground mining of coal from Class A gassy mines accounted for 54%of coal emissions in 2002 but only 11%of all coal mined. Similarly, the CO_2 content of natural gas deposits varies widely among different fields and is a significant driver of emissions from natural gas projects.

Production levels are driven by both domestic and export demand, which are in turn influenced by factors such as domestic and world economic growth, relative fuel prices and fuel substitutability in the various end–use markets.

Analytical approach followed

Fugitive Emissions from Fuels projections were prepared using a combination of top-down and bottom-up modelling approaches, which are closely based on the methodologies used to compile the *2003 National Greenhouse Gas Inventory* estimates for the sector.

For coal mining emissions, the AGO developed projections using a combination of top-down and bottom-up modelling approaches. Since top-down modelling by itself was unable to account for changes in the share of production from each type of mine, bottom–up analysis was employed to forecast the share of coal production expected to come from underground Class A 'gassy mines', which is the primary driver of coal emissions.

Emissions from oil and gas projects were estimated using a bottom-up approach. Most emissions are either associated with the extraction of oil and gas, or leakage from gas distribution systems. The main source of emissions data for these activities is the annual survey conducted by the Australian Petroleum Production and Exploration Association. This data was supplemented by data from a variety of other sources for those emissions unrelated to oil and gas production, including gas transmission, gas distribution and oil refinery flaring.

Assumptions

The Fugitive Emissions from Fuels projection is heavily driven by assumptions about specific coal, oil and gas projects, particularly emissions intensive Class A 'gassy' coal mines and major Liquefied Natural Gas projects. Assumptions about overall production of coal together with oil and gas are derived from the Stationary Energy projection, and are outlined below in Table 5.6.

Table 5.6 Projection of fossil fuel production from 1990 to 2020

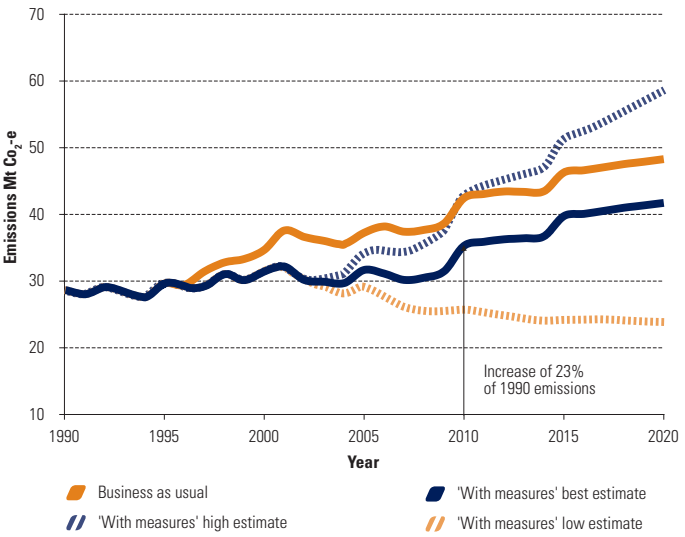
Fossil Fuel	1990	2002	2010	2020
Coal (million tonnes raw coal)	189	317	406	447
Oil and Gas (petajoules)	797	1,427	2,806	3,820

'With measures' projections

Emissions from the Fugitive Emissions from Fuels sector in 2010 are projected to be 35 Mt CO_2-e. This represents a 23% increase on the 1990 levels. 'With measures' emissions for 2020 are projected to be 42 Mt CO_2-e, which is an increase of 45% over the 1990 level.

The emissions projection range for this sector is shown in Figure 5.3.

Figure 5.3 Emissions from the Fugitive Emissions from Fuels sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

The impact of measures affecting the Fugitive Emissions from Fuels sector is estimated to be 7.2 Mt CO_2-e in 2010 and is estimated to decrease to 6.5 Mt CO_2-e by 2020. A list of measures and their impacts is provided in Table 5.7.

Table 5.7 Impact of current measures in the Fugitive Emissions from Fuels sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Coal subsector		
Greenhouse Challenge	3.0	3.0
Greenhouse Gap Abatement Programme	2.3	2.3
Oil and gas subsector		
Greenhouse Challenge and Greenhouse Friendly	1.9	1.3
Total Fugitive Emissions from Fuels	**7.2**	**6.5**

Note: Columns may not add up to total due to rounding

Projections for the Industrial Processes sector

The Industrial Processes sector includes process greenhouse gas emissions from the following subsectors:

- mineral products
- chemical industries
- metals production
- industries that use gases covered by the *Montreal Protocol on Substances that Deplete the Ozone Layer*
- sulphur hexafluoride (SF_6) used in electrical circuit breakers and switchgear.

Non-process greenhouse gas emissions and abatement from the above industries are counted in other sectors in accordance with the definitions used in the National Greenhouse Gas Inventory.

Factors influencing sectoral emissions projections

Emissions from the Industrial Processes sector increased by 15% over the period 1990 to 2003. This reflects strong growth in the consumption of hydrofluorocarbons (HFCs) by Montreal Protocol Industries and significant growth in emissions from the chemical sector. During this period, emissions growth has been partially offset by a substantial decline in emissions from metal production, due to some contraction in the iron and steel industry and significant reduction in perfluorocarbon (PFC) emissions from aluminium smelting.

Strong emissions growth is projected in the near term to 2010 and in the medium term to 2020. In this period, projected growth in emissions is expected to be driven by:

- continued expansion of synthetic gas usage in Montreal Protocol industries as these industries make the transition away from ozone depleting substances
- expected increases in metals production, driven by strong export demand
- increased production in chemical industries.

Analytical approach followed

The 2004 emissions projections for the Industrial Processes sector were undertaken using a single bottom-up model drawing on input from industry sources.

Assumptions

In the mineral, chemical and metal subsectors, production levels largely influence annual fluctuations in emissions. Over time, technological change in production processes can also have a significant impact on process emissions, for example, improved process monitoring and control has reduced PFC emissions from aluminium smelting.

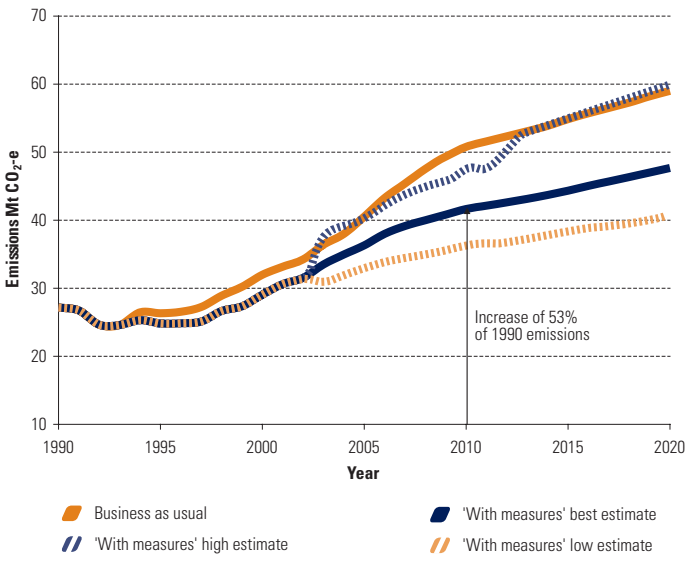
Key assumptions driving emissions in the Montreal Protocol and electricity supply industries include the growth in demand for products and equipment that require synthetic gases in operation (such as air conditioning units and electrical switchgear) and the amount of gas leakage occurring from those products.

'With measures' projections

Emissions from the Industrial Processes sector in 2010 are projected to be 42 Mt CO_2-e. This represents a 53% increase on 1990 levels. 'With measures' emissions for 2020 are projected to be 48 Mt CO_2-e, an increase of 75% over the 1990 levels.

The emissions projection range for this sector is shown in Figure 5.4.

Figure 5.4 Emissions from the Industrial Processes sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

The impact of measures is estimated to be 9.2 Mt CO_2-e in 2010 and is projected to increase to 11.3 Mt CO_2-e in 2020. This estimate is made up from the following measures:

- Greenhouse Challenge program
- Synthetic gas legislation
- Greenhouse Gas Abatement Programme
- Best practice management of SF_6 in electrical distribution (see Table 5.8).

Table 5.8 Impact of current measures in the Industrial Processes sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Greenhouse Challenge	4.1	4.7
Synthetic Gas Legislation	4.7	6.2
Greenhouse Gas Abatement Programme	0.7	0.8
Best Practice Management of SF_6	0.3	0.4
Overlap between measures	-0.7	-0.8
Total Industrial Processes	**9.2**	**11.3**

Note: Columns may not add up to total due to rounding

Projections for the Agriculture sector

Sources of greenhouse gas emissions from the Agriculture sector, under the UNFCCC classification of agriculture, include non-CO_2 gases from livestock enteric fermentation, manure management, rice cultivation, agricultural soils, prescribed burning of savannas and field burning of agricultural residues. Livestock account for 78% of agricultural emissions with the single largest component, enteric fermentation, accounting for 64%.

Factors influencing sectoral emissions projections

The key driver impacting on emissions projections for the Agriculture sector is the size of the beef herd, which is largely driven by export demand, and climate conditions, such as droughts.

Analytical approach followed

The 2005 projections of greenhouse gas emissions for the Agriculture sector use projections from two bottom-up models from ABARE and the Centre for International Economics (CIE). The projections methodology is in line with that used in the *2003 National Greenhouse Gas Inventory*, which adopted revised emission factors as a result of an intensive review of livestock methodologies in 2002.

ABARE and CIE undertook projections using bottom-up models. Both models contain links with international markets, with the CIE specifying market conditions and economic growth for each of Australia's major trading partners, whilst the ABARE model treats all trading partners as a single 'rest of the world' sector.

Assumptions

The most important assumptions in the agriculture projection are the levels of demand projected in key export markets for Australian agricultural commodities. Table 5.9 details the values for these key variables assumed by each of the sectoral models (ABARE and CIE).

Table 5.9 Key assumptions for the Agriculture sector, 2004 to 2020

Assumption	ABARE	CIE
Rest of world GDP growth (%)	3.7	1.8 to 6.7[a]
Rest of world population growth (%)	NA	-0.1 to 2.0[a]
Exchange rate (2010) ($AUS/$US)	NA	1.51
Carcass weight (% improvement)	0.5	1.0

[a] CIE modelling contains estimates for 21 of Australia's major trading partners. The range presented here indicates the span of these forecasts.

Also important to each projection is the rate of productivity improvement assumed for Australian producers relative to the rate of improvement in our competitors. The CIE assumes that Australian producers increase productivity slightly faster than their international competitors, leading to higher demand for Australian produce on international markets. In contrast, ABARE assumes that competitors keep pace with Australian productivity improvements, leading to lower demand for Australian produce.

The size of the beef herd is the main driver of Australian agricultural emissions. Both modellers expect meat exports to expand, with overseas economic growth driving increased demand for Australian beef in the short to medium term, particularly in countries where consumers switch to meat from grain protein as incomes rise. However, growth in the CIE projection is strongest. Each modellers' projection of cattle numbers is presented in Table 5.10.

Table 5.10 Projected total cattle numbers (million head)

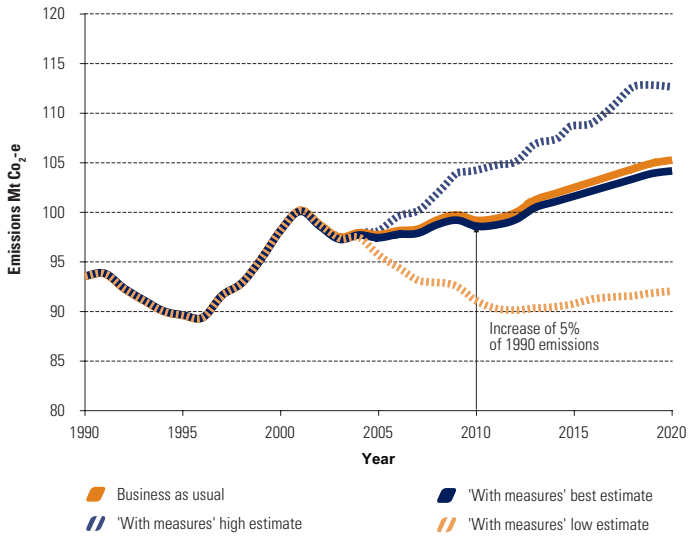
Modeller	2010	2020
ABARE	26.6	27.9
CIE	27.5	31.0

'With measures' projections

Emissions from the Agriculture sector in 2010 are projected to be 99 Mt CO_2-e. This represents a 5% increase on the 1990 levels. 'With measures' emissions for 2020 are projected to be 104 Mt CO_2-e, which is an increase of 11% over the 1990 levels.

The emissions projection for this sector is shown in Figure 5.5.

Figure 5.5: Emissions from the Agriculture sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

The impact of measures in 2010 is estimated to be 0.6 Mt CO_2-e and is projected to rise to 1.1 Mt CO_2-e by 2020. A list of the measures and impacts is shown in Table 5.11.

Table 5.11 Impact of current measures in the Agriculture sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Reduced fertiliser application	0.5	0.8
Waste management	0.03	0.1
Residue burning	0.1	0.2
Total Agriculture	**0.6**	**1.1**

Note: Columns may not add up to total due to rounding

Projections for the Waste sector

The Waste sector covers emissions from solid waste disposal on land, domestic, commercial and industrial wastewater treatment and waste incineration. The primary greenhouse gas emitted is CH_4, with CO_2 and N_2O also emitted.

Factors influencing sectoral emissions projections

The main drivers of BAU emissions from the Waste sector are population growth and GDP. Improvements in landfill management and waste recovery management are projected to significantly reduce emissions from the sector.

Analytical approach followed

The Waste sector projection is based on two subsectoral projections, municipal solid waste and wastewater. The projection is based on the methodology used in the *2003 National Greenhouse Gas Inventory*. The main factors affecting the municipal solid waste subsector are population growth and the amount of waste produced per capita, whereas the main factors for the wastewater subsector are population growth and the proportion of population sewered.

Assumptions

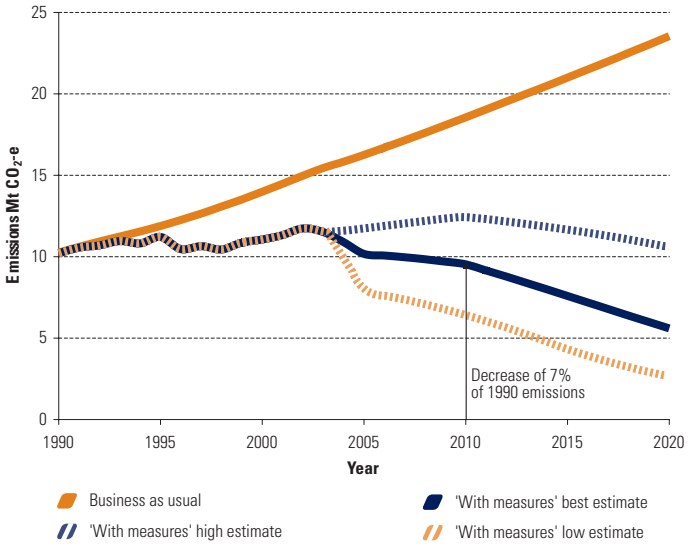
Best, low and high population time series were provided by the Australian Bureau of Statistics. Best, low and high estimates of the growth of waste per capita has been based on the historical data available from the National Greenhouse Gas Inventory.

'With measures' projections

Emissions from the Waste sector in 2010 are projected to be 10 Mt CO_2-e. This represents a 7% decrease on the 1990 levels. 'With measures' emissions for 2020 are projected to be 6 Mt CO_2-e, which is a decrease of 45% over the 1990 levels.

The emissions projection range for this sector is shown in Figure 5.6.

Figure 5.6 Emissions from the Waste sector (Mt CO_2-e), 1990 to 2020



Effects of policies and measures already in place

The impact of measures is estimated to be 9.0 Mt CO_2-e in 2010 and is projected to increase to 17.9 Mt CO_2-e in 2020. The Waste sector measures reflect the expected impacts of state and territory policies on waste management, including their performance against meeting waste diversion and landfill gas capture targets.

Table 5.12 Impact of current measures in the Waste sector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Solid waste diversion	4.5	9.8
Landfill gas capture	4.0	7.5
Methane emissions from wastewater	0.6	0.6
Total Waste	**9.0**	**17.9**

Note: Columns may not add up to total due to rounding

Projections for the Land Use, Land Use Change and Forestry sector

Projections for the Land Use, Land Use Change and Forestry sector are divided into the Forest Lands and the Land Use Change (forest conversion) subsectors.

Forest Lands

The Forest Lands subsector covers commercial forestry operations and environmental tree planting in Australia, and the prescribed burning of forest and wildfires.

The projections provided in this section are for the Forest Lands subsector as defined by the UNFCCC inventory reporting guidelines and are different from the accounting provisions under the Kyoto Protocol. Under the UNFCCC definitions, forestry is counted as a sink in 1990, whereas under Kyoto accounting only new forestry plantings (afforestation and reforestation) on agricultural land since 1990 are counted. The impact of this difference is significant as it reduces the 1990 baseline under UNFCCC accounting when calculating the growth in emissions.

Factors influencing subsectoral emission projections

Sequestration from commercial forestry, environmental planting and managed native forests is dependent on the area of the forestry estate, the contribution of forest growth in each year and the rate of harvesting. In all cases, projections rely on estimates of the amount of carbon sequestered in biomass, which differ by tree species and for different climatic and geographical conditions.

Analytical approach followed

Forest Lands emissions are estimated on a 'with measures' basis. The impact of most Forest Lands measures has not been able to be estimated. High and low scenarios have also not been quantified.

The projected areas of future forest plantations have been provided on a regional basis by the Bureau of Rural Sciences. Remote sensing methods to identify areas of reforestation have also been developed since the publication of the *Third National Communication*.

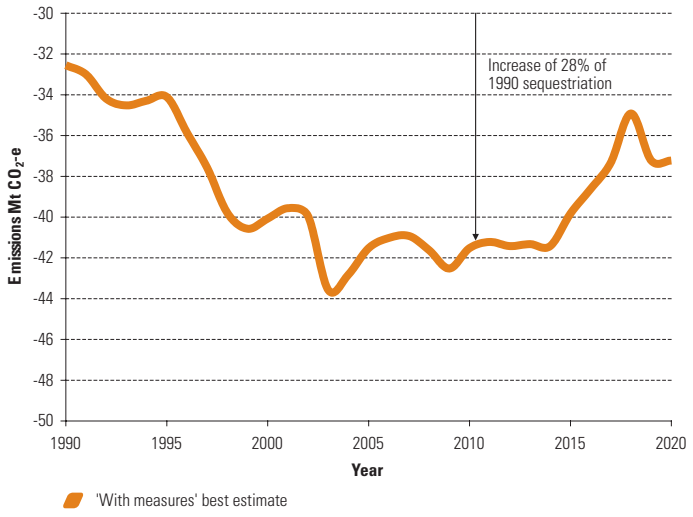
Future development of reporting for Forest Lands emissions under UNFCCC accounting will be finalised when the exact nature of the 2006 Intergovernmental Panel on Climate Change National Greenhouse Gas Inventory guidelines is known.

'With measures' projections – Forest Lands under UNFCCC accounting rules

Using UNFCCC accounting, the 'with measures' projection for the Forest Lands subsector is 42 Mt CO_2-e of sequestration in 2010, an increase in sequestration of approximately 9 Mt CO_2-e compared to 1990 levels (Figure 5.7). As noted above, this UNFCCC outcome is different to that relevant under the Kyoto Protocol.

The above estimate is based on actual or planned forestry plantings data and includes the impact of measures to increase environmental plantings by 2010.

Figure 5.7 Emissions from the Forest Lands subsector (Mt CO_2-e), 1990 to 2020 (UNFCCC accounting method)



'With measures' projections – Forest Lands under Kyoto accounting rules

Under Kyoto accounting rules, no forestry sinks are included in the 1990 baseline. Only greenhouse sinks credits from new forestry plantings on agricultural land (afforestation and reforestation) activities occurring since 1 January 1990 count towards achievement of the Kyoto target.

Current projections are for 21 Mt CO_2-e per year to be sequestered under the Kyoto rules for afforestation and reforestation over 2008–12.

Land Use Change

Deforestation is included in the emissions accounts for both 1990 and 2008–12 under the Kyoto Protocol rules applying to Australia and is equivalent to the Land Use Change subsector under the UNFCCC guidelines.

In the *Third National Communication*, application of the full suite of datasets and the spatial modelling capability of the National Carbon Accounting System provided best estimates for emissions from past land use change in Australia. The 'with measures' projection has since been further improved by providing estimates of the combined impact of land clearing legislation.

Based on results from the National Carbon Accounting System, CO_2 emissions from the Land Use Change subsector are estimated at 126 Mt CO_2-e in 1990.

Factors influencing subsectoral emissions projections

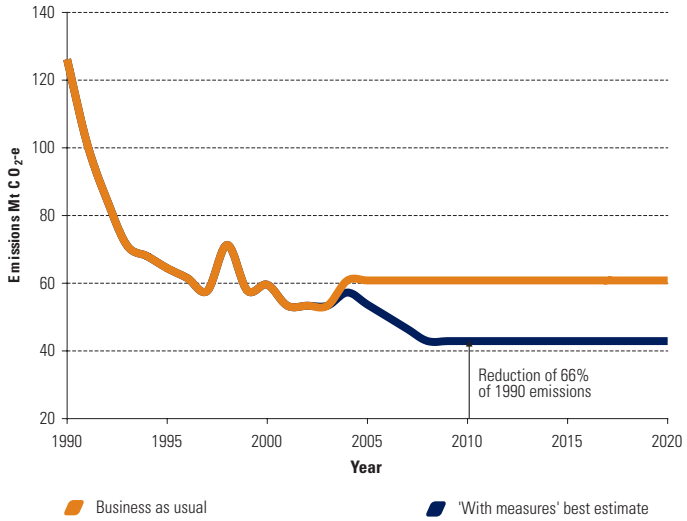
Estimates of Land Use Change emissions depend on the area of forest cover removal and the method of forest conversion and land development, and rely on estimates of the amount of carbon sequestered in biomass and soils, which differ by vegetation type, geography and climate. Recent rates of forest cover removal have varied according to seasonal conditions (particularly rainfall), vegetation management regulation and commodity prices.

'With measures' projections

Emissions from the Land Use Change subsector in 2010 are projected to be 43 Mt CO_2-e. This represents a 66% decrease on 1990 levels. The 'with measures' projection is assumed to remain at this level to 2020.

The emissions projection for this subsector is shown in Figure 5.8.

Figure 5.8 Emissions from the Land Use Change subsector (Mt CO_2-e), 1990 to 2020



Effect of policies and measures already in place

The Queensland and New South Wales governments have introduced legislation to limit the amount of land clearing in those states. The best estimate of the impact of measures is 17.9 Mt CO_2-e in 2010.

Table 5.13 Impact of current measures in the Land Use Change subsector (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Queensland land clearing legislation	17.5	17.5
New South Wales land clearing legislation	3.4	3.4
Adjustment for uncertainty	-3.0	-3.0
Total Land Use Change	**17.9**	**17.9**

Note: Columns may not add up to total due to rounding

Projections of Unallocated Abatement from Policies and Measures

Abatement estimates are allocated to sectors according to individual programme projects. As details of all projects funded under Round 3 of the Greenhouse Gas Abatement Programme (GGAP) and the Greenhouse Friendly programme are not yet available, the impact of emissions from these programmes have been estimated but have not been attributed to individual sectors (see Table 5.14).

The GGAP Round 3 abatement is projected at 0.4 Mt CO_2-e in 2010 increasing to 0.6 Mt CO_2-e in 2020.

The Greenhouse Friendly programme is estimated to provide an additional 0.7 Mt CO_2-e in 2010, beyond the abatement already included in the Stationary Energy and Fugitive Emissions from Fuels sectors. In 2010, the total abatement for Greenhouse Friendly across all sectors is estimated to be 1.1 Mt CO_2-e.

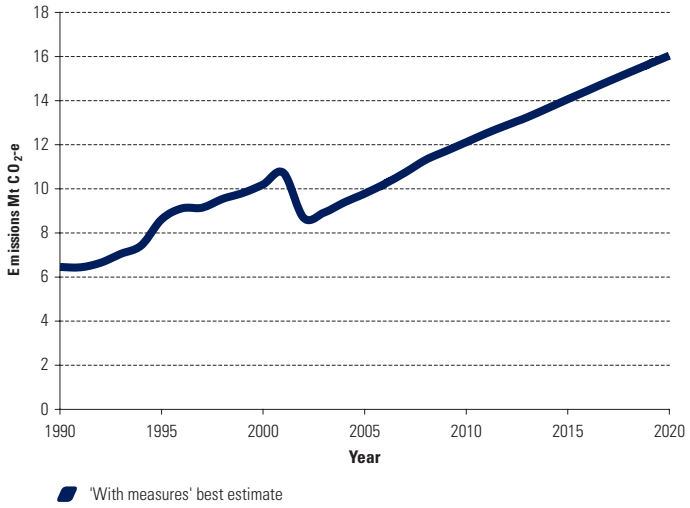
Table 5.14 Impact of current measures not yet allocated to individual sectors (Mt CO_2-e), in 2010 and 2020

Measure	2010	2020
Greenhouse Gas Abatement Programme	0.4	0.6
Greenhouse Friendly	0.7	0.7
Total Unallocated Abatement from Policies and Measures	**1.1**	**1.3**

Projections of international bunker fuels emissions

International bunker fuels relate to fuels used for the purpose of international trade and travel between Australia and other nations, which is dominated by aviation fuel. Emissions from this sector are projected to approximately double over the period 1990 to 2010 (see Figure 5.9). The large increase is a result of rapid projected growth in trade and international travel. Emissions from international bunker fuels are not counted in the total emissions for Australia.

Figure 5.9 Projected emissions from international bunker fuels (Mt CO_2-e), 1990 to 2020



Projections by gas

The sectoral projections provided in the sector by sector analysis are shown on a CO_2-e basis. This is the aggregate of the individual greenhouse gas species multiplied by their global warming potential. Table 5.15 shows the breakdown of emissions in each sector by gas species.

Projections methodology

Australia's general approach to emissions projections was discussed earlier. Overall emissions are calculated by aggregating the various sectoral projections, which were also described individually in earlier sections of this paper. However, some methodological points are common to all projections and are briefly discussed here.

- 'With measures' projections include an estimate of the impact of current greenhouse gas abatement measures. Greenhouse gas abatement measures are defined as measures that have been implemented or supported by regulation, fiscal incentive or other policy initiatives at the Australian, state and territory or local government level.
- BAU projections exclude all greenhouse gas abatement measures adopted or implemented since 1990.
- Measures estimates are generally allocated to the appropriate sectors. However, this has not always been possible and a small proportion of the Greenhouse Gas Abatement Programme and Greenhouse Friendly have remained unallocated.
- High and low 'with measures' projections are also estimated, to provide a plausible range of future emissions, and reflect uncertainty relating to underlying activity levels.
- The approach used to project emissions for each sector is to estimate the relevant activity levels within each sector and to convert these into emissions using the National Greenhouse Gas Inventory methodology. Thus, the historical emission factors – the quantity of greenhouse gases emitted per unit of a specific activity – are consistent with the National Greenhouse Gas Inventory and form the basis for projected emission factors.
- A number of key sectors (including Stationary Energy) incorporate multiple models:
  - Projections for the Stationary Energy sector include projections from top-down computable general equilibrium models
  - Several sectors use bottom-up projections or econometric models
  - Projections from each model class are combined using a simple average approach and the final best estimate is an average of the combined result for each model class
  - Detailed papers on the sectoral projections are available from the AGO website (http://www.greenhouse.gov.au/projections). Each of these sectoral papers reconciles new and earlier projections, and provides details of the relevant methodologies for each projection. Stakeholders in each sector are consulted to provide their views and ensure quality.

Uncertainty and sensitivity analysis

Emissions projections are inherently uncertain, involving judgements about the future of the global and national economy, policy actions affecting emissions, technological innovation and other human behaviour.

High and low scenarios are published for the majority of sectors, to provide a plausible range of emissions outcomes reflecting the impact of simultaneous deviations in key variables from the modellers' best outcomes. Sensitivity analysis of the impact on the projections of variations in individual key assumptions is also undertaken.

The aim is to provide policy makers with greater understanding of the key risks related to the projections, to complement the analysis of key drivers for each sectoral projection.

Given the complexity of the models used, and uncertainty about both the likely future distribution of the values of key drivers and the correlations between them, no attempt is made to quantify overall 'confidence intervals' using Monte Carlo analysis.

However, an indicative estimate of uncertainty can be obtained by combining the various sectoral high and low scenarios. These scenarios give a range of 522 to 605 Mt CO_2-e in 2010, or 102 to 118% of 1990 levels using UNFCCC accounting provisions. Under the Kyoto accounting framework, the scenarios give an uncertainty range of 100 to 115%, which is 8% around the central estimate of the Kyoto projection. These ranges are based on the following scenarios:

- The low scenario combines all of the sectoral low estimates, and the best estimate for Land Use, Land Use Change and Forestry.
- The high scenario combines all of the sectoral high estimates, and the best estimate for Land Use, Land Use Change and Forestry.

These scenarios will likely understate total uncertainty as they do not include contributing uncertainty from the Land Use, Land Use Change and Forestry estimates.

Table 5.15 Emissions estimates by sector by gas 'with measures' (Mt CO_2-e) (UNFCCC accounting method)

Year		Stationary Energy	Transport	Fugitive Emission from Fuels	Industrial Processes	Agriculture	Waste Processes	Unallocated Abatement from other Policies and Measures	Land Use, Land Use Change and Forestry
1990	CO_2	192.9	59.7	6.0	21.0	na	na	0.0	88.7
	CH_4	1.8	0.6	22.8	0.1	75.3	9.7	na	3.9
	N_2O	0.7	1.6	0.0	0.03	18.2	0.5	na	1.1
	PFCs	na	na	na	3.9	na	na	na	na
	SF_6	na	na	na	1.1	na	na	na	na
	HFCs	na	na	na	1.1	na	na	na	na
	Total	195.5	61.9	28.8	27.2	93.6	10.2	0.0	93.6
1995	CO_2	211.3	65.5	5.7	21.0	na	na	0.0	27.8
	CH_4	1.8	0.6	23.9	0.1	70.9	10.7	na	2.0
	N_2O	0.8	3.0	0.0	0.02	18.8	0.5	na	0.5
	PFCs	na	na	na	1.3	na	na	na	na
	SF_6	na	na	na	1.3	na	na	na	na
	HFCs	na	na	na	1.1	na	na	na	na
	Total	214.0	69.1	29.7	24.8	89.6	11.2	0.0	30.3
2000	CO_2	251.6	71.1	6.5	21.5	na	na	0.0	17.2
	CH_4	1.5	0.6	25.0	0.1	74.6	10.5	na	1.8
	N_2O	0.9	4.9	0.0	0.02	23.6	0.5	na	0.5
	PFCs	na	na	na	1.1	na	na	na	na
	SF_6	na	na	na	1.6	na	na	na	na
	HFCs	na	na	na	4.8	na	na	na	na
	Total	254.1	76.6	31.5	29.0	98.2	11.1	0.0	19.5
2005	CO_2	268.7	78.9	5.6	25.8	na	na	-0.1	10.0
	CH_4	1.6	0.7	26.1	0.1	73.0	9.6	na	1.6
	N_2O	1.0	5.4	0.0	0.02	24.4	0.6	na	0.4
	PFCs	na	na	na	1.3	na	na	na	na
	SF_6	na	na	na	2.0	na	na	na	na
	HFCs	na	na	na	7.1	na	na	na	na
	Total	271.2	85.0	31.7	36.3	97.4	10.2	-0.1	12.1
2010	CO_2	281.7	87.7	8.4	29.6	na	na	-1.1	-0.3
	CH_4	1.9	0.8	26.9	0.1	74.4	8.9	na	1.3
	N_2O	1.0	6.0	0.0	0.03	24.2	0.6	na	0.4
	PFCs	na	na	na	0.8	na	na	na	na
	SF_6	na	na	na	2.5	na	na	na	na
	HFCs	na	na	na	8.7	na	na	na	na
	Total	284.7	94.4	35.3	41.6	98.6	9.5	-1.1	1.4
2015	CO_2	304.1	95.2	11.0	31.0	na	na	-1.3	1.4
	CH_4	2.0	0.8	28.7	0.1	77.2	7.0	na	1.3
	N_2O	1.1	6.6	0.0	0.03	24.5	0.6	na	0.4
	PFCs	na	na	na	0.9	na	na	na	na
	SF_6	na	na	na	2.5	na	na	na	na
	HFCs	na	na	na	9.9	na	na	na	na
	Total	307.1	102.6	39.7	44.3	101.6	7.6	-1.3	3.1
2020	CO_2	330.1	102.2	11.0	32.2	na	na	-1.3	4.0
	CH_4	2.0	0.9	30.7	0.1	79.5	5.0	na	1.3
	N_2O	1.2	7.0	0.0	0.03	24.7	0.6	na	0.4
	PFCs	na	na	na	1.0	na	na	na	na
	SF_6	na	na	na	2.6	na	na	na	na
	HFCs	na	na	na	11.2	na	na	na	na
	Total	333.3	110.2	41.7	47.1	104.2	5.6	-1.3	5.7

na Not applicable

VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION

Australia has a wide range of climate regimes, and experiences large year-to-year variations in rainfall, with droughts, fires and floods being common. The surrounding oceans play a large part in Australia's climate, which is strongly influenced by El Niño Southern Oscillation (ENSO) occurrences.

Climate projections suggest that Australia is likely to experience increased temperatures with associated heat waves and fewer frosts, changes to rainfall distribution, with reductions in southern Australia and increases in the tropical north, and increases in extreme weather events (see Chapter 2—National circumstances).

While there is growing consensus on the science of climate change and the likely consequences at global and national scales, there is still uncertainty about the timing and nature of climate change at scales relevant to sectoral decision-making. Recognising this, Australia considers that there are benefits in treating climate change as a risk factor and exploring opportunities to achieve multiple benefits through adaptation.

Climate change impacts are expected to place additional stress on systems, sectors and regions on top of the usual climate variability and other pressures. Similarly, opportunities or benefits are expected if adaptation planning is initiated early. The Australian Government has introduced a National Climate Change Adaptation Programme to begin preparing Australian governments and vulnerable industry and communities for the unavoidable consequences of climate change.

The Council of Australian Governments (COAG), as part of its focus on developing opportunities for additional practical cooperation between governments, has identified climate change adaptation as an area for greater collaboration. Similarly, work is underway in a number of inter-governmental ministerial councils, such as the Natural Resource Management Ministerial Council and the Primary Industries Ministerial Council to examine the specific sectoral and regional impacts and commence adaptation planning.

State and territory governments are also starting to plan for adaptation to climate change. The Victorian Government, for example, recently released a revised Greenhouse Strategy Action Plan, which includes a range of adaptation measures such as research into the vulnerability of water supply, assessment of adaptation options for coastal areas, the development and dissemination of information and tools for planning, and integrated assessments of three key regions in the state.

The Queensland Government's 2004 Greenhouse Strategy specifies impact research to be undertaken for water supply, agriculture and biodiversity (in particular the Great Barrier Reef), as well as a focus on improved modelling of climate change projections and regional and local planning. The Western Australian Government's Greenhouse Strategy supports the Indian Ocean Climate Initiative, an integrated assessment of the south-west of the state, investigations into water supply and measures to protect biodiversity.

To assist in identifying vulnerable sectors and regions in Australia, the Australian Government commissioned a national risk and vulnerability assessment. The report from this assessment has recently been published and this chapter draws on its major findings.

Research into the impacts of climate change is continuing in Australia, including research into adaptation options. Most studies use climate projections indicating the likely range of changes in regional temperature and rainfall as a starting point. The studies define potential impacts on natural systems, agricultural systems, infrastructure and human health. Further studies are underway to assess the vulnerability of, and identify effective adaptation options for, sectors and regions. Integrated assessments are recognised as a key methodology and are being more widely utilised.

Adaptation strategies are important in complementing Australia's mitigation efforts described in earlier chapters. It is recognised that some level of climate change is inevitable, given the existing levels of greenhouse gases in the atmosphere. Adaptation measures will assist Australian industries, sectors and communities to increase their resilience in meeting the effects of climate change. In some industries and sectors, adaptation may afford some opportunities.

Australia recognises the need to minimise the risks associated with the impact of climate change on the environment, society and the economy. Australia also recognises that there are benefits in exploring opportunities to achieve multiple benefits through adaptation. All levels of government and some industries and communities are placing greater priority on adaptation.

Vulnerability assessment

Following the introduction of the National Climate Change Adaptation Programme in May 2004, the Australian Government commissioned a major study into climate change risks. The report on this work—*Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*—was released in July 2005. It is the first high-level strategic risk and vulnerability assessment of climate change impacts across sectors and regions in Australia. The report provides an assessment of the overall priority of sectors and regions using a risk management framework. The components of this framework—exposure, sensitivity, adaptive capacity, adverse implications and the potential to benefit—were applied to each of the sectors and regions examined. The report is relevant to governments, non-government organisations, industry and regional communities.

Using this risk assessment framework, the sectors identified as requiring urgent attention are agriculture, biodiversity, buildings and settlements, water supply and energy. Other sectors requiring some attention are health, tourism, fishing and forestry. The high priority regions identified were Cairns and the Great Barrier Reef, the Murray–Darling Basin and the south-west of Western Australia. Other regions were also noted as vulnerable to climate change, especially where they are areas of national significance, regions already under significant stress or areas that support climate sensitive industries. Alpine areas and communities in low-lying coastal areas in northern Australia are examples.

This work builds on existing regional, sectoral and state based vulnerability assessments. Examples include a state-wide coastal vulnerability study in Tasmania, vulnerability studies on sections of the agricultural industry, and a scoping study on the vulnerability of Cairns and the Great Barrier Reef region and related industries.

Case study: *Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*

Early planning will help governments, industries and communities adjust to the effects of climate change. Australia has begun this process though the release, in July 2005, of the report *Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*.

The report examines:

- incentives and decision frameworks likely to underpin the level and timing of adaptation responses
- the role for government and policy makers in facilitating 'efficient' adaptation and representing wider community interests
- priority sectors and regions for further research and development under the National Climate Change Adaptation Programme, with the aim of enhancing the effectiveness and pay-off of government expenditure in this area.

The report identifies a series of priority regions with a strong reliance on highly vulnerable industries and assets, or which represent populations already experiencing stresses that climate change could easily exacerbate. They are sensitive to low level climate changes and face significant costs from additional climate pressures—often with limited capacity because of restricted resources and incomes.

The Australian Greenhouse Office (AGO), within the Department of the Environment and Heritage, is currently considering these findings and has begun commissioning additional studies to begin planning for and within these regions.

A copy of the *Climate Change Risks and Vulnerability* report can be found at http://www.greenhouse.gov.au/impacts/publications/risk-vulnerability.html.

Impacts and adaptation responses

Over the past two years, governments in Australia have made significant efforts to lay the groundwork for adaptation planning. As noted above, the Australian Government introduced the $14.2 million National Climate Change Adaptation Programme in 2004–05 to begin preparing Australian governments and vulnerable industries and communities for the unavoidable consequences of climate change. The programme will support policy analysis of the cross-sectoral implications of climate change, partnerships to address climate change in regions of national priority, and the development of tools and information to assist in the development of adaptation plans.

In addition, the Australian Government has introduced the $20.5 million Greenhouse Action in Regional Australia programme. It is being implemented in close collaboration with rural industry groups. Its aims include coordinating greenhouse action across the land sectors (including adaptation measures), overcoming knowledge gaps through research, and integrating climate change issues in regional natural resource management.

All levels of government in Australia have recognised the importance of planning for climate change adaptation. COAG has identified climate change adaptation as one area for national cooperation on policy development, and the cross-jurisdictional Natural Resource Management Ministerial Council has included climate change as one of its cross-cutting priority issues for attention, with biodiversity and agriculture as major priorities.

The following sections briefly outline the impacts, vulnerability and adaptation responses for each of the vulnerable sectors and regions identified in the report, *Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*. Adaptation planning is still at an early stage and further initiatives are under development. High priority sectors and regions will be the initial focus of adaptation work.

Agriculture

Impacts of climate change on agriculture are a major concern to Australia because of this sector's importance to the national economy. In 2004–05, farm exports represented about one-third of Australia's total commodity export earnings. Agriculture (including pastoralism) and forestry enterprises cover more than 60% of Australia's land mass. Predicting the likely impacts of climate change on agriculture is complicated because change in different climatic factors can work in different ways. For example, an elevated concentration of atmospheric carbon dioxide (CO_2) may boost plant growth by increasing water use efficiency, but this effect has not been verified under Australian conditions.

On the other hand, the projected rises in temperature and reductions in rainfall for some regions, together with an increase in extreme events, are likely to reduce production in those regions. Adaptation to climate change is likely to involve improvements in crop varieties and farm management practices to maintain or improve yield and quality. The impacts of climate change on agricultural weeds, diseases and pests will also need adaptation strategies for continued production, with some regions and sectors more affected than others.

The Australian Government initiated a national workshop in December 2004, bringing together key agricultural stakeholders to provide guidance on climate related issues for the sector and appropriate adaptation responses. Further consultations have been conducted around Australia.

The Australian Government is also co-ordinating greenhouse action across the land sectors by investing in research under the Greenhouse Action in Regional Australia programme. Some $880,000 has been allocated to adaptation research in 2004–05, with further allocations to be made. This research is focusing on building capacity and developing technical solutions to manage the effects of climate change on agriculture and natural resource management across regional Australia. It will prepare the agricultural community for the unavoidable impacts of climate change, including developing adaptation options for vulnerable industry sectors.

The suite of government programmes on natural resource management, such as the Natural Heritage Trust, the National Action Plan for Salinity and Water Quality, the National Water Initiative, the Living Murray and the National Biodiversity and Climate Change Action Plan are addressing the longer term issues affecting agriculture and natural resource systems, including those of climate change.

The National Landcare Programme (NLP) is a long-standing Australian Government programme which, by supporting collective action by communities to sustainably manage the environment and natural resources, encourages landholders to undertake landcare and related conservation works. The NLP helps to enhance the resilience of agriculture and other natural resource uses in the face of potential climate change.

The Managing Climate Variability Program (funded by the Natural Heritage Trust and the Rural Industries Research and Development Corporation) is developing tools to help farmers better adapt to climate variablility, including that expected under climate change.

Biodiversity

Changes to Australia's climate are already occurring over and above natural variability. Natural resources and biodiversity are likely to be strongly affected by climate change, as climate change is likely to add to the existing substantial pressures on these sectors. There is reasonable scientific consensus about the expected types of impacts on species and ecosystems. However, there is uncertainty about how individual species and ecosystems will respond to the combined impacts of future climate change and other pressures on biodiversity.

Many of Australia's ecosystems are highly sensitive to climate change, especially coral reefs, alpine regions, wetlands and the wet tropics in Queensland. Vulnerability is also high due to limited adaptive capacity, especially those ecosystems that have very small geographic ranges. Fragile soils, fragmentation and potential ecosystem disturbance from the spread of weeds, pests and diseases, will put additional stress on Australia's biodiversity.

The National Biodiversity and Climate Change Action Plan, agreed by all governments in 2004, is being implemented in all states and territories to minimise the impacts of climate change on biodiversity. The plan sets out a series of adaptation options and accompanying actions to minimise the negative impacts of climate change on biodiversity by maximising the capacity of species and ecosystems to adapt to future climate change. The plan covers inland aquatic and semi-aquatic ecosystems, coastal, marine and estuarine ecosystems, and native terrestrial ecosystems, as well as research, communication and planning issues.

In June 2004, the Australian Government committed $2 million over four years to develop a climate change action plan for the Great Barrier Reef. This will provide a comprehensive framework for action to restore and maintain the resilience of the reef ecosystem, as well as the resilience of industries and regional communities that depend upon the reef. The plan will assess the main vulnerabilities, outline resilience strategies and outline institutional structures that can influence adaptation potential.

All jurisdictions have endorsed the Framework for a National Cooperative Approach to Integrated Coastal Zone Management, which includes a suite of actions to manage the impacts of climate change on the coastal zone. A major project to assess the vulnerability of Australia's coastal areas is planned.

Buildings and settlements

Climate change will affect Australian buildings and settlements through changes in the average climate and the frequency and intensity of extreme events such as strong winds, cyclones, storm surges, bushfires, floods, landslides and hail. The likely intensification of tropical cyclones, or their possible movement further south into areas where infrastructure is not designed to cope with them, for example, would have significant implications for building design, safety and emergency services.

Rising sea level, stronger tropical cyclones and increased intensity of oceanic storm surges are likely with climate change. The Australian trend towards coastal living means increased community exposure to these events. A Commonwealth Scientific and Industrial Research Organisation (CSIRO) study has shown that tropical cyclone intensity around Cairns in northern Queensland could increase by 5–10% by about 2050.

Increased property damage due to rises in sea level, increased storm surge activity, bushfires, floods and, in the north of Australia, a possible increase in cyclone intensities may have important implications for the insurance industry.

The Australian Government has initiated a range of projects to improve understanding, build capacity and develop adaptation options. These projects include the following:

- The Australian Building Codes Board and the Department of the Environment and Heritage's Australian Greenhouse Office are working together to identify possible options for adjusting building standards and practices in response to likely climate change impacts, especially in areas highly vulnerable to climate change. A scoping study is nearing completion and further work is planned on ways to raise awareness of climate change adaptation options
- A scoping study into the vulnerability of Australia's major cities to the impacts of climate change. This report will be prepared in consultation with stakeholders and will provide a basis for future research such as an integrated assessment of one major capital city

- The Australian Government is coordinating an assessment of the risks of natural hazards in response to the recent report by COAG on natural disasters in Australia. Many of these hazards cause damage to cities and towns, and the intensity of some (e.g. cyclones, floods) could be affected by climate change.

Water supply

Australia's water supply and hydrological systems are likely to become increasingly stressed with the projected drying trends over much of the continent due to climate change. In addition, Australia has relatively high interannual and interdecadal rainfall variability. For example, the storage capacities of Australia's large dams are about six times larger than those of European dams for the same mean annual stream flow and probability of water shortfall. Dry conditions in most parts of Australia tend to be associated with El Niño and the link between rainfall, stream flow and ENSO is statistically significant in most parts of eastern Australia.

Decreases in stream flow seem likely for southern Australia due to reductions in rainfall, although stream flow in northern Australia may increase if summer rainfall increases. For example, estimated changes in stream flow in the whole Murray–Darling Basin catchment range from zero to –20% by 2030 and +5 to –45% in 2070. This would result in water shortages, particularly in winter rain-fed systems that are already under stress.

As part of the South-East Australia Climate Project, a consortium comprising the Murray–Darling Basin Commission, Land & Water Australia, the AGO, the Victorian Department of Sustainability and Environment, CSIRO, the Bureau of Meteorology and the University of Melbourne is undertaking research in the south-east Murray–Darling Basin to assess the impacts of climate change on the quantity and quality of water resources. The research will revolve around three themes: characterisation and attribution of current climate; high-resolution climate projections; and seasonal forecasts to formulate policies and propose measures to adapt to climate change.

Some regions are affected by natural climate variability and already experience periods of low rainfall and stream flow. These areas would be placed under even more stress by further decline in rainfall as a consequence of climate change. Other pressures, such as increasing demand on water resources from population increases, will also affect water supply and quality. Adelaide, Perth and the inland communities are recognised as being the most vulnerable to water shortages, especially during the annual dry season and drought. The south-west of Western Australia has already experienced a 15% decrease in rainfall since the mid 1970s. General circulation models project further reductions in rainfall for the south-west region and an increase in temperature. These trends will have significant impacts on water resources, the environment and other sectors. However, city water shortages have led to water restrictions in many cities and towns including Brisbane, Canberra, Melbourne and Sydney. Increasing salinity and falling water quality are also concerns.

Improving water management across Australia is the aim of the National Water Initiative (NWI). Agreed to by most state and territory governments in June 2004, this comprehensive strategy encompasses a wide range of water management issues including the productivity and efficiency of water use, and encourages the adoption of best-practice approaches to water management in Australia. Climate change is considered one of the risks associated with continuing water supply. The Australian Government has also committed $2 billion over five years to the Australian Water Fund, which is part of the NWI. Consistent with, and helping to achieve the objectives, outcomes and actions of the NWI, the fund will invest in water infrastructure, improved knowledge and water management, and better practices in the stewardship of water resources.

State and territory governments are also actively considering ways to improve the supply of water for capital cities, with climate change being one of the factors affecting long-term supply issues.

Energy

Climate change is likely to affect the timing and amounts of peak seasonal energy loads. Warmer conditions mean less energy demand for winter heating and more energy demand for summer cooling.

The Australian Government (through the AGO) has commissioned a report into the vulnerability of Australia's energy infrastructure to the effects of climate change. This report is being prepared in consultation with stakeholders and will provide a basis for future discussions with the energy sector about ways to plan for identified risks. It is expected that the report will be released in late 2005.

Other sectors warranting attention

Forestry

Future forest productivity will depend in part on the balance between the effects of increased CO_2 concentrations and the impact of a more variable climate, a potential change in dynamic between forests and pests/pathogens, and an increase in other forest disturbances such as fire. Through the Greenhouse Action in Regional Australia programme, the Australian Government is supporting investigations into the effects of increased CO_2 concentrations and climate change on Australian forests. The programme will help land managers understand and address climate change implications for forests and forest sink establishment, and help regional organisations to link forest sinks into their natural resource management plans.

Fisheries

Australia specialises in high-value, low-tonnage fisheries such as lobsters, pearl oysters, prawns, abalone and tuna. Winds, changing ocean currents, rising sea temperature and run-off from flooding are known to impact on wild and aquaculture species. The effects are expected to be greater on temperate species due to the southward extensions of native and introduced marine pests. The ramifications of such changes for fisheries in Australia are largely unknown.

Tourism

Climate change could have important implications for Australia's tourist industry, which has a significant international component. Major attractions include the country's unique flora and fauna, vast stretches of coastal beaches, the Great Barrier Reef and the snowfields. All of these are likely to be affected by climate change, and possibly become less attractive to tourists as a result. Overall impacts on the tourist industry are still difficult to gauge. This is mainly due to uncertainties about how climate change will affect the relative attractiveness of Australia as an international tourist destination, the adaptive capacity of the industry and the extent to which domestic consumers will substitute one domestic holiday destination for another.

The major project on the Great Barrier Reef region being undertaken by the Australian Government will provide some insight into this issue.

Human health

Australians generally enjoy comparatively good health. However, climate change presents some challenges to manage health risks including heat stress and the spread of vector-, food- and water-borne diseases such as malaria, Ross River virus, dengue fever and diarrhoea.

Estimates of the weather-related deaths in Australia between 1803 and 1992 suggest that 40% were due to heatwaves, 20% to tropical cyclones and 20% to floods. An increase in the intensity of these events is anticipated due to climate change. An estimate of climate-related deaths (excluding floods and cyclones) in Australia's five largest cities by 2030 indicates that climate change would lead to an increase in climate-related deaths in summer but a decrease in such deaths in winter.

The Australian Government, through the Department of Health and Ageing, has supported a major review of the likely impacts of climate change on health. There are key systems in place to manage emerging infectious diseases, including the Australian Government's National Incident Room, which functions as a national coordination centre for disease outbreaks.

In 2003, the Australian Government published a report on *Human Health and Climate Change in Oceania: a risk assessment*. Further research is planned on adaptation measures that could be implemented through existing health service systems.

Regions

The *Climate Change Risk and Vulnerability* report assessed the impact of climate change on regions as well as sectors. This approach allows for integrated assessment of risks and opportunities and the consideration of adaptation options that can be applied across sectors. Some regions in Australia are highly vulnerable to climate change. These include the Murray–Darling Basin, south-west Western Australia and the Cairns and Great Barrier Reef region. Other areas likely to be affected by climate change include low-lying coastal communities, alpine regions and areas with a high dependence on vulnerable industries.

Some work has begun to prepare these regions for the effects of climate change. The Australian Government is working with state and territory governments and regional stakeholders to support the long-term future prosperity of regions likely to be most affected by climate change.

For example, the Australian Government has begun projects to assist with adaptation to climate change in the three regions identified in the *Climate Change Risk and Vulnerability* report as high priorities for further adaptation planning and response.

- Cairns and the Great Barrier Reef—the AGO and the Great Barrier Reef Marine Park Authority have begun a $2 million, four-year project to develop a climate change action plan for the Great Barrier Reef
- Murray–Darling Basin—the AGO is working with the Murray Darling Basin Commission, Land and Water Australia, the Victorian Department of Sustainability and Environment, CSIRO and the Bureau of Meteorology on a major project investigating climate change in the Murray–Darling Basin, with particular emphasis on its implications for shared water resources, details of which will be announced soon
- South-west Western Australia—the Australian Government and the Government of Western Australia have established a partnership to conduct a study into climate change adaptation in south-west Western Australia.

Local and regional planning

One of the key issues for adaptation is to ensure that consideration of climate change effects is incorporated into regional and local planning. There is a suite of Australian Government programmes on natural resource management, such as the Natural Heritage Trust, the National Action Plan for Salinity and Water Quality, and The Living Murray which form appropriate avenues for considering some longer term issues affecting agriculture and natural resource systems, including those of climate change.

In addition, the Australian Government has begun to work with local governments to identify climate change adaptation options that provide a net economic, social or environmental benefit. A report on this work is expected in late 2005 and further work is planned to build capacity for local government to address the impacts of climate change.

State and territory governments are also progressing regional and local government planning for climate change impacts. For example, Victoria has begun an integrated assessment study of the Victorian alpine region and the impact of climate change with a view to identifying adaptation options for local communities and industries.

Tools and support for adaptation planning

The Australian Government is developing a suite of tools to assist sectors, regions, communities and enterprises with adaptation planning. These tools will cover geographically based information about the likely impacts of climate change, methods for understanding the economic and financial implications of climate change adaptation decisions, guidelines for adaptation planning, guidance on assessment of climate change impacts and adaptation options, and tools for understanding and managing the risk associated with climate change.

The Australian Government is committed to helping other countries address climate change issues through the transfer of environmentally sound technology and capacity building, particularly those developing countries in the Asia–Pacific region. The Australian Government, through its overseas aid programme, provides assistance for activities in developing countries, in support of the United Nations Framework Convention on Climate Change (UNFCCC). The purpose of Australia's overseas aid programme, managed by the Australian Agency for International Development (AusAID), is to assist developing countries to reduce poverty and achieve sustainable development. Addressing local and global environmental degradation that impacts disproportionately on developing countries and the poor is integral to this objective. A number of other Australian Government and state and territory government agencies also provide significant assistance to developing countries to address local and global climate change issues.

Provision of financial resources

In accordance with its commitments under Articles 4.3, 4.4 and 4.5 of the UNFCCC, Australia has provided significant financial resources to help developing countries respond to climate change. These resources have been delivered through bilateral, regional and multilateral institutions and programmes with significant climate change programmes, such as the Global Environment Facility (GEF).

Details of Australia's multilateral, bilateral and regional assistance are set out below. All monetary sums in this chapter are in Australian dollars unless indicated otherwise.

Overseas aid programme

Since 1996–97, the Australian Government, through its overseas aid programme, has provided over $279 million for bilateral and regional overseas aid activities that contribute to sustainable development while reducing net greenhouse gas emissions, or that help developing countries to adapt to climate change. This represents an increase of $119 million since Australia's *Third National Communication*. These resources have been aimed at transferring 'soft' technologies—through support for capacity building, information networks, training and research—as well as hardware.

Contributions to the Global Environment Facility

Australia channels most of its funding in support of UNFCCC activities through the GEF, which was established as a mechanism for international cooperation for the purpose of providing new and additional funding to the GEF's focal areas. Since 1991, Australia has committed over $184 million to the GEF. This represents an increase of $68 million of new and additional financial resources provided to the GEF since Australia's *Third National Communication*. Australia's annual contributions to the GEF during the period 1996–97 to 2003–04 are set out in Table 7.1.

In the current, third replenishment (2003–06) Australia pledged $68.2 million. Australia is currently negotiating the fourth replenishment (2006–09). According to GEF statistics, approximately 37% of funds contributed by all donors have been allocated to the climate change focal area.

Through the GEF contributions, Australia supports a number of projects complementary to its own bilateral and regional climate change assistance. An example of a GEF-funded climate change project is the Indonesia Solar Home Systems Project, managed by the World Bank. The project has assisted in the commercialisation of solar in-home systems for Indonesian households, and brought clean energy to areas too remote to connect to existing power grids.

Other multilateral assistance

In addition to its support for the GEF, Australia funds several other multilateral institutions and programmes that contribute to the implementation of the UNFCCC. With support from Australia and other donors, organisations such as the World Bank, the Asian Development Bank and the United Nations Development Programme have increased their emphasis on climate change issues. Details of Australia's annual financial contributions to multilateral institutions and multilateral scientific, technological and training programmes are set out in Table 7.2.

World Bank's National Strategy Studies Programme

In 1997, the World Bank launched the National Strategy Studies (NSS) programme, designed to enhance understanding of the Clean Development Mechanism (CDM) under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) in host countries and to build their capacity to participate in the CDM. Australia contributed over US$2.9 million to the programme. Part of this funding was used to assist governments in Indonesia (forestry and carbon sinks only), Thailand and Vietnam to develop national strategies.

When the NSS programme concluded in February 2004, the remaining Australian funds were rolled into the Carbon Finance (CF) Assist programme. CF-Assist is both a technical assistance facility with its own donor constituency and work programme as well as an umbrella programme providing coordination and synergy for all World Bank activities in the area of technical assistance for carbon finance. Australia is currently working with the World Bank to determine how the remaining Australian funds will be used to build developing country capacity to address climate change in the region.

United Nations Framework Convention on Climate Change—core budget

In accordance with its obligations, Australia has made timely annual contributions to the core budget of the UNFCCC. For the financial years 1996–97 to 2003–04, Australia's contributions to the UNFCCC core budget totalled approximately $2.1 million. This represents an increase of approximately $0.9 million since Australia's *Third National Communication*.

United Nations Framework Convention on Climate Change—voluntary contributions

Australia has made several voluntary contributions to the UNFCCC in support of participation and supplementary activities. For the financial years 1996–97 to 2003–04, Australia's voluntary contributions to the UNFCCC totalled approximately $0.3 million. This represents an increase of approximately $0.1 million since Australia's *Third National Communication*. Australia has also funded the participation of experts in greenhouse gas inventory review processes and other UNFCCC activities.

Intergovernmental Panel on Climate Change

Australia has provided funding to the Intergovernmental Panel on Climate Change (IPCC) for a range of activities, including participation by developing countries at IPCC meetings, workshops and capacity building activities. For the financial years 1996–97 to 2003–04, this assistance totalled approximately $0.7 million. This represents an increase of over $0.2 million since Australia's *Third National Communication*. Australia has also provided substantial financial assistance for lead authors and review editors of IPCC technical and assessment reports.

Bilateral and regional assistance

Australian bilateral and regional overseas aid projects, primarily in forestry, land management and renewable energy, are helping to reduce greenhouse gas emissions and preserve carbon sinks. Australia has also funded a significant programme of assistance to help vulnerable Pacific Small Island Developing States (SIDS) monitor and adapt to climate change.

In addition to multilateral action on climate change, Australia is working with bilateral partners, particularly in the Asia-Pacific region, on practical actions that contribute to the global effort to respond to climate change.

In 2004–05, the Australian Government committed additional funding to underpin Australian climate change action at the international level. In particular, $5.1 million was allocated over 2004–08 specifically for developing and implementing bilateral partnerships and projects that deliver mutual practical benefit for Australia and partner countries and help build the capacity of developing countries to take action on climate change. These activities are being implemented through the Bilateral Climate Change Partnerships Programme.

Specific objectives for the Programme are to work with other countries to:

- Undertake practical actions that achieve or facilitate emissions reductions
- Build capacity to enable implementation of mitigation and adaptation programmes
- Improve scientific understanding of climate change
- Build support for an effective global response to climate change

- Facilitate market opportunities for greenhouse technologies, products and expertise from Australia and partner countries

- Foster direct involvement by industry, business, scientists and communities in bilateral projects to broaden participation in climate change action.

Arrangements for bilateral cooperation are currently in place with the United States, China, New Zealand, the European Union and Japan.

The Australian Government is becoming a financial member of the Renewable Energy and Energy Efficiency Partnership (REEEP), and is funding the establishment and initial three-year operation of a secretariat for the Partnership.

Australia is also an active participant in and has made regular financial contributions to the Asia–Pacific Seminar on Climate Change.

Details of Australia's funding for bilateral and regional activities are set out in Table 7.3.

In the Pacific

Australia's assistance for greenhouse gas mitigation in the South Pacific has focused on sustainable forestry and renewable energy activities. Significant current and recently completed activities include the following:

- The Papua New Guinea Forestry Human Resource Development Project (Australian contribution of $21.3 million), which improved in-country forestry training at the Timber Industry Training College and the University of Technology, strengthened human resource development for all forestry agencies, including non–government organisations and conservation agencies, and assisted the Papua New Guinea Forest Authority to enhance its capacity to monitor and control logging

- The Solomon Islands Forestry Management Project (Australian contribution of $6 million), which aims to implement the *Solomon Islands Forestry Act 1999,* drafted with assistance from Australia. The project will re-establish the monitoring capacity of the Forestry Division's Forest and Revenue Monitoring Unit and seek to increase forestry revenue for forest owners and the Solomon Islands Government.

In Asia

Australia's climate change-related aid activities in Asia have focused on sustainable energy, cleaner production and environmental regulation, land rehabilitation and community reforestation. Several of these activities are discussed under the section in this chapter on technology transfer. Other significant current and recently completed land rehabilitation and reforestation activities include the following:

- The Alxa League Environmental Rehabilitation/ Management Project in Inner Mongolia, to which Australia will contribute $10.35 million, will run during 2001–06. The goal of the project is to contribute to an improved environment through sustainable resource use and poverty reduction by developing a sustainable community and institutional framework to facilitate a coordinated approach to implementing environmental interventions in Alxa League

- The Sri Lanka–Australia Natural Resource Management Project, which will be implemented from 2003–09 at a cost of $9.9 million. The project aims to alleviate poverty through improved natural resource management in the dry zone of Sri Lanka and involves the development and application of models for improved and equitable natural resource management and the dissemination of the results nationally

- The Karst Environment Rehabilitation Project (Australian contribution of $10.4 million during 2001–05), which aims to address the inter-related problems of environmental degradation, poverty and demand for firewood in degraded Karst mountain areas in Guangxi Zhuang Autonomous Region, southern China. This will involve closing off degraded areas for natural revegetation and the provision of integrated assistance to farming households in agro-forestry, income generating activities and sustainable energy development.

Assistance to developing countries that are particularly vulnerable to climate change

In accordance with Article 4.4 of the Convention, Australia is assisting developing countries in the Asia–Pacific region in their efforts to adapt to climate change. The UNFCCC recognises that SIDS may be particularly vulnerable and require special assistance. The focus of Australia's assistance to developing countries for climate change adaptation has therefore been on SIDS in the South Pacific.

Adaptation assistance to vulnerable South Pacific Small Island Developing States

Pacific SIDS have long been concerned about the potential impacts of rising sea levels and increased variability in weather patterns resulting from global climate change. Australia has responded by supporting their efforts to better understand and reduce their vulnerability through activities focused on long-term sea level data collection, climate monitoring, vulnerability studies, institutional strengthening, capacity building and technology transfer.

Australia is the largest financial supporter of the South Pacific Regional Environment Programme (SPREP). The Samoa-based SPREP is instrumental in bringing a strategic and coherent approach to climate issues in the region. A focus of its work on climate change is the South Pacific Sea Level and Climate Monitoring Project, which Australia began funding in 1989 after Pacific nations first voiced their mounting concern about the threat of rising sea levels (see Table 7.4).

Another related activity supported through Australia's aid programme is the Enhanced Application of Climate Predictions in Pacific Island Countries. The objective of this project is to strengthen Pacific island countries' capacity in climate prediction, by expanding and enhancing the prudent use of climate predictions by those countries in both National Meteorological Services and client planning departments.

Australia's assistance for long-term data collection and analysis is complemented by its support for disaster management in the Pacific. Australian funding helped to establish the South Pacific Disaster Reduction Programme, under which Pacific islanders built their capacity for disaster management and regional disaster coordination. Australia focuses its support for disaster management through the South Pacific Applied Geoscience Commission.

Activities related to transfer of technology

Australia's overseas aid programme helps partner countries to build capacity, develop enabling environments and to gain access to innovative and environmentally sound sustainable energy and pollution control technologies. Similarly, projects under Australia's Bilateral Climate Change Partnerships Programme may support the transfer of climate-related technologies to assist developing countries in the Asia–Pacific region to more effectively address climate change.

Australia is also a founding member of the Methane to Markets Partnership, which aims to promote collaboration between developed and developing country partners by facilitating the transfer of technology for the capture and use of methane emissions from coal mines, landfills and the oil and gas sector.

Transfer of environmentally sound technology

Renewable energy technology

Australia has gained considerable experience from delivering electricity to remote rural communities using renewable energy technologies. This experience can be adapted to the needs of Australia's Asian and Pacific neighbours where there is significant demand for decentralised rural electrification schemes. Recent examples of Australian assistance for the transfer of renewable energy technologies include:

- The Houaphan micro-hydropower project in Laos which provides power and supporting infrastructure to villages to allow local development priorities to be realised
- The Aitutaki wind energy monitoring station in the Cook Islands which is trialling wind powered electricity generation as a means of reducing dependency on fossil fuels
- The Sri Lanka solar home systems monitoring project, which is monitoring the effectiveness of solar home systems in order to identify how they can be improved.

Australia is also helping to promote the use of renewable energy in industrial applications. Under the third phase of the Association of South-East Asian Nations (ASEAN)–Australia Economic Cooperation Programme, Australia contributed $4 million to the Energy from Biomass Project, which assisted ASEAN countries in the commercial development of fluidised bed combustion technologies for the production of combined heat and power utilising biomass residues.

Pollution control technology

In Indonesia, Australia provided $21 million to the Bapedal East Java Pollution Control Implementation Project. One of the technologies demonstrated is solar-powered, reverse osmosis water purification equipment. This innovative technology not only benefits the global climate, but also assists sustainable development by assuring a clean water supply for local villages.

International Greenhouse Partnerships

As part of the Prime Minister's Safeguarding the Future package in 1997, $6 million was allocated to advance Australian interests in international collaborative projects to reduce greenhouse gas emissions through the International Greenhouse Partnerships (IGP) programme. The programme was administered by the IGP Office within the Department of Industry, Tourism and Resources.

The IGP Office established 15 projects in nine countries—Chile, Fiji, India, Indonesia, Malaysia, Mauritius, Peru, Solomon Islands and Vietnam—under the Activities Implemented Jointly (AIJ) pilot phase. These pilot projects provided Australia and its partners with first-hand experience in the establishment of collaborative projects. The projects encompassed a wide range of technologies and applications, including solar, micro-hydro, wind, landfill gas recovery, carbon sequestration, energy efficiency, fugitive gas capture, fuel substitution and rural electrification.

The IGP Office closed in 2002. This kind of development activity is now managed through AusAID and the Department of the Environment and Heritage's Australian Greenhouse Office.

Capacity building

Australia recognises the importance of capacity building to address climate change. Improving governance and institutional capacity, particularly in the public sector is a focus of the Australian aid programme. In recent years, Australia has contributed to a number of capacity building projects, including:

- $5.9 million to the Energy Policy and Systems Analysis Project, funded through the ASEAN–Australia Economic Cooperation Programme. The project aims to enhance the capacity of ASEAN policy makers and planners to assess the impact of a range of policy options and strategies to tackle economic, technical and environmental problems associated with energy sector activities

- $9 million over five years to the Bapedal Regional Denpasar Project, which aims to improve environmental management capability and promote good environmental governance in Bali and Nusa Tenggara.

Given the significant increase in renewable energy installations planned in China over the coming decade, the Australian Government is sponsoring a joint project between Australian and Chinese renewable energy industry representatives, under the Australia-China Climate Change Partnership, to develop a five-year renewable energy training framework for China. The project aims to ensure that China will have an adequate, ongoing workforce, trained to international standards, to meet its expanding demand for renewable energy, thereby ensuring that quality systems offering long-term and effective emissions reductions are installed and maintained.

Innovative mechanisms for the transfer of technology

Asia–Pacific Partnership on Clean Development and Climate

In July 2005, the Australian Government announced its participation in the Asia–Pacific Partnership on Clean Development and Climate, along with China, India, the Republic of Korea, Japan and the United States. This partnership is an important new step in the global climate change response, bringing together key countries in the Asia–Pacific region to develop, deploy and transfer the cleaner, more efficient technologies that the world will need to make the required deep cuts in global greenhouse gas emissions. In particular, the partnership recognises the importance of the development agenda in considering any climate change approach, and seeks to improve access to affordable, reliable and cleaner energy in developing countries, a need identified by the World Summit on Sustainable Development.

Building on the foundation of existing bilateral and multilateral initiatives, the partnership will enhance cooperation to meet the challenges associated with increased energy and other resource needs, including those related to air pollution, energy security and greenhouse gas intensities. Partners will work together, in accordance with their respective national circumstances, to develop, deploy and transfer cleaner, more efficient technologies and to meet national pollution reduction, energy security and climate change concerns, consistent with the principles of the UNFCCC.

The partnership will promote and create an enabling environment for the development, diffusion, deployment and transfer of existing and emerging cost-effective, cleaner technologies and practices, and to achieve practical results. Areas for collaboration include, but are not limited to:

- energy efficiency
- clean coal
- integrated gasification combined cycle
- liquefied natural gas
- carbon capture and storage
- combined heat and power
- methane capture and use
- civilian nuclear power
- geothermal
- rural/village energy systems
- advanced transportation
- building and home construction and operation
- bioenergy
- agriculture and forestry
- hydropower, wind power, solar power and other renewables.

The partnership will also cooperate on the development, diffusion, deployment and transfer of longer term transformational energy technologies that will promote economic growth while enabling significant reductions in greenhouse gas intensities. Areas for possible mid- to long-term collaboration include, but are not limited to:

- hydrogen
- nanotechnologies
- advanced biotechnologies
- next-generation nuclear fission
- fusion energy.

There is more information about the Asia–Pacific Partnership on Clean Development and Climate in Chapter 4—Policies and measures.

Australian participation in G8 climate change outcomes

The Australian Government supports outcomes from the July 2005 G8 summit, including the Gleneagles Plan of Action. In particular, Australia supports the direction taken by the G8 countries to encourage the developed economies of the world to:

- work with developing countries to enhance private investment and transfer of technologies, taking into account their own energy needs and priorities
- work with developing countries to provide capacity-building assistance, develop policy frameworks, undertake research and development, and assess potential for renewable energy
- seek ways to improve the current arrangements for collaboration with developing countries, and enhance developing country participation in existing networks.

The Australian Government welcomes the Dialogue on Climate Change, Clean Energy and Sustainable Development launched at the G8 summit to monitor implementation of the plan of action and to facilitate the sharing of best practice information on mitigating greenhouse gas emissions between participating governments. Australia is looking forward to playing an active ongoing part in this important dialogue.

Other initiatives

Australian Centre for International Agricultural Research

Through the Australian Centre for International Agricultural Research (ACIAR), the Australian aid programme supports collaborative research and development projects between Australian and developing country organisations. This collaboration helps solve major agricultural and resource problems and strengthen local research capacity.

ACIAR-supported research relevant to climate change includes the development of planning methods for the sustainable management of Papua New Guinea timber stocks and work on the domestication of tree species indigenous to Papua New Guinea.

At the farm level, ACIAR aims to minimise greenhouse gas production through demonstrating the value of conservation of crop residues and build-up of soil organic matter and improving production efficiency by reduction of inputs such as energy-intensive nitrogen fertilisers and tillage. ACIAR has also implemented a seasonal climate forecasting (drought and flood early warning) project in India, Indonesia and Zimbabwe that should be sensitive to longer term climatic change.

Capacity building for climate change research

Australia continues to provide significant technical advice and assistance to neighbouring countries in the Asia–Pacific region to support the improvement of climate data management and monitoring capabilities. Further detail of this assistance is set out in Chapter 8—Research and systematic observation.

Table 7.1 Australia's financial contributions (in US dollars) to the Global Environment Facility, 1996–97 to 2003–04

	Contribution							
	1996–1997[a]	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002[b]	2002–2003[c]	2003–2004[d]
Global Environment Facility	$2,869,459	$5,944,222	$2,994,915	$3,424,666	$5,156,485	$4,954,729	$6,031,047	$15,251,354

[a] Based on an average annual exchange rate of AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996–2000).

[b] Based on an average exchange rate of AUD 1 = USD 0.5238 (source: Reserve Bank of Australia Statistics for 2001–2004).

[c] Based on an average exchange rate of AUD 1 = USD 0.5842 (source: Reserve Bank of Australia Statistics for 2001–2004).

[d] Based on an average exchange rate of AUD 1 = USD 0.7128 (source: Reserve Bank of Australia Statistics for 2001–2004).

Table 7.2 Australia's financial contributions (in US dollars) to multilateral institutions and programmes, 1996–97 to 2003–04

Institution or programme	Contribution							
	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002[a]	2002–2003[a]	2003–2004[a]
World Bank Group								
International Bank for Reconstruction and Development (IBRD)	$869,065[b]	$2,871,498[b]	$3,453,183[b]	$3,170,448[b]	–	–	–	–
International Development Association (IDA)	$100,027,941	$83,738,863	$73,120,818	$74,907,095	$61,599,337	$70,769,570	$78,937,688	$92,159,337
International Finance Corporation (IFC) Capital Subscription	$4,356,185[b]	$4,599,251[b]	$5,619,216[b]	$5,314,559[b]	–	–	–	–
Multilateral Investment Guarantee Agency (MIGA) membership and Subscription	–	–	$1,941,676[b]	–	$1,667,693[b]	–	–	–
Highly Indebted Poor Country Initiative (HIPC) Trust Fund	–	–	–	$2,200,000	$2,220,000	$2,173,014	–	–
National Strategy Studies Programme	–	–	$2,000,000	$284,212	$648,223	–	–	–
International Monetary Fund (IMF)								
Poverty Reduction and Growth Facility (PRGF)[c]	$1,668,290[b]	$1,668,290[b]	$1,668,290[b]	$1,668,290[b]	$1,668,290[b]	$1,399,500	$1,677,250	$1,709,750
PRGF HIPC Trust Fund	–	–	–	$5,575,904	$5,000,135	$5,019,314	–	–
Asian Development Bank								
Capital Subscription[d]	$1,447,998[b]	$1,617,828[b]	$1,792,953[b]	$1,724,778[b]	$5,038,222[b]	$3,992,194	$2,963,278	$2,963,278
Asian Development Fund	$59,337,415	$77,125,567	$69,251,468	$69,265,112	$67,696,640	$58,670,838	$53,416,911	$71,950,982
European Bank for Reconstruction and Development (EBRD)								
Membership and Capital[e]	$1,024,690[b]	–	–	–	$8,531,257[b]	$8,417,976.5	$7,833,095.34	$6,698,490.52
United Nations								
United Nations Development Programme (UNDP)	$7,090,000	$4,350,000	$4,150,000	$4,430,000	$4,000,000	$3,666,600	$3,797,300	$4,989,600
United Nations Environment Programme (UNEP)	$792,744	$311,400	$320,500	$299,400	$309,300	$340,470	$321,310	$392,040
International Fund for Agricultural Development (IFAD)	$1,229,298	$1,111,050	$944,100	$978,000	$758,700	$785,700	$1,460,500	$2,138,400
United Nations Framework Convention on Climate Change (UNFCCC)	$92,584	$164,255	$102,160	$160,862	$163,537	$236,583[f]	$447,080[f]	$370,739[f]
Other								
Intergovernmental Panel on Climate Change (IPCC)	$79,670	$65,900	$62,990	$63,620	$52,856	$79,457[g]	$65,446[g]	$92,740[g]
South Pacific Regional Environment Programme (SPREP)	$803,849[b]	$800,770[b]	$800,779[b]	$730,008[b]	$734,048[b]	$928,173	$959,256	$1,184,673
South Pacific Applied Geoscience Commission (SOPAC)	$531,927[b]	$560,546[b]	$533,853[b]	$533,853[b]	$533,853[b]	$877,365	$1,244,930	$1,318,680

[a] Figures are based on average annual exchange rate for each financial year unless otherwise stated. 2001–02: AUD 1 = USD 0.5238; 2002–03: AUD 1 = USD 0.5842; 2003–04: AUD 1 = USD 0.7128.

[b] Current prices, based on an average annual exchange rate of AUD 1 = USD 0.667 (source: OECD Development Assistance Committee statistics for the years 1996–2000). All other figures in the table are current prices reflecting the actual US dollar amount paid in that financial year.

[c] Payments are fixed (AUD). USD contribution based on exchange rate at time of payment.

[d] Payments are fixed (USD) and were determined at the time of Australia's subscription to the general capital increase.

[e] The reported USD figures for the EBRD are based on the AUD/USD exchange rate at the time of payment.

[f] Figure includes core contributions, contributions for participation, and contributions for supplementary activities to the UNFCCC.

[g] Figures are based on the annual exchange rate for each financial year. 2001–02: AUD 1 = CHF (Swiss francs) 0.8656; 2002–03: AUD 1 = CHF 0.8243; 2003–04: AUD 1 = CHF 0.9274 (source: Reserve Bank of Australia 6 September 2005).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 1996-97 (US dollars)[a, b]

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$133,463	$0	$4,437,704	$0	$0	$0	$0	$0	$0	$4,571,167
Regional - South Pacific	$50,993	$0	$200,195	$0	$0	$0	$75,872	$0	$792,026	$1,119,086
Vanuatu	$0	$0	$1,285,937	$0	$0	$0	$0	$0	$0	$1,285,937
Sub-total Pacific	**$184,456**	**$0**	**$5,923,836**	**$0**	**$0**	**$0**	**$75,872**	**$0**	**$792,026**	**$6,976,191**
Asia										
China	$3,053,815	$0	$33,365	$0	$0	$0	$0	$0	$0	$3,087,180
India	$0	$0	$0	$0	$0	$15,301	$0	$0	$0	$15,301
Indonesia	$8,500,397	$0	$0	$0	$0	$1,833,458	$0	$0	$0	$10,333,855
Laos	$23,166	$0	$0	$0	$0	$0	$0	$0	$0	$23,166
Maldives	$0	$0	$0	$0	$0	$0	$0	$0	$40,593	$40,593
Nepal	$0	$0	$708,242	$0	$0	$0	$0	$0	$0	$708,242
Pakistan	$0	$0	$47,353	$0	$0	$0	$0	$0	$0	$47,353
Philippines	$8,599,682	$0	$0	$0	$0	$0	$0	$0	$0	$8,599,682
Regional - South East Asia	$516,971	$734,048	$0	$0	$0	$0	$0	$0	$512,150	$1,763,169
Sri Lanka	$0	$0	$1,379,198	$0	$0	$0	$0	$0	$0	$1,379,198
Thailand	$370,197	$0	$0	$0	$0	$0	$0	$0	$0	$370,197
Vietnam	$0	$0	$170,663	$0	$0	$0	$0	$0	$0	$170,663
Sub-total Asia	**$21,064,228**	**$734,048**	**$2,338,820**	**$0**	**$0**	**$1,848,759**	**$0**	**$0**	**$552,743**	**$26,538,598**
Africa										
Namibia	$0	$0	$300,292	$0	$0	$0	$0	$0	$0	$300,292
Regional - Southern Africa	$0	$0	$121,180	$0	$0	$0	$0	$0	$0	$121,180
Southern Africa Ngo	$0	$0	$129,293	$0	$0	$0	$0	$0	$0	$129,293
Sub-total Africa	**$0**	**$0**	**$550,765**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$550,765**
Other										
World - Unspecified	$0	$0	$44,710	$0	$0	$0	$0	$0	$0	$44,710
Sub-total Other	**$0**	**$0**	**$44,710**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$44,710**
Total	**$21,248,684**	**$734,048**	**$8,858,131**	**$0**	**$0**	**$1,848,759**	**$75,872**	**$0**	**$1,344,769**	**$34,110,263**

[a] The Australian financial year is from 1 July to 30 June.

[b] Average annual exchange rate: AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996-2000).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 1997-98 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$0	$0	$3,551,744	$0	$0	$0	$0	$0	$0	$3,551,744
Regional - South Pacific	$33,366	$0	$133,463	$0	$0	$0	$54,208	$0	$934,162	$1,155,199
Vanuatu	$0	$0	$1,446,395	$0	$0	$0	$0	$0	$0	$1,446,395
Sub-total Pacific	**$33,366**	**$0**	**$5,131,601**	**$0**	**$0**	**$0**	**$54,208**	**$0**	**$934,162**	**$6,153,337**
Asia										
China	$1,654,664	$41,258	$66,731	$0	$0	$0	$0	$0	$0	$1,762,653
India	$0	$0	$0	$0	$0	$61,852				$61,852
Indonesia	$755,357	$0	$0	$0	$0	$2,894,740	$0	$0	$0	$3,650,097
Laos	$64,784	$0	$0	$0	$0	$0	$0	$0	$0	$64,784
Nepal	$0	$0	$1,164,148	$0	$0	$0	$0	$0	$0	$1,164,148
Pakistan	$0	$0	$621,526	$0	$0	$0	$0	$0	$0	$621,526
Philippines	$117,454	$0	$0	$0	$0	$0	$0	$0	$0	$117,454
Regional - South East Asia	$679,682	$0	$0	$0	$0	$0	$0	$0	$0	$679,682
Sri Lanka	$0	$0	$1,206,956	$0	$0	$0	$0	$0	$0	$1,206,956
Vietnam	$0	$0	$57,831	$0	$0	$0	$0	$0	$0	$57,831
Sub-total Asia	**$3,271,940**	**$41,258**	**$3,059,362**	**$0**	**$0**	**$2,956,592**	**$0**	**$0**	**$0**	**$9,329,152**
Africa										
Namibia	$0	$0	$16,349	$0	$0	$0	$0	$0	$0	$16,349
Southern Africa	$0	$0	$120,641	$0	$0	$0	$0	$0	$0	$120,641
Sub-total Africa	$0	$0	$136,991	$0	$0	$0	$0	$0	$0	$136,991
Other										
World - Unspecified	$0	$0	$88,753	$0	$0	$0	$0	$0	$0	$88,753
Sub-total Other	**$0**	**$0**	**$88,753**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$88,753**
Total	**$3,305,306**	**$41,258**	**$8,416,707**	**$0**	**$0**	**$2,956,592**	**$54,208**	**$0**	**$934,162**	**$15,708,233**

[a] The Australian financial year is from 1 July to 30 June.

[b] Average annual exchange rate: AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996-2000).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 1998-99 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$0	$0	$4,493,757	$0	$0	$0	$0	$0	$0	$4,493,757
Regional - South Pacific	$5,117	$0	$70,681	$0	$0	$0	$800,779	$0	$802,896	$1,679,474
Solomon Islands	$0	$0	$35,650	$0	$0	$0	$0	$0	$0	$35,650
Tonga	$781	$0	$0	$0	$0	$0	$0	$0	$0	$781
Vanuatu	$0	$0	$1,110,192	$0	$0	$0	$0	$0	$0	$1,110,192
Sub-total Pacific	**$5,898**	**$0**	**$5,710,281**	**$0**	**$0**	**$0**	**$800,779**	**$0**	**$894,000**	**$7,410,958**
Asia										
Burma	$0	$0	$388,538	$0	$0	$0	$0	$0	$0	$388,538
China	$631,305	$0	$111,890	$0	$0	$0	$0	$0	$0	$743,195
India	$0	$0	$16,034	$0	$0	$23,300	$0	$0	$0	$39,334
Indonesia	$0	$0	$0	$0	$0	$3,304,490	$0	$0	$0	$3,304,490
Laos	$21,797	$0	$0	$0	$0	$0	$0	$0	$0	$21,797
Maldives	$0	$0	$0	$0	$0	$0	$0	$24,816	$0	$24,816
Nepal	$0	$0	$2,088,898	$0	$0	$0	$0	$0	$0	$2,088,898
Pakistan	$0	$0	$275,938	$0	$0	$0	$0	$0	$0	$275,938
Philippines	$312,062	$0	$0	$0	$0	$0	$0	$0	$0	$312,062
Regional - South East Asia	$665,148	$0	$0	$0	$0	$0	$0	$0	$91,103	$756,251
Sri Lanka	$0	$0	$77,302	$0	$0	$0	$0	$0	$0	$77,302
Sub-total Asia	**$1,630,311**	**$0**	**$2,958,601**	**$0**	**$0**	**$3,327,790**	**$0**	**$24,816**	**$182,207**	**$8,123,725**
Africa										
Namibia	$0	$0	$16,349	$0	$0	$0	$0	$0	$0	$16,349
Southern Africa	$0	$0	$52,123	$0	$0	$0	$0	$0	$0	$52,123
Sub-total Africa	**$0**	**$0**	**$68,472**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$68,472**
Total	**$1,636,209**	**$0**	**$8,737,353**	**$0**	**$0**	**$3,327,790**	**$800,779**	**$24,816**	**$1,076,206**	**$15,603,154**

[a] The Australian financial year is from 1 July to 30 June.

[b] Average annual exchange rate: AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996-2000).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 1999-00 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$0	$0	$2,674,006	$660,192	$0	$0	$0	$0	$0	$3,334,198
Regional - South Pacific	$167,090	$0	$111,311	$0	$0	$0	$796,729	$0	$1,145,017	$2,220,148
Solomon Islands	$0	$0	$849,299	$0	$0	$0	$0	$0	$0	$849,299
Tonga	$175,681	$0	$0	$0	$0	$0	$0	$0	$0	$175,681
Vanuatu	$0	$0	$634,945	$0	$0	$0	$0	$0	$0	$634,945
Sub-total Pacific	**$342,772**	**$0**	**$4,269,560**	**$660,192**	**$0**	**$0**	**$796,729**	**$0**	**$1,145,017**	**$7,214,270**
Asia										
Burma	$0	$0	$42,020	$0	$0	$0	$0	$0	$0	$42,020
China	$446,865	$0	$852,791	$0	$0	$158,920	$0	$0	$0	$1,458,576
India	$0	$0	$186,986	$0	$0	$0	$0	$0	$0	$186,986
Indonesia	$1,681,637	$0	$0	$0	$0	$243,831	$0	$0	$0	$1,925,468
North Korea	$0	$0	$3,334,277	$0	$0	$0	$0	$0	$0	$3,334,277
Laos	$24,041	$0	$0	$0	$0	$0	$0	$0	$0	$24,041
Maldives	$0	$0	$0	$0	$0	$0	$0	$309,642	$0	$309,642
Mekong Basin Sub-region	$0	$0	$52,744	$0	$0	$0	$0	$0	$0	$52,744
Nepal	$0	$0	$1,451,853	$0	$0	$0	$0	$0	$0	$1,451,853
Pakistan	$0	$0	$415,516	$0	$0	$0	$0	$0	$0	$415,516
Philippines	$139,415	$0	$0	$0	$0	$0	$0	$0	$0	$139,415
Regional - South East Asia	$1,054,713	$0	$0	$326,865	$0	$0	$0	$0	$0	$1,381,578
Sri Lanka	$0	$0	$213,261	$0	$0	$0	$0	$0	$0	$213,261
Thailand	$29,752	$0	$0	$0	$0	$0	$0	$0	$0	$29,752
Vietnam	$0	$0	$0	$72,668	$0	$0	$0	$0	$0	$72,668
Sub-total Asia	**$3,376,421**	**$0**	**$6,549,449**	**$399,533**	**$0**	**$402,751**	**$0**	**$309,642**	**$0**	**$11,037,796**
Africa										
Mozambique	$0	$0	$267,113	$0	$0	$0	$0	$0	$0	$267,113
Southern Africa	$0	$0	$26,325	$0	$0	$0	$0	$0	$0	$26,325
Tanzania	$0	$0	$167,088	$0	$0	$0	$0	$0	$0	$167,088
Zimbabwe	$0	$0	$0	$125,599	$0	$0	$0	$0	$0	$125,599
Sub-total Africa	**$0**	**$0**	**$460,526**	**$125,599**	**$0**	**$0**	**$0**	**$0**	**$0**	**$586,124**
Total	**$3,719,193**	**$0**	**$11,279,534**	**$1,185,324**	**$0**	**$402,751**	**$796,729**	**$309,642**	**$1,145,017**	**$18,838,190**

[a] The Australian financial year is from 1 July to 30 June.

[b] Average annual exchange rate: AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996-2000).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 2000-01 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$0	$0	$3,745,051	$0	$0	$0	$0	$0	$0	$3,745,051
Regional - South Pacific	$333,658	$0	$74,051	$0	$0	$0	$0	$0	$1,146,870	$1,554,579
Solomon Islands	$0	$0	$677,920	$0	$0	$0	$0	$0	$0	$677,920
Tonga	$207,641	$0	$0	$0	$0	$0	$0	$0	$0	$207,641
Vanuatu	$0	$0	$99,766	$0	$0	$0	$0	$0	$0	$99,766
Sub-total Pacific	**$541,299**	**$0**	**$4,596,787**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,146,870**	**$6,284,957**
Asia										
Burma	$0	$0	$251,433	$0	$0	$0	$0	$0	$0	$251,433
China	$642,800	$0	$896,494	$625,153	$0	$492,851	$0	$0	$0	$2,657,299
India	$0	$0	$26,693	$0	$0	$0	$0	$0	$0	$26,693
Indonesia	$0	$0	$274,135	$0	$0	$0	$0	$0	$0	$274,135
Laos	$34,128	$0	$0	$0	$0	$0	$0	$0	$0	$34,128
Maldives	$0	$0	$0	$0	$0	$0	$0	$491,883	$0	$491,883
Mekong Basin Sub-region	$0	$0	$113,528	$0	$0	$0	$0	$0	$0	$113,528
Nepal	$0	$0	$1,538,930	$0	$0	$0	$0	$0	$0	$1,538,930
Pakistan	$0	$0	$686,875	$0	$0	$0	$0	$0	$0	$686,875
Regional - South East Asia	$715,987	$0	$0	$0	$0	$0	$0	$0	$0	$715,987
Sri Lanka	$0	$0	$108,723	$0	$0	$0	$0	$0	$0	$108,723
Thailand	$0	$222,696	$11,345	$0	$0	$0	$0	$0	$0	$234,041
Vietnam	$0	$0	$106,537	$0	$0	$0	$0	$0	$0	$106,537
Sub-total Asia	**$1,392,916**	**$222,696**	**$4,014,693**	**$625,153**	**$0**	**$492,851**	**$0**	**$491,883**	**$0**	**$7,240,191**
Africa										
Mozambique	$0	$0	$270,048	$0	$0	$0	$0	$0	$0	$270,048
Tanzania	$0	$0	$263,979	$0	$0	$0	$0	$0	$0	$263,979
Zimbabwe	$0	$0	$126,979	$0	$0	$0	$0	$0	$0	$126,979
Sub-total Africa	**$0**	**$0**	**$661,006**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$661,006**
Total	**$1,934,215**	**$222,696**	**$9,272,487**	**$625,153**	**$0**	**$492,851**	**$0**	**$491,883**	**$1,146,870**	**$14,186,154**

[a] The Australian financial year is from 1 July to 30 June.

[b] Average annual exchange rate: AUD 1 = USD 0.67 (source: OECD Development Assistance Committee statistics for the years 1996-2000).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 2001-02 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$0	$64,696	$1,742,988	$2,658,643	$0	$0	$0	$98,263	$0	$4,564,590
Regional - South Pacific	$261,900	$0	$486,680	$0	$0	$0	$807,187	$1,079,776	$59,722	$2,695,265
Solomon Islands	$0	$0	$894,844	$0	$0	$0	$0	$0	$0	$894,844
Tonga	$0	$31,928	$0	$0	$21,494	$0	$447,744	$0	$0	$501,166
Vanuatu	$0	$0	$0	$0	$0	$0	$17,513	$0	$0	$17,513
Samoa	$0	$0	$0	$165,264	$0	$0	$0	$0	$0	$165,264
Tuvalu	$0	$0	$0	$0	$141,702	$0	$0	$0	$0	$141,702
Cook Islands	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total Pacific	**$261,900**	**$96,623**	**$3,124,513**	**$2,823,907**	**$163,196**	**$0**	**$1,272,445**	**$1,178,039**	**$59,722**	**$8,980,344**
Asia										
Burma	$0	$0	$50,212	$218,700	$0	$0	$0	$0	$0	$268,911
China	$1,488,618	$0	$302,027	$0	$0	$0	$5,562,930	$0	$0	$7,353,575
India	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Indonesia	$102,508	$0	$0	$0	$0	$0	$0	$0	$0	$102,508
Laos	$62,154	$0	$0	$0	$0	$0	$0	$0	$0	$62,154
Nepal	$0	$0	$1,187,224	$0	$0	$0	$0	$0	$0	$1,187,224
Pakistan	$0	$0	$0	$55,915	$0	$0	$0	$0	$0	$55,915
Sri Lanka	$0	$0	$42,953	$0	$133,848	$0	$0	$0	$0	$176,801
Thailand	$102,508	$0	$0	$0	$3,373	$0	$0	$0	$0	$105,881
Vietnam	$102,508	$0	$0	$80,512	$3,373	$0	$1,043,590	$0	$0	$1,229,983
Cambodia	$0	$0	$0	$486,735	$0	$0	$0	$0	$0	$486,735
Philippines	$102,508	$0	$0	$163,321	$3,373	$0	$0	$0	$0	$269,202
East Timor	$0	$0	$0	$0	$0	$0	$396,673	$0	$0	$396,673
Mongolia	$0	$0	$43,011	$0	$0	$0	$0	$0	$0	$43,011
Malaysia	$102,508	$0	$0	$0	$3,373	$0	$19,129	$0	$0	$125,010
Sub-total Asia	**$2,063,313**	**$0**	**$1,625,426**	**$1,005,183**	**$147,339**	**$0**	**$7,022,323**	**$0**	**$0**	**$11,863,583**
Africa										
South Africa	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Kenya	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total Africa	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
South and Central America										
Haiti	$0	$0	$22,936	$0	$0	$0	$0	$0	$0	$22,936
Mexico	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Guatemala	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total South and Central America	**$0**	**$0**	**$22,936**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$22,936**
Total	**$2,325,213**	**$96,623**	**$4,772,875**	**$3,829,090**	**$310,535**	**$0**	**$8,294,767**	**$1,178,039**	**$59,722**	**$20,866,864**

[a] The Australian financial year is from 1 July to 30 June.

[b] Exchange Rate: AUD 1 = USD 0.523 (source: Reserve Bank of Australia statistics for 2001-02).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 2002-03 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$77,114	$44,447	$769,699	$2,407,764	$0	$0	$0	$138,793	$0	$3,437,818
Regional - South Pacific	$143,129	$0	$223,418	$0	$0	$0	$961,461	$1,525,194	$19,232	$2,872,434
Solomon Islands	$0	$0	$910,610	$0	$0	$0	$0	$0	$0	$910,610
Tonga	$25,117	$26,287	$0	$12,286	$2,454	$0	$25,852	$0	$0	$91,996
Vanuatu	$0	$0	$0	$47,882	$0	$0	$0	$0	$0	$47,882
Samoa	$0	$0	$0	$879,069	$3,100	$0	$0	$0	$0	$882,169
Tuvalu	$0	$0	$0	$0	$43,762	$0	$0	$0	$0	$43,762
Cook Islands	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total Pacific	**$245,361**	**$70,734**	**$1,903,727**	**$3,347,001**	**$49,315**	**$0**	**$987,313**	**$1,663,987**	**$19,232**	
Asia										
Burma	$0	$0	$0	$291,807	$0	$0	$0	$0	$0	$291,807
China	$1,221,084	$0	$1,823,455	$58,803	$0	$0	$4,433,831	$0	$0	$7,537,172
India	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Indonesia	$288,479	$0	$39	$0	$0	$0	$0	$0	$0	$288,518
Laos	$4,446	$0	$0	$4,404	$0	$0	$0	$0	$0	$8,850
Nepal	$0	$0	$459,059	$0	$0	$0	$0	$0	$0	$459,059
Pakistan	$0	$0	$0	$583,276	$0	$0	$0	$0	$0	$583,276
Sri Lanka	$0	$0	$450,252	$0	$387,197	$0	$0	$0	$0	$837,448
Thailand	$288,479	$0	$0	$0	$0	$0	$0	$0	$0	$288,479
Vietnam	$292,801	$0	$0	$318,907	$0	$0	$2,593,905	$0	$0	$3,205,612
Cambodia	$0	$0	$0	$1,153,332	$0	$0	$0	$0	$0	$1,153,332
Philippines	$288,479	$0	$0	$70,020	$0	$0	$0	$0	$0	$358,499
East Timor	$0	$0	$0	$83,761	$0	$0	$0	$0	$0	$83,761
Mongolia	$0	$0	$47,153	$0	$0	$0	$0	$0	$0	$47,153
Malaysia	$288,479	$0	$0	$0	$0	$0	$0	$0	$0	$288,479
Sub-total Asia	**$2,672,248**	**$0**	**$2,779,957**	**$2,564,309**	**$387,197**	**$0**	**$7,027,736**	**$0**	**$0**	**$15,431,446**
Africa										
South Africa	$0	$0	$0	$990,705	$0	$0	$0	$0	$0	$990,705
Kenya	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total Africa	**$0**	**$0**	**$0**	**$990,705**	**$0**	**$0**	**$0**	**$0**	**$0**	**$990,705**
South and Central America										
Haiti	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mexico	$0	$0	$15,189	$0	$0	$0	$0	$0	$0	$15,189
Guatemala	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sub-total South and Central America	**$0**	**$0**	**$15,189**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$15,189**
Total	**$2,917,608**	**$70,734**	**$4,698,873**	**$6,902,015**	**$436,512**	**$0**	**$8,015,049**	**$1,663,987**	**$19,232**	**$24,724,010**

[a] The Australian financial year is from 1 July to 30 June.

[b] Exchange Rate: AUD 1 = USD 0.584 (source: Reserve Bank of Australia statistics for 2002-03).

Table 7.3 Bilateral and regional financial contributions related to the implementation of the UNFCCC for the financial year 2003-04 (US dollars)[a, b] (continued)

Recipient country/ region	Mitigation						Adaptation			Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments	
Pacific										
Papua New Guinea	$21,384	$146,612	$1,247,339	$3,267,137	$0	$0	$0	$190,330	$0	$4,872,802
Regional - South Pacific	$96,698	$192,043	$567,909	$121,618	$0	$62,570	$2,650,117	$1,008,393	$0	$4,699,347
Solomon Islands	$0	$0	$1,145,171	$0	$0	$0	$0	$0	$0	$1,145,171
Tonga	$26,481	$27,714	$0	$12,954	$617,398	$0	$16,626	$0	$0	$701,174
Vanuatu	$0	$0	$0	$51,218	$0	$0	$0	$0	$0	$51,218
Samoa	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tuvalu	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cook Islands	$50,822	$0	$0	$0	$0	$0	$0	$0	$0	$50,822
Sub-total Pacific	**$195,386**	**$366,369**	**$2,960,420**	**$3,452,927**	**$617,398**	**$62,570**	**$2,666,743**	**$1,198,722**	**$0**	**$11,520,533**
Asia										
Burma	$94,004	$0	$0	$60,508	$0	$0	$0	$0	$0	$154,512
China	$798,467	$0	$1,489,570	$76,467	$0	$0	$4,574,126	$0	$0	$6,938,630
India	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Indonesia	$155,320	$0	$0	$0	$0	$0	$0	$0	$0	$155,320
Laos	$94,004	$0	$0	$0	$0	$0	$0	$0	$0	$94,004
Nepal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pakistan	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sri Lanka	$0	$0	$1,009,868	$0	$561,804	$0	$0	$0	$0	$1,571,672
Thailand	$155,320	$0	$0	$0	$0	$0	$0	$0	$0	$155,320
Vietnam	$155,320	$0	$0	$220,092	$0	$0	$1,529,735	$0	$0	$1,905,147
Cambodia	$0	$0	$0	$1,679,632	$0	$0	$0	$0	$0	$1,679,632
Phillipines	$155,320	$0	$0	$316,247	$0	$0	$0	$0	$0	$471,567
East Timor	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mongolia	$0	$0	$56,747	$0	$0	$0	$0	$0	$0	$56,747
Malaysia	$155,320	$0	$0	$0	$0	$0	$0	$0	$0	$155,320
Sub-total Asia	**$1,763,074**	**$0**	**$2,556,186**	**$2,352,946**	**$561,804**	**$0**	**$6,103,861**	**$0**	**$0**	**$13,337,872**
Africa										
South Africa	$0	$0	$0	$1,560,439	$0	$0	$0	$0	$0	$1,560,439
Kenya	$0	$0	$84,806	$0	$0	$0	$0	$0	$0	$84,806
Sub-total Africa	**$0**	**$0**	**$84,806**	**$1,560,439**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,645,245**
South and Central America										
Haiti	$0	$0	$3,980	$0	$0	$0	$0	$0	$0	$3,980
Mexico	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Guatemala	$0	$0	$19,246	$0	$0	$0	$0	$0	$0	$19,246
Sub-total South and Central America	**$0**	**$0**	**$23,225**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$23,225**
Total	**$1,958,460**	**$366,369**	**$5,624,636**	**$7,366,312**	**$1,179,202**	**$62,570**	**$8,770,604**	**$1,198,722**	**$0**	**$26,526,875**

[a] The Australian financial year is from 1 July to 30 June.

[b] Exchange rate: AUD 1 = USD 0.712 (source: Reserve Bank of Australia statistics for 2003-04).

Table 7.4 Description of selected projects or programmes that promote practicable steps to facilitate and/or finance the transfer of, or access to, environmentally sound technologies

Project/programme title: South Pacific Sea Level and Climate Monitoring Project

Purpose:

The South Pacific Sea Level and Climate Monitoring Project aims to provide an accurate, long-term record of sea levels in the South Pacific for partner countries and the international scientific community.

Recipient country	Sector	Total funding	Years in operation
Pacific countries	Other vulnerability assessments	US$7 million	January 1991–December 2005

Description:

The overall goal of the project is to provide an accurate long-term record of sea levels in the Pacific region for partner countries and the international scientific community, enabling them to respond to and manage related impacts. The project is assembling an archive of sea level and related climate data that Pacific island countries require to manage their near-shore and coastal resources sustainably and to respond to long-term sea level and climate trends.

The project builds on the achievements of two earlier Australian-funded project phases, initiated in response to concerns over the potential impact of climate change and sea level rise on Pacific island countries. To date, the project has installed sea level monitoring stations in 12 partner countries and is currently installing a related network of Continuous Global Positioning Systems (CGPS) receivers to monitor land movements. Phase I (1991–95) saw the installation of 11 sea level/meteorological monitoring stations around the Pacific, a transmission network and computer databases to collect, store and analyse data from the stations. Phase II (1995–2001) emphasised training, public education and the provision of monthly data reports that can be used by partner governments in vulnerability studies, integrated coastal management programmes, and contingency planning.

In Phase III of the project, the sea level monitoring equipment is being linked to global positioning satellites in order to deliver precise sea level data—removing uncertainty caused by possible vertical land movements. The equipment was positioned in order to ensure the sea levels of the entire region are monitored.

The current phase (Phase III) of the South Pacific Sea Level and Climate Monitoring Project is due to finish in December 2005 and a design for the next phase of the project is currently being developed.

Indicate factors which led to project's success:

The project addresses specific priority concerns identified by Pacific island countries.

Technology transferred:

Sea level and climate monitoring equipment and databases

National and regional capacity to gather and analyse sea level and climate data

Impact on greenhouse gas emissions/sinks (optional):

(Not applicable)

Project/programme title: China–Australia Datong Cleaner Environment Project

Purpose:

To improve the environment and hence the living conditions and health of residents of the Datong municipality and surrounding regions.

Recipient country	Sector	Total funding	Years in operation
China	Industry	US$4.42 million	March 2001–June 2004

Description:

The Datong Cleaner Environment Project was designed to assist Datong Environmental Protection Bureau (EPB), Datong Coal Gasification Corporation (DCGC) and Datong Water Resources Management Office (WRMO) to improve Datong's environment and water resources. The project used the dual strategy of implementing cleaner production within an individual coal gasification plant so that personnel and equipment at the plant could operate in compliance with government legislation and requirements; and building capacity within the provincial EPB and Water Resource Management Committee so that they could facilitate compliance of coal gasification plants with environmental legislation.

The project resulted in improved policies, strategies and procedures for environmental management, which are currently being implemented by the EPB, WRMO and DCGC to improve management practices of planning, information sharing, financial control, occupational health and safety, environmental management, community consultation, maintenance planning, personnel participation and reporting. This has led to reductions in atmospheric emissions from coking ovens, as well as local improvements to water quality, benefiting health and agricultural production.

The next step for government and DCGC will be to replicate this project in other coal gasification plants around China. The project developed a detailed replication strategy and programme to achieve this end.

Indicate factors which led to project's success:

The success of the project is attributed to several factors:

- The adoption of a dual strategy involving both regulators and industry in the project from the outset
- Communication between all of the parties, allowing them to work together effectively and maintain the flexibility to modify project activities in order to achieve optimum results. Achievements were limited in those aspects of the project in which there was less than optimum communication between parties involved
- The ability of cleaner production at DCGC to provide a means to convert an industry in financial decline to a cash-positive state
- The effectiveness of occupational health and safety training at DCGC.

Technology transferred:

This project developed breakthrough technology for treating wastewater to Grade 1 National Standard, a worldwide first for the coal gasification industry.

Impact on greenhouse gas emissions/sinks (optional):

(Not quantified)

Australian scientists continue to play an active role in climate, climate change and climate variability research. This commitment to research means that Australia has the most comprehensive research and monitoring activities related to climate change in the Southern Hemisphere.

Australia supports this activity through a broad base of climate change science and systematic observation aimed at advancing understanding of global and regional climate change and climate variability, and its possible effects on Australia's natural and managed systems. This research is broadly based, covering climate processes, modelling and the impacts of climate and climate change on various sectors of society. It contributes significantly to the assessments of the Intergovernmental Panel on Climate Change (IPCC), and a number of Australian scientists are playing leading roles in the preparation of the *Fourth Assessment Report*, scheduled for publication in 2007.

Australia has established and maintains national networks of meteorological, atmospheric, oceanographic and terrestrial observations, which provide the basis for its climate observing network and contribution to global climate monitoring. These networks contribute to the Global Climate Observing System (GCOS), which builds upon, and works in partnership with, other observing systems such as the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS), and the Global Observing System and the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO).

Australia's participation in GCOS, GOOS and GTOS is planned and coordinated through the GCOS/GOOS/GTOS Joint Working Group, which reports to a steering committee consisting of Australian representatives of the main international sponsoring organisations. The terms of reference and membership of the Joint Working Group are currently under review with the aim of refocusing on the scientific and technical aspects of Australia's contribution to the Global Earth Observation System of Systems (GEOSS).

Australia's meteorological observing network is operated and maintained by the Bureau of Meteorology. Marine and ocean observation programmes are operated by organisations that include the Bureau of Meteorology, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research (CMAR) division, the Royal Australian Navy and the Australian Institute of Marine Science (AIMS), whilst the terrestrial observing network is managed by the CSIRO and a range of Australian universities.

A detailed treatment of the science of climate change as it applies to Australia can be found in *Climate Change: an Australian guide to the science and potential impacts* (Pittock, B. ed., Commonwealth of Australia, 2003), available electronically at http://www.greenhouse.gov.au.

A detailed discussion of climate-related research and systematic observation may be found in *Climate Activities in Australia*, published every two years by the Bureau of Meteorology and available at http://www.bom.gov.au. The latest edition is due for publication in late 2005.

Case study: *Climate Change: An Australian guide to the science and potential impacts*

2003 saw Australia release its first major publication to focus on the science of climate change in Australia and the southern hemisphere *Climate Change: An Australian Guide to the Science and Potential Impacts*. Describing material covered in the *Intergovernmental Panel on Climate Change Third Assessment Report* relevant to Australia, the guide also presents new information on key regional climate issues, and contributes to informed debate on climate change issues.

Australian research has resulted in a far greater understanding of the role the Southern and Antarctic Oceans play in influencing regional and global climate change. The Southern Ocean is a key global climate driver and underpins the spread of nutrients and thus the productivity of many of the world's major oceans (Pacific, Indian and Atlantic).

Australia is recognised internationally for its research on how climate change may affect El Niño events that cause floods and droughts, the latter often leading to bushfires in Australia as well as extreme weather events in the Asia–Pacific region.

Another area of research concentrates on impacts on the health of coral reefs, particularly increased sea-surface temperatures. Bleaching of corals is related to higher sea-surface temperatures and since the 1970s there has been a global increase in the number and scale of bleaching events. While the focus of Australian research is primarily the Great Barrier Reef, due to its ecological and economic importance to Australia, much of this science is applicable internationally.

All of these research areas are of emerging global priority for climate change science. This publication makes a significant contribution to national and international understanding of the influences of climate change in the Southern Hemisphere.

Research capacity

Climate research in Australia is conducted by a variety of organisations and institutions including government research agencies and universities. Australian science is confronted by a significant challenge in addressing complex scientific problems of national and international significance across a broad geographic region with limited resources.

In 2002, the Australian Government announced a series of four National Research Priorities to provide a vision of where research can contribute to Australia's future prosperity and wellbeing, and to help align the nation's research effort in these key areas.

The National Research Priorities identify the need to continue research in climate change within the broader priority of 'An Environmentally Sustainable Australia'. This priority includes specific focus areas such as: water; transforming existing industries; overcoming soil loss, salinity and acidity; reducing and capturing emissions in transport and energy generation; sustainable use of Australia's biodiversity; developing deep earth resources; and responding to climate change and variability.

Australian climate research capacity has been significantly enhanced since the *Third National Communication* as a result of:

- increased funding for the Australian Climate Change Science Programme
- the establishment of the Australian Research Council (ARC) Earth Systems Science Network
- a decision by key research agencies to cooperate in developing the Australian Community Climate and Earth System Simulator
- increased funding for research on energy innovation.

Australian Climate Change Science Programme

The Australian Climate Change Science Programme is the key facilitator of Australian climate change science. This programme, funded through and managed by the Department of the Environment and Heritage's Australian Greenhouse Office (AGO), provides strategic research funding to improve understanding of the causes, nature, timing and consequences of climate change, so that industry, community and government decisions can be better informed.

In May 2004, the Australian Government renewed funding for the programme, increasing the amount to $30.7 million over four years. The effect of this funding is magnified by contributions of equal value from the CSIRO and the Bureau of Meteorology.

An independent evaluation in 2003 assessed the programme as being the core driver of Australian climate change science, and as highly effective and efficient, observing that the programme has supported a strong level of engagement in the international research effort.

ARC Earth System Science Network

The ARC Earth System Science Network has funding of $1.95 million over five years to link researchers in universities and other research institutions who are investigating the effects of climate change and variability on human, biological and physical systems. This network will help researchers, particularly those in universities, participate more effectively in the national climate change research effort.

Australian Community Climate Earth System Simulator

The CSIRO and the Bureau of Meteorology will jointly develop the Australian Community Climate Earth System Simulator (ACCESS) with strong links to and contributions from university research groups. Initiated through the Australian Climate Change Science Programme, ACCESS will feature new generation global and regional climate modelling capability, include a fully coupled carbon cycle model and eventually provide the opportunity for incorporation of socio-economic processes.

Increased funding for research on energy innovation

Australian organisations are very active in the research and development of renewable energy technology, particularly solar energy. Significant areas of Australian Government support for energy innovation include the following:

- A national research priority goal—Reducing and capturing emissions in transport and energy generation, which provides a context and focus for Australia's broader innovation effort

- In May 2004, the Australian Government provided $305 million in additional funding for CSIRO flagship research programmes. 'Energy transformed', one of six CSIRO flagship research programmes, has an overall goal of the cost effective reduction of greenhouse gas emissions from the energy sector

- The part funding of a range of Cooperative Research Centres (CRCs) that deal directly or indirectly with energy issues. Three CRCs are developing advanced technologies for black and brown coal combustion as well as technology for the capture and storage of greenhouse emissions from power stations. In addition, the CRC for Mining Technology and Equipment supports improvements in efficiency and profitability of the mining sector, the Rail CRC supports more cost-effective rail transport, and many manufacturing CRCs conduct work on manufacturing processes and materials that can reduce energy needs in meeting consumer demands

- Australian Research Centre funding supports a Key Centre for Photovoltaic Engineering at the University of New South Wales and the Centre for Sustainable Energy Systems at the Australian National University, both of which continue to develop leading-edge solar technologies, including high efficiency applications such as sliver cells that can significantly reduce production costs.

In 2004, the Australian Government announced a range of programmes aimed at the research and development of low greenhouse gas emission technology and renewable energy solutions. These included the $500 million Low Emissions Technology Demonstration Fund, the $26.9 million Low Emission Technology Abatement Programme, $14 million for Wind Energy Forecasting Capability, the $20.4 million Advanced Energy Storage Technologies initiative and the $100 million Renewable Energy Development Initiative. Details of these programmes can be found in Chapter 4—Policies and measures.

Other research capacity

Another key Australian Government research programme is the Australian Antarctic Science Programme. Managed by the Department of the Environment and Heritage's Australian Antarctic Division, in conjunction with the CRC for the Antarctic Climate and Ecosystem, and numerous Australian universities, this programme contributes to Southern Hemisphere research outcomes.

The Bureau of Meteorology and the CSIRO undertake research and observations outside, but complementary to, the Australian Climate Change Science Programme. Other Australian Government research agencies, including the Australian Institute of Marine Science, the Bureau of Rural Sciences, the Australian Bureau of Agricultural and Resource Economics and Geoscience Australia also conduct research relevant to climate change and variability. In addition, a number of rural research and development corporations and state government agencies are involved in climate change research.

Several CRCs conduct research related to climate change and its impacts. These include the CRC for Greenhouse Accounting, the CRC for Australian Weed Management and the CRC for Antarctic Climate and Ecosystems.

International cooperation

The Australian Climate Change Science Programme helps to facilitate Australian participation in two significant international programmes through the Australian Academy of Science, the International Geosphere–Biosphere Programme (IGBP) and the World Climate Research Programme (WCRP), and also supports an Australian-based international project office of the Global Carbon Project of the IGBP. In addition, Australian researchers contribute significantly to international climate research through their participation in the activities of the World Climate Impacts and Response Strategies Programme (WCIRP) and continue to play prominent roles in the Scientific Committee on Antarctic Research and its sub-committees.

Australia is also a member of other international climate change research and information exchange programmes and organisations. For example, Australia is in the process of establishing an Asia–Pacific Climate Change Exchange to promote collaboration between Australian businesses and researchers and their regional partners, as well as being a member of the Asia–Pacific Network for Global Change Research (APN), an inter-governmental network that promotes global change research and the links between science and policy-making in the Asia–Pacific region.

Research focus

Significant developments in the focus of Australia's climate change research since the *Third National Communication* include a refocusing of the Australian Climate Change Science Programme, the development of a blueprint for carbon cycle research and an increased emphasis on impacts and adaptation research.

The Australian Climate Change Science Programme is the Australian Government's primary driver of climate change research.

Designed to advance understanding of Australia's unique circumstances and respond to stakeholder requests for accelerated research efforts to describe the implications of climate change for industry sectors and the community, the programme targets policy relevant research. Following an independent evaluation and a process of stakeholder consultation, the programme now has six key themes:

- understanding the key drivers of climate change in Australia
- improved climate modelling systems
- climate change, climate variability and extreme events
- regional climate change projections
- international research collaboration
- strategic communications and coordination.

With support from the AGO, Australia's leading carbon-climate researchers have developed a Blueprint for Australian Terrestrial Carbon Cycle Research. This will provide a cohesive structure for future carbon cycle research across Australia using three main themes:

- patterns of carbon sources and sinks across Australia
- vulnerability of terrestrial carbon sinks
- interactive coupling of the carbon cycle to the physical climate system.

Australia recognises that early and effective adaptation to potential climate change impacts can help minimise risks, generate economic benefits, and reduce the costs associated with the effects of climate change that are already occurring. The Australian Government, particularly through the National Climate Change Adaptation Programme, will foster research on climate change impacts and adaptation through partnerships with key stakeholders and research organisations. State and territory governments are also placing increased emphasis on impacts and adaptation research. Further information about these initiatives is set out in Chapter 6—Vulnerability assessment, climate change impacts and adaptation.

Some illustrative research projects

The following small sample of projects illustrates the range of Australian climate change research activity. A more complete description can be obtained from *Climate Activities in Australia 2005* and *Climate Change: an Australian guide to the science and potential impacts*.

Understanding key drivers of climate change

The CSIRO recently completed a study of seasonal and interannual variability of the Southern Ocean mixed layer, south of Australia. The variability of the mixed layer is important for understanding both physical and biogeochemical climate processes. Repeat measurements south of New Zealand were used to document upper ocean variability. Southern Ocean temperature anomalies were found to extend well below the sea surface, with implications for the dynamics of modes of variability such as the Antarctic Circumpolar Wave.

The Bureau of Meteorology has analysed the relationship between the El Niño Southern Oscillation (ENSO) and Australian rainfall using observations and coupled models, to understand why ENSO's impact on Australia varies from decade to decade and why some El Niño episodes lead to significant drought while others do not. This research will also examine the extent to which these changes can be predicted.

A major finding of CSIRO research under the Australian Climate Change Science Programme is that the Southern Hemisphere is responsible for approximately 60% of the ocean carbon storage. This research confirms the importance of the Southern Ocean in regulating carbon uptake.

Improved climate modelling systems

In March 2004, a workshop including representatives from the Bureau of Meteorology Research Centre (BMRC), CMAR, the Tasmanian Partnership for Advanced Computing (TPAC), the CRC for the Antarctic Climate and Ecosystem and various universities established a plan to develop the next generation ocean model for climate studies in Australia. A common configuration, called AusCOM (Australian Climate Ocean Model), was agreed on. Work has now started on the new model, and a preliminary version developed, with TPAC working on adding an ice model. A 10-year inter-annually varying simulation of AusCOM has been performed and an assessment is underway.

The CSIRO has continued development of an ocean biogeochemical module for incorporation into the ocean component of the CSIRO Mark 3 climate model. The final module will simulate the following species: oxygen, phosphate, dissolved inorganic carbon, nitrogen, argon, chlorofluorocarbon (CFC)-11, CFC-12 and alkalinity.

The CSIRO is working to provide more reliable and comprehensive regional climate change projections for Australia, with better quantification of uncertainty and risk, tailored for use in impact assessments.

Similarly, several groups are working to improve Australia's capability to derive regional and local estimates of weather and climate from large-scale models. This research has shown that downscaling techniques allow different climate models to produce consistent estimates of local climate. Statistical downscaling undertaken by the BMRC and CSIRO Land and Water has progressed to cover south-west Western Australia, south-eastern Australia, Queensland and the Murrumbidgee and Murray–Darling River basins.

Climate change, climate variability and extreme events

Understanding Australian climate variability and how climate will affect this variability and the frequency or intensity of extreme events is a key area of research for Australia.

The CSIRO has conducted high-resolution modelling of extreme rainfall events and accurately simulated observed extreme rainfall intensities. These extreme events have the potential to affect flooding, drainage and dam safety. Researchers have now developed techniques that can help identify weather events likely to lead to extreme rainfall, compare the climatology of modelled extreme weather with observations and identify any changes in the frequency and intensity of these events due to climate change.

Research in the BMRC has identified a decrease in frost occurrence in the Murray–Darling Basin in recent decades. The frequency of hot days and nights has increased across nearly all of east and South-East Asia and the western Pacific, while cool days and nights have become less frequent. It has been found that variations in the frequency of these extremes appear to be related to the ENSO, but that trends in their frequency cannot be explained by ENSO trends.

Climate processes such as the Indian Ocean Dipole, the Interdecadal Pacific Oscillation and the Antarctic Oscillation, which have been linked to climate variability in regional Australia, are still not well understood and changes in the mean state of the ocean or atmosphere (for example, a warming of the tropical oceans or a shift in atmospheric pressure) may alter the frequency or intensity of ENSO or other modes of variability. Researchers from the CSIRO and the BMRC are investigating the implications of such changes.

Impacts and adaptation

Understanding the likely effects of elevated carbon dioxide (CO_2) concentrations on plant growth and function under Australian conditions is critical to predicting the possible effects of climate change on a range of natural, agricultural and forest systems. Some studies have been completed and information can be gleaned from research overseas, but this knowledge is not an adequate foundation for policy-makers. The AGO is working with scientists from universities and the CSIRO to establish a major series of experiments to study the response of wheat and tree species commonly found in Australian forests to elevated CO_2 concentrations under field conditions.

International collaboration

The Bureau of Meteorology has a key role in the planning of the international research collaboration, the Tropical Warm Pool International Cloud Experiment (TWP–ICE), which will take place in 2006. TWP–ICE aims to describe and understand monsoon convection, the associated cloud fields, and the relationship to large-scale conditions, as well as to improve the representation of these processes in climate models.

The Bureau of Meteorology has an ongoing programme of detailed observation of tropical cloud properties that are a significant resource for climate studies and model development. The Bureau of Meteorology, in collaboration with the Atmospheric Radiation Measurement (ARM) programme run by the United States Department of Energy, has also augmented its Darwin facility with additional cloud and radiation monitoring equipment, with the aim of improving how climate models handle clouds.

Systematic observation

The 1997 plan for an Australian Climate Observing System (ACOS) provides the framework for Australia's systematic observation of climate. Australia contributes to the systematic observation of the global climate under GCOS through the provision of meteorological and oceanographic observations and through participation in international terrestrial and space-based observing programmes.

The ACOS plan sets out the components necessary for a system capable of supplying observational data for better understanding of the global and Australian climate, prediction of seasonal and inter-annual variations in Australia's climate, and the detection and quantification of longer term climate change. It catalogues current observing systems and recommends enhancements and additions to them, in particular those that could realistically be implemented in the next 10 years. The plan covers measurements of the land-surface climate, atmospheric constituents, atmospheric circulation, radiation, hydrology, surface–air interactions, ocean circulation and climate, sea level and the cryosphere. Paleoclimatic studies, along with the issues of data and network management, are also covered. A summary of the plan is available from the Bureau of Meteorology's website at http://www.bom.gov.au.

Progress has also been made on the planning for an Australian Integrated Ocean Observing System (AusIOOS). Envisaged as a national system that will systematically acquire and deliver marine data and derived products in a reliable and timely manner, the AusIOOS will deliver cost-effectiveness by serving multiple applications with individual products, providing multiple products from individual data streams, and maintaining multiple sensors and data streams on individual platforms. All elements will be fully integrated.

Following similar developments elsewhere, it is proposed to design AusIOOS around two linked components: a global (ocean basin/climate) component and a coastal component. The ocean basin/climate component depends on international collaboration, particularly with nations in our immediate vicinity, and is intended to support assessment and forecasting of ocean circulation, sea state, weather and climate, and other marine issues that have a global dimension. The coastal component would be a system of state or regional and national initiatives, covering the effects of weather, climate and anthropogenic pressures on marine ecosystems, living resources and human commercial and recreational activity in the Australian Economic Exclusion Zone, which would be developed and implemented as a partnership across government agencies, industry, and universities.

A Southern Hemisphere focus for the GOOS has been provided through the establishment in Australia of a Regional Program Office of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). Established in Perth in 1999, the role of the office is to facilitate the development and implementation of GOOS activities in the Indian Ocean, South West Pacific and South-East Asia, and to build the capacity of countries in the region to participate.

Meteorological and atmospheric observations

Australia maintains observing stations in the GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN), the GCOS radiation network (Baseline Surface Radiation Network) and the GAW. These stations are located on the Australian mainland, on remote islands and in Antarctica. The GSN, GUAN and GAW Regional and Ozone monitoring stations are operated and maintained by the Bureau of Meteorology. The funding and management of the operation of the Cape Grim Baseline Air Pollution Station GAW global observatory in Tasmania is also the responsibility of the Bureau of Meteorology, but the Bureau of Meteorology and CSIRO jointly manage its research programme.

In general, the operation of Australia's GSN, GUAN and GAW stations adheres to the GCOS climate monitoring principles and best practices. All principles are supported by current Bureau of Meteorology policy, but inadequate resources sometimes mean they are not fully implemented. A range of current and future projects are required to fully address some principles, such as further digitisation of paper records, routine homogeneity testing, improved quality testing and enhanced network performance monitoring.

All computerised data for Australian GSN and GUAN stations, and some from the GAW stations, are stored in the Australian Data Archive for Meteorology. Most stations have data available from the late 1800s or early 1900s. Vast amounts of hard-copy climate records, such as observation field books, rainfall record sheets, pluviographs, upper-air traces and CLIMAT message forms, are held in store by the National Archives of Australia.

There are currently more than 22,000 paper files holding metadata relating to observation stations within Australia. In recent years the Bureau of Meteorology has developed a relational database to store metadata concerning site location, instrumentation, verification results, equipment faults and observation programme details.

Generally, all 64 operating GSN stations in Australia meet required standards. According to statistics produced by the GSN Monitoring Centre, international reporting of monthly data from Australia's GSN stations is rated as good relative to the rest of the world.

Australia's 16 GUAN stations mostly meet the required standards, though only four are currently operating to GCOS standards. However, according to the GUAN Monitoring Centre, monthly data for Australia's GUAN stations compares favourably with the remainder of the global network.

Australia also maintains three radiation stations that report data to the Baseline Surface Radiation Network Archive.

Australia's land surface climate observation programme is based on an extensive network of manual and automatic observing stations recording a range of meteorological variables in support of climate monitoring, and weather forecasting and warning services.

Australia's upper air climate observation programme is based on a combination of ground-based and satellite-based observing systems operated in support of climate monitoring, and weather forecasting and warning services.

Oceanographic observations

Australia maintains a mix of in-situ and space-based oceanographic observing systems that contribute to GCOS and GOOS. Ocean observations are collected by various government agencies and institutions in support of climate monitoring and prediction, weather forecasting and warning services, and ocean and coastal marine research.

The Bureau of Meteorology is responsible for the management and operation of the in-situ ocean surface observing networks that provide real-time data for weather prediction, operational ocean analyses and forecasting. These networks include:

- Australia's contribution to the international Volunteer Observing Ship Scheme
- 22 meteorological drifting buoys deployed in the oceans surrounding Australia.

The Bureau of Meteorology also contributed to an Automated Shipboard Aerological Programme in the Southern Hemisphere between 2001 and early 2005, and operates the Australian expendable bathythermograph Ship-of-Opportunity Programme in conjunction with CMAR and the Royal Australian Navy.

The National Tidal Centre, now operating as part of the Bureau of Meteorology, manages and operates the 14 station Australian Baseline Sea-Level Monitoring Array, and, with the member countries of the South Pacific Forum, manages a network of stations in 12 Pacific island countries. The Australian Antarctic Division, in conjunction with the National Tidal Centre and the Australian Surveying and Land Information Group, operates a network of specially designed tide gauges at Australian bases in Antarctica and on sub-Antarctic islands.

CMAR operates several research-based in-situ ocean observing systems. In conjunction with the Bureau of Meteorology, CMAR also participates in the international Argo project by deploying autonomous profiling floats for Argo Australia in the Southern Ocean and eastern Indian Ocean. At present Australia maintains 57 Argo floats.

Australia proposes to deploy a surface mooring within the next two to three years and implement a tsunami early warning system by 2009, comprising additional tide gauges and a network of Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys.

In general, Australia's oceanographic observing practices follow the GCOS/GOOS climate monitoring principles. Operational elements of the various networks are considered to be part of an integrated, multi-purpose system, which includes climate monitoring.

Each Australian marine agency is responsible for archiving and distributing its own marine and oceanographic data. Whilst the former Australian Oceanographic Data Centre (AODC), renamed the Defence Oceanographic Data Centre (DODC), is now responsible for Navy data only, it is proposed that major Australian marine agencies will, in future, act as data portals in a redesigned and distributed AODC. This will demonstrate Australia's commitment to the principles of free and unrestricted exchange of its ocean climate data.

Regular monthly analyses of the upper ocean temperature field are produced by the Joint Australian Facility for Ocean Observing Systems (JAFOOS), which also acts as the World Ocean Circulation Experiment (WOCE) Indian Ocean Upper Ocean Thermal Data Assembly Centre. All upper ocean thermal data in the Indian Ocean for the WOCE period (1990–1998) are currently being assembled and provided with scientific quality control before analysis on ocean basin scales. This work also contributes to the Global Temperature Salinity Profile Program (GTSPP) of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the International Oceanographic Data and Information Exchange (IODE).

Australia participates in all international panels related to the global ocean observing system. The Bureau of Meteorology currently provides the Chairman of the International Buoy Program for the Indian Ocean and the Chairman of the JCOMM Ship Observations Team (SOT).

Terrestrial observations

Australia also contributes to the GCOS and GTOS programmes for terrestrial observations. The recent Implementation Plan for the Global Observing System for Climate in support of the UNFCCC drew attention to the lack of homogeneous terrestrial observations around the globe, which in turn limits capacity to monitor the changes relevant to climate and to determine causes of land-surface changes.

Australian terrestrial observations continue to advance, though there is scope for further improvement. Additional work in the area of data management, including metadata, quality management and archiving, is required, whilst improvements in integrating these data with observations from the other domains would also be welcomed.

OzFlux is a network of eight micrometeorological flux stations that provide continuous measurements of the fluxes of energy, CO_2 and water vapour over long time periods in a range of terrestrial ecosystems across Australia.

OzFlux is part of Fluxnet, a global network of over 250 sites where fluxes between terrestrial ecosystems and the atmosphere are measured continuously over long periods. The CSIRO have been operating three Ozflux flux stations, Virginia Park, which closed in late 2004, Burdekin Delta and Tumbarumba. The five other stations are operated and maintained by Monash University, James Cook University, the Northern Territory University and the Australian National University.

Having no permafrost regions within its purview, Australia makes no contribution to the Global Terrestrial Network—Permafrost (GTN–P), but through the Antarctic Science Program, Australia contributes to the Global Terrestrial Network—Glaciers (GTN–G). Responsibility of the 29 sites rests with the Australian Antarctic Division, which monitors the fluctuations of glaciers on sub-Antarctic Heard Island.

Space-based observations

Australia is an active user and major contributor to research, development and applications in relation to space-based observing systems used to derive climate-related information. Australian activities in support of international space-based observing programmes include:

- membership of international coordinating bodies such as the Committee for Earth Observation Satellites
- development and construction of satellite hardware
- provision of ground stations for the reception of satellite data and satellite orbit determination
- active involvement in various calibration/validation programmes, including participation in the Along Track Scanning Radiometer series of satellite instruments onboard the European Space Agency's satellites (ERS-1, ERS-2 and ENVISAT), involvement by the CSIRO, the Australian Institute of Marine Science and the Bureau of Meteorology in ongoing validation studies for satellite instruments, and a dedicated research cruise by the Australian Antarctic Division to validate sea-ice products from the new generation of passive microwave radiometers (AMSR).

There are five main archives of meteorological and oceanographic satellite data in Australia. The Bureau of Meteorology maintains an accessible archive of about 20 years of satellite data for potential use in climate studies. This archive includes data primarily from the Geostationary Meteorological Satellite (GMS) series of Japan from the late 1970s, Geostationary Operational Environmental Satellite (GOES) and the National Ocean and Atmospheric Administration (NOAA) series of meteorological satellites. The CSIRO's Office of Space Science and Applications Earth Observation Centre in Canberra has an archive of Advanced Very High Resolution Radiometer (AVHRR) data dating back to the early 1990s and has been compositing orbits received from different reception stations. Other archives of satellite data, which include NOAA, AVHRR and Sea-viewing Wide-Field Sensor (SeaWiFS) measurements, are held by the Australian Institute of Marine Science in Townsville and the Western Australian Satellite Technology and Applications Consortium at the Leeuwin Centre in Perth. The latter archive goes back to 1981, and in recent years has been expanded to include Moderate Resolution Imaging Spectrometer (MODIS) imagery from the United States National Aeronautics and Space Administration's Terra and Aqua satellites. MODIS data are also archived and available online from Geoscience Australia.

Support for developing countries to establish and maintain observing systems, and related data and monitoring systems

Australia continued and enhanced its support to neighbouring countries in the Asia–Pacific region by providing technical advice and assistance to improve climate data management and monitoring capabilities. These activities support a range of benefits including: enhanced capabilities within developing countries to develop climate services; research and development; and improved data-sets for the international research community from areas where observations are sparse but where important climatic phenomenon are observed (e.g. ENSO).

The state of climate observational networks and systems is poor in several of Australia's neighbouring countries. However, the Pacific Island Global Climate Observing System (PI–GCOS) initiative has already gone some way to overcoming observational and data management problems in the region.

PI–GCOS was the first regional implementation vehicle for climate observation activities over the globe. During its relatively short life-time, PI–GCOS has been successful in building awareness of the importance of climate observations and in funding, managing and overseeing a number of activities to reduce deficiencies in climate observation networks and systems.

Australia, through the Bureau of Meteorology, is represented on the PI–GCOS Steering Committee and the Science and Technology Panel, which provides guidance on scientific and technical issues related to climate observations. The Steering Committee maintains linkages with the GCOS Secretariat and its science panels and developed the PI–GCOS Action and Implementation Plans for the region.

Consistent with the need to increase understanding of the importance of climate observations, one of the main Australian PI–GCOS activities is an AusAID funded project to enhance the use and application of seasonal climate predictions in nine Pacific island countries. Commencing in 2003, this project forms part of the Australia–United States Climate Action Partnership and the Strategic Plan for the Development of Meteorology in the Pacific Region 2000–2009.

Similarly, awareness of the importance of observation networks has been raised though the development of seasonal climate forecasting services in several Pacific island countries throughout the South Pacific in an AusAID project managed by the Bureau of Meteorology.

The South Pacific Sea Level and Climate Monitoring Project, initiated in response to Pacific islands leaders' concerns over the potential impact of climate change and sea level rise on Pacific island countries, is a long-term project which monitors sea level at 11 sites in the Pacific. It can detect variations as small as 1 millimetres (mm) per year. The project, which is funded by AusAID and managed by the National Tidal Centre, contributes to the worldwide sea level monitoring effort and also includes capacity building and public awareness. This project will enter into its fourth five-year phase on 1 January 2006, and the primary aim remains to achieve an extended sea level data record, in support of climate monitoring and research. These stations have taken on a higher profile given the development, through Geoscience Australia, the Bureau of Meteorology and Emergency Management Australia of improved tsunami warning services in the region.

The Bureau of Meteorology has also been an active supporter of the climate data management and data rescue aspects of GCOS, including through providing training and capacity building to Pacific and South-East Asian countries. Since an Oracle-based national climate database, similar to that used in Australia, would be too costly to maintain in most neighbouring developing countries, Australia is exploring lower cost alternatives with the WMO and other countries. In July 2005, the AGO commissioned the Bureau of Meteorology to undertake a data rescue project within the Pacific region, with a focus on preserving hard copy meteorological records.

The WMO Commission for Climatology, in which the Australian Bureau of Meteorology participates, has developed of a series of guidelines to assist developing countries manage their climate data. These include guidelines on: climate data management; data rescue; metadata and homogenisation; managing changes in observation systems; and assessing the cost/benefits of automated versus manual observing systems.

Australia has also continued its direct support of observation networks and systems in recent years. During 2004–05, the Bureau of Meteorology funded and implemented the rehabilitation of the Port Moresby GUAN station and provided consumables to run the station for one year. The Bureau is also currently implementing the RANET (Radio and Internet) Feasibility Study project designed to investigate and, where possible, install communications on radio and satellite links to improve the communications infrastructure in the South Pacific for the exchange of climate and weather data and information.

To promote the appropriate analysis of data from GSN and other good-quality climate stations in the region, the BMRC hosted two workshops on climate extremes for the Asia–Pacific Network for Global Change Research. Representatives from 16 countries across South-East Asia and the western Pacific Ocean attended the second workshop held in March 2004, which focused on data rescue, metadata and analysis of climate extremes using consistent methods of quality control and trend analysis. Scientific papers resulting from the workshops were published.

Education and public awareness programmes have continued to play a significant role in Australia's response to climate change. There is a growing awareness of the need to move beyond purely information-based activities to more functional approaches designed to assist in the challenging task of changing behaviours. Working with relevant partners in the education sector can overcome barriers to the implementation of high quality education and training on climate change matters. There is also a growing trend, particularly in the area of formal education, to blend climate change issues into the overarching subject of 'sustainability'.

Formal education and training

The Australian Government recognises that an effective, national level of commitment to environmental education is necessary if systemic and long lasting attitudinal and behavioural change is to be achieved. The Australian Government released its National Action Plan for Environmental Education in July 2000. All the key structural initiatives of the plan have now been implemented and lay the foundation for an increased focus and raised profile of education for sustainability within Australian society. These foundation measures include the following:

- the establishment of the National Environmental Education Council (NEEC) in 2000. NEEC is an expert advisory body to the Environment Minister and comprising people from a variety of sectors, helps set priorities in Education for Sustainability
- the establishment of the National Environmental Education Network (NEEN) in 2001. NEEN, with representatives from Australian, state and territory environment and education agencies, promotes better coordination of activities and has had a significant role in the development of the Australian Sustainable Schools Initiative
- the implementation of a research programme to improve the quality of environmental education and achieve better outcomes, through the establishment of the Australian Research Institute in Education for Sustainability (ARIES) in 2003 under a contractual arrangement between the Department of the Environment and Heritage and Macquarie University
- the establishment of the Environmental Education Forum, an environmental education working group, to coordinate education activities across the Australian Government Environment and Heritage portfolio and develop an internal environmental education policy.

In addition to these measures, the Department of the Environment and Heritage has worked collaboratively with the Department of Education, Science and Training and the state and territory governments to achieve approval from the Ministerial Council for Employment, Education, Training and Youth Affairs for a National Environmental Education Statement (NEES) for Schools. The NEES will be launched in late 2005, providing a nationally agreed description of the nature and purpose of environmental education and illustrating ways in which such a vision can be implemented in Australian curricula and school programmes. The NEES also acknowledges climate change as a critical global issue, and several of the key concepts and themes highlighted in the NEES are relevant to climate change mitigation.

While the Australian Government's action on environmental education is making good progress, there remains room for increased activity and coordination in relation to climate change specific education. The Department of the Environment and Heritage's Australian Greenhouse Office (AGO) is establishing closer links to the environmental education networks and structures mentioned and is currently researching the level and nature of specific climate change related content in existing environmental education programmes. As a result of this investigation, the AGO will be able to identify where improvements to the profile and focus of climate change content are needed and develop a plan to progress a more integrated approach to climate change education.

Primary and secondary

Under Australia's federal system, responsibility for primary and secondary school education resides with the states and territories.

With cooperation and support from the Australian Government and state and territory governments, the Sustainable Schools Initiative integrates sustainability education into a holistic programme with measurable environmental, economic, educational and social outcomes. The programme implements improvement in a school's management of resources and grounds (including energy, waste, water, biodiversity, landscape design, products and materials) and integrates this approach into the existing curriculum and daily running of the school. The programme is action based and involves the whole school community in the sustainable management of the school.

The Australian Government has committed $2 million to the programme over four years. State and territory governments have also given financial support.

The Australian Sustainable Schools Initiative:

- seeks to develop a school culture committed to the principles of ecologically sustainable development (ESD)
- aims beyond awareness raising to action learning and integration with school curricula
- encourages the involvement of the whole school community including teachers, students, administrative staff, grounds staff, canteen operators and parents
- encourages the involvement of a school's local community, including environment experts, local businesses, government and non-government organisations, and a shift in the broader community towards more sustainable practices and processes
- seeks to develop relationships with organisations that affect the management of a school (e.g. Properties, Facilities, Operations and government supplies)
- is founded on a sound basis of theory and practice in schools and school systems, quality teaching and learning, values education, cultural and environmental change, environmental education for sustainability, organisational theory, systems theory, action research and community development
- encourages schools to achieve measurable social, environmental, educational and economic outcomes.

Sustainable Schools links to and complements existing environmental education programmes such as Solar in Schools, WasteWise, Waterwatch, Waterwise and Landcare. Energy efficiency is a core element of the programme.

Climate change specific education in primary and secondary schools has largely taken the form of the development and provision of resources and school focused elements of major public awareness raising campaigns.

Resources

TravelSmart Australia is a national programme that brings together the many community and government based programmes that are asking Australians to use alternatives to travelling in their private car. TravelSmart includes a teaching resource about travel options and the social and physical environment in which we live. It aims to:

- introduce students to the benefits of sustainable travel options
- reduce the impact of the car on our environment, health and community
- encourage individuals to think about how they can change their travel habits by choosing and using a range of transport modes
- identify personal and environmental benefits of planning and using a variety of travel options.

The Australian Government's Renewable Energy Industry Development Programme has sponsored the Australian Science Teachers' Association (ASTA) to develop a *Resource Book on Energy*. It is designed to encourage teachers to take up the theme with their students, providing a balanced analysis of renewable and non-renewable energy solutions. The resource is provided to schools and ASTA members free-of-charge.

Public awareness raising activities

The AGO used the SunRace 2001, 2002 and 2003 events to bring greenhouse and climate change messages to schools along the route of the 10-day 2,300 kilometre event from Adelaide to Sydney. These popular solar vehicle races have been effective in promoting the benefits of energy efficiency and an increased awareness of global warming. Each year, the AGO sponsored educational events in 20 schools, including provision of teaching materials and holding theatrical displays.

State and territory governments have also implemented a number of school-based initiatives that raise awareness and build the capacity of schools and students to lower their greenhouse gas emissions.

For example, the New South Wales and Queensland governments, in partnership with ENERGEX, Integral Energy and Grassroots Marketing Alliance, support the Solar in Schools initiative, which provides schools with educational resources on renewable energy, energy efficiency and climate change.

To date, 79 participating schools have had a solar power system installed to demonstrate solar power in action and a further 28 schools will join the programme in 2005. The participating schools are supported by the http://www.solarschools.net website, which collects and displays data from the schools' solar power systems and provides teaching and learning resources.

Tertiary education, professional and ongoing development

The Australian Government continues to work with curriculum, professional and trade associations on the incorporation of greenhouse-related elements into relevant areas of tertiary education and training curricula and the development and delivery of targeted activities.

Vocational education and professional development

The AGO has commissioned a study aimed at examining options for enhancing the consideration of greenhouse issues in vocational and professional training in Australia. The study included consultation with National Industry Training Advisory Bodies and national professional associations to determine support for and requirements to incorporate training concerning greenhouse issues and principles into existing programmes. The results of the study will help to determine the most effective way of working with the vocational and professional training sector. Current climate change specific action with the sector includes the following:

- The Australian Government has funded the development and delivery of specialist professional development education courses on energy efficiency and other environmental issues for architects, designers, builders, planners, lighting engineers and quantity surveyors. Educational materials on environmentally sustainable buildings have been provided to around 10,000 tertiary students per year since 2002.

- To encourage the professional development of energy efficiency experts, the qualification 'Thermal Performance Assessors' has been registered with the National Training Authority, and the associated training programme has been developed, pilot tested and released to recognised training providers.

- An owner-builder and renovator training programme has also been developed and tested for commercial release. This education programme is designed to assist consumers to understand how their home interacts with the natural environment, and to direct them to more environmentally sustainable solutions.

Universities

Universities are also giving increased emphasis to greenhouse-related issues in their course offerings, community service and research.

Several universities are offering courses in renewable energy and related areas through the Research Institute for Sustainable Energy, based at Murdoch University in Perth, as well as on their own account.

The Green Steps programme is a successful partnership between the AGO and Monash University and has been extended to other universities. It is an innovative extracurricular training programme, offering a combination of education, training, community outreach and business engagement.

The Australian Government Department of the Environment and Heritage has recently supported education and information sharing on sustainable campus operations (campus greening) through Australian Campuses Towards Sustainability (ACTS). ACTS is a network of environmental managers, facilities staff, academic staff and students representing Australian universities and vocational education and training organisations that share knowledge and expertise in the field of campus environmental management. ACTS initiatives include greenhouse related projects like purchasing renewable energy, transport policies, participation in Greenhouse Challenge Plus and bush regeneration. With funding from the Australian Government's Environmental Education grants programme, ACTS will be developing a website and resource kits on campus greening and the principles of ecologically sustainable development.

State and territory governments are also working with the university sector. For example, in April 2005, the Department of Sustainability and Environment in Victoria hosted a Climate Change Roundtable for Victorian Universities.

Programme based education

A significant amount of educational activity has occurred in the context of achieving the aims of major greenhouse gas programmes. Educational activities, tools, materials and partnerships have been developed as an integral part of these programmes with the aim of building capacity or changing the behaviours of different sectors through the provision of incentives and the removal of barriers.

The Cities for Climate Protection™ Australia programme (CCP™ Australia) is funded by the Australian Government and aims to assist local governments and their communities reduce greenhouse gas emissions. As discussed in Chapter 4—Policies and measures, it has been an outstanding success.

To help member councils in their efforts, the programme provides case studies, workshops and regular seminars in each state and territory. Some tools have been specifically developed for councils, such as the Working Energy Resource Kit. This online toolkit provides information on office energy use and street lighting that can be used both as a reference and as a training resource for staff. It is designed to complement and assist with the achievement of commitments made under voluntary programmes such as CCP™ Australia, Energy Smart Business or Greenhouse Challenge Plus.

On joining the Greenhouse Challenge Plus programme, members are given a package of tools to help them achieve their greenhouse gas reduction goals. This includes company tools for managers to strengthen internal support for the programme, staff tools to help enthuse staff to get behind the organisation's membership, and community tools including ways to tell the community about the business's commitment to Greenhouse Challenge Plus actions.

Wherever possible, grants provided under the AGO's Renewable Energy Commercialisation Programme incorporate training and education activities that contribute to successful project outcomes. Examples of activities which are being funded include:

- training professionals and students at the University of Melbourne in photovoltaics, as part of a project to design and develop a large-scale building-integrated photovoltaic solar power generation project on campus
- training trades people and local government in designing and installing photovoltaics, a part of a major building demonstration site for specific solar energy products and building-integrated solar photovoltaics in the Kogarah Town Centre
- training members of indigenous communities in the operation and monitoring of photovoltaic solar arrays, as part of a project to install a 200 kilowatt grid feed solar concentrator 'sun farm' for the Anangu Pitjantjatjara Lands, in the far north-west corner of South Australia.

The Australian Government's Renewable Energy Industry Development Programme is designed to support the renewable energy industry through non-commercial or industry capability development projects that will deliver a broad benefit to the emerging industry.

One of the major achievements of the programme has been to establish educational pathways into the renewable energy industry that are supported by nationally recognised qualifications. The award of over $450,000 of funding grants since 2001 is helping to ensure that Australia's renewable energy industry is supported by quality education and training. Major projects include:

- development of a National Training Package for Renewable Energy
- a national scoping exercise to stocktake existing renewable energy support networks and materials, such as funding agencies, suppliers of training and education equipment, support materials and software development agencies, bodies willing to offer scholarships and awards, and energy suppliers and retailers who are offering incentives for renewable energy installations
- provision of a Standards, Training and Accreditation Executive Officer to support the effective implementation of government renewable energy programmes.

Public awareness raising

Australia uses a range of approaches, at both the state and Australian Government levels, to raise community awareness of climate change issues.

Public information

The Australian Government's climate change public awareness strategy has three key objectives:

- to ensure broad community understanding of human-induced climate change—and the likely effects and impacts of this change
- to inform key stakeholders and the general community of the policies and programmes being implemented by government to respond to climate change
- to encourage industry, community and individual action and involvement in greenhouse gas reduction initiatives.

The strategy is implemented through broad national and specifically targeted information and awareness initiatives and importantly, as mentioned, through building public awareness, education and training goals into specific climate change policies and programmes.

In recent years, the AGO has continued to work closely with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in promoting awareness of climate change in a number of ways. These include focusing on the issue as part of 2004 National Science Week's Great Big Science Gig and sponsoring the CSIRO's regular Science by Email initiative to ensure climate change is a ongoing item for discussion in both online forums and printed material for students and teachers.

Specific 'one-off' initiatives are underpinned by ongoing information activities such as a website (http://www.greenhouse.gov.au), a community phone information line and email response service (see below), a broad range of publications including *Global Warming: Cool It, Understanding Greenhouse Science* and *Greenhouse News*, and events and media activities to promote specific policy initiatives or greenhouse gas reduction actions.

Market research

The Australian Government's national climate change communications activities are informed by market research, with initial 'benchmarking' research conducted in 2003 to gain an understanding of community perceptions of climate change.

Tracking research is currently being undertaking to determine if those perceptions have changed given the increasing media focus on climate change as an issue, and to help monitor the impact of national climate change information and awareness-raising initiatives.

This research will inform the 2005 development of a new climate change communications strategy to provide the framework for public and stakeholder awareness and information initiatives into the future.

Building public awareness into policies and programmes

The Australian Government has also specifically incorporated public awareness goals into many of its policy measures. These include the following:

- Local Greenhouse Action—local governments and communities are encouraged to take greenhouse gas reduction action through membership of Cities for Climate Protection™ Australia. This also involves a travel demand management initiative which encourages cycling, walking and the use of public transport to reduce the environmental impacts of travel.

- Greenhouse Friendly—part of the Greenhouse Challenge Plus programme—provides opportunities for consumers to consider greenhouse issues when making their purchasing decisions through greenhouse certification and labelling of products and services.

- The National Appliance and Equipment Energy Efficiency Programme—raises consumer awareness of the energy intensity of appliances and equipment through comparative energy labelling and minimum energy performance standards for domestic appliances, commercial products and industrial equipment.

- Fuel Consumption Labelling—mandatory for all new cars in Australia, the fuel consumption label lists both fuel consumption and carbon dioxide emissions to raise awareness of greenhouse gas emissions associated with vehicle use, educate buyers about relative fuel efficiency, and offer a comparison of greenhouse gas emissions between different car models.

- The Renewable Energy Industry Development Programme—is supporting Environment Victoria, to undertake a community education campaign on wind farms in Victoria, and the Australian and New Zealand Solar Energy Society to increase community commitment to renewable energy.

Case study: the built environment—building awareness

The Australian Government recognises that a sustainable approach to our built environment is a key component to a long-term approach to reducing greenhouse gas emissions.

To raise public awareness of the environmental impact of the built environment and to create awareness of environmentally sustainable solutions the government has worked with the building industry and supported a range of activities directed at building professionals, tradespeople and consumers. Highlights include:

- publication of the *Your Home* Consumer Guide which has been hugely popular, with over three quarters of a million copies provided to interested stakeholders, and many others visiting the associated website
- the *Your Home* Technical Manual has become the industry guide to sustainable residential buildings, and was complemented in 2004 by the release of a DVD version of the *Your Home* guide
- an annual public lecture series called Sustainable Housing, which was held from 2001 to 2004, to encourage consumers to consider the environmental impact of their home and discover examples of low impact buildings.
- Funding support from the Australian Government has enabled the release of technical information on greenhouse, energy efficiency, water efficiency, and green urban development in the Building Design Profession's *Environment Design Guide*.

Community information services

The AGO operates a telephone information service that can be accessed nationally for the cost of a local call. The service provides the general community with access to information on Australian Government climate change publications, actions to reduce greenhouse gas emissions, and policy and programme initiatives.

This information service also responds to email inquiries from members of the public on a broad range of issues associated with climate change, and the Australian Government's response to it.

The telephone information service is supported by a comprehensive website (http://www.greenhouse.gov.au) that provides detailed information on the Australian Government's climate change measures and initiatives.

Consumer information on Australia's energy rating schemes for appliances and equipment, energy award programmes, fuel consumption labelling, and more sustainable travel options can also be accessed online at:

http://www.energystar.gov.au/

http://www.energyrating.gov.au/

http://www.greenhouse.gov.au/fuellabel/index.html

http://www.greenvehicleguide.gov.au/

http://www.travelsmart.gov.au/

http://www.greenhouse.gov.au/yourhome/

A number of states and territories have created energy information centres that provide information on government energy policies and programmes, energy safety and publications, as well as advice on a wide range of energy saving ideas for consumers and businesses. For example, the Australian Capital Territory Government funds the Home Energy Advice Team (HEAT) which is a group of professionals who provide free and independent advice to any resident of the Australian Capital Territory on improving the energy efficiency of existing houses, passive solar design of new houses and extensions, and energy efficient domestic appliances and services.

Contribution of non-governmental organisations

The Australian community has become more aware of the significance of climate change as an issue. The broad range of non-governmental organisations (NGOs) that are actively involved in promoting public awareness and understanding of greenhouse issues through research, lobbying, education and training and media activities have contributed to this greater awareness. These NGOs, which cover all sectors of the Australian economy, range from peak professional associations, industry and business organisations, to conservation and community groups and environment centres. A few examples follow.

- Many conservation groups have been active in working with the community and government on environmental issues that have positive greenhouse outcomes. For example, Cool Communities was an initiative between the Community Conservation Councils and related environmental organisations in states and territories and the Australian Government.

- Planet Ark's aim is to show people and business the many ways that they can reduce their day to day impact on the environment. In partnership with the public, business, councils and local community groups, Planet Ark works to achieve real and measurable results by running campaigns such as National Tree Day, the Plastic Bag Reduction campaign, Cartridges 4 Planet Ark and National Recycling Week.

- GreenSmart is a voluntary initiative of the Housing Industry Association which aims to promote a cost-effective, market-initiated approach to sustainable residential construction. GreenSmart aims to encourage interest and adoption of the initiative in a mainstream context, thereby inviting whole-of-industry participation. GreenSmart has delivered a range of national and regional outcomes including GreenSmart Display villages, building awards and partnerships, training to over 1,500 professionals and publication of the annual *GreenSmart* consumer magazine.

- Electrical power suppliers such as Origin Energy, ENERGEX and AGL now run various forms of public education on greenhouse gas emissions, energy expenditure and sustainable usage. As part of this, a number incorporate integration of renewable power sources for their customers. Origin Energy, for example, provides opportunities for customers to acquire some of their grid electricity from renewable sources through their GreenEarth programme, while ENERGEX offers a solar photovoltaics programme, where excess solar energy generated by the user's domestic panels is 'bought back' into the grid by ENERGEX at agreed rates.

- Community environmental centres are encouraging grassroots interest in the issue of climate change. The Centre for Education and Research in Environmental Strategies (CERES) Community Environmental Park in Victoria has integrated climate change, social, economic and sustainability issues through its interactive displays and education and website materials. Many other community centres throughout Australia are modelling themselves on the CERES example.

Public consultation

The Australian Government has given a high priority to public consultation in the development of forward policy planning. A number of mechanisms are provided to enable the public to comment on and have input into policy and programme development. A range of high level and expert groups and taskforces, comprised of government, industry, scientific and community representatives, advise on a wide range of issues.

The Government–Business Dialogue on Climate Change was established in 2002 to provide an opportunity for major business and industry associations to work directly with the government in setting the policy directions for future action on climate change.

The National Environment Consultative Forum provided a biannual opportunity for over 30 peak environmental organisations to hold discussions with the Minister for the Environment and Heritage and the Department on a range of environmental issues including climate change. Commencing in 2006, this forum will be replaced by a series of roundtable meetings with key environmental and industry groups that will focus on specific strategic issues.

In recognition of the need to gain support and be responsive to the needs of stakeholders through consultation, many of the programmes and initiatives of the Australian Government have encompassed extensive consultation throughout their development.

For example, to identify the 2004–08 research priorities for the Climate Change Science Programme the AGO hosted two workshops:

- an initial workshop with science providers in August 2003 to discuss current research, future priorities and key questions
- a second in September 2003 involving a wide range of stakeholders from government, industry, science organisations and the community to engage key stakeholders in discussions about climate change research priorities and their information needs in dealing with climate change issues.

The Australian Government's new Solar Cities programme was developed through an extensive five-phase consultation process. This included public presentations throughout Australia at several stages to promote the concept and consult with stakeholders on key issues, as well as formal written consultation on the Statement of Challenges and Opportunities and the draft programme guidelines. A website register facilitated discussion and contact amongst interested parties and an electronic newsletter was published to inform subscribers of recent developments.

Another example of consultation as a standard element of Australian Government programme development is the $500 million Low Emissions Technology Demonstration Fund (LETDF). The fund is being established to stimulate greater investment in demonstrating low-emission technologies across the full spectrum of energy sources. The draft guidelines for the fund have been made publicly available and industry forums will be held to allow stakeholders to have a say on the operation of the programme before first round applications are called in late 2005.

International activities

Australia contributes to the international awareness of climate change issues through its funding of effective bilateral and regional activities that focus on strengthening the capacity of developing countries, and by initiating and participating in information networks, training and research activities.

In 2004, the Australian Government announced that Australia would establish an Asia–Pacific Climate Change Exchange to promote collaboration between Australian businesses and researchers and their regional partners, and bring together developing countries to encourage technology partnerships and joint ventures to implement solutions to climate change.

Australia was a key funding contributor and participant in the Pacific Negotiators Forum. The forum aimed to raise awareness and understanding of climate change issues of Pacific countries and build the skills of these countries to participate in climate change negotiations including the United Nations Framework Convention on Climate Change (UNFCCC). It co-sponsored and participated in a workshop in the Pacific to build awareness on adaptation with regional partners.

Australia was a co-sponsor of the 2005 Asia–Pacific Seminar in Yokohama, which included a workshop on Article 6 of the UNFCCC. It is also a key supporter of the Asia–Pacific Network for Global Change Research.

Through Australia's bilateral climate change partnerships (with China, the European Union, Japan, New Zealand and the United States) a number of international activities that aim to increase public awareness of climate change issues have been undertaken in recent years.

Of particular note, the first Australia–New Zealand Climate Change and Business Conference and Trade Expo, held in New Zealand in November 2004, enabled extensive exchange of ideas and information on existing activities to address climate change, identification of immediate business risks and opportunities related to climate change, and exploration of future directions regarding climate change action. A follow-up to this successful forum is planned for February 2006 in Adelaide, Australia.

Of a similar nature, the Australia–New Zealand Climate Forum, facilitated by the Pew Centre—a United States climate change think tank—was held in Sydney in April 2005. The forum included a leader's roundtable of chief executive officers, ministers, and other senior executives and officials, to help find common ground on the most effective ways to respond to climate change, exchange ideas on the latest low emissions technologies and agree on what could be done regionally that would feed into a global strategy.

Given the significant increase in renewable energy installations planned in China over the coming decade, the Australian Government is sponsoring a joint project between Australian and Chinese renewable energy industry representatives to develop a five-year renewable energy training framework for China. The project aims to ensure that China will have an adequate, ongoing workforce, trained to international standards, to meet the expanding demands for renewable energy within the country, thereby ensuring that quality systems offering long-term and effective emissions reductions are installed and maintained.

Australia also makes contributions to a range of international technology-based partnerships, including the Methane to Markets Partnership, the Renewable Energy and Energy Efficiency Partnership, the Carbon Sequestration Leadership Forum and the International Partnership for the Hydrogen Economy, which are aimed at strengthening information networks, training, research and practical collaboration on climate change actions.

For further details on funding activities refer to Chapter 7—Financial resources and transfer of technology.

Estimates of Australia's greenhouse gas emissions, 1990–2003, derived using Kyoto accounting provisions

Table A1 Trends in emissions of carbon dioxide (CO_2) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
1. Energy	258,514.98	258,514.98	260,571.13	265,312.30	268,734.92	272,645.90	282,511.43	292,261.49	299,109.36	315,606.46	324,728.21	330,657.87	336,310.48	339,668.02	345,770.51
A. Fuel combustion (sectoral approach)	252,552.25	252,552.25	254,826.01	259,471.35	262,887.57	267,073.34	276,797.06	287,011.70	294,061.74	310,318.95	318,995.66	324,171.96	329,389.08	333,208.63	340,004.36
1. Energy industries	141,805.68	141,805.68	145,296.14	148,512.17	149,790.74	150,825.59	156,805.91	163,386.78	169,466.13	184,861.38	189,208.33	192,527.49	198,354.42	202,001.04	208,302.60
2. Manufacturing industries and construction	37,355.76	37,355.76	36,722.04	36,680.49	37,115.64	38,553.82	39,134.40	40,323.12	39,407.24	40,223.79	43,597.54	42,880.46	42,035.99	39,364.06	39,117.20
3. Transport	59,724.27	59,724.27	59,097.02	60,188.94	61,381.12	62,912.11	65,490.09	67,739.23	69,063.96	69,129.34	70,015.95	72,095.22	72,052.04	73,520.69	74,033.42
4. Other sectors	12,485.07	12,485.07	12,557.97	12,894.10	13,375.24	13,491.27	13,961.21	14,044.97	14,585.65	14,785.34	14,941.39	15,392.97	15,593.57	16,983.78	17,280.43
5. Other	1,181.47	1,181.47	1,152.85	1,195.65	1,224.84	1,290.55	1,405.45	1,517.59	1,538.76	1,319.01	1,232.46	1,275.82	1,353.07	1,339.07	1,270.71
B. Fugitive emissions from fuels	5,962.73	5,962.73	5,745.12	5,840.95	5,847.35	5,572.57	5,714.37	5,249.79	5,047.62	5,287.51	5,732.55	6,485.90	6,921.39	6,459.38	5,766.16
1. Solid fuel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Oil and natural gas	5,962.73	5,962.73	5,745.12	5,840.95	5,847.35	5,572.57	5,714.37	5,249.79	5,047.62	5,287.51	5,732.55	6,485.90	6,921.39	6,459.38	5,766.16
2. Industrial Processes	19,995.20	22,359.30	21,818.53	19,893.48	20,929.54	22,906.82	23,077.74	23,513.21	23,366.19	24,092.05	24,209.15	23,698.80	24,305.76	24,125.76	25,913.70
A. Mineral products	4,825.64	4,825.64	4,508.72	4,329.46	4,538.74	5,237.80	5,047.73	5,091.60	5,023.59	5,438.55	5,353.54	5,155.38	5,146.66	5,215.57	5,384.17
B. Chemical industry	503.70	503.70	477.77	633.84	663.91	672.51	798.51	837.18	877.27	1,082.03	777.81	888.02	1,017.98	935.85	952.11
C. Metal production	14,665.86	14,665.86	14,598.62	12,537.79	12,383.54	13,494.29	13,774.00	13,953.45	13,863.72	13,770.70	14,396.98	13,761.22	13,331.54	12,737.94	13,866.07
D. Other production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of halocarbons and sulphur hexafluoride[a]															
F. Consumption of halocarbons and sulphur hexafluoride[a]															
G. Other[b]	2,364.10	2,364.10	2,233.42	2,392.39	3,343.34	3,502.23	3,457.50	3,630.99	3,601.60	3,800.76	3,680.81	3,894.19	4,809.58	5,236.40	5,711.34
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed burning of savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field burning of agricultural residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A1 Trends in emissions of carbon dioxide (CO_2) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures (continued)

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
5. Land Use, Land Use Change and Forestry	122,225.44	122,225.44	97,350.33	80,659.56	67,106.47	63,606.58	59,895.25	56,364.32	51,324.96	63,493.51	48,503.47	47,102.19	40,010.16	45,431.48	32,876.97
A. Afforestation and reforestation[c]	0.00	0.00	-453.15	-928.64	-1,402.26	-1,752.32	-2,296.77	-2,948.58	-4,190.35	-5,589.02	-7,110.32	-10,177.06	-11,128.14	-12,978.84	-14,798.01
B. Land use change (deforestation)	122,225.44	122,225.44	97,803.48	81,588.21	68,508.74	65,358.90	62,192.02	59,312.90	55,515.30	69,082.52	55,613.79	57,279.25	51,138.31	58,410.33	47,675.07
6. Waste	11.58	11.58	11.58	11.58	11.58	11.58	16.83	13.53	16.94	17.13	17.49	16.30	16.30	16.30	16.30
A. Solid waste disposal on land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Waste-water handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste incineration	11.58	11.58	11.58	11.58	11.58	11.58	16.83	13.53	16.94	17.13	17.49	16.30	16.30	16.30	16.30
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (please specify)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total emissions/removals with land use, land use change and forestry	400,747.21	403,111.31	379,751.57	365,876.93	356,782.52	359,170.88	365,501.25	372,152.54	373,817.44	403,209.14	397,458.31	401,475.17	400,642.71	409,241.56	404,577.49
Total emissions without land use, land use change and forestry	278,521.77	280,885.87	282,401.24	285,217.36	289,676.04	295,564.31	305,606.00	315,788.22	322,492.48	339,715.63	348,954.84	354,372.98	360,632.54	363,810.08	371,700.52
Memo items:															
International bunkers	6,400.97	6,400.97	6,378.80	6,584.40	6,987.84	7,361.83	8,532.60	9,030.65	9,059.30	9,449.69	9,718.28	10,099.67	10,625.28	8,603.39	8,837.12
Aviation	4,345.12	4,345.12	4,520.39	4,795.71	5,199.38	5,349.80	5,857.66	6,311.70	6,540.10	7,232.89	7,268.09	7,330.88	8,151.32	6,392.44	6,615.32
Marine	2,055.85	2,055.85	1,858.42	1,788.69	1,788.46	2,012.03	2,674.93	2,718.95	2,519.20	2,216.80	2,450.19	2,768.79	2,473.96	2,210.95	2,221.80
Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 emissions from biomass	15,112.99	15,112.99	14,964.91	13,664.99	15,317.65	16,227.76	17,071.01	17,114.32	18,998.78	19,321.49	19,580.00	19,263.31	18,254.75	15,465.63	15,947.94

[a] Shading in the cells indicates that there cannot be a value in that cell, because of the nature of the process or because of the Intergovernmental Panel on Climate Change reporting instructions for National Greenhouse Gas Inventories (IPCC 1997).

[b] Speciated emissions from ammonia production, nitric acid production, magnesia production and soda ash production and use are confidential. These emissions are reported as CO_2-e.

[c] Greenhouse sinks credits are accounted for in 2008–12 only. The values provided are only an indicative estimate of sequestration in reforestation activities.

Table A2 Trends in emission of methane (CH_4) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total emissions	5,400.62	5,400.62	5,380.70	5,348.85	5,239.94	5,209.62	5,254.73	5,198.52	5,285.12	5,361.81	5,329.75	5,460.02	5,465.31	5,327.15	5,165.14
1. Energy	1,198.42	1,198.42	1,173.71	1,224.82	1,186.00	1,225.16	1,283.17	1,267.30	1,299.86	1,375.35	1,268.76	1,318.34	1,255.21	1,170.20	1,069.66
A. Fuel combustion (sectoral approach)	113.93	113.93	115.06	117.56	118.83	117.35	115.75	113.94	115.48	111.23	108.58	105.22	97.86	89.66	87.86
1. Energy industries	1.89	1.89	1.91	2.00	2.05	2.08	2.25	2.30	4.69	5.05	7.49	9.20	9.11	10.38	10.45
2. Manufacturing industries and construction	1.49	1.49	1.44	1.41	1.52	1.60	1.71	1.72	2.35	2.42	2.41	2.45	2.30	1.99	1.99
3. Transport	26.47	26.47	25.56	25.78	26.37	27.16	28.38	29.40	30.31	31.37	31.70	31.69	29.46	31.13	30.47
4. Other sectors	84.03	84.03	86.11	88.32	88.84	86.46	83.36	80.47	78.06	72.33	66.93	61.83	56.93	46.11	44.91
5. Other	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05
B. Fugitive emissions from fuels	1,084.49	1,084.49	1,058.65	1,107.26	1,067.17	1,107.82	1,167.41	1,153.35	1,184.38	1,264.13	1,160.18	1,213.12	1,157.35	1,080.54	981.80
1. Solid fuel	753.16	753.16	760.91	790.69	791.02	828.21	832.39	846.98	865.54	954.70	903.33	935.15	878.36	831.25	787.34
2. Oil and natural gas	331.33	331.33	297.75	316.57	276.15	279.61	335.02	306.38	318.84	309.42	256.86	277.97	278.99	249.28	194.46
2. Industrial Processes	3.29	3.29	3.26	3.30	3.33	3.72	3.80	3.88	3.80	3.96	3.70	3.33	3.11	3.08	3.32
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	0.44	0.44	0.40	0.41	0.32	0.40	0.38	0.46	0.43	0.35	0.34	0.44	0.35	0.36	0.44
C. Metal production	2.85	2.85	2.85	2.89	3.01	3.32	3.42	3.43	3.37	3.60	3.36	2.90	2.76	2.71	2.88
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of halocarbons and sulphur hexafluoride[a]															
F. Consumption of halocarbons and sulphur hexafluoride[a]															
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	3,587.41	3,587.41	3,593.11	3,525.90	3,455.06	3,390.58	3,373.87	3,370.09	3,416.58	3,426.34	3,481.68	3,552.18	3,610.26	3,542.94	3,505.95
A. Enteric fermentation	3,214.89	3,214.89	3,225.53	3,165.04	3,096.48	3,023.30	2,999.76	2,987.93	3,012.34	3,011.19	3,048.77	3,064.57	3,086.27	3,014.23	2,988.00
B. Manure management	73.32	73.32	73.39	74.88	77.86	80.50	82.14	82.95	86.55	90.18	92.65	94.14	96.57	97.40	97.50
C. Rice cultivation	23.36	23.36	24.94	25.72	28.69	28.87	30.89	33.56	34.44	34.50	31.94	35.30	35.13	28.06	19.05
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	267.06	267.06	260.74	251.58	242.72	248.72	251.51	255.30	271.51	278.18	296.14	345.63	379.40	392.35	391.44
F. Field burning of agricultural residues	8.79	8.79	8.52	8.68	9.32	9.19	9.56	10.35	11.74	12.29	12.18	12.54	12.88	10.90	9.96

Table A2 Trends in emission of methane (CH_4) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures (continued)

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land Use Change and Forestry	**147.73**	**147.73**	**130.97**	**108.84**	**97.05**	**98.51**	**83.85**	**83.18**	**82.38**	**83.70**	**82.90**	**85.12**	**83.23**	**80.43**	**72.62**
A. Afforestation and reforestation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Land use change (deforestation)	147.73	147.73	130.97	108.84	97.05	98.51	83.85	83.18	82.38	83.70	82.90	85.12	83.23	80.43	72.62
6. Waste	**463.78**	**463.78**	**479.65**	**485.99**	**498.50**	**491.65**	**510.04**	**474.08**	**482.51**	**472.46**	**492.71**	**501.06**	**513.51**	**530.49**	**513.61**
A. Solid waste disposal on land	355.82	355.82	370.21	375.17	386.43	378.44	395.62	358.10	365.01	353.84	372.79	379.71	390.67	406.01	387.69
B. Waste-water handling	107.95	107.95	109.44	110.82	112.06	113.20	114.42	115.98	117.41	118.61	119.92	121.35	122.84	124.48	125.92
C. Waste incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (please specify)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo items:															
International bunkers	0.13	0.13	0.11	0.11	0.11	0.12	0.16	0.15	0.15	0.13	0.15	0.16	0.15	0.14	0.14
Aviation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
Marine	0.11	0.11	0.01	0.09	0.09	0.10	0.14	0.14	0.13	0.11	0.12	0.13	0.12	0.11	0.11
Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Carbon dioxide (CO_2) emissions from biomass[a]															

[a] Shading in the cells indicates that there cannot be a value in that cell, because of the nature of the process or because of the Intergovernmental Panel on Climate Change reporting instructions for National Greenhouse Gas Inventories (IPCC 1997).

Table A3 Trends in emissions of nitrous oxide (N_2O) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Total emissions	70.75	70.84	72.02	72.08	73.78	75.61	76.12	76.44	81.36	85.72	90.87	96.36	98.98	100.23	99.04
1. Energy	7.70	7.70	8.75	9.56	10.46	11.40	12.33	13.17	13.99	15.04	15.92	16.84	17.23	18.80	19.52
A. Fuel combustion (sectoral approach)	7.58	7.58	8.65	9.45	10.36	11.31	12.23	13.07	13.92	14.93	15.85	16.75	17.14	18.71	19.44
1. Energy industries	1.41	1.41	1.47	1.50	1.49	1.51	1.55	1.61	1.72	1.92	1.95	1.97	2.03	2.04	2.11
2. Manufacturing industries and construction	0.66	0.66	0.63	0.57	0.64	0.68	0.72	0.72	0.79	0.80	0.81	0.78	0.73	0.65	0.65
3. Transport	5.26	5.26	6.29	7.12	7.96	8.85	9.69	10.47	11.14	11.95	12.83	13.74	14.13	15.79	16.45
4. Other sectors	0.24	0.24	0.25	0.25	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.23	0.23	0.21	0.21
5. Other	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
B. Fugitive emissions from fuels	0.12	0.12	0.11	0.11	0.10	0.09	0.01	0.10	0.07	0.11	0.07	0.09	0.09	0.08	0.07
1. Solid fuel	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Oil and natural gas	0.12	0.12	0.11	0.11	0.10	0.09	0.01	0.10	0.07	0.11	0.07	0.09	0.09	0.08	0.07
2. Industrial Processes	0.09	0.09	0.09	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.07
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
C. Metal production	0.09	0.09	0.09	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.07
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of halocarbons and sulphur hexafluoride[a]															
F. Consumption of halocarbons and sulphur hexafluoride[a]															
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and other product use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	58.77	58.77	59.19	58.85	59.84	60.68	60.53	59.98	64.09	67.36	71.62	76.14	78.38	78.01	76.31
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	1.68	1.68	1.86	2.14	2.44	2.70	3.00	2.91	3.23	3.50	4.00	4.24	4.26	4.25	4.15
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	48.96	48.96	49.39	49.05	49.98	50.38	49.83	49.25	52.52	55.32	58.57	61.39	62.62	62.01	60.38
E. Prescribed burning of savannas	7.84	7.84	7.66	7.39	7.13	7.31	7.39	7.50	7.98	8.17	8.70	10.15	11.14	11.52	11.50
F. Field burning of agricultural residues	0.28	0.28	0.27	0.27	0.29	0.30	0.31	0.33	0.35	0.36	0.35	0.36	0.36	0.31	0.29
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A3 Trends in emissions of nitrous oxide (N_2O) (Gg) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures (continued)

Greenhouse gas source and sink categories	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
5. Land Use, Land Use Change and Forestry	**2.74**	**2.74**	**2.43**	**2.02**	**1.80**	**1.82**	**1.55**	**1.54**	**1.53**	**1.55**	**1.54**	**1.58**	**1.54**	**1.49**	**1.34**
A. Afforestation and reforestation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Land use change (deforestation)	2.74	2.74	2.43	2.02	1.80	1.82	1.55	1.54	1.53	1.55	1.54	1.58	1.54	1.49	1.34
6. Waste	**1.55**	**1.55**	**1.57**	**1.59**	**1.60**	**1.62**	**1.64**	**1.66**	**1.68**	**1.70**	**1.72**	**1.74**	**1.76**	**1.78**	**1.80**
A. Solid waste disposal on land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Waste-water handling	1.55	1.55	1.57	1.59	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (please specify)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo items:															
International bunkers	0.19	0.19	0.19	0.19	0.21	0.22	0.25	0.27	0.27	0.28	0.29	0.30	0.31	0.25	0.26
Aviation	0.13	0.13	0.13	0.14	0.16	0.16	0.18	0.19	0.20	0.22	0.22	0.22	0.25	0.19	0.20
Marine	0.06	0.06	0.05	0.05	0.05	0.06	0.07	0.08	0.07	0.06	0.07	0.08	0.07	0.06	0.06
Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Carbon dioxide (CO_2) emissions from biomass[a]															

[a] Shading in the cells indicates that there cannot be a value in that cell, because of the nature of the process or because of the Intergovernmental Panel on Climate Change reporting instructions for National Greenhouse Gas Inventories (IPCC 1997).

Table A4 Trends in emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) in Australia (Gg), 1990 to 2003, estimated using Kyoto accounting procedures

Greenhouse gas source and sink categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)														
Emissions of HFCs[b]–CO_2 equivalent (Gg)	1,126.27	1,126.27	1,126.27	1,053.94	1,446.59	819.19	923.87	546.17	1,026.48	1,622.81	2,185.74	2,716.33	3,257.79	3,762.47	4,309.02
HFC-23	0.01	0.01	0.01	0.09	0.12	0.07	0.06	C	C	C	C	C	C	C	C
HFC-32	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-41	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-43-10mee	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-125	NO	NO	NO	NO	NO	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.08	0.11
HFC-134	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-134a	NO	NO	NO	NO	NO	0.01	0.14	0.38	0.70	1.11	1.47	1.80	2.13	2.43	2.70
HFC-152a	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-143	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-143a	NO	NO	NO	NO	NO	0.00	0.00	0.01	0.01	0.02	0.04	0.05	0.06	0.08	0.11
HFC-227ea	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-236fa	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
HFC-245ca	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Emissions of PFCs – CO_2 equivalent (Gg)	3,938.28	3,938.28	3,941.47	3,935.01	2,833.07	1,847.57	1,309.06	1,205.39	1,050.67	1,396.99	981.99	1,103.21	1,555.97	1,507.17	1,472.05
CF_4	NE	0.51	0.51	0.51	0.37	0.24	0.17	0.16	0.14	0.18	0.13	0.14	0.20	0.20	0.19
C_2F_6	NE	0.07	0.07	0.07	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02
C_3F_8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C_4F_{10}	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
c-C_4F_8	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C_5F_{12}	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C_6F_{14}	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Emissions of SF_6 – CO_2 equivalent (Gg)	521.02	521.02	521.02	521.02	521.02	521.02	521.02	529.62	527.00	524.68	524.61	523.41	521.02	521.02	521.02
SF_6	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Chemical	Global Warming Potential (GWP)
HFCs	
HFC-23	11700
HFC-32	650
HFC-41	150
HFC-43-10mee	1300
HFC-125	2800
HFC-134	1000
HFC-134a	1300
HFC-152a	140
HFC-143	300
HFC-143a	3800
HFC-227ea	2900
HFC-236fa	6300
HFC-245ca	560
PFCs	
CF_4	6500
C_2F_6	9200
C_3F_8	7000
C_4F_{10}	7000
c-C_4F_8	8700
C_5F_{12}	7500
C_6F_{14}	7400
SF_6	23900

[a] Australia is yet to decide whether a 1990 or 1995 baseline will be used for synthetic greenhouse gases under the Kyoto Protocol. The 1990 estimates are included to enable indicative trends analysis only.

[b] Includes the following confidential HFC emissions:

Emissions of HFCs - CO_2 equivalent (Gg)	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Confidential HFC emissions							4.54	13.62	22.70	31.77	40.99	52.15	64.00	76.55	89.79

Table A5 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by gas in Australia, 1990 to 2003 estimated using Kyoto accounting procedures

Greenhouse gas emissions	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net carbon dioxide (CO_2) emissions/removals[b]	403,111.31	403,111.31	379,751.57	365,876.93	356,782.52	359,170.88	365,501.25	372,152.54	373,817.44	403,209.14	397,458.31	401,475.17	400,642.71	409,241.56	404,577.49
CO_2 emissions (without land use, land use change and forestry)[b]	280,885.87	280,885.87	282,401.24	285,217.36	289,676.04	295,564.31	305,606.00	315,788.22	322,492.48	339,715.63	348,954.84	354,372.98	360,632.54	363,810.08	371,700.52
Methane (CH_4)	113,413.12	113,413.12	112,994.79	112,325.86	110,038.81	109,402.06	110,349.36	109,169.02	110,987.58	112,598.08	111,924.79	114,660.49	114,771.51	111,870.06	108,468.02
Nitrous oxide (N_2O)	21,959.26	21,959.26	22,325.90	22,345.97	22,870.84	23,438.01	23,598.64	23,695.13	25,221.00	26,572.53	28,170.18	29,872.97	30,682.96	31,070.10	30,701.19
Hydrofluorocarbons (HFCs)	1,126.27	1,126.27	1,126.27	1,053.94	1,446.59	819.19	923.87	546.17	1,026.48	1,622.81	2,185.74	2,716.33	3,257.79	3,762.47	4,309.02
Perfluorocarbons (PFCs)	3,938.28	3,938.28	3,941.47	3,935.01	2,833.07	1,847.57	1,309.06	1,205.39	1,050.67	1,396.99	981.99	1,103.21	1,555.97	1,507.17	1,472.05
Sulphur hexafluoride (SF_6)	NE	NE	NE	NE	NE	NE	NE	529.62	527.00	524.68	524.61	523.41	521.02	521.02	521.02
Total (with net CO_2 emissions/removals)[b]	**543,548.24**	**543,548.24**	**520,140.01**	**505,537.78**	**493,971.82**	**494,677.71**	**501,682.19**	**507,297.89**	**512,630.17**	**545,924.23**	**541,245.62**	**550,351.58**	**551,431.96**	**557,972.39**	**550,048.80**
Total (without CO_2 from land use, land use change and forestry)[b]	**421,322.80**	**421,322.80**	**422,789.68**	**424,878.22**	**426,865.35**	**431,071.13**	**441,786.94**	**450,933.57**	**461,305.21**	**482,430.72**	**492,742.15**	**503,249.38**	**511,421.80**	**512,540.91**	**517,171.83**

Greenhouse gas source and sink	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Categories	CO_2 equivalent (Gg)														
1. Energy	286,067.71	286,067.71	287,933.01	293,997.96	296,884.21	301,909.52	313,279.77	322,958.21	330,742.66	349,150.70	356,307.23	363,563.15	368,010.77	370,069.48	374,283.09
2. Industrial Processes	28,040.78	28,040.78	27,502.32	25,495.02	25,822.01	26,196.85	25,936.24	25,900.56	26,074.64	27,743.21	28,004.00	28,134.64	29,726.18	29,999.83	32,305.70
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	93,555.11	93,555.11	93,803.34	92,286.74	91,107.88	90,013.32	89,614.41	89,366.89	91,614.61	92,833.60	95,317.77	98,198.79	100,114.32	98,611.86	97,280.64
5. Land Use, Land Use Change and Forestry	126,175.78	126,175.78	100,852.57	83,570.01	69,701.55	66,240.66	62,137.44	58,588.43	53,527.72	65,731.76	50,720.22	49,378.15	42,235.59	47,582.30	34,818.71
6. Waste	10,229.88	10,229.88	10,569.70	10,709.08	10,977.19	10,838.37	11,235.35	10,483.80	10,670.54	10,464.95	10,896.40	11,076.85	11,345.10	11,708.93	11,360.68
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] Australia is yet to decide whether a 1990 or 1995 baseline will be used for synthetic greenhouse gases under the Kyoto Protocol. The 1990 estimates are included to enable indicative trends analysis only.

[b] Includes confidential emissions from ammonia production (2B1) and soda ash production and use (2A4), magnesia production (2A7) and N_2O from nitric acid production (2B2).

Table A6 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures

Greenhouse gas source and sink categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	286,067.71	286,067.71	287,933.01	293,997.96	296,884.21	301,909.52	313,279.77	322,958.21	330,742.66	349,150.70	356,307.23	363,563.15	368,010.77	370,069.48	374,283.09
A. Fuel combustion (sectoral approach)	257,294.72	257,294.72	259,922.70	264,871.19	268,594.00	273,044.17	283,020.14	293,457.09	300,801.47	317,283.17	326,188.13	331,575.20	336,756.01	340,892.86	347,876.89
1. Energy industries	142,282.25	142,282.25	145,790.84	149,018.63	150,295.05	151,336.13	157,334.23	163,933.98	170,096.62	185,562.12	189,970.63	193,332.46	199,174.45	202,851.56	209,176.90
2. Manufacturing industries and construction	37,590.47	37,590.47	36,948.68	36,887.76	37,345.62	38,799.48	39,392.64	40,582.33	39,699.95	40,522.21	43,898.56	43,174.67	42,310.01	39,607.42	39,361.38
3. Transport	61,911.31	61,911.31	61,582.90	62,936.89	64,402.68	66,226.14	69,090.68	71,602.80	73,154.84	73,492.19	74,658.71	77,021.09	77,051.12	79,069.58	79,772.15
4. Other sectors	14,324.53	14,324.53	14,442.60	14,826.98	15,320.49	15,385.98	15,790.02	15,812.39	16,303.01	16,380.05	16,420.99	16,764.25	16,860.15	18,018.02	18,289.32
5. Other	1,186.16	1,186.16	1,157.68	1,200.93	1,230.16	1,296.44	1,412.58	1,525.59	1,546.95	1,326.60	1,239.23	1,282.74	1,360.37	1,346.28	1,277.14
B. Fugitive emissions from fuels	28,773.00	28,773.00	28,010.40	29,126.77	28,290.21	28,865.35	30,259.64	29,501.11	29,941.19	31,867.54	30,119.01	31,987.95	31,254.67	29,176.62	26,406.19
1. Solid fuel	15,816.36	15,816.36	15,979.04	16,604.39	16,611.41	17,392.34	17,480.17	17,786.50	18,176.44	20,048.78	18,969.85	19,638.07	18,445.52	17,456.28	16,534.08
2. Oil and natural gas	12,956.64	12,956.64	12,031.36	12,522.38	11,678.80	11,473.01	12,779.46	11,714.61	11,764.75	11,818.76	11,149.24	12,349.87	12,809.16	11,720.34	9,872.12
2. Industrial processes	**28,040.78**	**28,040.78**	**27,502.32**	**25,495.02**	**25,822.01**	**26,196.85**	**25,936.24**	**25,900.56**	**26,074.64**	**27,743.21**	**28,004.00**	**28,134.64**	**29,726.18**	**29,999.83**	**32,305.70**
A. Mineral products	4,825.64	4,825.64	4,508.72	4,329.46	4,538.74	5,237.80	5,047.73	5,091.60	5,023.59	5,438.55	5,353.54	5,155.38	5,146.66	5,215.57	5,384.17
B. Chemical industry	512.89	512.89	486.24	642.40	670.65	680.87	806.50	846.73	886.30	1,089.40	785.00	897.24	1,025.27	943.50	961.28
C. Metal production	18,690.86	18,690.86	18,626.64	16,555.81	15,301.67	15,435.75	15,179.62	15,255.45	15,009.67	15,267.02	15,474.30	14,948.10	14,965.85	14,320.86	15,418.86
D. Other production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of halocarbons and sulphur hexafluoride	1,126.27	1,126.27	1,126.27	1,053.94	1,446.59	811.70	718.85	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of halocarbons and sulphur hexafluoride	521.02	521.02	521.02	521.02	521.02	528.51	726.04	1,075.80	1,553.48	2,147.48	2,710.34	3,239.74	3,778.81	4,283.49	4,830.04
G. Other	2,364.10	2,364.10	2,233.42	2,392.39	3,343.34	3,502.23	3,457.50	3,630.99	3,601.60	3,800.76	3,680.81	3,894.19	4,809.58	5,236.40	5,711.34
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	**93,555.11**	**93,555.11**	**93,803.34**	**92,286.74**	**91,107.88**	**90,013.32**	**89,614.41**	**89,366.89**	**91,614.61**	**92,833.60**	**95,317.77**	**98,198.79**	**100,114.32**	**98,611.86**	**97,280.64**
A. Enteric fermentation	67,512.63	67,512.63	67,736.04	66,465.79	65,026.00	63,489.39	62,995.06	62,746.53	63,259.13	63,234.89	64,024.23	64,356.06	64,811.65	63,298.87	62,748.00
B. Manure management	2,061.13	2,061.13	2,119.21	2,235.01	2,390.42	2,527.21	2,655.17	2,643.01	2,819.19	2,978.71	3,185.92	3,291.28	3,347.22	3,361.86	3,333.64
C. Rice cultivation	490.50	490.50	523.78	540.22	602.42	606.24	648.74	704.75	723.17	724.59	670.74	741.36	737.83	589.29	400.09
D. Agricultural soils	15,178.92	15,178.92	15,311.99	15,204.68	15,495.16	15,616.59	15,446.58	15,267.65	16,282.47	17,150.11	18,155.68	19,030.14	19,412.31	19,223.66	18,716.27
E. Prescribed burning of savannas	8,040.04	8,040.04	7,849.82	7,573.97	7,307.12	7,487.91	7,571.96	7,686.10	8,174.04	8,374.74	8,915.48	10,405.50	11,422.18	11,812.02	11,784.48
F. Field burning of agricultural residues	271.90	271.90	262.49	267.08	286.76	285.98	296.90	318.76	356.62	370.56	365.72	374.44	383.13	326.17	298.17
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A6 Trends in greenhouse gas emissions (Gg carbon dioxide (CO_2)-equivalent) by sector and subsector in Australia, 1990 to 2003, estimated using Kyoto accounting procedures (continued)

Greenhouse gas source and sink categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
5. Land use, Land Use Change and Forestry	126,175.78	126,175.78	100,852.57	83,570.01	69,701.55	66,240.66	62,137.44	58,588.43	53,527.72	65,731.76	50,720.22	49,378.15	42,235.59	47,582.30	34,818.71
A. Afforestation and reforestation[b]	0.00	0.00	-453.15	-928.64	-1,402.26	-1,752.32	-2,296.77	-2,948.58	-4,190.35	-5,589.02	-7,110.32	-10,177.06	-11,128.14	-12,978.84	-14,798.01
B. Land use change (deforestation)	126,175.78	126,175.78	101,305.72	84,498.66	71,103.81	67,992.98	64,434.21	61,537.01	57,718.06	71,320.77	57,830.55	59,555.21	53,363.73	60,561.14	49,616.80
6. Waste	10,229.88	10,229.88	10,569.70	10,709.08	10,977.19	10,838.37	11,235.35	10,483.80	10,670.54	10,464.95	10,896.40	11,076.85	11,345.10	11,708.93	11,360.68
A. Solid waste disposal on land	7,472.31	7,472.31	7,774.35	7,878.50	8,115.11	7,947.33	8,308.01	7,520.11	7,667.07	7,430.69	7,828.52	7,973.82	8,204.09	8,526.30	8,141.48
B. Waste-water handling	2,745.99	2,745.99	2,783.77	2,818.99	2,850.49	2,879.46	2,910.51	2,950.16	2,986.52	3,017.13	3,050.40	3,086.72	3,124.71	3,166.32	3,202.89
C. Waste incineration	11.58	11.58	11.58	11.58	11.58	11.58	16.83	13.53	16.94	17.13	17.49	16.30	16.30	16.30	16.30
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total emissions/removals with land use, land use change and forestry	544,069.26	544,069.26	520,661.03	506,058.80	494,492.84	495,198.73	502,203.21	507,297.89	512,630.17	545,924.23	541,245.62	550,351.58	551,431.96	557,972.39	550,048.80
Total emissions without land use, land use change and forestry	417,893.48	417,893.48	419,808.46	422,488.79	424,791.29	428,958.07	440,065.77	448,709.45	459,102.45	480,192.47	490,525.39	500,973.43	509,196.37	510,390.09	515,230.01
Memo items:															
International bunkers	6,461.31	6,461.31	6,438.80	6,646.42	7,053.77	7,431.37	8,613.45	9,116.20	9,145.29	9,539.42	9,809.68	10,194.60	10,725.56	8,684.21	8,920.19
Aviation	4,385.53	4,385.53	4,562.42	4,840.41	5,247.98	5,399.87	5,912.66	6,371.10	6,601.70	7,301.19	7,336.02	7,399.30	8,227.86	6,451.95	6,676.98
Marine	2,075.78	2,075.78	1,876.37	1,806.01	1,805.79	2,031.51	2,700.79	2,745.01	2,543.59	2,238.24	2,473.67	2,795.30	2,497.71	2,232.26	2,243.21
Multilateral operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Carbon dioxide (CO_2) emissions from biomass	15,112.99	15,112.99	14,964.91	13,664.99	15,317.65	16,227.76	17,071.01	17,114.32	18,998.78	19,321.49	19,580.00	19,263.31	18,254.75	15,465.63	15,947.94

[a] Australia is yet to decide whether a 1990 or 1995 baseline will be used for synthetic greenhouse gases under the Kyoto Protocol. The 1990 estimates are included to enable indicative trends analysis only.

[b] Greenhouse sinks credits are accounted for in 2008–12 only. The values provided are only an indicative estimate of sequestration in reforestation activities.

APPENDIX B

Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a]

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Policies and measures affecting $CO_2/CH_4/N_2O/PFCs/HFCs/SF_6$[b]							
Greenhouse Challenge Plus	Voluntary, incentive-based and compulsory partnerships between the Australian Government and industry to abate greenhouse gas emissions	Cross-sectoral	Regulatory/ Economic/ Voluntary	Implemented	Australian Government	$31.6 million over 4 years	15.8
International climate change partnerships	International action at the multilateral, regional and bilateral levels to support the development of an environmentally effective and economically efficient global response to climate change, and support for practical action to reduce greenhouse gas emissions	Cross-sectoral	Economic/ Voluntary/ Information/ Education/ Research	Implemented	Australian Government	$20.1 million	Actions do not target domestic abatement
Other initiatives to reduce emissions from industrial processes	Victorian Government's State Environment Protection Policy (Air Quality Management) and Business Energy Innovation Initiative	Industrial Processes	Regulatory/ Economic	Implemented	Victorian Government	$7.5 million from 2002–06	Not estimated – sufficient information not available
Total							15.8
Policies and measures affecting $CO_2/CH_4/N_2O/PFCs/HFCs$							
Greenhouse Gas Abatement Programme (GGAP)	Market-based allocation of grants to cost effective abatement opportunities	Cross-sectoral	Economic	Implemented	Australian Government	232.2 million from 1999–2013[c]	6.1
Total							6.3
Policies and measures affecting $CO_2/CH_4/N_2O$							
Low Emissions Technology Demonstration Fund	Support for the commercial demonstration of technologies that have the potential to deliver large-scale greenhouse gas emission reductions in the energy sector	Cross-sectoral	Economic	Implemented	Australian Government	$500 million over up to 15 years from 2005	0.0
Local Greenhouse Action	Increasing abatement from local government and increasing capacity of local government to respond to impacts and adaptation.	Cross-sectoral	Voluntary/ Negotiated agreements/ Education	Implemented	Australian Government; states and territories; local government	$13.6 million from 2004–08	0.4
Energy market reform	Accelerating and monitoring energy market reform	Energy–Stationary	Regulatory	Implemented	Australian Government; states and territories	Not able to be determined	Can no longer be separated from 'business as usual' projection
Low Emissions Technology and Abatement Programme	Supporting technologies that reduce energy demand and emission intensity in four theme areas: strategic abatement; renewables; fossil fuels; and geosequestration	Energy–Stationary	Economic	Implemented	Australian Government	$26.9 million over 4 years	0.2[d]
Queensland Government 13% Gas Scheme	Scheme requiring electricity retailers to source 13% of electricity from gas-fired generation	Energy–Stationary	Regulatory	Implemented	Queensland Government	Not available	1.1
New South Wales Greenhouse Gas Abatement Scheme	Scheme requiring electricity retailers to meet mandatory annual targets for greenhouse emissions	Energy–Stationary	Regulatory	Implemented	New South Wales Government	Not available	18.1[e]
Australian Capital Territory Greenhouse Gas Abatement Scheme	Scheme requiring electricity retailers to source an increasing percentage of electricity from cleaner or renewable energy sources	Energy–Stationary	Regulatory	Implemented	Australian Capital Territory Government	$0.3 million from 2005–12	Not estimated – sufficient information not available

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a] (continued)

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Queensland Centre for Low Emission Technology	Research, development and demonstration into the key technologies that will lower greenhouse gas emissions from coal-based power generation	Energy–Stationary	Research	Implemented	Australian Government; Queensland Government	$9 million over 5 years from 2003	Not estimated – the primary focus of this measure is technology demonstration
Victorian Government Energy Technology and Innovation Strategy	To facilitate a coordinated approach to the advancement of low emissions energy technologies to commercial-ready stage	Energy–Stationary	Research/ Economic	Implemented	Victorian Government	$106 million	Not estimated – sufficient information not available in 2004
National Framework for Energy Efficiency	Whole-of-government platform to improve energy efficiency performance nationally	Energy–Stationary	Regulatory/ Information/ Education	Implemented	Australian Government; states and territories	$33 million from 2004–07	Accounted for under other energy efficiency measures in this table
Energy efficiency standards for residential and commercial buildings	Introduction of minimum energy performance requirements for residential and commercial buildings	Energy–Stationary	Regulatory	Implemented	Australian Government; states and territories	$6.4 million from 1998–2006	3.5
Energy Efficiency Opportunities	To stimulate large energy using businesses to take a more rigorous approach to energy management	Energy–Stationary	Regulatory	Implemented	Australian Government	$16.9 million from 2004–05	0.8
National Appliance and Equipment Energy Efficiency Programme	Introduction of energy performance codes and standards (including labelling) for domestic appliances and commercial and industrial equipment	Energy–Stationary	Regulatory/ Voluntary	Implemented	Australian Government; states and territories	Funded through National Framework for Energy Efficiency (refer to figure in table above)	7.9
Improving energy efficiency in government operations	Reducing greenhouse gas emissions from government operations	Energy–Stationary	Regulatory/ Voluntary/ Negotiated agreements	Implemented	Australian Government; states and territories	$4.5 million from 2004–08	0.6
Energy Efficiency Best Practice and Benchmarking Programme	Assist industry in the efficient use of energy through innovation and capacity building	Energy–Stationary	Voluntary/ Negotiated agreements	Completed	Australian Government	$10.3 million over 5 years	0.2
State and territory action on energy efficiency	State and territory action to improve energy efficiency	Energy–Stationary	Various	Implemented	States and territories	Not able to be determined	2.9[f]
ecoBiz	Provision of financial incentives to encourage uptake of actions to meet energy efficiency targets	Energy–Stationary	Voluntary/ Economic/ Education	Implemented	Queensland Government	$2.8 million for 2005-06	Not estimated – sufficient information not available
Queensland Sustainable Energy Innovation Fund	Provision of financial incentives to support organisations in their efforts to commercialise energy-efficient or renewable energy technologies.	Energy–Stationary	Voluntary/ Economic/ Education	Implemented	Queensland Government	Up to $4.4 million from 2005–09	Not estimated – sufficient information not available
Mandatory Renewable Energy Target (MRET)	Mandatory targets for the uptake of renewable energy in power supplies	Energy–Stationary	Regulatory	Implemented	Australian Government	$6 million (in administrative costs)	6.6
Renewable Energy Development Initiative	Research and development, proof-of-concept, and early-stage commercialisation of renewable energy projects	Energy–Stationary	Economic/ Research	Implemented	Australian Government	$100 million over 7 years	Not estimated – focused on longer-term abatement beyond 2012

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a] (continued)

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Solar Cities	Trialling new sustainable energy models for electricity supply and use	Energy–Stationary	Economic	Implemented	Australian Government	$75 million over 9 years	Not estimated – proposals not yet assessed; focused on longer-term abatement beyond 2012
Advanced Energy Storage Technologies	Development of advanced storage systems for electricity from intermittent generation	Energy–Stationary	Economic	Implemented	Australian Government	$20.4 million over 4 years	Not estimated – focused on longer-term abatement beyond 2012
Wind Energy Forecasting Capability	Addressing barriers to take-up of wind energy in electricity networks/markets	Energy–Stationary	Research	Implemented	Australian Government	$14 million over 5 years	Not estimated separately from MRET
National Green Power Accreditation Programme	Facilitate installation of new renewable energy generators and encourage consumer demand for electricity generated from renewable sources	Energy–Stationary	Voluntary/ Negotiated agreements	Implemented	states and territories	Not able to be determined	0.9
Strategic development of renewable energy	Renewable Energy Commercialisation Programme; Renewable Energy Showcase Programme; Renewable Remote Power Generation Programme; Renewable Energy Equity Fund; Photovoltaic Rebate Programme.	Energy–Stationary	Economic	Implemented	Australian Government	$343 million	0.5[g]
Queensland Government coal mine gas capture	Capture and use of waste mine gas from coal mines	Energy–Fugitive Emissions from Fuels	Regulatory/ Economic	Implemented	Queensland Government	$1.5 million over 5 years	Not estimated separately
New South Wales Greenhouse Gas Abatement Scheme	Provision of a market for waste coal mine gas	Energy–Fugitive Emissions from Fuels	Regulatory	Implemented	New South Wales Government	Refer to figure in table above	Abatement included in main New South Wales GGAS entry
Greenhouse Action in Regional Australia	Build capacity to enhance forest sinks and build capacity to reduce emissions from agriculture	Land Use, Land Use Change and Forestry, and Agriculture	Information/ Research	Implemented	Australian Government	$20.5 million	0.6
Environmental Management Systems (EMS) programmes	Support to primary producers for improved environmental and natural resource management outcomes	Agriculture	Economic/ Voluntary	Implemented	Australian Government	$31.2 million from 2002–07	Not estimated separately
Australian Government, state, territory and local government waste management strategies	Policies and measures to reduce and capture methane emissions from the waste sector	Waste	Voluntary/ Regulatory/ Economic	Implemented	Australian Government; states and territories; local governments	Not able to be determined	9.0
Natural Heritage Trust—land and vegetation programmes (Landcare and Bushcare)	Environmental plantings	Land Use, Land Use Change and Forestry	Economic/ Information	Implemented	Australian Government; S&T	Not able to be determined	Not estimated separately in the 'with measures' projection
National Landcare Programme	Environmental plantings	Land Use, Land Use Change and Forestry	Economic/ Information	Implemented	Australian Government; states and territories	$109.8 million from 2004–08	Not estimated separately in the 'with measures' projection

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a] (continued)

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Estimated mitigation overlap	Estimated overlap between projected abatement from the Queensland Government's Cleaner Energy Strategy and abatement arising from state and territory action on energy efficiency referred to in this table	-	-	-	-	-	-0.1
Estimated mitigation overlap	Estimated overlap of 13.5 Mt between projected abatement from the New South Wales Greenhouse Gas Abatement Scheme and abatement arising from other Australian Government and state government collaborative actions referred to in this table	-	-	-	-	-	-13.5[e]
Total							39.7
Policies and measures affecting CO_2/CH_4							
Alternative Fuels Conversion Programme	Subsidy for conversion of vehicles to use alternative fuel	Energy–Transport	Economic	Implemented	Australian Government	$37.5 million from 2000–08	0.04[h]
State and territory alternative fuels programmes	State and territory alternative fuels programmes such as the Western Australian Government's hydrogen fuel cell bus trial and the South Australian Government's use of CNG buses	Energy–Transport	Economic	Implemented	States and territories	Not able to be determined	Not estimated separately
Compressed Natural Gas Infrastructure Programme	Subsidy of compressed natural gas refuelling stations	Energy–Transport	Economic	Completed	Australian Government	$1.5 million	Included in Alternative Fuels Conversion Programme above
Energy Grants (Credits) Scheme	Reducing the incentive to switch from using alternative fuels to diesel	Energy–Transport	Economic	Implemented	Australian Government	Not able to be determined	Not estimated
Total							0.04
Policies and measures affecting PFCs/HFCs							
Ozone depleting substances and synthetic greenhouse gas replacements from Montreal Protocol industries	Minimise synthetic greenhouse gas emissions, while providing long-term certainty for industry	Industrial Processes	Regulatory	Implemented	Australian Government	Not able to be determined	4.7
Estimated mitigation overlap	Estimated mitigation overlap of 0.7 Mt CO_2-e between projected abatement from actions targeting industrial processes under the Greenhouse Gas Abatement Programme (GGAP) and abatement projected to result from the introduction of synthetic gas legislation affecting ozone depleting substances and synthetic greenhouse gas replacements from Montreal Protocol industries referred to in this table	Industrial Processes	-	-	-	-	-0.7
Total							4.0

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a] (continued)

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Policies and measures affecting CO_2							
Renewable Energy Support Fund	Develop small-scale renewable energy generation projects in Victoria	Energy–Stationary	Economic	Implemented	Victorian Government	$6.7 million since 2002	Not estimated separately from MRET
Environmental Strategy for the Motor Vehicle Industry	National Average CO_2 Emissions Target; Fuel Consumption Labelling Scheme; Green Vehicle Guide; Australian Government Fleet Target	Energy–Transport	Regulatory/ Voluntary/ Information	Implemented	Australian Government	Not able to be determined	0.5
Biofuels Capital Grants Program	Capital grants for projects that provide new or expanded biofuels production capacity	Energy–Transport	Economic	Implemented	Australian Government	$37.6 million	Included in abatement from 350ML Biofuels Target
350 ML Biofuels Target	The contribution of at least 350 million litres of biofuels to the total fuel supply by 2010	Energy–Transport	Economic	Implemented	Australian Government	Not able to be determined	0.3[j]
Production grants for ethanol and biodiesel	Grants to encourage the production of biofuels	Energy–Transport	Economic	Implemented	Australian Government	Not able to be determined	Included in abatement from 350ML Biofuels Target
Strategic transport planning	Initiatives to improve the sustainability of passenger and freight transport	Energy–Transport	Various	Implemented	Australian Government; states and territories; local governments	Not able to be determined	Not estimated separately
State and territory transport measures	State and territory initiatives to reduce emissions from the transport sector	Energy–Transport	Various	Implemented	States and territories	Not able to be determined	0.8
Plantations for Australia: The 2020 Vision	Remove impediments to plantation establishment	Land Use, Land Use Change and Forestry	Economic/ Information	Implemented	Australian Government; states and territories; industry	Not able to be determined	Not estimated separately in the 'with measures' projection
National Action Plan for Salinity and Water Quality	Enhance sink capacity by preventing, stabilising and reversing trends in dryland salinity	Land Use, Land Use Change and Forestry	Economic/ Information	Implemented	Australian Government	$1.4 billion from 2001–08	Not estimated separately in the 'with measures' projection
Queensland Government legislation for the management of native vegetation	Reduce land use change emissions from clearing of native vegetation in Queensland	Land Use, Land Use Change and Forestry	Regulatory	Implemented	Queensland Government	$150 million	17.5
New South Wales Government legislation for the management of native vegetation	Reduce land use change emissions from clearing of native vegetation in New South Wales	Land Use, Land Use Change and Forestry	Regulatory	Implemented	New South Wales Government	Not able to be determined	3.4
Other land and vegetation programmes	Various activities to improve vegetation management and enhance forest carbon sinks, including legislation covering carbon sequestration	Land Use, Land Use Change and Forestry	Regulatory/ Economic	Implemented	States and territories	Not able to be determined	Not estimated – sufficient information not available
Mitigation adjustment	Adjustment to estimated mitigation to result from initiatives to reduce clearing of native vegetation	Land Use, Land Use Change and Forestry	-	-	-	-	-3.0[j]

Table B1 Summary of policies and measures aimed at limiting and reducing greenhouse gas emissions in Australia, categorised by greenhouse gas affected[a] (continued)

Name of policy or measure	Objective and/or activity affected	Sector or subsector affected	Type of instrument	Status	Implementing entity or entities	Cost of measure	Estimate of mitigation impact in 2010 (Mt CO_2-e)
Total							19.5
Policies and measures affecting CH_4							
Estimated mitigation overlap	Estimated overlap of 0.2 Mt CO_2-e between projected abatement from Greenhouse Challenge Plus and abatement projected to arise from Australian Government, state, territory, and local government waste management strategies referred to in this table	-	-	-	-	-	-0.2
Total							-0.2

[a] This table summarises policies and measures set out in this chapter, including official Australian Government estimates of abatement in 2010. In some cases the estimated abatement in 2010 is calculated as the average annual abatement for the measure over the period 2008–2012. Abatement has not been estimated for programmes that are either broadly related to information dissemination rather than specific actions, or for which information is not yet available to provide an estimate. The term 'not estimated' is used in both cases.

[b] CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; PFCs = perfluorocarbon compounds; HFCs = hydrofluorocarbon compounds; SF_6 = sulphur hexafluoride.

[c] Additional funding originally allocated to GGAP in 1999 has since been reallocated to other measures with strategic abatement potential.

[d] The estimated mitigation impact shown for the Low Emissions Technology and Abatement Programme is a preliminary estimate only. Assessment, approval and implementation of proposals under the Programme is expected to begin in the latter part of 2005. Until such time, it is not possible to estimate the total abatement impact of this initiative.

[e] Projected abatement from the New South Wales Greenhouse Gas Abatement Scheme includes estimated mitigation overlap of 13.5 Mt CO_2-e with abatement projected to arise from other actions referred to in this table

[f] This estimated abatement is in addition to that expected through programmes implemented jointly by the Australian Government and state and territory governments, such as building efficiency initiatives and MEPS as described in this chapter.

[g] Figure shown relates to the estimated mitigation impact of the Renewable Energy Commercialisation Programme and Renewable Remote Power Generation Programme, in addition to that reported against the Mandatory Renewable Energy Target above. Greenhouse gas reductions from the Renewable Energy Showcase, the Renewable Energy Equity Fund, and the Photovoltaic Rebate Programme have not been estimated, because they focus primarily on technology development and commercialisation as opposed to greenhouse gas abatement, and because the potential greenhouse gas abatement depends on the degree of commercial uptake and application of the technologies developed.

[h] Figure shown relates to the total estimated mitigation impact of all elements of the Alternative Fuels Conversion Programme, including mitigation resulting from the CNG Infrastructure Programme shown below in this table.

[i] The abatement has been calculated as a net estimate, which includes some increase in emissions from the Stationary Energy sector resulting from the production of biofuels.

[j] The Australian Greenhouse Office has introduced an adjustment of 3.0 Mt CO_2-e in 2010 to the total projected abatement expected to result from initiatives to reduce clearing of native vegetation to reflect the high levels of uncertainty associated with estimating abatement from the Land Use, Land Use Change and Forestry sector.

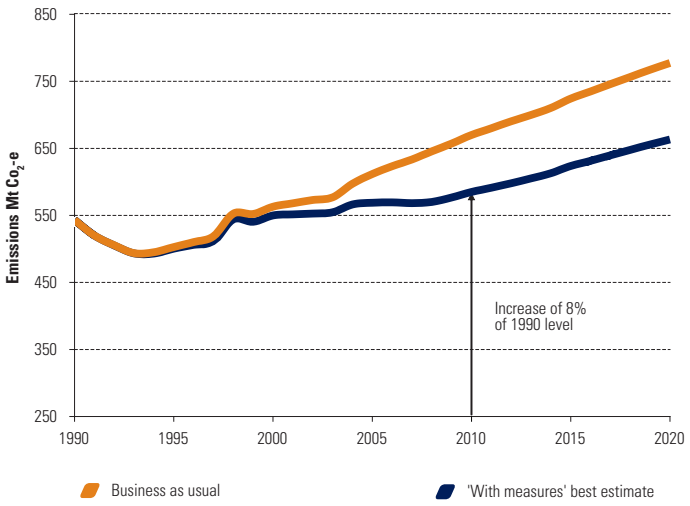
APPENDIX C

Summary of 2008-12 Projections under Kyoto Accounting

Australia is on track to achieve its target of limiting greenhouse emissions to 108% of 1990 emissions over the period 2008-12 under Kyoto accounting rules.

According to Kyoto accounting rules, Australia's greenhouse gas emissions are projected to reach around 108% of 1990 levels by 2010 or 585 million tonnes (Mt) carbon dioxide equivalent (CO_2-e). Emissions from 1990 to 2020 including savings from greenhouse measures are shown in Figure B.1.

Figure C1 'Business as usual' and 'With measures' emissions estimates (Mt CO_2-e), 1990 to 2020 (Kyoto accounting method)



A summary of the sectoral breakdown of the current Projection using Kyoto accounting rules is shown in Table B.1.

Emissions for 2020 are projected to reach 122% of the 1990 level on an indicative basis, reflecting the impact of ongoing growth in emissions in the energy sector.

Table C1 Net greenhouse gas emissions projections (Mt CO_2-e) 1990 and 2008–12 (Kyoto accounting method)[a, b, c]

Sector	1990	2010	
		With measures	% of 1990
Energy	286	414	145
Stationary	195	285	146
Transport	62	94	153
Fugitive Emissions from Fuels	29	35	123
Agriculture	94	99	105
Waste	10	10	93
Industrial Processes	27	42	153
Unallocated Abatement from Policies and Measures		-1	
Sub Total	417	563	135
Land Use, Land Use Change and Forestry	126	22	17
Forest Lands	0	-21	ne
Land Use Change	126	43	34
TOTAL	543	585	108

Note: Columns may not add up to total due to rounding

a These projections are made under Kyoto Protocol accounting rules, which differ from those of the United Nations Framework Convention on Climate Change, notably in their treatment of forestry sinks.

b The 2010 emissions projection is representative of the 2008–2012 average.

c Forestry sinks estimates relate to sequestration in Kyoto-compliant plantations.

ACRONYMS AND ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
ACCESS	Australian Community Climate Earth System Simulator
ACG	Apelbaum Consulting Group
ACIAR	Australian Centre for International Agricultural Research
ACOS	Australian Climate Observing System
ACTS	Australian Campuses Towards Sustainability
AGEIS	Australian Greenhouse Emissions Information System
AGO	Australian Greenhouse Office
AIJ	Activities Implemented Jointly
AIMS	Australian Institute of Marine Science
AODC	Australian Oceanographic Data Centre [now DODC]
APN	Asia–Pacific Network [for Global Change Research]
ARC	Australian Research Council
ARIES	Australian Research Institute in Education for Sustainability
ARM	Atmospheric Radiation Measurement [programme, US]
ASEAN	Association of South East Asian Nations
ASTA	Australian Science Teachers' Association
AusAID	Australian Agency for International Development
AusCOM	Australian Climate Ocean Model
AusIOOS	Australian Integrated Ocean Observing System
AVHRR	Advanced Very High Resolution Radiometer
BASIX	Building Sustainability Index
BAU	'business as usual' [no change approach to greenhouse gas emissions]
BMRC	Bureau of Meteorology Research Centre
BTRE	Bureau of Transport and Regional Economics
C	*See* inventory indicators
CCP™	Cities for Climate Protection™ [programme]
CCP™ Australia	Cities for Climate Protection™ Australia [programme]
CDM	Clean Development Mechanism
CERES	Centre for Education and Research in Environmental Strategies
CF-Assist	Carbon Finance Assist [programme]
CFCs	chlorofluorocarbon compounds
CGPS	Continuous Global Positioning System
CH_4	methane [a greenhouse gas]
CIE	Centre for International Economics [Australia]
CMAR	CSIRO Marine and Atmospheric Research
CNG	compressed natural gas
CO	carbon monoxide [a greenhouse gas]
CO_2	carbon dioxide [a greenhouse gas]
CO_2-e	carbon dioxide equivalent [of another greenhouse gas]
COAG	Council of Australian Governments
CRC(s)	Cooperative Research Centre(s)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DART	Deep-ocean Assessment and Reporting of Tsunamis [buoys]
DCGC	Datong Coal Gasification Corporation
DODC	Defence Oceanographic Data Centre [Australia]
EBRD	European Bank for Reconstruction and Development
EEO	Energy Efficiency Opportunities [programme]
E4CAST	ABARE model for projecting energy use
EGCS	Energy Grants (Credits) Scheme
EMR	energy market reform
EMS	environmental management system(s)
ENSO	El Niño Southern Oscillation
ENVISAT	Environment Satellite
EPB	Datong Environmental Protection Bureau
ERS	Earth Resources Satellite
ETIS	Energy Technology and Innovation Strategy [Victoria]
FullCAM	Full Carbon Accounting Model
G	giga (10^9)
GARA	Greenhouse Action in Regional Australia [programme]
GAW	Global Atmospheric Watch
GCM	Global Climate Model
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility
GEOSS	Global Earth Observation System of Systems
GES	generator efficiency standards
Gg	gigagram (10^9 grams)
GGAP	Greenhouse Gas Abatement Programme
GGAS	Greenhouse Gas Abatement Scheme [Australian Capital Territory and New South Wales]
GOES	Global Operational Environmental Satellite
GOOS	Global Ocean Observing System
GOS	Global Observing System
GSN	GCOS Surface Network
GST	goods and services tax
GTEM	ABARE model for projecting energy use
GTN-G	Global Terrestrial Network—Glaciers
GTN-P	Global Terrestrial Network—Permafrost
GTOS	Global Terrestrial Observing System
GTSPP	Global Temperature Salinity Profile Program
GUAN	GCOS Upper Air Network
GVA	gross value added
GWh	gigawatt hour(s)
GWP	Global Warming Potential

ACRONYMS AND ABBREVIATIONS

ha	hectare(s)
HEAT	Home Energy Advice Team
HFCs	hydrofluorocarbon compounds [greenhouse gases]
HIPC	Highly Indebted Poor Country [Initiative]
IBRD	International Bank for Reconstruction and Development
IDA	International Development Agency
IE	*See* inventory indicators
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IGBP	International Geosphere–Biosphere Programme
IGP	International Greenhouse Partnerships [programme]
IMF	International Monetary Fund
inventory indicators	In tables 3.7, 3.8, 3.9 and tables A1–A6, the following standard indicators are used: NO (not occurring) when the activity or process does not occur in Australia NA (not applicable) when the activity occurs in Australia but the nature of the process does not result in emissions or removals NE (not estimated) where it is known that the activity occurs in Australia but there are no data or methodology available to derive an estimate of emissions IE (included elsewhere) where emissions or removals are estimated but included elsewhere in the inventory C (confidential) where reporting at a disaggregated level could lead to the disclosure of confidential information. Shading in cells indicates that there cannot be a value in that cell, because of the nature of the process or because of the Intergovernmental Panel on Climate Change (IPCC) reporting instructions for National Greenhouse Gas Inventories (IPCC 1997)
IOC	International Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IPCC	Intergovernmental Panel on Climate Change
IVA	industry value added
J	joule(s) [unit of energy]
JAFOOS	Joint Australian Facility for Ocean Observing Systems
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
k	kilo (10^3)
km	kilometre(s)
km^2	square kilometre(s)
kW	kilowatt
L	litre(s)
LETA	Low Emissions Technology and Abatement Programme
LETDF	Low Emissions Technology Demonstration Fund
LNG	liquefied natural gas
LPG	liquefied petroleum gas
M	mega (10^6)
MEPS	minimum energy performance standards
MIGA	Multilateral Investment Guarantee Agency
ML	megalitre(s) (10^6 L)
mm	millimetre(s)
MODIS	Moderate Resolution Imaging Spectrometer
MRET	Mandatory Renewable Energy Target
Mt	megatonne (10^6 tonnes)
N_2O	nitrous oxide [a greenhouse gas]
NA	*See* inventory indicators
NACE	National Average CO_2 Emissions [target]
NAEEEP	National Appliance and Equipment Energy Efficiency Programme
NAP	National Action Plant for Salinity and Water Quality
NCAS	National Carbon Accounting System
NE	*See* inventory indicators
NEEC	National Environmental Education Council
NEEN	National Environmental Education Network
NEES	National Environmental Education Statement
NEM	National Electricity Market
NFEE	National Framework for Energy Efficiency
NGGI	National Greenhouse Gas Inventory
NGGIC	National Greenhouse Gas Inventory Committee
NGO	non-governmental organisation
NHT	Natural Heritage Trust
NLP	National Landcare Programme
NMVOC(s)	non-methane volatile organic compound(s) [greenhouse gases]
NO	*See* inventory indicators
NOAA	National Oceanographic and Atmospheric Administration [US]
NO_x	oxides of nitrogen [greenhouse gases]
NSS	National Strategy Studies [World Bank]
NWI	National Water Initiative
OECD	Organisation for Economic Co-operation and Development
P	peta (10^{15})
PFCs	perfluorocarbons [greenhouse gases]
PICs	Pacific island countries
PI-GCOS	Pacific Island Global Climate Observing System
PJ	petajoules (10^{15} joules)
PRGF	Poverty Reduction and Growth Facility
QA	quality assurance
QC	quality control

RANET	Radio and Internet [Feasibility Study]
RECP	Renewable Energy Commercialisation Programme
REDI	Renewable Energy Development Initiative
REEEP	Renewable Energy and Energy Efficiency Partnership
RRPGP	Renewable Remote Power Generation Programme
SEAV	State Energy Authority of Victoria [now Sustainability Victoria]
SeaWIFS	Sea-viewing Wide-Field Sensor
SF_6	sulphur hexafluoride [a greenhouse gas]
SIDS	Small Island Developing States
SO_2	sulphur dioxide [a greenhouse gas]
SOPAC	South Pacific Applied Geoscience Commission
SPREP	South Pacific Regional Environment Programme
TPAC	Tasmanian Partnership for Advanced Computing
TWP-ICE	Tropical Warm Pool International Cloud Experiment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
W	watt(s) [unit of power]
WCIRP	World Climate Inputs Impacts and Response Strategies System
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WRMO	Datong Water Resources Management Office

INDEX

abatement estimates *see* emissions projections

adaptation – climate change
- planning, 83, 85
  - local and regional, 89
  - tools and support for, 89
- responses, 1, 6–7, 85–89
  - agriculture, 85–86
  - biodiversity, 86
  - buildings and settlements, 86–87
  - energy, 87
  - fisheries, 88
  - forestry, 88
  - human health, 88
  - regions, 88–89
  - tourism, 88
  - water supply, 87
- strategies, 83
- *see also Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*; National Climate Change Adaptation Programme

Advanced Energy Storage Technologies, 47, 61, 139
- and research, 110

agricultural exports, 2

agriculture, 21–22
- climate change impacts and adaptation responses, 85–86
- and greenhouse gas emissions, 15, 18

Agriculture sector
- emissions projections, 5, 6, 68, 75–76, 143
  - analytical approach followed, 75
  - assumptions, 75–76
  - factors influencing, 75
  - by gas, 82
  - 'with measures', 76
- greenhouse gas emissions, 2, 24, 25, 31, 35, 55, 69
  - methane, 27, 55
  - nitrous oxide, 28, 55
  - trends, 33, 134, 135
  - uncertainty in estimates of, 30
- greenhouse gas emissions estimates, 127
- policies and measures to reduce greenhouse gas emissions, 5, 55–56, 65
  - effects of, 76
- trends in methane emissions, 129
- trends in nitrous oxide emissions, 131

Alternative Fuels Conversion Programme, 50, 51, 62, 140

alternative fuels programmes, 50–51, 140

aluminium industry, 20

Asia
- bilateral and regional assistance, 92

Asia–Pacific Climate Change Exchange, 110, 125

Asia–Pacific Network for Global Change Research (APN), 110, 117, 125

Asia–Pacific Partnership on Clean Development and Climate, 1, 36, 41, 94–95

Asia–Pacific region
- bilateral and regional assistance, 7, 91, 92
- capacity building for climate change research, 96
- cooperation on climate change research in, 110
- technical advice and assistance to improve climate data management and monitoring capabilities, 116–117
- transfer of environmentally sound technology to countries in to assist with climate change issues, 7, 93

Asia–Pacific Seminar on Climate Change, 92

assistance to developing countries that are particularly vulnerable to climate change, 93

Association of South-East Asian Nations (ASEAN)–Australia Economic Cooperation Programme
- and Energy from Biomass Project, 94
- and Energy Policy and Systems Analysis Project, 94

Australia
- national circumstances of response to climate change by, 1–2, 10–22

Australia–China Climate Change Partnership, 94

Australian Academy of Science
- and international cooperation on climate change research, 110

Australian Agency for International Development (AusAID), 90, 94, 116

Australian Antarctic Division
- and oceanographic observations, 114
- and research, 110
- and terrestrial observations, 115

Australian Antarctic Science Programme, 110

Australian Baseline Sea-Level Monitoring Array, 114

Australian Building Codes Board
- and building standards and climate change, 86

Australian Bureau of Agricultural and Resource Economics (ABARE)
- and emissions projections models, 70, 75–76
- and research on climate change, 110

Australian Campuses Towards Sustainability (ACTS), 120

Australian Capital Territory Government
- energy information centre, 123
- policies and measures to reduce greenhouse gas emissions, 4, 43, 48, 52, 56, 60, 137

Australian Centre for International Agricultural Research (ACIAR)
- aid programme through, 96

Australian Climate Change Science Programme, 7–8, 109, 110, 111, 125

Australian Climate Observing System (ACOS) plan, 8, 113

Australian Community Climate and Earth System Simulator (ACCESS), 109

Australian Energy Market Commission, 42

Australian Energy Regulator, 42

Australian Government Fleet Target, 5, 50

Australian Greenhouse Emissions Information System (AGEIS), 3, 23
- making Australia's inventory accessible (case study), 24
- and quality assurance/quality control plan and inventory preparation process, 29–30

Australian Greenhouse Office (AGO), 1, 11
- and Australian Climate Change Science Programme, 7, 109
- and Australian Greenhouse Emissions Information System, 3, 23
- and building standards and climate change, 86
- and *Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia*, 84
- and Climate Change Strategy, 37
- community information services, 123
- and emission projections, 68, 70
- and environmental and climate change education, 118
- and public awareness raising, 8, 119, 122
- and public consultation, 125
- Renewable Energy Commercialisation Programme, 121
- and review of performance of policies and measures to reduce greenhouse gas emissions, 38
- and Solar Cities, 47

Australian Institute of Marine Science (AIMS)
- and meteorological observing network, 108
- and research on climate change, 110
- and satellite data archives, 116
- and validation studies for satellite instruments, 115

Australian Integrated Ocean Observing System (AusIOOS) plan, 113

Australian Local Government Association, 51

Australian National Greenhouse Gas inventory *see* National Greenhouse Gas Inventory (NGGI)

Australian Oceanographic Data Centre (AODC), 115

Australian Research Council (ARC) Earth Systems Science Network, 109

Australian Research Institute in Education for Sustainability (ARIES), 118

Australian Science Teachers' Association (STA)
- *Resource Book on Energy*, 119

Australian Sustainable Schools Initiative, 118

Australian Transport Council, 37

Australian Water Fund, 87

Australia–United States Climate Action Partnership, 54, 116

Australia–United State Climate Action Partnership, 116

Baseline Surface Radiation Network Archive, 114
- *see also* GCOS radiation network (Baseline Surface Radiation Network)

bilateral and regional assistance, 91–92, 99–106, 125

Bilateral Climate Change Partnerships Programme, 7, 91–92, 93

biodiesel
- production grants for, 51, 63, 141

biodiversity
- climate change impacts and adaptation responses, 86
- conservation of, 11

Biofuels Capital Grants Program, 51, 63, 141

biofuels initiatives, 51, 72
- *see also* 350 ML biofuels target

biogas energy, 16

Blueprint for Australian Terrestrial Carbon Cycle Research, 111

Building Code of Australia
- and energy efficiency standards for residential and commercial buildings, 44

Building Design Profession's *Environment Design Guide*, 123

building standards
- and climate change, 86

building stock and urban structure, 21

Building Sustainability Index (BASIX) (NSW), 44

buildings and settlements
- climate change impacts and adaptation responses, 85–86

the built environment—building awareness (case study), 123

bunker fuels emissions *see* international bunker fuels emissions

Bureau of Meteorology
- and archive of satellite data, 116
- and data rescue project in Pacific region, 117
- and GCOS, 117
- and GUAN, 117
- and meteorological and atmospheric observations, 8, 113, 114
- and oceanographic observations, 114
- and RANET, 117
- and research, 108, 110, 111, 112–113
- and validation studies for satellite instruments, 115

Bureau of Meteorology Research Centre (BMRC), 112, 117

Bureau of Rural Sciences, 78
- and research on climate change, 110

Bureau of Transport and Regional Economics (BTRE)
- and emissions projections models, 71–72

Bushcare Programme, 57, 65, 139

Business Council for Sustainable Energy, 54

Business Energy Innovation Initiative (Vic), 54, 64

Cairns and Great Barrier Reef region *see* Great Barrier Reef

capacity building for climate change research
Asia–Pacific region, 96

capacity building projects in Asia
and climate change, 94

Cape Grim Baseline Air Pollution Station GAW global observatory (Tasmania), 113

carbon dioxide (CO_2)
emissions, 2, 3, 26–27, 35
projections, 82
trends, 134
research on effect of elevated concentrations of on plant growth and function, 112

Carbon Sequestration Leadership Forum, 42, 126

Carbon Tender initiative (Vic), 59

Centre for Education and Research in Environmental Strategies (CERES) Community Environmental Park, 124

Centre for Low Emission Technology (Qld), 4, 43, 60, 138

Centre for Sustainable Energy Systems (Australian National University)
and research on energy innovation, 110

China
Karst Environment Rehabilitation Project, 92
renewable energy training in, 126
see also Australia–China Climate Change Partnership

China–Australia Datong Cleaner Environment Project, 107

Cities for Climate Protection™ Australia (CCP™ Australia), 37, 40, 41, 121, 122

Clean Development Mechanism (CDM), 91

Cleaner Energy Strategy (Qld), 4, 43, 53

climate, 11, 12–13, 83

Climate Activities in Australia (Bureau of Meteorology), 108, 111

climate change, 83, 85, 86
adaptation *see* adaptation – climate change
education, training and public awareness *see* education, training and public awareness
environmental and economic vulnerability of Australia to, 10, 83
ecosystems, 86
energy infrastructure, 87
scoping study re impacts on major cities, 86
water shortages, 87
see also Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia; national risk and vulnerability assessment; vulnerability assessment – climate change
impacts, 83
and adaptation responses, 6–7, 85–89
see also adaptation – climate change; National Biodiversity and Climate Change Action Plan
national circumstances of response to by Australia, 10–22
projections, 13–14, 83
provision of financial resources to other countries to assist with issues of, 90–92
research on *see* climate change scientific research
transfer of environmentally sound technology to other countries to assist with issues of, 90
see also emissions management; foundation; international engagement; Managing Climate Variability Program; policies and measures to reduce greenhouse gas emissions; policy-making process

Climate Change: An Australian Guide to the Science and Potential Impacts, 108, 111
case study, 108

climate change education *see* environmental and climate change education

Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia, 6, 84, 85, 88, 89
case study, 84

climate change scientific research, 1, 7–8, 108
capacity, 109–110
capacity building for in Asia–Pacific region, 96
on effect of elevated carbon dioxide concentrations on plant growth and function, 112
on energy innovation, 109–110
international cooperation, 110, 112–113
on low greenhouse gas emission technology, 110
see also systematic observation of climate change

Climate Change Strategy, 3, 10, 36, 36–37
Australian Greenhouse Office and, 37
Low Emissions Technology and Abatement Programme and, 42
and renewable energy policies and measures, 46
Securing Australia's Energy Future (2004 Energy White Paper) and, 42

climate modelling systems, 112

climate variability, 83, 87
research on, 108, 112
see also Managing Climate Variability Program

coal, 15
export of, 10, 17
reserves of, 14, 15
see also fossils fuels

coal mine gas capture (Qld), 64, 139

Coal subsector
policies and measures to reduce greenhouse gas emissions
effects of, 73

Coastcare Programme, 57

Commonwealth Scientific and Industrial Research Organisation (CSIRO)
and climate change projections, 13–14
and climate change research, 110, 111
Marine and Atmospheric Research (CMAR) division, 108, 114
and meteorological and atmospheric observations, 113

Office of Space Science and Applications Earth Observation Centre, 116
and public awareness raising, 122
and research on energy innovation, 110
and terrestrial observations, 115
and validation studies for satellite instruments, 115

community information services, 123

compressed natural gas (CNG), 50, 51

Compressed Natural Gas Infrastructure Programme, 51, 63, 140

conservation
of biodiversity, 11
of natural environment, 11–12

Cook Islands
Aitutaki wind energy monitoring station in, 93

Cool Communities, 40

Cooperative Research Centres (CRCs)
and research on climate change, 110
and research on energy innovation, 110

Council of Australian Governments (COAG), 1, 37, 42, 83, 85, 87

cross-sectoral policies and measures to reduce greenhouse gas emissions, 4, 39–42, 60

Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys, 114

Department of the Environment and Heritage
and Australian Greenhouse Office, 1, 11, 23, 37, 68, 84, 86, 94, 109
Department of Industry, Tourism and Resources, 37, 38, 94

Diesel and Alternative Fuels Grants Scheme, 51

Earth Systems Science Network (ARC), 109

ecoBiz Programme (Qld), 46, 61, 138

economy, 14–15
and greenhouse gas emissions, 1–2, 14

ecosystems
vulnerability of to climate change, 86

education, training and public awareness, 8, 118–126

El Niño–Southern Oscillation (ENSO), 12, 83, 87
projections, 14
research on, 108, 111, 112
see also La Niña events

electricity generation, 16
and energy consumption, 16

emission-intensive goods *see* energy-intensive materials

emissions intensity *see* greenhouse gas emissions intensity

emissions per capita, 18

emissions per dollar of GDP, 18

emissions profile *see* greenhouse gas emissions, profile

emissions projections, 1, 5–6, 67–82
Australia's approach to, 67–68
by gas, 80, 82
methodology, 80–81
reconciliation with previous projections, 69
summary, 143
uncertainty and sensitivity analysis, 80–81
see also 'business as usual' (BAU) projections; factors influencing sectoral emissions projections; 'with measures' projections

emissions trading, 41

energy, 15–18
climate change impacts and adaptation responses, 87
consumption, 15, 17
electricity generation and, 16
fuel types, 15–16
market structure, 16
production, 15, 17
reserves, 10, 15
trade in, 15, 17
see also Energy sector; renewable energy

energy efficiency
action on, 44–46, 71

Energy Efficiency Best Practice and Benchmarking Programme, 46, 61, 138

Energy Efficiency in Government Operations Programme, 46, 61, 138

Energy Efficiency Opportunities (EEO), 45, 61, 71, 138

energy efficiency standards for residential and commercial buildings, 44–45, 61, 138

Energy from Biomass Project
Association of South-East Asian Nations (ASEAN)–Australia Economic Cooperation Programme and, 94

Energy Grants (Credits) Scheme (EGCS), 51, 63, 140

energy information centres, 123

energy infrastructure
vulnerability of to climate change, 87

energy innovation
research on, 109–110

energy-intensive industries, 18

energy-intensive materials
trade in, 15

energy market reform (EMR), 3, 42–43, 60, 137

Energy Policy and Systems Analysis Project
ASEAN–Australia Economic Cooperation Programme and, 94

Energy sector
emissions projections, 5, 6, 68, 143

- greenhouse gas emissions, 2, 25, 31, 35, 69
  - carbon dioxide, 27
  - estimates, 127
  - methane, 27
  - nitrous oxide, 28
  - trends, 33, 134, 135
- trends in methane emissions, 129
- trends in nitrous oxide emissions, 131
- *see also* Fugitive Emissions from Fuels subsector; Stationary Energy subsector; Transport subsector

energy storage technologies *see* advanced energy storage technologies

Energy Technology and Innovation Strategy (ETIS) (Vic), 4, 43–44, 60, 138

Energy White Paper, 2004, (*Securing Australia's Energy Future*), 3, 37, 39, 47, 48, 70
- integrating energy and greenhouse policy (case study), 38
- and Stationary Energy subsector, 42

Enhanced Application of Climate Predictions in Pacific Island Countries, 7, 93

Environment Design Guide (Building Design Profession), 123

Environment Protection and Heritage Council, 37

Environment Protection Policy (Air Quality Management) (Vic), 54

environmental and climate change education, 1, 8, 118–121

environmental management systems (EMS)
- programmes supporting, 56, 65, 139

Environmental Strategy for the Motor Vehicle Industry, 5, 49, 62, 72, 141

ethanol
- production grants for, 51, 63, 141

evaporation and moisture balance
- projections, 14

exports, 2, 14

extreme events, 12, 85, 86
- research on, 112
- *see also* natural disasters

fertiliser application, 76

fisheries
- climate change impacts and adaptation responses, 88

5 Star Housing initiative (Vic), 44

Fluxnet, 115

Forest Lands subsector
- emissions projections, 6, 68, 77–78, 143
  - analytical approach followed, 78
  - factors influencing, 77
  - 'with measures'
    - under Kyoto accounting rules, 78
    - under UNFCCC accounting rules, 78
- greenhouse gas emissions, 69

forestry industry, 2, 22, 57
- climate change impacts and adaptation responses, 88
- *see also* Land Use, Land Use Change and Forestry sector

fossils fuels
- Australia's reliance on, 10
- consumption of, 15
- reserves of, 10
- *see also* coal

freight transport *see* domestic freight transport

Fuel Consumption Labelling Scheme, 5, 50, 122

Fugitive Emissions from Fuels subsector
- emissions projections, 6, 68, 72–73, 143
  - analytical approach followed, 73
  - assumptions, 73
  - factors influencing, 72
  - by gas, 82
  - 'with measures', 73
- greenhouse gas emissions, 2, 24, 25, 26, 31
  - carbon dioxide, 27
  - methane, 27
  - nitrous oxide, 28
  - trends, 33
  - uncertainty in estimates of, 30
- policies and measures to reduce greenhouse gas emissions, 52–53, 63–64
  - effects of, 73

Gas Scheme (Qld), 4, 43, 60, 137

GCOS radiation network (Baseline Surface Radiation Network), 113

GCOS Surface Network (GSN), 113, 114, 117

GCOS Upper Air Network (GUAN), 113, 114, 117

Generator Efficiency Standards (GES), 4, 40

geography, 11–12

Geoscience Australia
- and research on climate change, 110
- and satellite data archives, 116

Global Atmosphere Watch (GAW), 8, 108, 113, 114

Global Carbon Project (IGBP)
- and international cooperation on climate change research, 110

Global Climate Observing System (GCOS), 8, 108, 113, 115, 116, 117

Global Earth Observation System of Systems (GEOSS), 108

Global Environment Facility (GEF), 7, 90, 97

Global Observing System (GOS), 8, 108

Global Ocean Observing System (GOOS), 8, 108, 113, 114

Global Temperature Salinity Profile Program (GTSPP), 115

Global Terrestrial Network—Glaciers (GTN–G), 115

Global Terrestrial Observing System (GTOS), 8, 108, 115

Global Warming: Cool It, Understanding Greenhouse Science, 122

government structure, 1, 10–11
  and climate change, 37

Great Barrier Reef
  climate change action plan for, 6, 86, 88, 89

Green Power *see* National Green Power Accreditation Programme (Green Power)

Green Vehicle Guide, 50

Greenhouse Action in Regional Australia (GARA), 5, 6–7, 55–56, 57, 65, 85, 88, 139

Greenhouse Challenge Agricultural Strategy, 56

Greenhouse Challenge Plus Programme, 4, 40, 53, 60, 66, 121, 122, 137
  fugitive emissions elements, 53, 64, 73
  industrial processes elements, 55, 64, 75
  stationary energy elements, 49, 62, 71
  and sulphur hexafluoride, 54
  waste elements, 57, 65

Greenhouse Challenge Programme, 39, 40

Greenhouse Friendly programme, 4, 40, 73, 79, 122

Greenhouse Gas Abatement Programme (GGAP), 4, 39, 53, 60, 66, 137
  fugitive emissions elements, 53, 63, 73
  industrial processes elements, 55, 64, 75
  land use, land use change and forestry elements, 59, 66
  stationary energy elements, 49, 62, 71
  transport energy elements, 52, 63, 72

Greenhouse Gas Abatement Scheme (GGAS)
  ACT, 4, 43, 60, 137
  NSW, 4, 43, 53, 57, 60, 64, 137, 139

greenhouse gas emissions, 2
  agriculture and, 15, 18
  economy and, 1–2, 14
  estimates, 127–128
  by gas type, 2–3, 26–28
  Kyoto target, 23
  national overview, 24–26
  profile, 11, 14, 15, 18, 23
    UNFCCC accounting, 24–25
      changes in, 25–26
  projections *see* emissions projections
  trends, 134–136
  see also Australian Greenhouse Emissions Information System (AGEIS); emissions management; energy-intensive industries; inventory accounting rules; National Greenhouse Gas Inventory (NGGI)

greenhouse gas emissions intensity, 18

Greenhouse News, 122

Greenhouse Strategy Action Plan (Vic), 7, 83

Greenhouse Strategy (Qld), 7, 83

Greenhouse Strategy (WA), 7, 83

GreenSmart, 124

health *see* human health

Household Greenhouse Action, 40

human health
  climate change impacts and adaptation responses, 88

Human Health and Climate Change in Oceania: a risk assessment, 88

hydro-electricity, 16

hydrofluorocarbons (HFCs)
  emissions, 3, 26, 28, 35
    Montreal Protocol industries, 28, 74
    projections, 82
    trends, 133, 134

Indian Ocean Climate Initiative, 83

indirect greenhouse gases
  emissions, 28

Indonesia
  Bapedal East Java Pollution Control Implementation Project, 94
  Bapedal Regional Denpasar Project, 94

Indonesia Solar Home Systems Project, 90

Industrial Processes sector
  emissions projections, 5, 6, 68, 74–75, 143
    analytical approach followed, 74
    assumptions, 74
    factors influencing, 74
    by gas, 82
    'with measures', 74
  greenhouse gas emissions, 2, 24, 25, 31, 35, 53, 69
    carbon dioxide, 27
    methane, 27
    nitrous oxide, 28
    trends, 33, 134, 135
    uncertainty in estimates of, 30
  greenhouse gas emissions estimates, 127
  policies and measures to reduce greenhouse gas emissions, 5, 53–55, 64
    effects of, 75
  trends in methane emissions, 129
  trends in nitrous oxide emissions, 131

industry, 19–21
  see also energy-intensive industries

Inner Mongolia
  Alxa League Environmental Rehabilitation/ Management Project in, 92

Intergovernmental Oceanographic Commission (IOC)
Regional Program Office of, 113
Intergovernmental Panel on Climate Change (IPCC), 36
financial contributions to, 91, 98
research contributions to, 108
international bunker fuels emissions
projections, 79–80
international climate change partnerships to reduce greenhouse gas emissions, 41–42, 60, 137
International Geosphere–Biosphere Programme (IGBP)
and international cooperation on climate change research, 8, 110
International Greenhouse Partnerships (IGP) programme, 94
International Partnership for the Hydrogen Economy, 42, 126
inventory accounting rules
UNFCCC accounting and Kyoto target accounting, 24
see also Kyoto accounting; UNFCCC accounting
IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Inventories, 23

Joint Australian Facility for Ocean Observing Systems (JAFOOS), 115
Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), 115

Kyoto accounting
and emission projections, 67
forestry 'with measures' projections, 78
summary of 2008–12 projection under, 143
and UNFCCC accounting, 24, 67
Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol)
Australian Government view of, 1, 36
and Clean Development Mechanism (CDM), 91
Kyoto target for greenhouse gas emissions, 1, 5, 23, 36, 38
Climate Change Strategy and, 36
emissions projections and, 67, 68, 143

La Niña events, 14
see also El Niño–Southern Oscillation (ENSO)
land and vegetation programmes, 66, 141
Natural Heritage Trust, 57–58, 65, 139
land clearing legislation
Queensland and New South Wales, 79, 141
land degradation, 21–22
land management practices, 11
land use, 21
Land Use, Land Use Change and Forestry sector
emissions projections, 5, 6, 68, 77–79, 143
by gas, 82
greenhouse gas emissions, 2, 11, 15, 24, 25, 26, 31, 32, 35
carbon dioxide, 27
methane, 27
nitrous oxide, 28
trends, 34, 134, 136
uncertainty in estimates of, 30
greenhouse gas emissions estimates, 128
policies and measures to reduce greenhouse gas emissions, 5, 57–59, 65–66
trends in methane emissions, 130
trends in nitrous oxide emissions, 132
see also forestry industry
Land Use Change subsector, 77
emissions projections, 6, 68, 78–79, 143
factors influencing, 78
'with measures', 78–79
greenhouse gas emissions, 69
policies and measures to reduce greenhouse gas emissions
effects of, 79
Landcare Programme, 57, 65, 139
landfill gas capture, 77
Laos
Houaphan microhydropower project in, 93
liquified natural gas (LNG), 16
export of, 2, 10, 16, 17
Living Murray, 85, 89
local and regional planning
climate change impacts and adaptation responses, 89
local government, 1, 10
and environmental and climate change education, 121
and local and regional planning, 89
and strategic transport planning, 51
and waste management strategies, 56, 139
see also Cities for Climate Protection™ Australia (CCP™ Australia); Local Greenhouse Action
Local Greenhouse Action, 3, 37, 39, 40–41, 60, 122, 137
fugitive emissions elements, 52
stationary energy elements, 49, 62
transport energy elements, 52, 63
Low Emissions Technology and Abatement (LETA) Programme, 4, 43, 71, 137
and research, 110

Low Emissions Technology Demonstration Fund (LETDF), 4, 39, 60, 71, 125, 137
fugitive emissions elements, 63
and research, 110
stationary energy elements, 49, 62
transport energy elements, 52, 63
low emissions technology measures by state and territory governments, 43–44
low greenhouse gas emission technology
research on, 110

macro greenhouse indicators, 18
Managing Climate Variability Program, 86
Mandatory Renewable Energy Target (MRET), 3, 4, 46–47, 48, 61, 71, 138
Marine and Atmospheric Research (CMAR) division (CSIRO), 108, 114
marine and ocean observation *see* oceanographic observations
marine protected areas, 12
market structure – energy, 16
Measures for a Better Environment, 39
meteorological and atmospheric observations, 8, 113–114
meteorological observing network, 108
methane (CH_4)
emissions, 2, 3, 26, 27, 35
projections, 82
trends, 134
emissions from wastewater, 77
trends in emissions, 129–130
Methane to Markets Partnership, 42, 93, 126
mineral resources industry, 19–20
minimum energy performance standards (MEPS), 45
airconditioners (case study), 45
Ministerial Council on Energy, 37
and National Framework for Energy Efficiency, 44
Ministerial Council on Natural Resource Management, 37
Montreal Protocol industries
and hydrofluorocarbons (HFC) emissions, 28, 74
ozone-depleting substances and synthetic greenhouse gas replacements from, 54, 64, 140
Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol), 54
multilateral assistance and programmes, 90, 98
Murray–Darling Basin
ENSO and, 112
impacts of climate change on the quantity and quality of water resources, 6, 87, 89

National Action Plan for Environmental Education, 8, 118
National Action Plan for Salinity and Water Quality (NAP), 21–22, 58, 65, 85, 89, 141
National Appliance and Equipment Energy Efficiency Programme (NAEEEP), 4, 45, 61, 122, 138
National Audit Office
and review of performance of policies and measures to reduce greenhouse gas emissions, 38
National Average CO_2 Emissions (NACE) Target, 5, 49
National Biodiversity and Climate Change Action Plan, 85, 86
National Carbon Accounting System (NCAS), 23, 29, 57
National Carbon Accounting Toolbox and Data Viewer, 23, 57
assistance for land managers (case study), 29
National Charter of Integrated Land Use and Transport Planning, 51–52
national circumstances *see under* Australia
National Climate Change Adaptation Programme, 6, 83, 84, 85, 111
National Electricity Market (NEM), 16, 42
National Environmental Education Council (NEEC), 118
National Environmental Education Network (NEEN), 118
National Environmental Education Statement (NEES) for Schools, 118
National Framework for Energy Efficiency (NFEE), 44, 61, 138
National Green Power Accreditation Programme (Green Power), 48, 62, 139
National Greenhouse Gas Inventory Committee, 29
National Greenhouse Gas Inventory (NGGI), 1, 2–3, 23–35, 67
development of, 23
methodologies, 23, 29–30
changes since *Third National Communication*, 29
documentation, 30
quality assurance and quality control, 29–30
reporting, averaging and adjustments, 29
uncertainty, 30
purpose of, 23
National Greenhouse Strategy, 36, 37, 42
National Landcare Programme, 58, 65, 85, 139
National Research Priorities
and climate change research, 109
national reserve system, 11, 12
national risk and vulnerability assessment, 83
National Strategy Studies (NSS) programme (World Bank), 91
National Tidal Centre
and Australian Baseline Sea-Level Monitoring Array, 114
and South Pacific Sea Level and Climate Monitoring Project, 116
National Training Package for Renewable Energy, 121

National Water Initiative (NWI), 85, 87

native vegetation management
- New South Wales Government, 5, 66, 141
- Queensland Government, 5, 65, 141

natural disasters
- climate change and, 87
- *see also* extreme events

natural environment
- conservation of, 11–12

natural gas
- market structure, 16
- reserves of, 15
- *see also* compressed natural gas (CNG); liquified natural gas (LNG)

Natural Heritage Trust (NHT), 57, 85, 89
- land and vegetation programmes, 57–58, 65, 139

Natural Resource Management Ministerial Council, 83, 85

New South Wales Government
- policies and measures to reduce greenhouse gas emissions, 4, 5, 43, 44, 48, 53, 57, 58, 59, 60, 64, 66, 79, 137, 139, 141
- and public awareness raising, 119

nitrous oxide (N_2O)
- emissions, 2, 3, 26, 28, 35
  - projections, 82
  - trends, 131–132, 134

No Waste by 2010 Strategy (ACT), 56

non-governmental organisations (NGOs)
- contribution of to public awareness raising, 8, 124

Northern Territory Government
- policies and measures to reduce greenhouse gas emissions, 52, 59

Northern Territory Transport Plan, 52

oceanographic observations, 8, 114–115

oil
- export of, 17
- market structure, 16
- reserves of, 15

Oil and Gas subsector
- policies and measures to reduce greenhouse gas emissions
  - effects of, 73

OzFlux, 115

ozone-depleting substances
- from Montreal Protocol industries, 54, 64, 140

Ozone Protection Act 1989, 5, 54

Ozone Protection and Synthetic Greenhouse Management Act 1989, 5, 54

Pacific Island Global Climate Observing System (PI–GCOS) initiative, 116

Pacific Negotiators Forum
- and public awareness raising, 125

Pacific region
- bilateral and regional assistance, 91, 92
- data rescue project in, 117
- observation networks and systems in, 117
- technical advice and assistance to improve climate data management and monitoring capabilities, 116–117

Pacific Small Island Developing States (SIDS)
- climate change adaptation assistance, 7, 91, 93

Papua New Guinea Forestry Human Resource Development Project, 92

passenger transport, 18–19

perfluorocarbons (PFCs)
- emissions, 3, 26, 28, 35, 74
  - projections, 82
  - trends, 133, 134

Photovoltaic Rebate Programme, 48

Plantations for Australia: The 2020 Vision, 58, 65, 141

Plantations for Greenhouse (Vic), 59

policies and measures to reduce greenhouse gas emissions, 1, 3–5, 39–66, 137–142
- building public awareness and, 122
- effects of, 71, 72, 73, 75, 76, 77, 79
- mechanisms for review of performance of, 38
- projections of unallocated abatement from, 79–80
- *see also* policy-making process

population, 1, 10, 11
- growth rate, 1, 10, 11

primary and secondary schools
- and environmental and climate change education, 118–119

Primary Industries Ministerial Council, 37, 83

professional and ongoing development
- and environmental and climate change education, 120

projections *see* emissions projections

projections of international bunker fuels emissions, 79–80

public awareness raising, 1, 8, 119, 121–126
- international activities, 8, 125–126
- non-governmental organisations and, 8, 124
- and policies and programmes, 122
- *see also* education, training and public awareness

public consultation in development of forward policy planning, 124–125

quality assurance/quality control (QA/QC) plan
and National Greenhouse Gas Inventory, 29–30
Queensland Government
and climate change adaptation planning, 7, 83
policies and measures to reduce greenhouse gas emissions, 4, 5, 43, 46, 48, 52, 53, 58, 60, 61, 64, 65, 79, 137, 138, 139, 141
and public awareness raising, 119
Queensland Sustainable Energy Innovation Fund, 46, 61, 138

railway
extension from Alice Springs to Darwin, 52
rainfall, 12
projections, 13–14
research on, 111, 112
variability, 12, 83, 87
recycling of waste, 21
regions
climate change impacts and adaptation responses, 88–89
renewable energy, 16
education, 120
policies and measures, 46–48
strategic development of, 48, 139
Renewable Energy and Energy Efficiency Partnership (REEEP), 42, 92, 126
Renewable Energy Commercialisation Programme (AGO), 121
Renewable Energy Commercialisation Programme (RECP), 48
Renewable Energy Development Initiative (REDI), 47, 61, 71, 138
and research, 110
Renewable Energy Equity Fund, 48
Renewable Energy Industry Development Programme, 8, 119, 121, 122
Renewable Energy Showcase, 48
Renewable Energy Support Fund (Vic), 48, 62, 141
renewable energy technology
transfer of to countries in Asia–Pacific region, 93–94
Renewable Remote Power Generation Programme (RRPGP), 3, 48
research *see* climate change scientific research
Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories, 23
Rivercare Programme, 57
Royal Australian Navy
and meteorological observing network, 108

Scientific Committee on Antarctic Research
participation in, 110
Securing Australia's Energy Future (2004 Energy White Paper), 3, 37, 39, 47, 49, 70
integrating energy and greenhouse policy (case study), 38
and Stationary Energy subsector, 42
Senior Officials' Group on Climate Change (COAG), 1, 37
Solar Cities, 4, 47, 61, 71, 125, 139
solar energy, 16
Solar in Schools, 119
Solomon Islands Forestry Management Project, 92
solvent and other product use
greenhouse gas emissions, 31, 35
trends, 33, 134, 135
greenhouse gas emissions estimates, 127
trends in methane emissions, 129
trends in nitrous oxide emissions, 131
South Australian Government
policies and measures to reduce greenhouse gas emissions, 48, 50, 52, 56, 59
South-East Australia Climate Project, 87
South East Queensland Integrated Regional Transport Plan, 52
South Pacific Disaster Reduction Programme, 93
South Pacific Regional Environment Programme (SPREP), 7, 93, 98
South Pacific Sea Level and Climate Monitoring Project, 93, 107, 116
south-west Western Australia
study of climate change adaptation in, 6, 89
Southern Ocean
research on, 108, 111
space-based observations, 115–116
Sri Lanka solar home systems monitoring project, 93
Sri Lanka–Australia Natural Resource Management Project, 92
State Environment Protection Policy (Air Quality Management) (Vic), 54–55, 64, 137
case study, 55
states and territories, 1, 3, 10
action on energy efficiency, 46, 61, 138
action to reduce fugitive emissions from fuels, 53
alternative fuels programmes, 50, 63, 140
and climate change adaptation planning, 7, 83, 89
and emissions trading, 41
energy information centres, 123
and environmental and climate change education, 118, 120
low emissions technology measures, 43–44
and public awareness raising, 119
regulatory measures, 43
stationary energy measures, 71

and strategic transport planning, 51
transport measures, 5, 63, 72, 141
and waste management strategies, 5, 56, 139

Stationary Energy subsector
model projections for, 67
emissions projections, 6, 68, 69–71, 143
analytical approach followed, 70
assumptions, 70
factors influencing, 70
by gas, 82
'with measures', 70
greenhouse gas emissions, 2, 24, 25, 42
carbon dioxide, 26, 27
methane, 27
nitrous oxide, 28
uncertainty in estimates of, 30
policies and measures to reduce greenhouse gas emissions, 4, 42–49, 60–62
effects of, 71

Strategic Plan for the Development of Meteorology in the Pacific Region, 116

strategic transport planning, 51–52, 63, 141

stream flow
decreases in, 87

subsidies for energy production, 18

sulphur hexafluoride (SF_6)
best practice management of, 54, 64, 75
emissions, 26, 28, 35, 74
projections, 82
trends, 133, 134

SunRace, 119

Sustainability Victoria (formerly SEAV), 54

Sustainable Environment Committee of Cabinet, 37

Sustainable Housing lecture series, 123

Sustainable Schools Initiative, 8, 118–119

Sustainable Transport Plan (ACT), 52

synthetic gas legislation, 75

synthetic gases *see* hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6)

synthetic greenhouse gas replacements
Montreal Protocol industries, 54, 64

systematic observation of climate change, 1, 7–8, 108, 113–117

Tasmanian Government
coastal vulnerability study, 7, 84

taxes
and mining and oil and gas production, 18

technology transfers *see* transfer of environmentally sound technology to other countries to assist with climate change issues

temperature
maxima, 13
projections, 13

terrestrial observations, 8, 115

tertiary education
and environmental and climate change education, 120

Third National Communication, 36
changes in emissions projections from, 68, 69
changes in National Greenhouse Gas Inventory methodology since, 29

350 ML Biofuels Target, 51, 63, 141

tourism
climate change impacts and adaptation responses, 88

Towards Zero Waste Strategy (Vic), 56

trade, 15
in energy, 15, 17

training *see* education, training and public awareness

transfer of environmentally sound technology to other countries to assist with climate change issues, 7, 90, 93–96
innovative mechanisms for, 94–95

transport industry, 18–19
and energy use, 15

Transport subsector
emissions projections, 6, 68, 71–72, 143
analytical approach followed, 71
assumptions, 71–72
factors influencing, 71
by gas, 82
'with measures', 72
greenhouse gas emissions, 2, 24, 25, 31, 49
carbon dioxide, 26, 27
methane, 27
nitrous oxide, 28
trends, 33
policies and measures to reduce greenhouse gas emissions, 5, 49–52, 62–63
effects of, 72

Travel Demand Management, 40, 41

TravelSmart, 37, 41

TravelSmart Australia, 119

tropical cyclones
projections, 14

Tropical Warm Pool International Cloud Experiment (TWP–ICE), 112–113

uncertainty and sensitivity analysis
emissions projections, 80–81

UNFCCC accounting
forestry 'with measures' projections, 78
and Kyoto target accounting, 24, 67
see also under greenhouse gas emissions

United Nations Framework Convention on Climate Change (UNFCCC), 1, 10, 36, 90, 98
contributions to core budget of, 91
and emissions projections, 67, 68
National Greenhouse Gas Inventory and, 23
voluntary contributions to, 91
see also Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol)

universities
and environmental and climate change education, 120

uranium
export of, 17

urban structure *see* building stock and urban structure

vegetation *see* land and vegetation programmes; native vegetation management

Victorian Government
and climate change adaptation planning, 7, 83, 89
policies and measures to reduce greenhouse gas emissions, 4, 43–44, 44, 46, 48, 54, 56, 59, 60, 62, 64, 138, 141

Victorian Greenhouse Strategy, 37

Victorian State Environment Protection Policy, 54, 64, 137
case study, 55

vocational education
and environmental and climate change education, 120

vulnerability assessment – climate change, 1, 6–7, 83, 84
see also Climate Change Risk and Vulnerability: promoting an efficient adaptation response in Australia; national risk and vulnerability assessment

waste, 21

waste management, 76
strategies, 56–57, 65, 139

Waste sector, 82
emissions projections, 5, 6, 68, 76–77, 143
analytical approach followed, 75
assumptions, 77
factors influencing, 76
by gas, 82
'with measures', 77
greenhouse gas emissions, 2, 24, 25, 31, 35, 69
methane, 27
nitrous oxide, 28
trends, 34, 134, 136
uncertainty in estimates of, 30
greenhouse gas emissions estimates, 128
policies and measures to reduce greenhouse gas emissions, 5, 56–57, 65
effects of, 77
trends in methane emissions, 130
trends in nitrous oxide emissions, 132

water balance *see* annual water balance

water supply
climate change impacts and adaptation responses, 87

websites
community information services, 123

Western Australia
study of climate change adaptation in south-west of, 89

Western Australian Government
and climate change adaptation planning, 83
policies and measures to reduce greenhouse gas emissions, 5, 50, 52, 58, 59

wind energy, 16

Wind Energy Forecasting Capability, 48, 62, 139
and research, 110

'with measures' emissions projections, 5, 80
Agriculture sector, 76
Forest Lands subsector
forestry under Kyoto accounting rules, 78
forestry under UNFCCC accounting rules, 78
Fugitive Emissions from Fuels subsector, 73
Industrial Processes sector, 74
Land Use Change subsector, 78–79
Stationary Energy subsector, 70
Transport subsector, 72
Waste sector, 77

'with measures' projections, 67, 68

World Bank
National Strategy Studies Programme, 91

World Climate Impacts and Response Strategies Programme (WCIRP), 8, 110

World Climate Research Programme (WCRP)
and international cooperation on climate change research, 8, 110

World Heritage Areas
Wet Tropics of Queensland, 11

World Meteorological Organization (WMO), 8, 108
Commission for Climatology, 117

World Ocean Circulation Experiment (WOCE)
Indian Ocean Upper Ocean Thermal Data Assembly Centre, 115

World Summit on Sustainable Development, 94

Your Home, 123

Zero Waste SA strategy, 56