Australian Government

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education

Australia's Sixth National Communication on Climate Change

A report under the United Nations Framework Convention on Climate Change

2013

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Many Australian Government programs are ongoing. The information in this publication was correct at the time of its publication in August 2013.

Contents

1 Executive Summary 2
1.1 Australia's national circumstances 4
1.2 Australia's National Greenhouse Gas Inventory 7
1.3 Policies and measures 8
1.4 Greenhouse gas emissions projections 9
1.5 Climate change vulnerability and adaptation 11
1.6 Financial resources and technology cooperation 12
1.7 Research and systematic observation 13
1.8 Education, training and public awareness 13

2 Australia's national circumstances 17
2.1 Australia – geography, demography & government 19
2.2 Economy 20
2.3 Energy 21
2.4 Industry 25
2.5 Transport 26
2.6 Landscape and environment 27
2.7 Climate 28
2.8 Agriculture 31
2.9 Forestry 32
2.10 Building stock and urban structure 32
2.11 Waste 32

3 National Greenhouse Gas Inventory 36
3.1 Overview of national emissions 37
3.2 Emissions by greenhouse gas type 41
3.3 National inventory systems 45
3.4 National registry 60

4 Policies and Measures 68
4.1 Policy-making process 71
4.2 Policies and measures at the national level 76
4.3 Policies and measures at the state, territory and local levels 111
4.4 Policies and measures no longer in place 114

5 Projections **121**
5.1 Australia's approach to emissions projections 123
5.2 Summary of projections 124
5.3 With carbon price projections in detail 127
5.4 Projections by sector 129
5.5 Projections methodology 151

6 Climate change vulnerability and adaptation **155**
6.1 Expected impacts of climate change on Australia 156
6.2 Vulnerability assessment 161
6.3 Adaptation measures 165

7 Financial Resources and technology cooperation **185**
7.1 Multilateral activities 187
7.2 Bilateral and regional activities 189
7.3 Adaptation 192
7.4 Mitigation and capacity building 195
7.5 Technology cooperation 203
7.6 Other initiatives 208

8 Research and systematic observation **220**
8.1 National Framework for Climate Change Science 222
8.2 Research capacity 226
8.3 International cooperation 231
8.4 Research focus 233
8.5 Systematic observation 245

9 Education, Training and Public Awareness **256**
9.1 Education and training 258
9.2 Industry 264
9.3 Non-government organisations 265
9.4 Public awareness raising 266
9.5 Public access to information 270
9.6 International activities 272

Abbrieviations and Acronyms **278**

Glossary **287**

Annex A **292**
Australia's Biennial Report 1

Ministerial Foreword

The Australian Government is taking strong and decisive action to address climate change. In the period since the Fifth National Communication on Climate Change was submitted, the Government has successfully implemented the Clean Energy Future Plan; a comprehensive suite of climate change measures. This includes implementing an emissions trading scheme, promoting innovation and investment in renewable energy, encouraging energy efficiency, and creating opportunities in the land sector.

Australia's Sixth National Communication on Climate Change summarises the progress we have made as a nation to meet our obligations under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

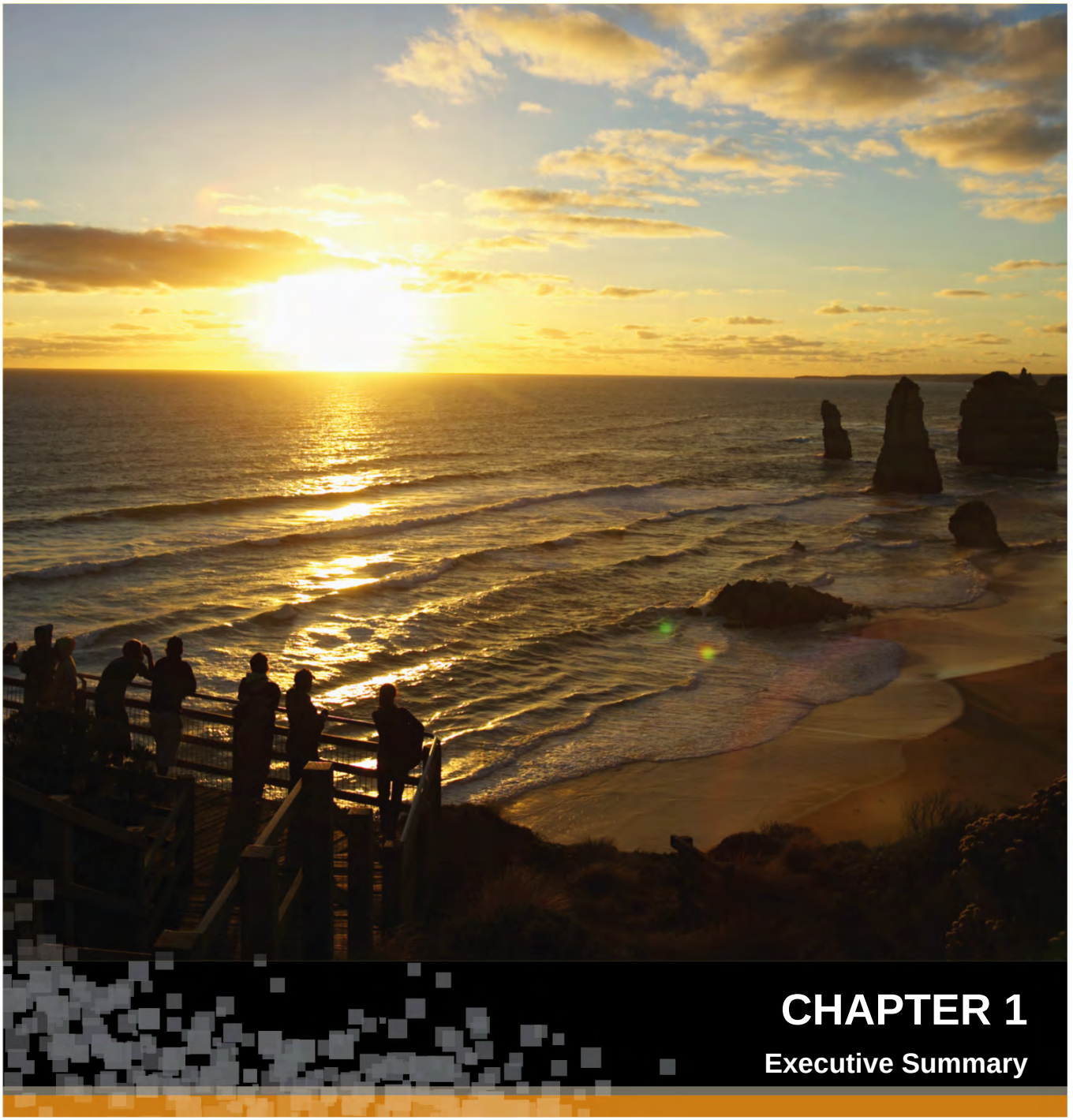
The Australian Government has committed to responsible targets to reduce carbon pollution and to play our part in the global effort to avoid dangerous climate change. The Government has committed to reduce carbon pollution by 5 per cent from 2000 levels by 2020 irrespective of what other countries do, and by up to 15 or 25 per cent depending on the scale of global action. Looking out to 2050, the Government has committed to cut carbon pollution by 80 per cent below 2000 levels.

The Clean Energy Future Plan will ensure Australia meets these commitments. Australia's emissions trading scheme puts a price on carbon pollution released into the atmosphere and imposes limits on emissions. The scheme, which has been operational since 1 July 2012, creates a financial incentive for Australian businesses to move to low carbon systems, equipment and processes. It will transform our economy

Other significant new climate change measures include multi-billion dollar investments in renewable energy research and development, efforts to ensure Australia's long-term energy supply, and a range of biodiversity and land-based measures to help protect Australia's ecosystems and help build resilience to climate change. Further, Australia is actively engaging with our international partners and neighbours to build climate change capacity in developing countries.

Australia is proud of the policies that have been implemented since our Fifth National Communication, and remains committed to working constructively internationally to respond to the global challenge of climate change.

The Hon Mark Butler MP
Minister for Climate Change



CHAPTER 1

Executive Summary

1.1 Australia's national circumstances 4
1.2 Australia's National Greenhouse Gas Inventory 7
1.3 Policies and measures 8
1.4 Greenhouse gas emissions projections 9
1.5 Climate change vulnerability and adaptation 11
1.6 Financial resources and technology cooperation 12
1.7 Research and systematic observation 13
1.8 Education, training and public awareness 13

Australia's Sixth National Communication on Climate Change updates Australia's progress in addressing climate change. As an Annex I signatory to the United Nations Framework Convention on Climate Change (UNFCCC) Australia is required to submit a national communication every four years.

National communications are designed to provide a consistent, comparable, accurate and complete account of action being taken by Parties to the Convention to address climate change.

Australia's Sixth National Communication on Climate Change showcases Australia's comprehensive response to the challenge of climate change and reflects the considerable progress made since the submission of its Fifth National Communication in 2010.

Key developments since then are listed in the box below.

Key Achievements Since Australia's Fifth National Communication On Climate Change

- Commitment to ambitious emissions reduction targets, including the adoption of an 80 per cent reduction in emissions on 2000 levels by 2050;
- Development of a comprehensive Clean Energy Future Plan to address the challenge of climate change;
- Introduction of an economy-wide carbon price in 2012;
- Passage of legislation to establish the Clean Energy Regulator, Climate Change Authority and Clean Energy Finance Corporation;
- Creation of an independent Climate Commission staffed by scientists, economists and public policy specialists to provide accessible information on climate change to the general public;
- Development of a Plan for Implementing Climate Change Science and a National Climate Projections Program to further Australia's climate change science research and observation efforts;
- Increased understanding of the impacts of climate change on Australian ecosystems and our coastline; and
- Continued and enhanced investment in adaptation, mitigation, capacity building and technology cooperation throughout the Asia– Pacific region.

The report addresses the recommendations of the 2012 UNFCCC Report of the In-Depth Review of the Fifth National Communication of Australia through more detailed presentation of significant policies and measures; clearer information on the monitoring systems and institutional arrangements in place to support and deliver climate change policy, research and evaluation; and improvements in the quality and transparency of reporting on financial resourcing and technology cooperation actions.

Since the Fifth National Communication on Climate Change, the Australian Government has implemented the comprehensive Clean Energy Future Plan, informed by extensive research and analysis on the most efficient and effective options to address climate

change with input from science, industry, non-government organisations and the Australian public.

Australia's climate change strategy rests on three key pillars:

- reducing Australia's emissions
- adapting to unavoidable climate change
- helping to shape a global solution.

A comprehensive suite of mitigation, adaptation, capacity building and engagement measures operationalise this strategy to position Australia as a constructive actor in global efforts to tackle climate change.

Australia's Sixth National Communication provides:

- a detailed description of Australia's national circumstances as context for Australia's emissions profile and overarching responses to climate change (Chapter 2);
- the most recent inventory of greenhouse gas emissions and the methodologies used to calculate these emissions (Chapter 3);
- details of progress on climate change policies and measures since Australia's Fifth National Communication (Chapter 4);
- detailed sectoral projections for Australia's greenhouse gas emissions (Chapter 5);
- evidence of Australia's vulnerability to climate change impacts and adaptation measures to address those impacts (Chapter 6);
- Australia's international efforts to assist developing countries through financial and capacity building support to address their specific climate change challenges and information on international technology cooperation (Chapter 7);
- details of progress by Australian research programs and institutions in climate research, systematic observation, and adaptation and mitigation technologies (Chapter 8);
- An overview of efforts to increase knowledge of climate change issues through public awareness-raising education and training activities (Chapter 9).

1.1 Australia's national circumstances

As one of the hottest and driest continents on Earth, Australia will be adversely affected by climate change. Unmitigated climate change poses a significant threat to Australia's economic security, natural heritage and way of life. Responsibility for addressing climate change in Australia is shared between three levels of government—the Australian Government, the governments of the six states and two territories and around 700 local government authorities. The Department of Innovation, Industry, Climate Change, Science Research and Tertiary Education is the lead agency in the Australian Government's response to climate change.

Australia has a relatively small population of 23.1 million people and contributes approximately one and a half per cent to total global greenhouse emissions. However, Australia's per capita greenhouse gas emissions are the highest of any OECD country

and are among the highest in the world. This is due in part to the dominance of resource-based industries in the economy and a reliance on low-cost fossil fuels for electricity generation. Australia is an open, export-led economy. The availability of low-cost coal, in particular, has led to a dominance of coal-fired electricity generation and energy-intensive industries. These industries make a significant contribution to economic growth, employment and regional development in Australia.

Australia has one of the most naturally variable climates in the world (see Figure 1.1). With climate change, this variability will become more extreme in the future. Australia's geography, coastal population concentrations and biodiversity render it particularly vulnerable to small variations in climate. Many of Australia's key industry sectors such as agriculture and tourism are also vulnerable to high variability in temperature and rainfall patterns. If global greenhouse gas emissions continue to rise unchecked, Australia will experience further declines in agricultural production, as well as rising costs. Ecosystems, the economy and Australian society are likely to be strongly affected by climate change. The analysis presented by the 2008 Garnaut Climate Change Review, and its subsequent update in 2011, builds an unequivocal case for responding to climate change with mitigation action.

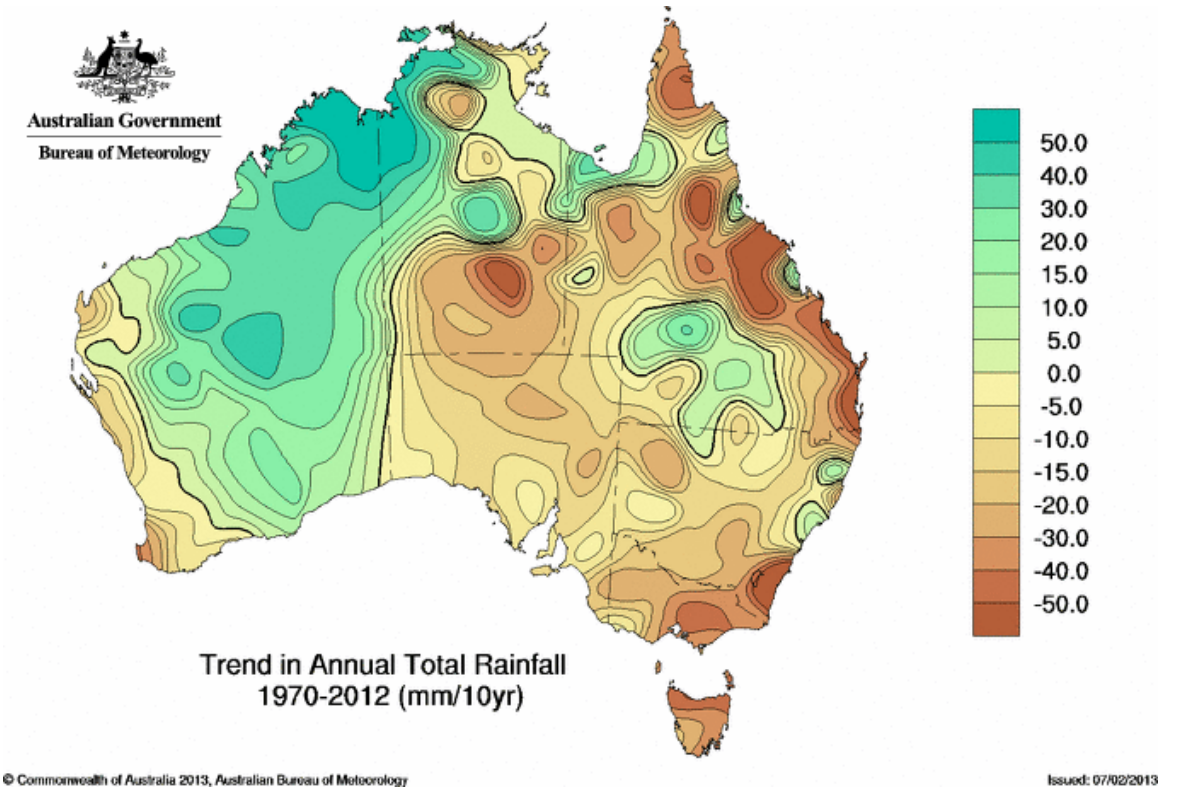


Figure 1.1 Trend in Annual Total Rainfall across Australia, 1970-2012 (°C)

Summary of Australia's three-pillar Climate Change Strategy

The Australian Government's climate change policy agenda rests on three pillars:

- Reducing Australia's greenhouse gas emissions;
- Adapting to the climate change we cannot avoid; and
- Helping to shape a global climate change solution.

Pillar 1: Reducing emissions

The Government has developed a comprehensive climate change strategy through the Clean Energy Future Plan to cut carbon pollution. The centrepiece of the plan is an emissions trading scheme that is creating economic incentives for businesses to reduce their pollution in the cheapest possible way. The emissions trading scheme started with a fixed carbon price on 1 July 2012 and is complemented by significant policies and investment to drive the uptake of clean energy and energy efficiency, and deliver action on the land.

Working together these policies are catalysing a transformation of the economy towards a clean energy future. Chapter 4 details Australia mitigation policies and measures.

Pillar 2: Adapting to unavoidable climate change

The Government has developed a comprehensive adaptation policy to prepare Australia to manage the social, economic and environmental risks of climate change, and is building capacity to adapt to the unavoidable impacts of climate change through a range of research initiatives, research facilities, and risk assessments.

In 2012 the Australian Government released a position paper, *Adapting to Climate Change in Australia*, which sets out the vision for adapting to the impacts of climate change and proposes practical steps to realise that vision. The paper outlines the Government's role in adaptation, which includes building community resilience and establishing the right conditions for people to adapt; taking climate change into account in the management of Commonwealth assets and programs; providing sound scientific information; and leading national reform.

Additionally, the Government is supporting a broad range of climate change science research activities through the Australian Climate Change Science Program that will facilitate a better understanding of global and regional climate change and its potential impact on Australia's natural and managed systems. Chapters 6 details the impacts of climate change and the Government's comprehensive adaptation policy response.

Pillar 3: Helping to shape a global solution

Climate change is a global problem that requires a global solution. All countries have an interest in preventing rising temperatures and taking action to manage risks and impacts. Australia is making a direct contribution to global efforts to tackle climate change, through the UNFCCC, for a legally-binding global climate outcome that is effective, fair and efficient.

Australia uses opportunities to complement and advance the UNFCCC negotiations that arise through participation in the Major Economies Forum on Energy and Climate, the Group of Twenty, the Pacific Islands Forum, the Asia-Pacific Economic Cooperation forum and the East Asia Summit. Australia also pursues its climate change goals through active bilateral engagement with strategic partners such as China, the European Union, India, Indonesia, Japan, New Zealand, North America and the Republic of Korea.

Chapter 7 details Australia's financial and capacity building support to assist developing countries address their specific climate change challenges, and information on international technology cooperation.

1.2 Australia's National Greenhouse Gas Inventory

As a Party to the UNFCCC and the Kyoto Protocol, Australia has an obligation to prepare, publish and update greenhouse gas inventories on an annual basis. Since the Fifth National Communication, Australia has developed a range of measures to improve the national greenhouse gas inventory system and produce more accurate and comprehensive emissions estimates.

These measures, described in Chapter 3, include the adoption of new data and methods and strengthening of planning and quality control systems.

Australia's most recent inventory covers the year 2011 and is being submitted to the UNFCCC in 2013. The inventory results for the period between 1990 and 2011 are summarised below and illustrated in Figure 1.2.

In 2011, Australia's total greenhouse gas emissions— excluding the land-use, land-use change and forestry (LULUCF) sector—were 552.3 million tonnes (Mt) carbon dioxide equivalent (CO2-e). Energy-related emissions (stationary energy, transport and fugitive emissions from fuels) dominate Australia's emissions profile; contributing 76.4 per cent of total emissions in 2011. Emissions associated with the agriculture sector are also a significant component (15.2 per cent) of the inventory. The emissions from the industrial processes and waste sectors are relatively minor.

According to the accounting provisions of the UNFCCC, Australia's total greenhouse gas emissions (excluding the LULUCF sector) increased by 32 per cent between 1990 and 2011. When the LULUCF sector emissions and removals are included, Australia's net greenhouse gas emissions in 2011 decreased by 2 per cent compared with 1990 levels.

Sectors with increasing emissions over the period 1990 to 2011 included stationary energy (up 50.5 per cent), transport (up 41.2 per cent), fugitive emissions from fuels (up 27.4 per cent) and industrial processes (up 35.0 per cent). Sectors with decreasing emissions over the period included waste (down 26.5 per cent), agriculture (down 2.7 per cent) and LULUCF (down 138.0 per cent).

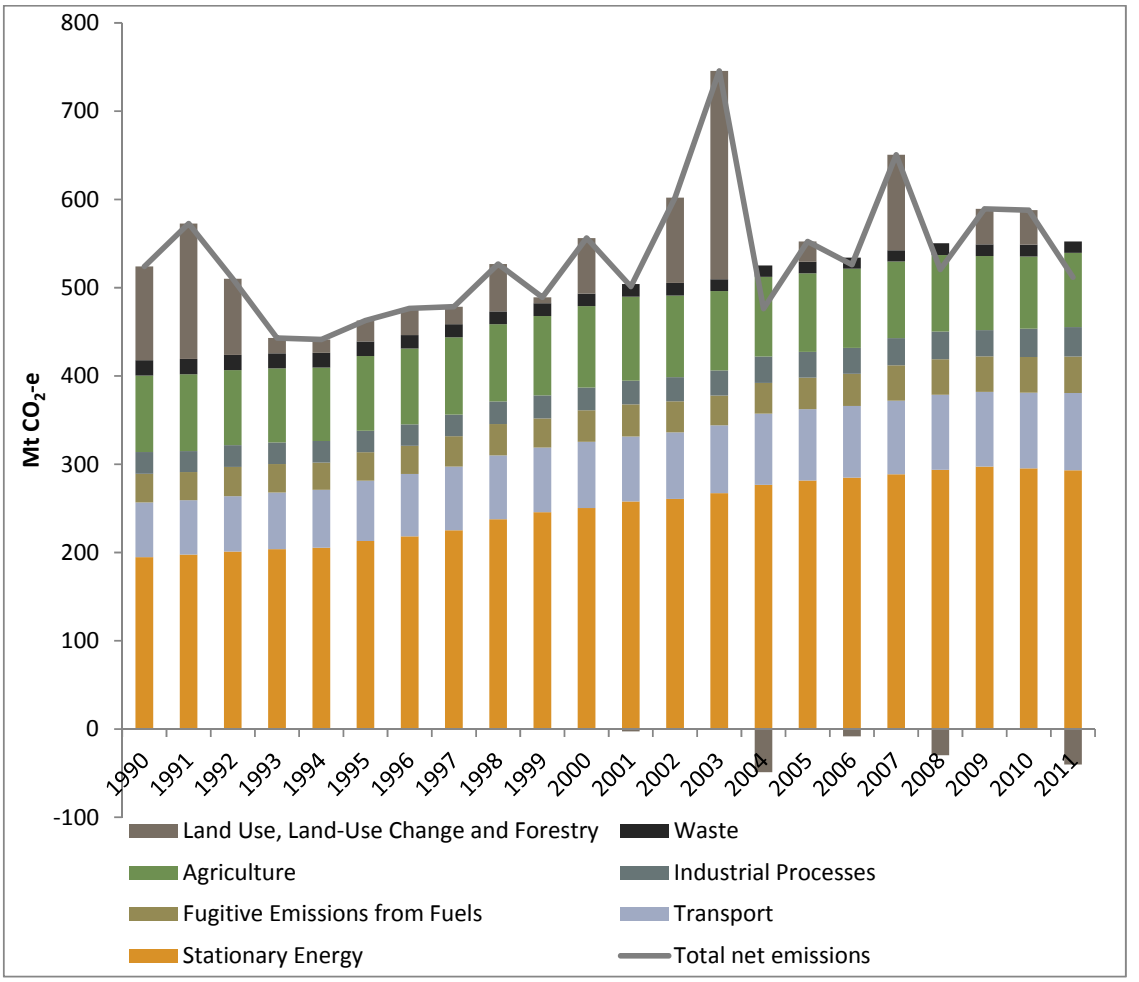


Figure 1.2 Greenhouse gas inventory for Australia for the period 1990 to 2011

1.3 Policies and measures

Since the Fifth National Communication on Climate Change, Australia has developed and implemented an economy-wide carbon price and refined its suite of complementary measures to meet current and future commitments to reduce its greenhouse gas emissions.

Australia has committed to reducing its greenhouse gas emissions by between 5 and 15 or 25 per cent below 2000 levels by 2020. The 5 per cent target is unconditional, while the 15 per cent and 25 per cent targets are conditional on the extent of international action. Australia has also committed to a long-term target to cut pollution by 80 per cent below 2000 levels by 2050.

Chapter 4 describes the major policies and measures developed and implemented by all levels of government to meet Australia's emission reduction targets. It also outlines the political context and policy processes that underpin Australia's climate change policy framework.

In July 2011, the Government announced a comprehensive Clean Energy Future Plan to drive innovation, reduce carbon pollution and restructure the economy. The core component of the plan is the introduction of a cap-and-trade emissions trading scheme to reduce carbon pollution cheaply and effectively, and incentivise investment in clean energy sources such as solar, wind and gas. The emissions trading scheme is one of the most comprehensive in the world, covering over 60 per cent of Australia's total emissions.

Australia's carbon price commenced on 1 July 2012. Since that date, around 370 of Australia's largest emitters are required to pay a price for each tonne of carbon pollution they put into the atmosphere. Implementation of the emissions trading scheme will occur in two phases, commencing with a fixed price period before moving to a cap-and trade scheme where the carbon price is determined by the market. The fixed price period is currently legislated to run for three years. On 16 July 2013 the Government announced it would bring forward the start of the flexible cap-and-trade emissions trading scheme to 1 July 2014, one year earlier than anticipated.

The scheme has been designed to link to other international emissions trading schemes, on the basis that an effective global carbon market is central to the development of sound international solutions to climate change and will foster least-cost global abatement. Australia and the European Union have agreed to link their respective schemes over the coming years and action is underway to operationalise this agreement.

Measures announced in the Clean Energy Future Plan to complement the emissions trading scheme include:

- Funding for the research, development and commercialisation of clean energy and low emissions technologies through the establishment of the $10 billion Clean Energy Finance Corporation and $3 billion Australian Renewable Energy Agency;
- Measures to help Australian businesses and households transition to a clean energy future, including the $9.2 billion Jobs and Competitiveness Program;
- Opportunities for Australian homes and workplaces to make energy efficiency improvements;
- Measures to help protect Australia's ecosystems, including the establishment of a Biodiversity Fund; and
- Support for climate change action on the land, and to build land sector resilience to the impacts of climate change.

The new measures in the Clean Energy Future Plan were designed to operate with a range of successful existing policies such as the Renewable Energy Target and targeted appliance, equipment, building and industrial energy efficiency programs.

1.4 Greenhouse gas emissions projections

Chapter 5 presents sectoral projections for Australia's greenhouse gas emissions that were prepared in 2012. Baseline greenhouse gas emissions projections show the projected effect of emissions reduction policies and measures on Australia's emissions.

The projections are provided for each National Greenhouse Gas Inventory sector, focusing on the Kyoto first commitment period and 2020.

Projections are made in accordance with the UNFCCC and the Kyoto Protocol requirements. The Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education has an ongoing program to update and improve sectoral projections.

Updated sectoral projections together with the impact of mitigation policies and measures show that Australia remains on track to meet its Kyoto Protocol target of limiting emissions to 108 per cent of 1990 levels without the use of flexibility mechanisms or imported emissions permits. Australia's emissions (on a Kyoto Protocol accounting basis) are projected to reach an average of 575 Mt CO_2-e per year over the first commitment period (2008–12), which is 105 per cent of 1990 levels. Projections made using UNFCCC accounting rules are also detailed in Chapter 5.

Figure 1.3 shows historical and projected emissions from 1990 to 2020 and comparisons with Australia's target range of 5, 15 and 25% below 2000 levels. This provides a measure of the amount of additional abatement or avoided emissions that are required to achieve Australia's 2020 target range given the policies and measures that are already in place.

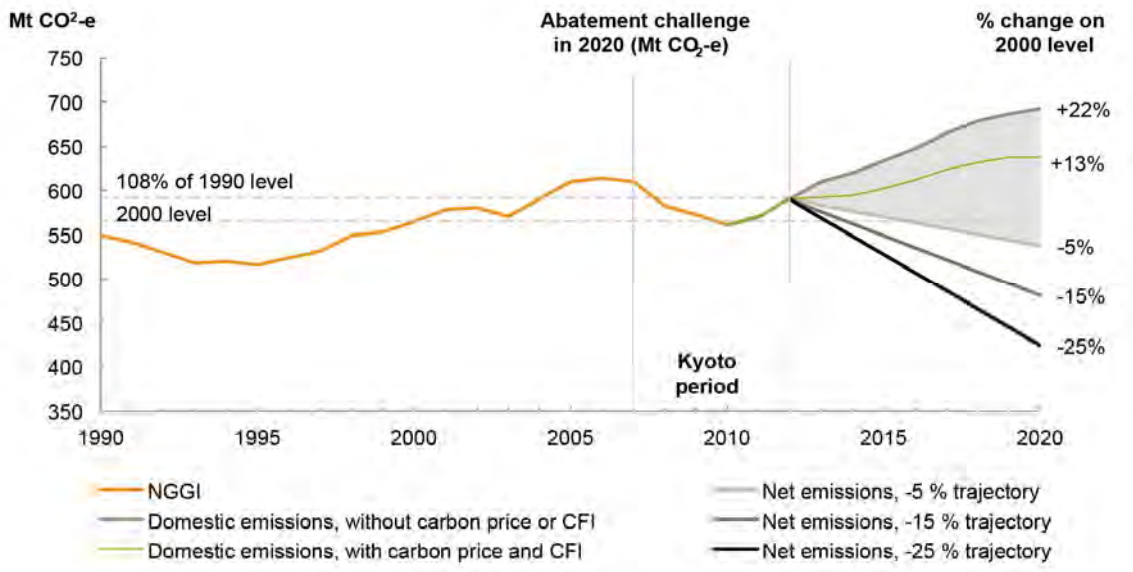


Figure 1.3 Historical and projected emissions, 1990 to 2020 (Mt CO_2-e) and comparisons with Australia's emissions reduction targets of 5, 15 and 25 per cent below 2000 levels

The emissions trading scheme and Carbon Farming Initiative (CFI) will limit growth in Australia's domestic emissions over the period to 2020. With the introduction of the emissions trading scheme and CFI, Australia's national emissions in 2020 (including the purchase of international permits) are projected to decline to 537 Mt CO_2-e under the

minus 5 per cent target, 481 Mt CO_2-e under a minus 15 per cent target, and 424 Mt CO_2-e under a minus 25 per cent target. Without the emissions trading scheme and CFI, emissions are projected to continue to increase. In 2020, emissions are projected to be 693 Mt CO_2-e on a Kyoto Protocol accounting basis, equivalent to 122 per cent of 2000 levels, in the absence of these policies.

Emissions projections are updated every year and the 2013 projections will be able to take into account a range of changes in the economy and electricity markets. For instance, data from the Australian Energy Market Operator indicates that for the National Electricity Market in 2012-13, electricity demand was down 2.5 per cent, emissions were down 7 per cent and renewable energy output was up 25 per cent compared to the same period in 2011-12. In July 2013, the government published *How Australia's Carbon Price is Working - One Year On* setting out some of the recent analysis and information on the implementation of the Clean Energy Future Plan.

1.5 Climate change vulnerability and adaptation

Australia is already experiencing the effects of climate change and will face more substantial impacts in the future. Higher temperatures, more frequent and severe weather events, and a further decrease in rainfall and water availability are predicted to threaten major declines in agricultural production, and cause damage to natural land and marine ecosystems and coastal infrastructure.

Developing a comprehensive understanding of the impacts of climate change on Australia is essential to assessing the exposure, risks and opportunities arising from climate change and the development of evidence-based policy responses.

Since Australia's Fifth National Communication, governments at all levels have undertaken a range of activities to develop an adaptation response to climate change through increasing knowledge of climate change risks and vulnerabilities and developing policies and programs to address these risks. These activities are outlined in detail in Chapter 6.

In 2010, the Australian Government released the position paper *Adapting to Climate Change in Australia*, which sets out the Government's vision for adapting to the impacts of climate change and proposes practical steps to realise that vision. The position paper identifies six national priority areas for action: water, coasts, infrastructure, natural ecosystems, natural disaster management, and agriculture.

Australian governments have funded research on a range of strategic national vulnerability assessments of climate change risks to Australia's coasts, biodiversity, iconic ecosystems, primary industries and national infrastructure. The Government is continuing to support adaptation research across a range of areas including urban coastal vulnerability, national reserves, health impacts and primary industries.

1.6 Financial resources and technology cooperation

Australia's approach to climate change financing and technology cooperation recognises that early mitigation and adaptation actions will reduce global costs and the costs to individual countries. Australia also recognises that targeting support to build capacity in developing countries will enhance their ability to implement domestic policies and measures, and increase access to international finance to support their efforts, including through the carbon market.

Australia's priorities for climate change finance and technology cooperation include:

- supporting adaptation in the most vulnerable countries, particularly countries in the Asia–Pacific region;
- creating enabling environments for private sector investment;
- addressing market failures; and
- facilitating the transformation of economies in areas where market-based approaches do not reach, such as through research, development and demonstration of low-emissions technologies.

The Government has adopted the UNFCCC's common tabular format for the Sixth National Communication to ensure transparency and consistency in reporting financial data.

Many of Australia's adaptation, mitigation, capacity building and technology cooperation programs are administered through bilateral partnerships. However, a proportion of Australia's climate change financing and technology cooperation is distributed through multilateral institutions such as the Global Environment Facility and the Climate Investment Funds.

Key bilateral and multilateral activities include support for efforts to reduce emissions deforestation and forest degradation in developing countries, and support for the development and deployment of industrial-scale carbon capture and storage technology, in Australia and abroad.

Australia participates in high-level meetings on climate change that complement and help progress the UNFCCC agenda, including the Group of Twenty and the Major Economies Forum on Clean Energy and Climate.

Australia has provided a total of approximately $490 million of new and additional financial resources for climate change programs in developing countries since the Fifth National Communication. This is an increase of more than 70 per cent on the average annual expenditure over the previous reporting period.

Recent developments in Australia's approach to financial resources and technology cooperation have included:

- A range of adaptation assistance to the Pacific, Southeast Asia, South Asia, Asia, Africa and the Caribbean through the $328.2 million International Climate Change Adaptation initiative;
- Investment of $273 million in the International Forest Carbon Initiative- Australia's key contribution to global action on REDD+;
- Provision of $12.5 million and technical assistance to the World bank Partnership for Market Readiness; and
- Participation in a range of multilateral and bilateral technology cooperation fora.

1.7 Research and systematic observation

Australia has the most comprehensive research and monitoring activities related to climate change in the southern hemisphere. This research is focused on four main areas: process studies, climate models, emissions reduction technologies and systematic observation.

Chapter 8 outlines how Australian climate change scientists continue to play an active role in research on climate and climate change through participation in international scientific committees and ongoing contributions to global climate change research.

Research by Australian institutions and scientists has contributed significantly to the climate change assessments of the Intergovernmental Panel on Climate Change including the soon to be released Fifth Assessment Report. Australia is also a member of key international climate change research and information exchange programs and organisations and participates in a range of international research networks.

Key developments in research and systematic observation since the Fifth National Communication include:

- The adoption of A Plan for Implementing Climate Change Science in Australia by the Australian Government in 2012;
- The development of a National Climate Projections Program to facilitate collaboration to inform decision making and build national capacity to manage climate change risks;
- $15 million in funding for research to produce regional climate change information to support natural resource management planning;
- Forty six Australian scientists contributing to the Intergovernmental Panel on Climate Change reports, including the Fifth Assessment Report.

1.8 Education, training and public awareness

Information and education are fundamental to building broad support for climate change policies. The Government recognises that a diverse range of information and education approaches are required to reach the broad range of audiences interested in, or affected by, climate change and climate change policies. These are described in Chapter 9. Information and education approaches are tailored to cater for and reach all relevant audiences.

Australian governments at all levels have developed public awareness and education programs to communicate the need to change behaviours that contribute to climate change through stakeholder engagement, education, training and professional development.

Information networks provided by schools, universities, vocational training and public information portals such as the internet and television have been harnessed to increase awareness and understanding of government policies on climate change, energy efficiency and other mitigation activities. A range of non-government organisations also promote public awareness and understanding of climate change through research, lobbying, education, training and media activities.

The Government and state and territory governments are working to identify skill needs, reform training products, and deliver training to upskill and reskill the workforce. These measures will build the capacity of the workforce to respond to climate change and transition to a low-carbon economy.

Australia shares its experiences and knowledge in implementing climate change policies to assist other countries, in particular developing countries, to measure and manage their emissions, reduce emissions from key sectors and adapt to the unavoidable impacts of climate change.

Key developments in education, training and public awareness since the Fifth National Communication on Climate Change include:

- Extensive community engagement by the Government (including a public awareness campaign) to explain its Clean Energy Future plan.
- Establishment of a Climate Commission to provide Australians with an independent and reliable source of information about climate change science, economics and international action.
- The Australian Government commissioning eminent economist Professor Ross Garnaut to update key areas of his landmark 2008 Garnaut Climate Change Review
- Introduction of a range of educational and vocational measures by governments at all levels to ensure that Australia's current and future workforce will be equipped with the ingenuity, skills and knowledge to respond to climate change and to facilitate the transition to a low-carbon economy
- Implementation of a range of international measures to assist developing countries address climate change.

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CHAPTER 2

Australia's national circumstances

2.1 Australia – geography, demography & government 19
2.2 Economy 20
2.3 Energy 21
2.4 Industry 25
2.5 Transport 26
2.6 Landscape and environment 27
2.7 Climate 28
2.8 Agriculture 31
2.9 Forestry 32
2.10 Building stock and urban structure 32
2.11 Waste 32

Key Developments

The United Nations Framework Convention on Climate Change 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 strategy must be tailored to suit its particular circumstances.

Australia is one of the world's top twenty emitters on an absolute basis and has the highest per capita emissions of the developed economies. Australia's relatively high greenhouse gas emissions per person can be attributed to factors such as the prevalence of low-cost coal in electricity generation, historical emissions from land clearing, population growth, and the production of resource and agricultural products for export. Australia's population and industry also depend heavily on long-haul transport due to the widely dispersed nature of Australian settlements, the location of natural resources, and the distance from overseas markets.

Australia's per capita emissions have been declining for the past twenty years. For the year to December 2012, Australia's per capita emissions were 25 tonnes of carbon dioxide equivalent (CO_2-e) per person (including land use, land-use change and forestry). This represents a 24.0 per cent decline from 1989-90 levels despite a population increase of 35 per cent over this period. These declines have resulted from specific emissions management actions across sectors, a large decline in land use change emissions over the period, and structural changes in the economy.

Australia is a vast continent; its diverse ecosystems include extreme desert, tropical rainforests, sensitive alpine regions, and extensive coastal and marine zones. Australia is classified as one of only seventeen mega-diverse countries in the world, and is home to more than one million native species, many of which are found nowhere else. Climate variability has been the backdrop to Australian history, helping to shape Australia's pattern of human settlement, agriculture and infrastructure development. Australia's size, environmental diversity and predisposition to climate variability pose significant challenges to managing the impacts of climate change. These important contextual factors require climate change policy responses that are both comprehensive in scope but tailored to highly localised circumstances.

The Australian Government has taken these national circumstances into account in formulating its climate change strategy. This chapter describes those circumstances, outlining the opportunities and constraints that Australia faces in engaging in action on climate change. This includes: government structure; demography; economic performance; energy and waste profiles; industry, settlement, and transport characteristics; and climate and landscape features. These national circumstances provide the foundation upon which Australia's tailored climate change response can be understood.

2.1 Australia – geography, demography & government

Mainland Australia is the world's largest island and smallest continent, with a land area of 7.7 million square kilometres. It spans approximately 3700 kilometres from north to south and 4000 kilometres from east to west. In area, Australia is the sixth largest country in the world after Russia, Canada, China, the United States and Brazil. Its ocean territory, which is the third largest in the world, spans three oceans and covers almost 14 million square kilometres.

Australia's population of 23 million people is small relative to its physical size and is concentrated along the east and west coastal regions. More than 80 per cent of Australians live within 100 kilometres of the coastline, with around two per cent in remote or very remote inland areas. The population is not only coastal but highly urbanised, primarily in the state and territory capitals of Sydney, Melbourne, Brisbane, Perth, Darwin, Hobart, Adelaide and Canberra. In 2012 more than 15 million people lived in Australia's major cities.

Over the past ten years, Australia's population has increased by 16 per cent or 3.1 million people. All states and territories experienced population growth over the 12 months to 30 September 2012. This growth is due to natural increase and net overseas migration: 27 per cent of Australia's population was born overseas.

Australia's population is projected to continue to grow strongly out to 2020 and an underlying ageing trend has been evident in recent decades. Population growth is a strong driver of emissions growth, and is an important consideration for the Australian Government when projecting future emissions trajectories.

Australia has a federal system of government with three levels: Commonwealth (the Australian Government), state and territory (New South Wales, Victoria, Queensland, Western Australia, South Australia, Tasmania, the Australian Capital Territory and the Northern Territory) and local. Local government bodies are created by legislation at the state and territory level and there are currently around 700 local government authorities.

Australia has a written constitution that sets out core functions of the Australian Government, for example, foreign relations and trade, defence and immigration. States and territories are responsible for matters not assigned to the Commonwealth. In practice the two levels of government cooperate in many areas.

The Council of Australian Governments (COAG) is the peak intergovernmental forum for inter-jurisdictional cooperation in Australia, comprising of the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association. The role of COAG is to initiate, develop and monitor the implementation of policy reforms that are of national significance and which require cooperative action by Australian governments.

COAG is supported by a network of ministerial councils that lead on sector specific or issue based policy matters. The responsible Ministers from the state, territory and Commonwealth governments participate in the councils.

In February 2011 the network of ministerial councils underwent significant reform. At this time a number of new councils were created including a Select Council on Climate Change (SCCC). The SCCC was established to support an effective response to climate change policy issues with national implications. It provided a forum for the Australian Government to engage with state, territory and local governments, and the New Zealand Government on program implementation issues. The SCCC played an important role in streamlining mitigation measures in the lead up to, and after the implementation of, an economy wide price on carbon on 1 July 2012. In April 2013 Australian governments took the decision to dissolve the SCCC and devolve climate change coordination to a range of existing standing councils. The following standing councils are expected to play a key role in collaborative climate change efforts across Australian governments:

- Energy and Resources;
- Environment and Water;
- Police and Emergency Management;
- Transport and Infrastructure; and
- Health.

The Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education is the lead agency responsible for providing policy advice on climate change matters, and coordinating the implementation of Australia's climate change strategy; covering mitigation, adaptation and international policy activities.

2.2 Economy

As a result of decades of structural and policy reforms, the Australian economy is increasingly integrated with global markets. Australia has progressively dismantled or cut tariffs and now has low barriers to international trade and investment. Microeconomic reforms have created substantial competition across the economy, including in key areas such as the energy generation, finance, air transport and telecommunications sectors.

Australia's economy has grown continuously for over 21 years. Between 1992 and 2011 Australia's average economic growth was 3.5 per cent compared to an average of 2.2 per cent for OECD countries. For the 2011-2012 financial year, Australia's nominal gross domestic product (GDP) was $1.47 trillion, an increase of 4.9 per cent from 2010-11. Australia's strong economic growth has boosted domestic living standards and consumption. Despite a weaker global outlook, the fundamentals of the Australian economy remain strong and the outlook remains positive. The Australian economy grew 2.5 per cent in the 2012-13 financial year.

For the 2011-12 financial year Australia's nominal GDP per capita was around $64 725, an increase of 3.4 per cent from the previous year. Over the medium term, rising per

capita incomes in developing economies, further global trade liberalisation and economic integration are expected to continue to drive demand for Australia's commodity exports and maintain the pattern of trade with growing Asia–Pacific markets.

2.3 Energy

Australia is the world's ninth largest energy producer, accounting for 2.7 per cent of the world's energy production. Australia's energy production is dominated by coal, which accounts for around 60 per cent of energy production, followed by uranium (20 per cent, which is all exported), natural gas (13 per cent), and oil (6 per cent). Renewable energy accounts for about 2 per cent of primary production in Australia, but is expected to grow due to measures such as the Renewable Energy Target.

Australia has a large, diverse energy resource base which includes coal, uranium, natural gas, oil and renewable energy resources. With the exception of oil, these resources are expected to last for many decades, even as production increases. Australia's energy resource base could further increase as more resources are discovered, renewable energy technology develops, and extraction costs decrease.

Unlike many OECD countries, Australia is a net energy exporter. In the 2010-11 financial year, net energy exports represented around 63 per cent of Australian production. The value of Australia's energy exports has grown rapidly over recent years as prices have risen strongly, primarily due to increasing demand from growing non-OECD economies. Earnings from energy exports were around $75 billion in 2011–12 (Figure 2.1), accounting for 34 per cent of the total value of Australia's commodity exports.

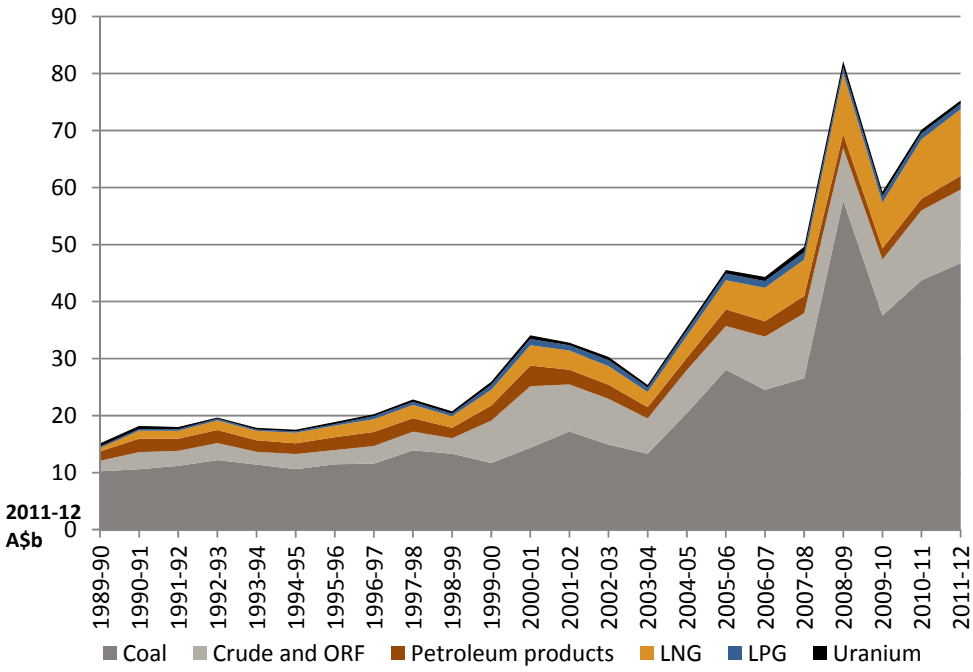


Figure 2.1 Australia's energy exports, 1989-90 to 2011-12
Source: BREE 2013, Energy in Australia

2.3.1 Fuel types

Coal

Australia has a substantial coal resource, with significant reserves of both black and brown coal. A large proportion of Australian black coal resources are high-quality bituminous coals, characterised by low sulphur and low ash content. As of December 2012, Australia had demonstrated black coal resources of around 71 billion tonnes, of which around 57 billion tonnes were considered economically recoverable. Economically recoverable brown coal resources are currently estimated at 44 billion tonnes, or 25 per cent of the world's economic demonstrated resources. The proportion of economic demonstrated resources to current production is estimated at 500 years for brown coal and 100 years for black coal.

Australia accounts for 6 per cent of world black coal production, around 97 per cent of which is sourced from New South Wales and Queensland. The coal industry is one of Australia's largest export sectors with earnings of around $48 billion in 2011-12. More than 80 per cent of Australia's black coal production is destined for export, where it generates more than half of Australia's energy export trade. Continued global reliance on coal has led Australia to commit to investment in the development of industrial-scale carbon capture and storage technology to reduce carbon dioxide emissions.

Oil

Australia has relatively small oil and gas resources and is a net importer of crude oil and refined petroleum products. Australia's oil and gas resources encompass crude oil, condensate and naturally occurring liquefied petroleum gas. The proportion of crude oil reserves to current production is estimated at around 11 years. In the absence of major new discoveries, oil production in Australia will continue to decline due to the maturity of Australia's existing production areas.

Natural Gas

Australia has significant natural gas resources— identified natural gas resources have increased threefold over the past 20 years and there is significant potential for further gas discoveries.

More than half of Australia's natural gas production is exported in the form of liquefied natural gas (LNG); around 19 million tonnes (worth $12 billion) in 2011-12. LNG exports have increased rapidly in recent years with the opening of new liquefaction plants in Darwin in 2005 and Karratha in 2012. This growth is expected to continue with a number of new LNG export projects in Western Australia, Queensland and the Northern Territory either committed to or under construction.

Uranium

Australia has the world's largest economic demonstrated resource of uranium (1196 kilotonnes) and, after Kazakhstan and Canada, is the world's third largest producer with more than 11 per cent of world uranium production. Australia has no significant national

demand for uranium and all production is exported under stringent conditions to ensure it is used only for peaceful purposes.

2.3.2 Renewable Energy

Australia's production of renewable energy is currently dominated by hydroelectricity and biomass, with wind, solar and biofuels accounting for the remainder. Except for hydro, where the available resource is already mostly developed, and wind energy where use is growing more strongly, these resources are largely undeveloped and could contribute more to Australia's future energy supply. As the most arid inhabited continent in the world, Australia has little further large-scale hydroelectric generation potential, but is currently operating hydroelectric power stations with a total installed capacity of 7.8 gigawatts.

Australia has significant non-hydro renewable energy potential and is investing in emerging renewable energy technologies. Wind and solar power, in particular, have grown strongly in recent years. Electricity generation from these sources has increased, and is expected to continue increasing considerably. Substantial private and public sector investment has also been made to develop other renewable energy resources such as geothermal and ocean energy.

Furthermore, the emissions trading scheme and the 2020 Renewable Energy Target are improving the competitiveness of alternative, cleaner technologies by requiring emissions-intensive fossil fuels to compete with renewable technologies on a playing field that reflects the real cost of greenhouse gas emissions (See Chapter 4 for details of these policies). The Bureau of Resource and Energy Economics projects that Australia's renewable energy production will be more than four times larger in 2050 than it is today.

2.3.3 Domestic energy consumption

Australian primary energy consumption is dominated by readily available, low-cost fossil fuels, predominantly petroleum and coal. In the 2010-11 financial year, the share of coal in total consumption fell to 35 per cent – its lowest contribution since the early 1970s – as a result of substitution away from coal to other energy sources in the electricity generation sector. Petroleum use, however, has been increasing steadily in recent years and now represents 36 per cent of total energy consumption. Renewable energy consumption provided around 4 per cent of total energy consumption in 2010-11. Reflecting its relatively high standard of living, Australia is the world's seventeenth largest consumer of non-renewable resources, ranking eighteenth on a per person basis.

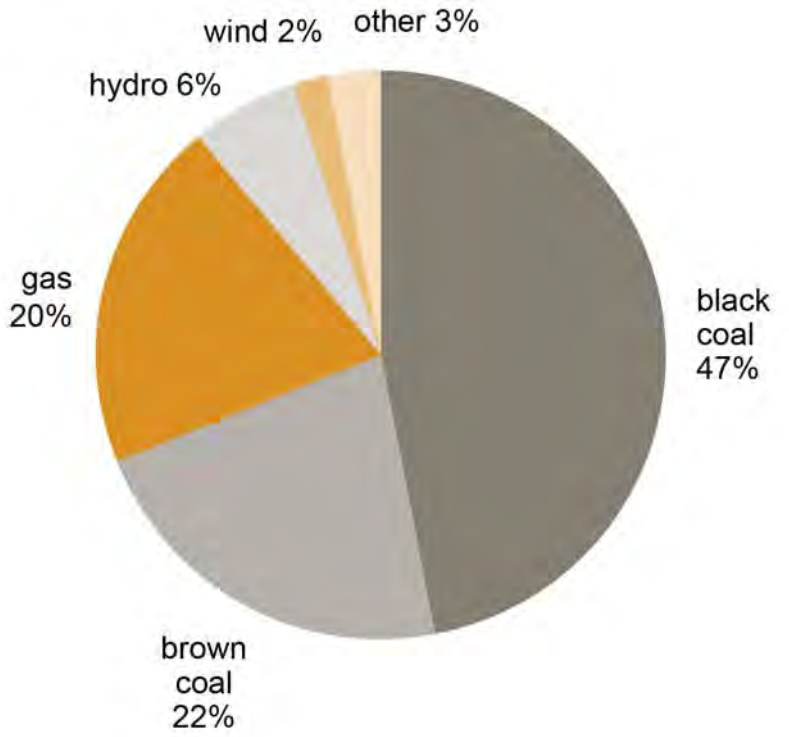
The electricity generation sector is the largest consumer of energy inputs and has historically been one of the fastest-growing sectors. Other major energy-using sectors are the transport and manufacturing sectors. Together, these three sectors account for more than 75 per cent of Australia's energy consumption.

In terms of energy consumption these sectors are followed by the mining, residential and commercial services sectors. Despite falling energy prices and robust economic growth,

annual average growth in primary energy consumption has increased slowly over the past two decades, reflecting improving energy efficiency and structural shifts in the Australian economy away from energy intensive industries.

2.3.4 Electricity

In 2010–11, total electricity production in Australia was around 252 terawatt hours (900 petajoules). Increased gas-fired and renewable generation has offset falling coal-fired generation in recent years. Despite this, black coal is expected to remain the most commonly used fuel in electricity generation until at least 2035; it represented 46 per cent of electricity generation in 2010-11 (figure 2.2). Generation in the National Electricity Market (NEM) has been declining since 2008-09, however off-grid generation has been increasing rapidly, supported by the growth in the mining industry. Factors that are restricting growth in total energy generation include reduced demand arising from rising retail electricity prices and milder weather, increases in energy efficiency and long-term structural changes associated with the growth of small-scale generation, particularly household rooftop solar photovoltaics.



a Other includes oil, bioenergy, solar PV, and multi-fuel fired power plants

Source: BREE preliminary estimates

Figure 2.2 Australian electricity generation, by energy source 2011-12

2.3.5 Energy market structure

State and territory governments regulate exploration, development, safety, environmental assessment and royalties of energy markets in their respective jurisdictions. Commercial exploration and development of oil and gas is undertaken entirely by the private sector but is actively promoted through government-sponsored production and dissemination of basic geospatial information.

The Australian energy market has been progressively reformed to create a national market for electricity and enhance the maturity of the gas industry. The NEM, comprising a wholesale sector and a competitive retail sector, is structured around a common pool, or spot market, for trading wholesale electricity. It provides an interconnected transmission network that allows for market-determined power flows across the participating eastern Australian states. All electricity produced by market generators must be traded through the central spot market.

The Australian Energy Market Operator, established in July 2009, operates the electricity and gas markets throughout much of Australia (excluding Western Australia and the Northern Territory which operate separate markets), and is responsible for long-term national electricity transmission planning and gas market information. The Australian Government published the Energy White Paper in 2012, which sets out a strategic policy framework to address the challenges in our energy sector and positions Australia for a long term transformation in the way the country produces and uses energy.

2.4 Industry

Australia's economic growth has historically been based on the production of mineral, energy and agricultural commodities. While these sectors are still important, the services sector, including the banking, finance, tourism and retail sectors, is making an increasing contribution to growth in Australia's economy. This trend mirrors the industrial profiles of most developed economies over recent decades. In March 2013, the finance and insurance services industry contributed the most to GDP in terms of industry gross value, at 9.7 per cent, followed by manufacturing at 8.2 per cent, construction at 7.8 per cent and mining at 7.3 per cent.

While Australia's economic outlook is strong with high demand for our natural resources, the recent unusual combination of a sustained high Australian dollar and falling commodity prices has posed challenges to Australia's export industries, particularly manufacturing. Future sectoral emissions will be influenced by trends in these economic factors. An overview of the key industries which contribute most to Australia's greenhouse gas emissions profile is outlined below.

Australia has an abundance of mineral resources and ranks as one of the world's leading mining nations. The **mining industry** makes a significant contribution to Australian export earnings contributing 7.3 per cent of Australia's total GDP in 2010-11. Between 2006-07 and 2010-11 the value of exports from the mining industry more than doubled to

$136 billion. The industry contributed 55 per cent of the total value of goods exported from Australia in March 2013, an increase of 37 per cent from 2006–07. The vast majority of employees within the mining sector work in remote and regional areas of Australia. In terms of wages and salaries, the largest industry contributors were metal ore mining ($5.6 billion or 33 per cent) and coal mining ($4.1 billion or 25 per cent).

Key **manufacturing industries** include the heavy engineering industry, the automotive industry and the wood, pulp and paper industry. The **automotive industry** is Australia's leading exporter of manufactured goods. In 2010–11, the sector exported automotive goods valued at $3.8 billion, motor vehicles at $2.6 billion and automotive components at $1.2 billion. Major export markets for vehicles were Saudi Arabia, the United States and New Zealand, and major markets for components were the United States, South Korea and New Zealand. The **wood, pulp and paper industries** represent a large segment of Australian manufacturing and contribute particularly to the economic and social wellbeing of rural and regional Australia. Australia's native and plantation forests provide the majority of the timber and a significant proportion of the paper products used by Australians.

The **construction industry** is closely linked to other parts of the Australian economy, such as manufacturing, wholesale and retail trade, and finance and insurance. The construction industry undertakes activity related to three main categories: residential building (e.g. houses, flats); non-residential building (e.g. offices, shops, hotels) and engineering construction (e.g. roads, bridges, water, sewerage, mines). Construction activity is carried out by both the public and private sectors. In 2010-11, the value of construction work done for the public sector was $48 billion and for the private sector was $119 billion (an increase of 6 per cent from 2009-10).

2.5 Transport

Travel plays a significant role 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. It is also due to the distances between natural resources and manufacturing and market centres, and the distances between Australia and its trading partners. Australia relies heavily on land transport networks (road and rail) to move freight and people in and between cities, and to major ports.

Australia's major population centres are located along the coastline but are separated by long distances. Significant amounts of freight are transported between these centres; by road Brisbane is 982 kilometres north of Sydney, which is 872 kilometres north of Melbourne. Adelaide is positioned on the southern coastline and is 731 kilometres west of Melbourne, 2781 kilometres east of Perth and 3020 kilometres south of Darwin. Hobart is separated from the other capitals by both distance and the waters of Bass Strait.

The transport sector is consequently the largest user of final energy, that is, energy in its final processed form, with around 39 per cent of final energy use employed in moving people and goods across the country. The transport sector is also the largest final user of

liquid fuels, accounting for around three-quarters of Australia's final liquid fuel use. Australian demand for liquid fuels has risen steadily over the past decade and consumption of refined petroleum products, and their associated emissions, is projected to grow.

2.5.1 Passenger transport

Australian cities have comparatively low urban population densities and are characterised by extensive suburban land use patterns that result in significant distances between localities. As a result Australian cities require greater intra-city travel and reliance on private vehicles. While public transport remains important in urban areas, private vehicles remain the principal mode of transport for the general public. Of the 16.7 million motor vehicles registered across Australia, as at January 2012, 12.7 million were registered as passenger vehicles.

Petrol is the predominant fuel source for cars, powering approximately 83 per cent of the Australian vehicle fleet. The number of vehicles registered with diesel fuel in 2012 accounted for 15.9 per cent (or 2.7 million vehicles) of the total fleet compared with 11.2 per cent of vehicles in 2007.

2.5.2 Domestic freight transport

Around two-thirds of domestic freight uplifted in Australia is hauled by road and 26 per cent by rail. Road transport accounts for 80 per cent of freight movements when the distance travelled is less than 100 kilometres. Registrations of rigid trucks with a gross vehicle mass (GVM) greater than 20 tonnes have increased by 22.3 per cent since 2007, while registrations of rigid trucks with a GVM of 20 tonnes or less have increased by 11.1 per cent over the same period.

A large proportion of rail freight involves intrastate movements of bulk commodities from their area of production to the seaport or processing location. 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. Road transport remains important in the long distance freight market on the north–south corridor linking cities along the eastern seaboard, whereas rail is more important in the east–west market of southern Australia.

2.6 Landscape and environment

Australia is endowed with an exceptional variety of landscapes and seascapes and is the world's largest island with the third largest marine estate of any nation in the world. Australia has many unique and iconic landforms, ranging from the eroded volcanic rock of the Glasshouse Mountains on the north-east coast, to the flat and expansive Nullarbor Plain in the south-west of the continent. Australia's marine reserves extend from the tropical seas of the north, encompassing the World Heritage Listed Great Barrier Reef to the sub-Antarctic waters of the Southern ocean.

Australia has been geographically isolated from other continents for 35 million years, which has resulted in the evolution of a unique biota. More than one million different native species call Australia home. This diversity has been internationally recognised and has led to Australia's classification as one of only seventeen mega-diverse countries.

More than 80 per cent of the country's flowering plants, mammals, reptiles and frogs are unique to Australia, along with most of its freshwater fish and almost half of its birds. Australia has more than 140 species of marsupials, including koalas and wombats, and also hosts the monotremes (egg-laying mammals). The most distinctive of which is the platypus, a river-dwelling animal with a duck-like bill, a furry body and webbed feet.

Australia's unique natural heritage is preserved through its National Reserve System, which in 2010 included more than 9700 terrestrial protected areas, covering around 103 300 hectares, or more than 13 per cent of Australia's land area. In 2012, the Australian Government established 40 new Commonwealth marine reserves around Australia building on the existing marine network and resulting in a total area of 3.1 million square kilometres of ocean being managed primarily for biodiversity conservation. This represents the largest system of marine reserves in the world.

Australia's special endowment of landscape, biota and marine diversity poses challenges for understanding and managing the impacts of climate change. The vulnerability of Australia's natural ecosystems to the impacts of climate change is discussed in Chapter 6.

2.7 Climate

The Australian continent covers a large range of climate zones, from the tropics in the north to the arid interior and temperate regions in the south. Overall, Australia is the driest of all inhabited continents, whilst experiencing considerable rainfall variability both across the region and from year to year. This variability sets Australia apart from the majority of other countries listed in Annex I to the UNFCCC.

2.7.1 Temperature

The annual average temperature in Australia has increased by 0.9 degrees Celsius (°C) since 1910, with most of the warming trend occurring since 1970, with significant regional variation (see Figure 2.3). Temperature data shows that the summer of 2012-13 was Australia's warmest on record, setting more than 100 heat-related records including; hottest summer, hottest month and hottest day on record. Each decade since the 1950s has been warmer than the preceding decade.

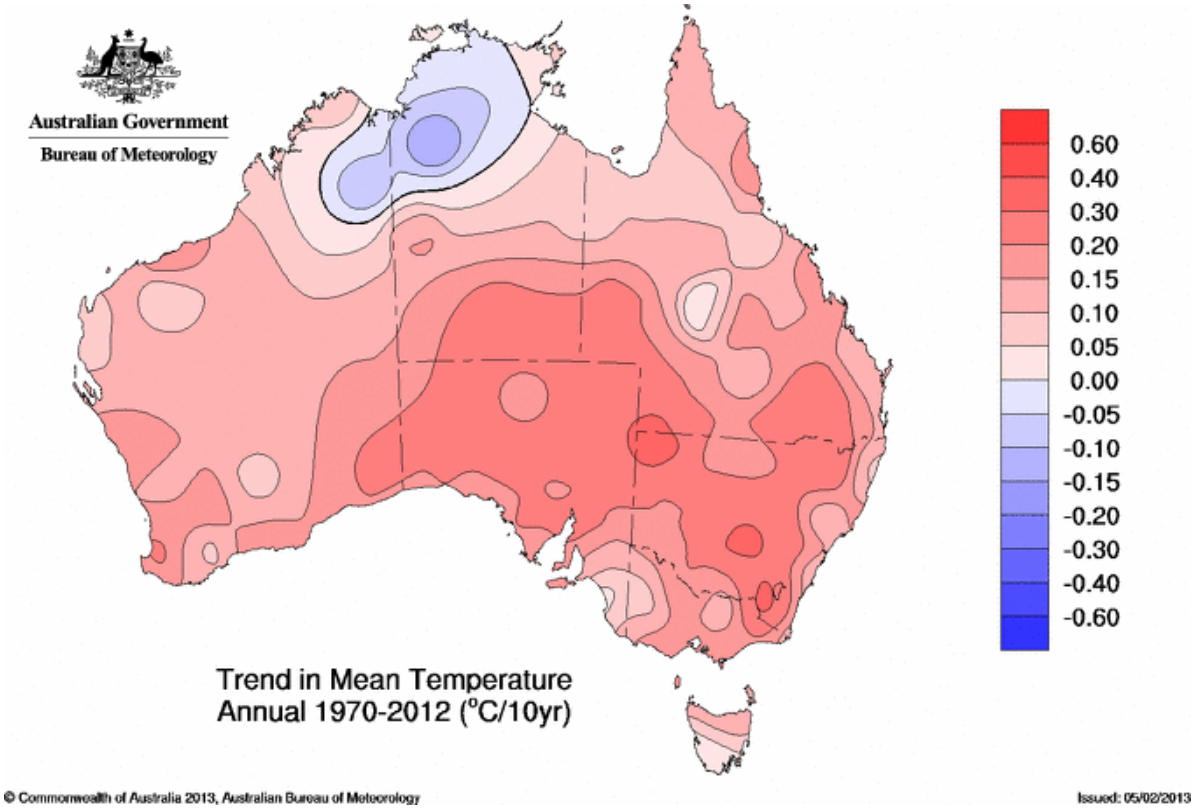


Figure 2.3: Trend in Mean Temperature across Australia, 1970-2012 (°C).

2.7.2 Rainfall

Australia's rainfall is highly variable, due primarily to the influence of large-scale modes of variability such as the El Niño-Southern Oscillation, the Indian Ocean Dipole and the Southern Annular Mode. During recent decades, there has been a general trend towards increased spring and summer monsoon rainfall across Australia's north, higher than normal rainfall across central parts of the continent, and decreased late autumn and winter rainfall across southern Australia. The south-west of Western Australia has experienced a 15 per cent decrease in the May to July rainfall since the mid-1970s (see Figure 2.4).

Recent research provides evidence that the Millennium Drought of 1997-2009 was the worst drought on the instrumental record (since 1865) when south-eastern Australia had its lowest 13-year rainfall total on record. This was followed by very strong La Niña events in 2010 and 2011, which brought the highest two-year Australian-average rainfall total on record. Despite these high rainfall events, in 2010 the south-west of Western Australia experienced its lowest rainfall on record and only average rainfall during 2011.

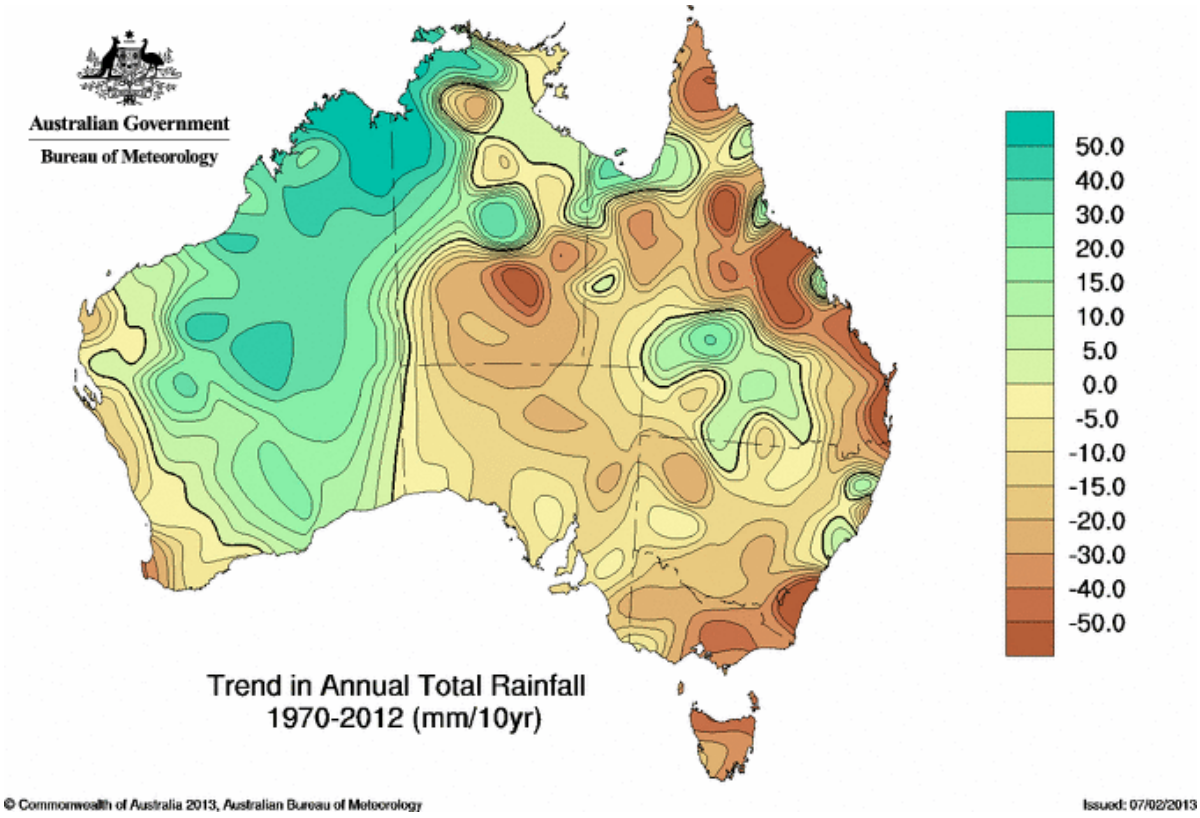


Figure 2.4: Trend in Annual Total Rainfall across Australia, 1970-2012 (°C).

2.7.3 Extreme events

Australia experiences many extreme weather phenomena, including droughts, floods, tropical cyclones, severe storms and bushfires. Individual extreme events occur as a result of a number of contributing climatic factors. While it is difficult to isolate the role of climate change in any given event, long term records demonstrate that we are now experiencing changes in the frequency and intensity of most climatic extreme events.

For example, in recent decades Australia has experienced an increasing number and intensity of heatwaves and bushfire weather. Weather associated with high fire danger showed a rapid increase in the late 1990s to early 2000s at many locations in south-eastern Australia and the number of record hot days annually has more than doubled in the last 50 years, with cold days declining. In early January 2013, unprecedented temperatures were experienced across Australia, with a record breaking seven consecutive days where the national average maximum daily temperature exceeded 39 C. This heatwave contributed to extreme bushfire conditions with extensive bushfires across New South Wales, Victoria and Tasmania.

2.7.4 Climate change projections

Australian average temperatures are expected to rise by 1 to 5 °C by 2070 when compared to the climate of recent decades. Climate model projections suggest long-term drying over southern areas during winter and over southern and eastern areas during

spring. The combination of drying and increased evaporation means soil moisture is likely to decline over much of southern Australia. Warmer and drier conditions are likely to also lead to further increases in fire weather risk.

Cyclones, storms, floods and other extreme weather events are likely to change in severity or frequency. For example, intense rainfall events in most locations will become more extreme, driven by a warmer, wetter atmosphere and there are likely to be slightly fewer tropical cyclones in a warmer world, but a greater proportion of severe cyclones. Tropical cyclones may also shift further south in the future.

2.8 Agriculture

Agriculture is the most extensive form of land use in Australia. In 2011, the estimated area of farms was 410 million hectares, representing about 53 per cent of Australia's total land area. Most of Australia's agricultural businesses are engaged in beef/dairy cattle farming, sheep farming, grain growing or a mixture of two or more of these activities. The primary agricultural activity in 2009-10 was beef cattle farming, comprising nearly a third of businesses classified to the agriculture industry.

Australia's agricultural industries have utilised the country's large land area to produce substantially more than is required for the domestic market. Australian agriculture has subsequently become export oriented, with exports in recent years comprising some 60 per cent of agricultural production. The proportion of production that is exported varies by agricultural subsector:

- Wool and cotton (virtually all);
- Wheat and sugar (approximately three quarters);
- Beef and wine (approximately two thirds); and
- Sheep meat and milk production (around half).

Favourable weather conditions and increased rainfall since Australia's Fifth National Communication resulted in increased crop and horticulture production and a jump in livestock numbers from 2010. Australia's largest crop, wheat, increased in production to 27 million tonnes in 2010-11, a rise of approximately 25 per cent. Rice, cotton, barley, canola and sorghum crops also rose significantly due to increased availability of irrigation. Sheep and lamb numbers recovered from the long-term decline experienced up until 2009-10, and meat and dairy cattle numbers also increased significantly.

While the majority of crops benefited from excellent seasonal conditions and rainfall, production in tropical and northern Australia (in particular sugarcane, bananas, pineapples and paw paws) declined due to the effects of flooding and Tropical Cyclone Yasi.

In general, Australian agriculture is heavily influenced by seasonal conditions that can cause high volatility in productivity estimates. As a consequence, greenhouse gas emission trends from agriculture are sensitive to Australia's relatively high climate variability.

2.9 Forestry

In 2011 Australia had 108.2 million hectares of forest, covering approximately 14 per cent of the continent. Of this, 106.2 million hectares are native forest and 2 million hectares are plantation forests. In 2011, forest land was a net sink of 102.1 million tonnes (Mt) CO_2-e; an increase of 56.7 Mt CO_2-e since 1990. This increase was primarily due to reduced land clearing, partly as a result of increased government regulation of land clearing practices.

Forest land is subject to considerable inter-annual variability in emissions and removals, with the key drivers of variation being annual harvest areas, the age class of the forests, climate variability and wildfires. Of these, wildfire is the biggest cause of variability in emissions from forest land. For example, in early 2013 wildfires in Australia's island state of Tasmania caused significant damage to a number of national parks and forests. In 2009 wildfires in the state of Victoria burned approximately 430 000 hectares of land. Beyond the significant impact major wildfires have on Australia's emissions profile, these wildfires also lead to soil erosion and affect water quality across forest tenures. Consequently, resulting natural regrowth contributes to reduced water yields in affected catchments for decades.

2.10 Building stock and urban structure

A comparatively high abundance of land, coupled with continued population growth and widespread car availability, has resulted in patterns of low urban density of development across Australia. The majority of Australians live in houses rather than terraces, townhouses or apartments. In 2009-10, more than three-quarters of all households (79 per cent) occupied separate houses, down from 81 per cent in 1994. The majority (40 per cent) of these separate houses had three bedrooms while a further 30 per cent had four or more bedrooms.

Australian households are becoming smaller on average with the number of persons per household declining from 3.1 in 1976 to 2.6 in the 2009–10 financial year. In the same period, there has been a slow but steady increase in the size of Australian dwellings with the average number of bedrooms per dwelling increasing from 2.8 to 3.1.

2.11 Waste

During the 2009-10 financial year, 53.7 million tonnes of waste was generated within the Australian economy. On average, each household in Australia is estimated to produce almost 1.5 tonnes of waste each year. Australia's fast-growing material-intensive economy and strong population growth have contributed to the continued growth in the amount of waste generated each year. Also, the average number of occupants per household is decreasing resulting in an increase in the ownership of more durable goods per person and in the consumption of smaller-serve goods that have higher packaging-to-product ratios.

The largest volume of waste generated by industry and households was masonry materials, which accounted for 37 per cent (19.8 million tonnes) of the total waste generated in 2009-10. Organic waste was the second largest type of waste generated, representing 24 per cent (12.8 million tonnes) followed by paper and cardboard with 12 per cent (6.4 million tonnes). This waste is either disposed to landfill, recovered for the domestic economy or exported. Of the total waste generated in 2009-10, 25.2 million tonnes was recovered domestically, 24.9 million tonnes was disposed to landfill and 3.7 million tonnes was exported.

In order to minimise waste generation and its environmental impacts including emissions, a National Waste Policy has been developed. This policy, agreed by all Australian environment ministers in November 2009 and endorsed by COAG, sets Australia's waste management and resource recovery direction to 2020. The policy sets directions in six key areas and identifies 16 priority strategies that would benefit from a national or coordinated approach. This nationally coordinated approach covers wastes, including hazardous wastes and substances, in the municipal, commercial and industrial, construction and demolition waste streams and covers gaseous, liquid and solid wastes. Radioactive waste is excluded.

Waste currently accounts for 2 per cent of Australia's national inventory of greenhouse gas emissions. Since 1990, emissions from the waste sector have declined by around 26.3 per cent in the year to December 2012 compared to the1990 base year. As outlined in Chapter 3, there has been a significant decline in emissions of waste methane from landfill due to methane recovery.

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CHAPTER 3

National Greenhouse Gas Inventory

3.1 Overview of national emissions 37
3.2 Emissions by greenhouse gas type 41
3.3 National inventory systems 45
3.4 National registry 60

Key Developments

Since the Fifth National Communication on Climate Change Australia has:

- developed more accurate and comprehensive emissions estimates following the adoption of new data, methods and source/sink categories;
- incorporated data collected under the National Greenhouse and Energy Reporting Act 2007 into the national inventory; and
- improved the national inventory system through strengthening of the planning, information technology and quality control systems.

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, Australia has an obligation to prepare, publish and update greenhouse gas inventories on an annual basis.

Australia's most recent inventory covers the year 2011 and was submitted to the UNFCCC Secretariat in 2013. In accordance with UNFCCC requirements, this chapter provides a summary of the inventory results for the period 1990 to 2011. Additional summary tables are included in Annex I. A complete report of greenhouse gas emissions and removals and their associated estimation methodologies can be found in Australia's **NATIONAL INVENTORY REPORT 2011**.

Under the Kyoto Protocol, Annex I Parties are required to have in place a national system for estimating greenhouse gas emissions and removals, and for reporting and archiving inventory information. The national system ensures the quality of the inventory through planning, preparation and management of inventory activities. This chapter outlines the main components of Australia's national system.

In accordance with the reporting requirements for the Kyoto Protocol, this chapter also includes a description of the structure and functions of the national registry (the Australian National Registry of Emissions Units).

3.1 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 fuel);
- industrial processes;
- solvent and other product use;
- agriculture;
- land use, land-use change and forestry; and
- waste

The inventory covers the major greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). Also covered in ancillary fashion are the indirect greenhouse gases: carbon monoxide (CO), oxides of nitrogen (NO_X), and non-methane volatile

organic compounds (NMVOCs). Sulphur dioxide (SO_2), an aerosol precursor, is also included because emissions of this gas influence global warming.

Geographical coverage of the Australian inventory includes the states and mainland territories, associated coastal islands, and external territories (Norfolk Island, Christmas Island, Cocos Islands, Heard and McDonald Islands, Coral Sea Islands, and the Ashmore and Cartier Islands). Australia's Antarctic Program operations in the Antarctic are also covered.

Box 3.1 Australia's national greenhouse accounts

The National Inventory Report is the cornerstone of the national greenhouse accounts. It enables Australia to meet its international reporting obligations and provides information at a sectoral level according to the classification system of the Intergovernmental Panel on Climate Change (IPCC).

The IPCC process-based classification was designed with ease of estimation and verification of national emissions in mind. Some stakeholders find the classification system does not meet their needs. Complementary classifications of emissions within the national inventory that better address the needs of users have been developed.

The national inventory is embedded within a set of national greenhouse accounts. These provide more information for users with respect to Australia's emissions on both a regional and industry basis. They also provide additional quality control for the inventory in terms of enhanced consistency, transparency and comparability.

In addition to the National Inventory Report the Australian national greenhouse accounts include:

- the Australian Greenhouse Emissions Information System (AGEIS).
  The AGEIS is an online database that provides detailed greenhouse gas emissions data from the National Greenhouse Accounts. Data is available at the national and state level and can be queried through a dynamic interface and search function;
- quarterly updates, which provide a preliminary estimate of emissions for the latest quarter. These products also give an assessment of Australia's progress against the Kyoto Protocol target;
- an overview of the state and territory greenhouse gas inventories; and
- the National Inventory by Economic Sector, which comprises emissions estimates by economic sector (rather than by IPCC sectors, as in this report).

The national greenhouse accounts are available on the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education's website.

The greenhouse gas emissions and removals reported in this chapter have been prepared in accordance with the accounting rules that apply for the UNFCCC. There are some differences between the UNFCCC rules and the rules used for the Kyoto Protocol, most notably those for the land use, land-use change and forestry (LULUCF) sector[1].

[1] LULUCF emissions and removal under the Kyoto Protocol accounting framework are restricted to a subset of activities (i.e. afforestation, reforestation and deforestation) that have occurred since 1990.

This means that the emissions totals and trends for the purposes of the UNFCCC and the Kyoto Protocol are different.

3.1.1 Emission profile

In 2011, Australia's total greenhouse gas emissions— excluding the LULUCF sector— were 552.3 million tonnes (Mt) CO_2 equivalent (CO_2-e) (see Table 3.1). Energy-related emissions (stationary energy, transport and fugitive emissions from fuels) dominate Australia's emissions profile; contributing 76.4 per cent of total emissions in 2011 (see Figure 3.1). Emissions associated with the agriculture sector are also a significant component (15.2 per cent) of the inventory. The emissions from the industrial processes and waste sectors are relatively minor.

When the LULUCF sector emissions and removals are included in the total, Australia's net greenhouse gas emissions in 2011 were 511.9 Mt CO_2-e[2]. From year to year the LULUCF sector may change from a net source to a net sink. In 2011, the LULUCF sector was a net sink of 40.3 Mt CO_2-e.

3.1.2 Emission trends

According to the accounting provisions of the UNFCCC, Australia's total greenhouse gas emissions (excluding the LULUCF sector) increased by 32 per cent between 1990 and 2011. When the LULUCF sector emissions and removals are included, Australia's net greenhouse gas emissions in 2011 decreased by 2 per cent compared with 1990 levels.

Sector	1990	2010	2011	Change 1990-2011	
				Mt CO_2 e	per cent
Energy	289.2	421.6	422.0	132.9	46.0
Stationery Energy	194.7	295.4	293.2	98.4	50.5
Transport	62.0	85.7	87.6	25.6	41.2
Fugitive emissions from fuels	32.4	40.5	41.3	8.9	27.4
Industrial processes	24.7	32.1	33.3	8.6	35.0
Agriculture	86.5	81.6	84.1	-2.4	-2.7
Waste	17.4	13.5	12.8	-4.6	-26.5
Total net emissions (excluding LULUCF)	**417.7**	**548.7**	**552.3**	**134.5**	**32.2**
Land use, land-use change and forestry	106.3	39.1	-40.3	-146.7	-138.0
Total net emissions (including LULUCF)	**524.0**	**587.8**	**511.9**	**-12.1**	**-2.3**

Table 3.1 Net greenhouse gas emissions (Mt CO_2-e) by sector in Australia, 1990, 2010 and 2011

[2] This total does not reflect Australia's emissions and removals under the Kyoto Protocol.

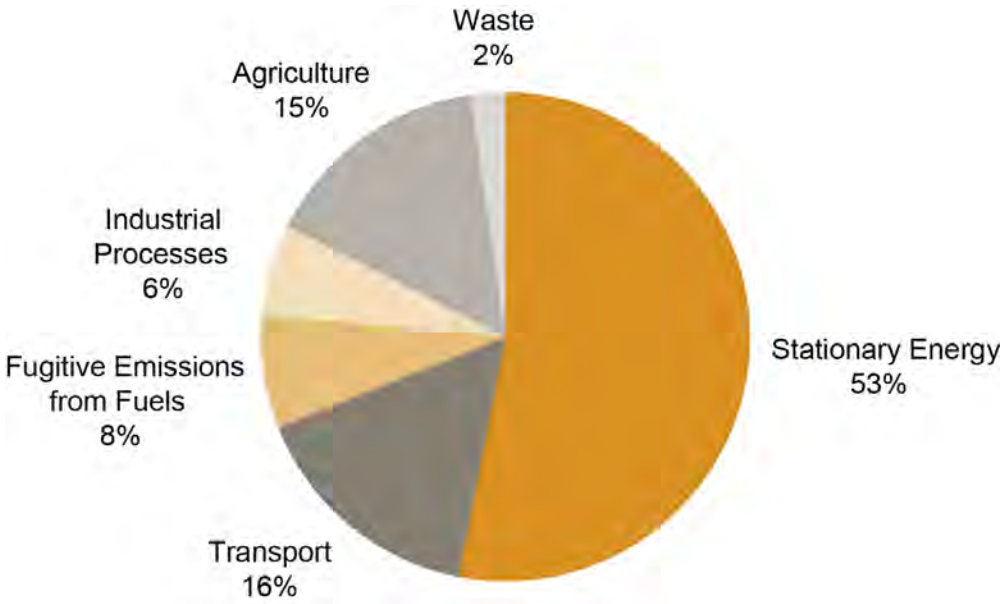

Figure 3.1 Contribution to total CO_2-e emissions by sector in Australia, 2011 (excluding LULUCF)

Sectors with increasing emissions over the period 1990 to 2011 included stationary energy (up 50.5 per cent), transport (up 41.2 per cent), fugitive emissions from fuels (up 27.4 per cent) and industrial processes (up 35.0 per cent). Waste (down 26.5 per cent), agriculture (down 2.7 per cent) and LULUCF (down 138.0 per cent) decreased.

The principal drivers of these emissions trends are as follows:

- **Energy**: The largest sectoral increase in greenhouse gas emissions over the period 1990 to 2011, of 50.5 per cent (98.4 Mt CO_2-e), occurred in the stationary energy sector, driven in part by increasing population, household incomes and increasing exports from the resources sector. The main driver for the increase in transport emissions is continuing growth in household incomes and numbers of vehicles. Fugitive emissions have increased due to increased production from open cut coal mines.
- **Industrial processes**: The increase in emissions since 1990 is primarily driven by the growth in emissions associated with HFCs and the chemical industries.
- **Agriculture:** Between 1990 and 2001, emissions increased due to increased fertiliser use and savanna burning. From 2002 to 2010, emissions declined due to prolonged and widespread drought conditions over southern and eastern Australia, which contributed to reductions in animal populations, crop production, fertiliser use, and associated emissions. With the return to wetter conditions, emissions have begun to increase again as high levels of crop production have been achieved and livestock populations have increased as farmers rebuild their herds following the drought.
- **Waste**: The net emissions from waste have decreased. Increases associated with growing populations and industrial productions have been offset by increased CH_4 recovery.
- **LULUCF:** By 2011, the net land use, land use change and forestry emissions had decreased from 106.3 Mt CO2-e in 1990 to -40.3 Mt CO2-e in 2011. The underlying

trend of declining emissions from LULUCF since 1990 has been mainly driven by the decline in emissions from forest land converted to cropland and grassland. Change in LULUCF emissions from year-to-year are affected by other factors, principally natural disturbances such as wildfire and inter-annual climate variability.

3.2 Emissions by greenhouse gas type

In 2011, CO_2had the largest share of the 511.9 Mt of greenhouse gases in Australia's inventory, at 71 per cent (363.5 Mt) of total CO_2-e emissions, followed by CH_4, which comprised 22.3 per cent (114.2 Mt CO_2-e). The remaining gases made up 6.7 per cent (34.2 Mt CO_2-e) of Australia's greenhouse gas emissions (see Table 3.2).

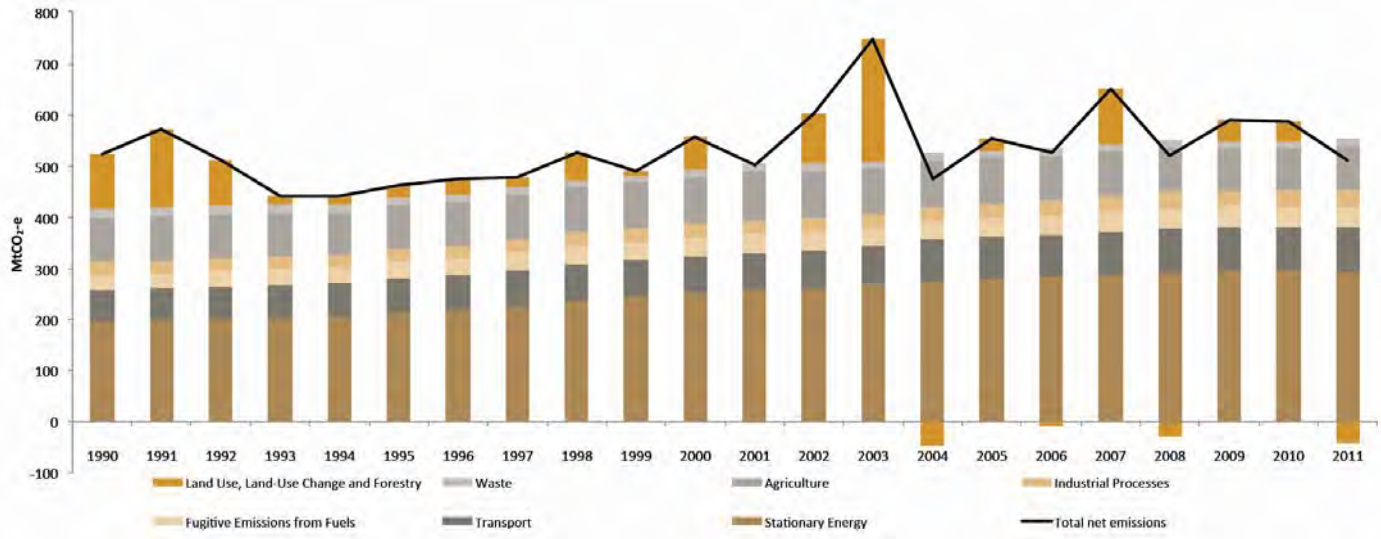

Figure 3.2 **Trends in CO2-e emissions and removals by sector in Australia, 1990 to 2011**

Greenhouse gas	1990		2011		Change Mt CO_2-e
	Mt CO_2-e	per cent of total	Mt CO_2-e	per cent of total	
Carbon dioxide (CO_2)	377.4	72.0	363.5	71.0	-13.9
Methane (CH_4)	120.9	23.1	114.2	22.3	-6.7
Nitrous oxide (N_2O)	20.4	3.9	26.2	5.1	5.8
Hydrofluorocarbons (HFCs)	1.1	0.2	7.6	1.5	6.5
Perfluorocarbons and sulphur hexafluoride (PFCs and SF_6)	4.2	0.8	0.4	0.1	-3.8
Total CO_2-e emissions	**524.0**	**100**	**511.9**	**100**	**-12.1**

Table 3.2: **Australia's net greenhouse gas emissions by gas, 1990 and 2011**

3.2.1 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 384 Mt in 2011, of which stationary energy accounted for about 75.7 per cent; transport around 22.3 per cent and fugitive emissions the remaining 2 per cent. The largest single contributor to CO_2 emissions was electricity generation (which relies mainly on coal), followed by road transport.

Greenhouse gas	1990	2011	Change Mt CO_2 e	Change per cent
Energy	259.6	384.0	124.5	47.9
Stationary energy	191.8	290.8	99.0	51.6
Transport	60.7	85.6	25.0	41.1
Fugitive emissions from fuels	7.1	7.7	0.5	7.7
Industrial processes	18.2	22.5	4.3	23.5
Waste	0.07	0.03	- 0.04	- 59.6
Total net emissions (excluding LULUCF)	**277.9**	**406.6**	**128.7**	**46.3**
Land use, land-use change and forestry	99.5	- 43.1	- 142.6	-143.3
Total net emissions (including LULUCF)	**377.4**	**363.5**	**- 13.9**	**- 3.7**

Table 3.3 **Total CO_2 emissions and removals (Mt) by sector in Australia, 1990 and 2011**

Emissions of CO_2 (excluding the LULUCF sector) increased by 46.3 per cent between 1990 and 2011. During this period, CO_2 emissions from the energy sector increased by 47.9 per cent while those in the industrial processes sector increased by 23.5 per cent.

The LULUCF sector is another major source of CO_2 emissions. In 2011, net CO_2 emissions from LULUCF were -43.1 Mt, which represents a significant decrease from 1990 levels. The trends in the LULUCF sector emissions are primarily driven by inter-annual climate variability and natural disturbance.

3.2.2 Methane

Australia's CH_4 emissions (Table 3.4) amounted to 114.2 Mt CO_2-e in 2011. This represents a decrease of 5.6 per cent from 1990 emission levels.

The agriculture sector accounted for around 57.5 per cent of national CH_4 emissions in 2011 (excluding LULUCF). Livestock contributed 87.3 per cent of CH_4 emissions from this sector through enteric fermentation and the decomposition of animal waste. Smaller quantities of CH_4 were generated through rice cultivation, burning of savannas and field burning of crop residues.

Sector	1990	2011	Change Mt CO_2-e	Change per cent
Energy	28.0	35.4	7.4	26.4
Stationary energy	2.2	1.4	-0.7	-33.9
Transport	0.6	0.4	-0.2	-37.6
Fugitive emissions from fuels	25.2	33.6	8.3	33.1
Industrial processes	0.1	0.1	0.0	-16.5
Agriculture	71.1	64.8	-6.3	-8.9
Waste	17.01	12.37	-4.6	-27.3
Total net emissions (excluding LULUCF)	**116.1**	**112.6**	**-3.6**	**-3.1**
Land use, land-use change and forestry	4.8	1.6	-3.2	-66.4
Total net emissions (including LULUCF)	**120.9**	**114.2**	**-6.7**	**-5.6**

Table 3.4 **Total CH_4 emissions (Mt CO_2-e) by sector in Australia, 1990 and 2011**

In 2011, CH_4 emissions from the agriculture sector were 8.9 per cent lower than in 1990 due to reduced animal numbers and rice cultivation as these industries continue to recover from recent droughts.

Fugitive emissions from fuels accounted for about 29.8 per cent of national CH_4 emissions (excluding LULUCF). Approximately 82.9 per cent of these fugitive emissions came from the mining of coal for domestic use and export. Fugitive emissions from coal mining have increased by 33.1 per cent between 1990 and 2011. 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 and flaring in underground mines.

Another significant contributor to CH_4 emissions is the waste sector, which accounted for 11 per cent of the national total. Anaerobic decomposition of organic matter in landfills generated 80.8 per cent of the CH_4 emissions from this sector. There was a

27.3 per cent decrease in waste sector CH_4 emissions between 1990 and 2011—as rates of CH_4 recovery from waste have improved significantly since 1990.

3.2.3 Nitrous oxide

Australia's N_2O emissions (Table 3.5) were 26.2 Mt $CO_{2\text{-}e}$ in 2011. This was a 28.4 per cent increase from 1990 emission levels. The agriculture sector accounted for 77.4 per cent of national N_2O emissions (excluding LULUCF). Most of this was produced from the application of fertiliser and animal wastes to agricultural soils. Burning of savannas, field burning of agricultural residues and manure management accounted for the balance. N_2O emissions in this sector increased by 25.5 per cent between 1990 and 2011 due to increasing intensification of the livestock industries and increased application of fertilisers.

The transport subsector accounted for 6.4 per cent of the N_2O inventory. Emissions of N_2O from transport more than doubled between 1990 and 2011 due to an increase in the number of vehicles using three-way catalytic converters.

Sector	1990	2011	Change Mt CO_2 e	Change per cent
Energy	1.58	2.60	1.03	65.2
Stationary energy	0.76	0.96	0.20	26.2
Transport	0.78	1.61	0.83	107.5
Fugitive emissions from fuels	0.04	0.03	-0.01	-21.1
Industrial processes	1.06	2.68	1.62	153.3
Agriculture	15.46	19.39	3.94	25.5
Waste	0.33	0.39	0.06	19.8
Total net emissions (excluding LULUCF)	**18.42**	**25.06**	**6.65**	**36.1**
Land use, land-use change and forestry	1.98	1.13	-0.85	-42.9
Total net emissions (including LULUCF)	**20.40**	**26.20**	**5.80**	**28.4**

Table 3.5 **Total N_2O emissions (Mt CO_2-e) by sector in Australia, 1990 and 2011**

3.2.4 Fluorinated greenhouse gases

Emissions of HFCs increased by 578 per cent between 1990 and 2011. HCFC-22 was produced in Australia from 1990 to 1995 and by-product emissions of HFC-23 peaked at

1.4 Mt CO_2-e in 1993. The use of HFCs in Montreal Protocol industries commenced in 1994, and estimated emissions from this source have increased to 7.6 Mt.

Most emissions of PFCs in Australia are generated during aluminium production. Better management of the aluminium smelting process and a shift of production to smelters with lower PFC emissions rates resulted in emissions declining from about 4 Mt CO_2-e in 1990 to 0.3 Mt CO_2-e in 2011. This is a fall of about 93 per cent, despite an increase in aluminium production of 57 per cent (1.2 Mt of aluminium in 1990 to 1.9 Mt in 2011).

Emissions of SF_6 from the electricity supply industry and miscellaneous industrial applications are estimated at 0.1 Mt CO_2-e in 2011. Between 1996 and 2000 a small quantity SF_6 was used as a cover gas in experimental work on magnesium casting.

3.2.5 Indirect greenhouse gases and SO_2

The indirect greenhouse gases (NO_x, CO, NMVOCs) and SO_2 are also reported in the inventory but as they have not been allocated global warming potentials they are not included within Australia's total aggregated emissions. Since 1990 there have been increases in the emissions of CO, NO_x, and SO_2 and a decrease in emissions of NMVOCs (Table 3.6).

The main source of NO_x is the energy sector, with energy industries as the largest single source. The agriculture and LULUCF sectors are the largest producers of CO. The Agriculture sector also produces the most NMVOC emissions.

This gas, along with CO and NO_x, are emitted during biomass burning. Emissions of SO_2 occur in the industrial processes and energy sectors. The principal sources are other metal production (65 per cent) and electricity production (25 per cent).

Greenhouse gas	1990	2011	Change per cent
Oxides of nitrogen (NO_x)	1.8	2.4	34.4
Carbon monoxide (CO)	20.8	21.3	2.2
Non-methane volatile organic compounds (NMVOCs)	2.6	2.3	-12.9
Sulphur dioxide (SO_2)	1.6	2.4	51.6

Table 3.6 **Total emissions (Mt CO_2-e) of indirect greenhouse gases and SO_2, 1990 and 2011**

3.3 National inventory systems

In accordance with Article 5, paragraph 1 of the Kyoto Protocol, Australia has put in place a national system for the estimation of anthropogenic emissions by sources, and removals by sinks, of all greenhouse gases not controlled by the Montreal Protocol. This section sets out the main components of Australia's national system.

3.3.1 Name and contact information for the national entity

The responsibility for Australia's national inventory has been assigned to a single agency: the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (the Department), under Amendments to the Administrative Arrangements Order of the Australian Government made on 26 March 2013.

The designated representative with overall responsibility for the national inventory is:

General Manager

National Inventory Systems and International Reporting Branch
Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
Australian Government
GPO Box 9839
Canberra City ACT 2601
AUSTRALIA
nationalgreenhouseaccounts@climatechange.gov.au

3.3.2 Roles and responsibilities

The Australian inventory is supported by a set of institutional arrangements that are designed to facilitate coordination of the inventory compilation, efficient emissions data management, broadly based quality assurance processes and secure and reliable data collections.

The Department is responsible for all aspects of activity data coordination, emissions estimation, quality control, improvement planning, and preparation of reports and their submission to the UNFCCC on behalf of the Australian Government.

The Department estimates emissions using the Australian Greenhouse Emissions Information System (AGEIS) and, for the LULUCF sector, the Full Carbon Accounting Model (FullCAM) (see Figure 3.3). AGEIS centralises emissions estimation, inventory compilation, reporting and data storage processes into a single system. It has been used to consolidate Australia's emissions estimation methodologies and fully integrate quality control procedures into the compilation process.

AGEIS provides high transparency levels for the set of inventory accounts, with emissions data publicly accessible through a dynamic web interface on the Department's website.

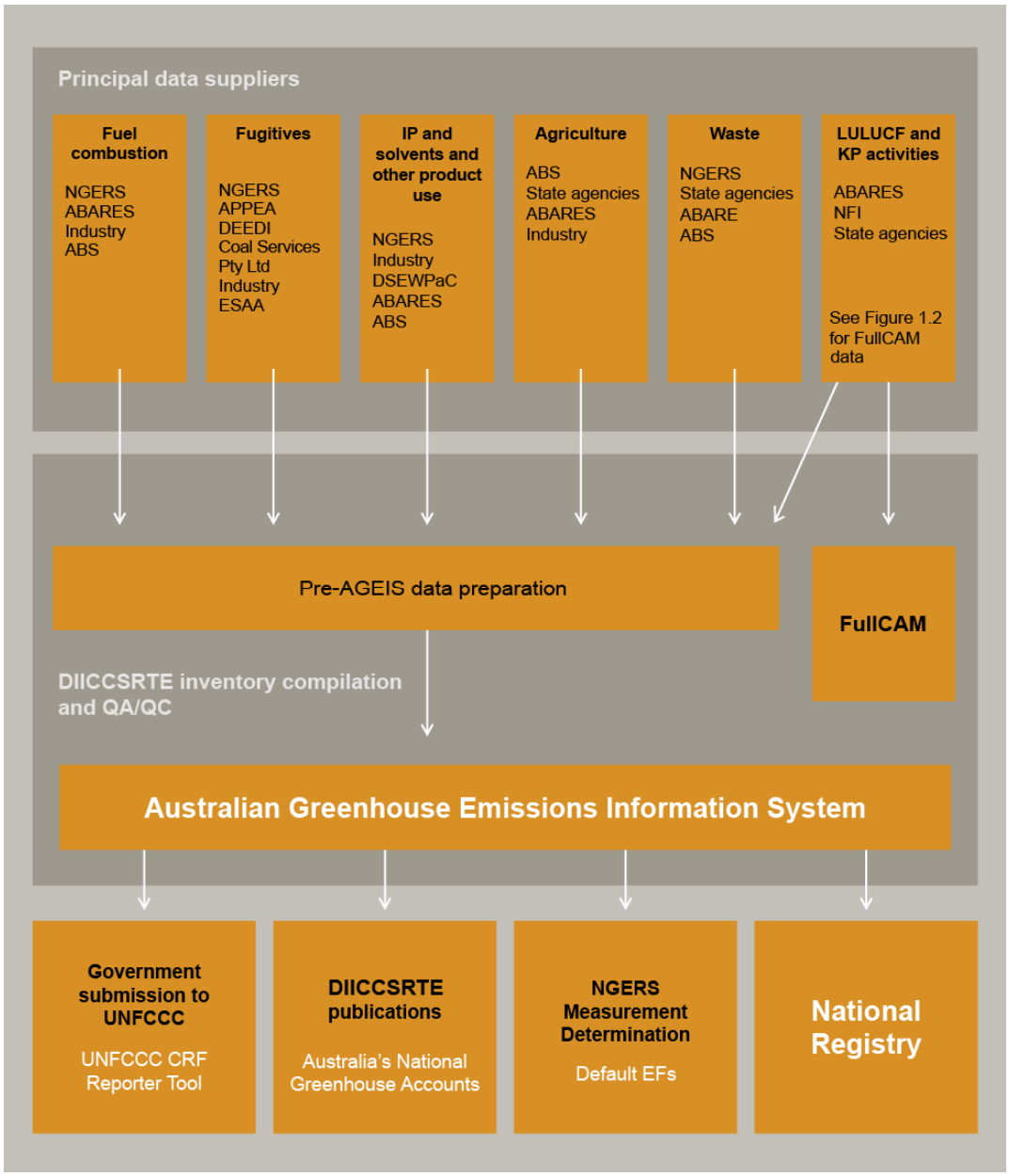

Figure 3.3 Department of Industry, Innovation, Climate Change, Science, Research, and Tertiary Education asset structures and relationships

Departmental staff and external consultants have extensive experience in inventory preparation. The Department ensures an appropriate number of staff have undergone the UNFCCC reviewer training and participated in UNFCCC expert review processes. All senior staff are qualified reviewers and have been accepted onto the UNFCCC Roster of Experts. The Australian Government has strongly supported the participation of Australian experts in the UNFCCC review process as this experience helps identify areas for improvement in Australia's inventory preparation.

Where particular technical expertise is not available within the Department, consultants are engaged to undertake inventory preparation and review tasks. The consultants pool is designed to foster a broad base of understanding of Australia's inventory systems and

to ensure that the Department meets the competition principles of the Australian Government's procurement guidelines.

In the LULUCF sector, contributors to the inventory process include the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Cooperative Research Centre for Spatial Information, universities, state government research organisations and private sector providers. These contributors fulfil various roles, from data generation to quality assurance and validation (see Figure 3.4).

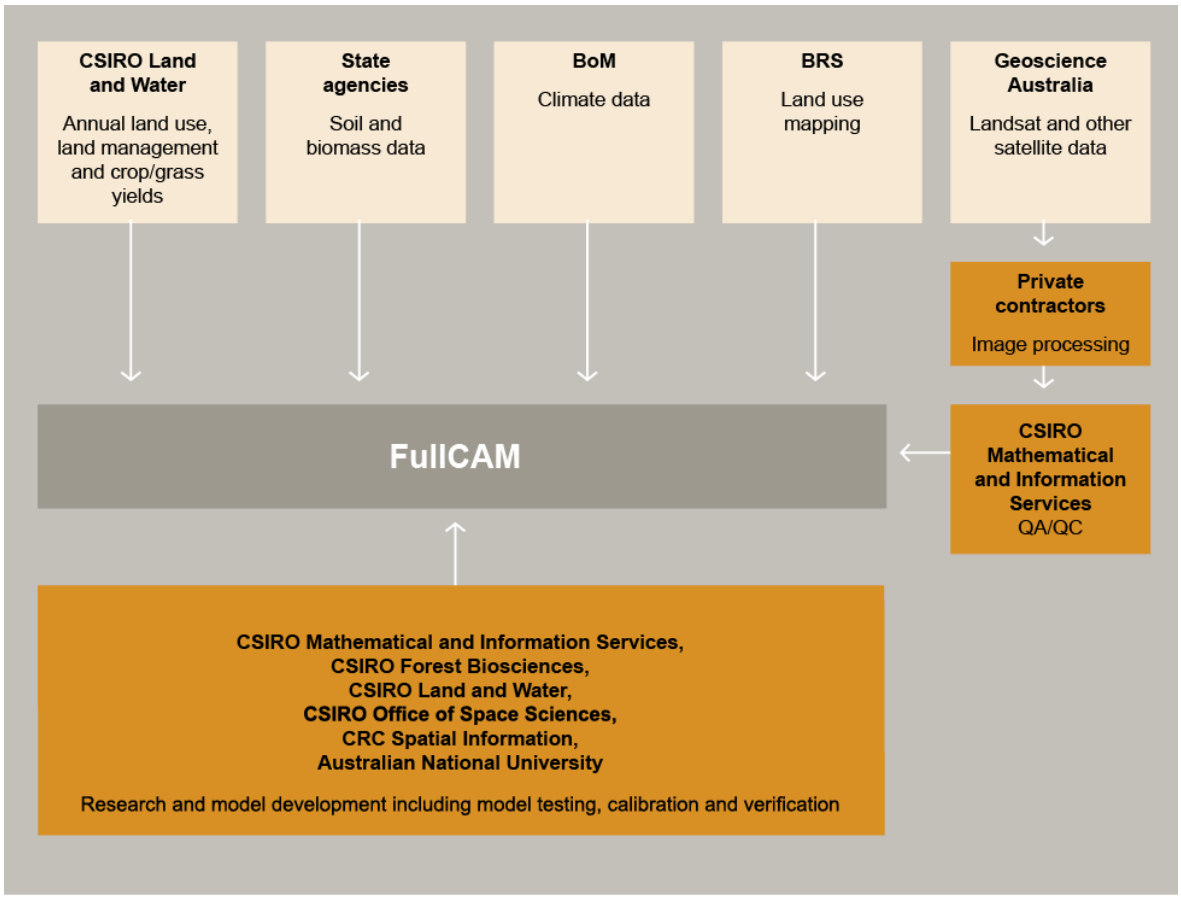

Figure 3.4 FullCAM Institutional Arrangements

The Department has instituted an annual cycle of evaluation through the preparation of an evaluation of outcomes document, providing a process for quality assurance and capture feedback to improve the national greenhouse accounts.

3.3.3 Process for national consideration and approval of the inventory

Preparation of the National Inventory Report is overseen by the Department's National Inventory Systems Executive Committee. The draft report is considered by the National Greenhouse Gas Inventory Committee which comprises representatives of the Australian, state and territory governments and the CSIRO, and has been in place since the early 1990s.

In 2011-12, the Department expanded its formal external review arrangements by adding a new consultation group, the National Inventory Users Group. This group includes key domestic users of the National Inventory data and includes members from Australia's premier science organisations, academics, and sectoral experts from the consulting sector and industry representatives. The National Inventory User Group meets twice a year to prioritise and oversee inventory improvements.

The National Greenhouse Gas Inventory Committee and the National Inventory Users Group are the principal mechanisms for formal review of the report prior to its release. The National Inventory Report is also circulated before submission to other Australian government departments and agencies and relevant state experts through the National Greenhouse Gas Inventory Committee.

Release of each year's new inventory and submission to the UNFCCC is approved by the Deputy Secretary of the Department.

3.3.4 Process for data collection, estimating emissions and archiving

Data collection

Data collection to support the preparation of Australia's inventory is managed centrally by the Department, using a mix of approaches to ensure the reliable flow of data from other agencies to support inventory preparation.

The National Greenhouse and Energy Reporting System (NGERS)

Input data to support the preparation of the national accounts for important elements of the energy, industrial processes and waste sectors are collected using the NGERS.

The legislative framework for this mandatory reporting system was established through the *National Greenhouse and Energy Reporting Act 2007*. An explicit objective of the Act is to collect information to support the development of the national inventory.

Under the NGERS, companies whose energy production, energy use, or greenhouse gas emissions (from the energy, industrial processes and waste sectors) meet certain thresholds must report facility-level data to the Clean Energy Regulator. The NGERS provides activity data inputs, such as fuel combustion, emission factors at facility level and, in some cases, directly measured emissions.

Annual reports have been submitted by companies under the NGERS to cover the Australian financial years since 2008-09. This data has been used in the preparation of the national inventory.

The rules for the estimation of activity data, emission factors and emissions by companies are well specified and set out in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Cwlth).

The estimation methodologies used for company and facility emissions are integrated within the National Greenhouse Accounts framework. This ensures consistency among

the relevant national, state and territory, industry, company and facility-level inventories. Integration of estimation methods and data is critical for ensuring that changes in emissions at the facility level are captured efficiently and accurately in the national inventory. The default methods used by companies are derived from the national inventory methods while the default emission factors have been derived using the AGEIS.

The Clean Energy Regulator manages the process of input data collection from companies and the dissemination of this data to relevant agencies. The Online System for Comprehensive Activity Reporting tool (OSCAR) is used for the collection of the input data from companies.

Audit provisions and penalties for non-compliance are set out in the *National Greenhouse and Energy Reporting Act 2007*. The Act, its regulations and detailed regulations governing the audit system are on the Clean Energy Regulator website (www.cleanenergyregulator.gov.au).

Other data sources

Where possible, the NGERS data sources are used for the energy, industrial processes and waste sectors. This data is supplemented by the use of other published data sources where necessary. The collection process for other data is well-integrated with the objectives of other programs, with a strong reliance on data collected and published by Australia's principal economic statistics agencies: the Australian Bureau of Statistics (ABS), the Bureau of Resources and Energy Economics (BREE) and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). BREE and its preceding organisations have collected energy statistics for over 35 years and utilised this data to meet Australia's reporting commitments to the International Energy Agency. The ABS is the national statistical agency with legislative backing for its collection powers. The ABS, in conjunction with ABARES, is the major source of agricultural activity data. A summary of data sources is in Table 3.7

Category (UNFCCC sector)	Principal data sources	Principal collection mechanism
Energy sector (1A1, 1A2, 1A4, 1A5)	BREE, NGERS	Published, Mandatory data reporting system
Energy sector (1A3)	BREE, ABS	Published
Energy sector (1B)	NGERS, Coal Services Pty Ltd, Queensland Department of Employment, Economic Development and Innovation (DEEDI), Australian Petroleum Production and Exploration Association (APPEA)	Mandatory data reporting system, Published
Industrial processes (2) and solvents (3)	NGERS, Department of Sustainability, Environment, Water, Population and Communities (SEWPaC)	Mandatory data reporting system Mandatory reporting of HFCs under import licensing arrangements
Agriculture (4)	ABS ABARES	Published Published
Land use, land use change and forestry (5)	Geosciences Australia ABARES	Memorandum of Understanding Published
Waste (6)	NGERS State and territory government waste agencies	Mandatory data reporting system Exchange of letters between government agencies

Table 3.7 **Principal data sources for the estimation of Australia's inventory**

The Department employs consultants to process the satellite imagery to determine land cover change for the LULUCF sector. Satellite imagery is sourced from Geoscience Australia (Australia's principal satellite ground station and data processing facility) via a memorandum of understanding. Data to support estimates of HFCs are sourced from compulsory reporting by importers under licensing arrangements under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 2003*. The collection of solid waste data from state and territory government agencies is supported by an exchange of letters between these agencies.

Box 3.2 National Greenhouse and Energy Reporting System (NGERS)

The NGERS is an integral element of the national inventory system. The rules for estimation of data and emissions at the facility level by companies are set out in the Determination made under subsection 10 (3) of the *National Greenhouse and Energy Reporting Act 2007*.

The structure of the Determination is designed to facilitate the integration of corporate and facility level data provided under the Act with international data standards on greenhouse emissions.

The scope of the Determination is given by the following categories of emission sources:

- Fuel combustion emissions from the combustion of fuel for energy (see Chapter 2 of the Determination);
- Fugitive emissions from the extraction, production, flaring, processing and distribution of fossil fuels;
- Industrial processes emissions where a mineral, chemical or metal product is formed using a chemical reaction that generates greenhouse gases as a by-product (see Chapter 4 of the Determination); and
- Waste emissions from waste disposal – either in landfill, as management of wastewater or from waste incineration.

The scope of the Determination does not include land based emissions covered by the IPCC categories Agriculture and LULUCF. Emissions from fuel combustion for land based industries are, nonetheless, covered by the Determination.

Four estimation methods are provided for under the NGERS ranging from low cost simple default methods to higher order methods requiring sampling and analysis of inputs or direct monitoring of emissions.

In general, as with the European Union Emissions Trading Scheme, reporters may choose the estimation method appropriate to their own circumstances. Some important exceptions relate to reporters in the electricity generation, underground coal mining and aluminium industries which are required to use method 2 or higher (see below) for key components of their emission estimations. These restrictions cover around 60 per cent of emissions reported under the NGERS.

The four NGERS estimation methods are:

NGERS Method 1: the National Greenhouse Accounts default method. Method 1 specifies the use of designated emission factors in the estimation of emissions. These emission factors are national average factors determined by the Department using the AGEIS. Although significantly updated, this method is very similar in approach to that used by many corporations for over a decade to report emission estimates under the Greenhouse Challenge Plus program – a voluntarily business climate change program that was run between 1995 and 2009.

The national inventory only utilises activity data collected from companies that report using this method as no new information is collected in relation to emission factors or in relation to other key facility-specific parameters.

NGERS Method 2: a facility-specific method. Industry sampling and Australian or international standards listed in the Determination or equivalent are used for analysis of fuels and raw materials to provide more accurate estimates of emissions. Method 2 enables corporations to undertake additional measurements – for example, the qualities of fuels consumed at a particular facility – in order to gain more accurate estimates for emissions for that particular facility. Method 2 draws on the large body of Australian and international documentary standards prepared by standards organisations in order to provide the benchmarks for procedures for the analysis of, typically, the critical chemical properties of the fuels being combusted. Method 2 is based on technical guidelines used by reporters under the Generator Efficiency Standards program, which was in place from 1998 until it was superseded by the NGERs in 2007.

The national inventory may utilise activity data and emission factors or other key facility-specific parameters collected by companies using this method, depending on the analysis of the quality of the data.

NGERS Method 3: a facility-specific method using Australian or international standards listed in the Determination or equivalent standards for both sampling and analysis of fuels and raw materials. Method 3 is very similar to method 2, except that it requires reporters to comply with Australian or equivalent documentary standards for sampling (of fuels or raw materials) as well as documentary standards for the analysis of fuels.

NGERS Method 4: direct monitoring of emission systems, either on a continuous or periodic basis. Method 4 provides for a different approach to the estimation of emissions. Rather than providing for the analysis of the chemical properties of inputs (or in some case, products), method 4 aims to directly monitor greenhouse emissions arising from an activity. This approach can provide a higher level of accuracy in certain circumstances, depending on the type of emission process. However, it is likely to be more data intensive than other approaches.

As for methods 2 and 3, there is a substantial body of documented procedures on monitoring practices, and state and territory government regulatory experience, which provide the principal sources of guidance for the establishment of such systems.

Estimation methodology

The Australian methodology for estimating greenhouse gas emissions and sinks uses a combination of country-specific and IPCC methodologies and emission factors. These methods are consistent with the **REVISED 1996 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES**, the **IPCC GOOD PRACTICE GUIDANCE AND UNCERTAINTY MANAGEMENT IN NATIONAL GREENHOUSE GAS INVENTORIES** and **GOOD PRACTICE GUIDANCE ON LAND USE, LAND USE CHANGE AND FORESTRY**, and are comparable with international practice.

The full description of the methods used by Australia in the estimation of emissions is provided in the **NATIONAL INVENTORY REPORT 2011**. In general, Australia's national greenhouse accounts have been moving towards a mix of tier 2 and tier 3 estimation methods that incorporate:

- facility-specific emissions estimation processes;
- characterisations of the capital and technology types at the point of emission;
- dynamic relationships that link current emissions outcomes with the activity levels of previous years; and
- spatial differences in emissions processes across Australia.

The additional complexity in the methodology allows emissions to be estimated more accurately.

The commencement of data collection under the *National Greenhouse and Energy Reporting Act 2007* provides the foundation for a progression of national inventory estimation approaches towards tier 3 or facility-specific estimation approaches within the energy, industrial processes and waste sectors.

Tier 3 approaches have been in place for fuel combustion in the electricity industry for a number of years, and from fugitive emissions from underground coal mining sources. These existing tier 3 approaches have been supported by the use of the new NGERS data. For a range of additional categories, a mix of tier 2 and tier 3 approaches will continue to be implemented over time as methods for facility-specific measurement of emissions or key data inputs are adopted by reporters and as key pre-conditions for implementation of the new methods are met. These circumstances include that the data must comply with prescribed data standards (in this case, set out in the Determination), that there is a timely and comprehensive data collection system in place, and that the resulting emission estimates for the source pass the inventory quality criteria set out in the Quality Assurance - Quality Control Plan (for example, in relation to completeness and international comparability).

Emissions estimation

The Department introduced the AGEIS into the inventory production process in 2005. The system is designed to receive input and activity data, generate emissions estimates, facilitate quality control checks, and provide secure access by the public to the emissions database.

The system is integrated with the UNFCCC Common Reporting Format Reporter Tool, which enables the smooth transfer of emissions data to the UNFCCC with the aim of improving the timeliness and quality of Australia's inventory submissions.

While the AGEIS is used for final preparation of the National Greenhouse Accounts, the inventory uses the Full Carbon Accounting Model (FullCAM) to estimate emissions and removals from the LULUCF sector and KP-LULUCF activities. FullCAM has been progressively developed to provide a greenhouse gas accounting capability for LULUCF.

The progressive development of the model is set around priorities according to the scale of emissions from either the land use activity or carbon pool. To date, spatially explicit process-based ecosystems modelling capability has been completed for the conversion of forests to other land uses (e.g. cropping and grazing), conversion of lands to forest, croplands remaining croplands and the grassland component of grasslands remaining grasslands.

Archiving

The Australian documentation systems aim to both manage and retain all data used in the estimation of emissions to ensure the continuity and security of the national inventory systems.

The AGEIS is at the heart of Australia's documentation systems as it allows efficient electronic data management and archiving of the significant quantities of data needed to generate an emissions inventory.

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Its data management functions include:

- archival and storage of the emissions estimates of past submissions;
- archival and storage of past activity data, emission factors and other parameters and models;
- archival and storage of data source descriptions, methodology descriptions and source reference material; and
- integrated access to the documentation of data sources, methodology descriptions and source reference material.

All these systems are designed to provide inventory staff ready access to all relevant materials that underpin the emissions estimates and to provide the means for replication of emissions estimates from past submissions.

AGEIS functions are supported by some additional and important elements of the documentation system:

- documentation of the inventory's emissions estimation methodologies in the National Inventory Report; and
- maintenance of a national inventory library of source material documents.

3.3.5 Key category identification

Parties to the UNFCCC are required to identify key categories to ensure use of appropriate methods and to prioritise inventory development and research efforts. A key category has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both.

Australia has identified key categories for the inventory using the tier 1 level and trend assessments, as recommended in the IPCC **GOOD PRACTICE GUIDANCE FOR LULUCF**. This approach identifies sources that contribute to 95 per cent of the total emissions or 95 per cent of the trend of the inventory in absolute terms.

When the LULUCF sector is included in the analysis, Australia has identified public electricity (solid fuel) and land converted to grassland as the most significant of the key categories (i.e. contributing more than 10 per cent of the level and/or trend) in 2011. When the LULUCF sector is excluded from the analysis, the most significant key categories in 2011 are public electricity (solid fuel), road transportation (liquid fuels) and enteric fermentation (cattle). Full analysis of the key categories is available in Australia's **NATIONAL INVENTORY REPORT 2011**.

3.3.6 Recalculation of previously submitted inventory data

Inventory estimates are periodically recalculated. This occurs for a number of reasons, including end-of-series averaging effects (for the agriculture sector), revisions in key external data sources, and revisions to data due to refinements in the estimation methodology or the inclusion of additional sources. To ensure the accuracy of the estimates, and to maintain consistency of the series through time, recalculations of past emissions estimates are undertaken for all previous years. These recalculations are conducted in accordance with IPCC guidelines and are reported in Australia's national inventory reports.

The scope of planned future refinements of the Australian inventory is set out in the Inventory Improvement Plan. It is informed by the ongoing technical review of sectoral methodologies and data sources undertaken by the Department as part of Australia's efforts to comply with inventory good practice.

Priorities for the inventory development process are informed by:

- the need to reduce uncertainty of the national emissions estimates;
- responses to international reviews;
- changing international practice and changing IPCC methodologies; and
- the need to continue to review completeness of the inventory and to identify and estimate minor additional sources.

3.3.7 Quality assurance and quality control

Quality assurance and quality control processes for Australia's national inventory systems are outlined in full in the National Inventory Systems: Quality Assurance—

Quality Control Plan. The plan has been prepared to conform with good practice (IPCC 2000, 2003) and to contribute to the production of accurate inventories in which uncertainties are reduced to the extent practicable, and which are transparent, documented, consistent over time, complete and internationally comparable.

To this end, the Department has established quality objectives for the national greenhouse account emissions estimates and for the National Inventory Report itself. The quality indicators comprise a mix of self-assessment and external assessment (in particular, by external consultants, the National Greenhouse Gas Inventory Committee and the UNFCCC expert review teams).

Quality control procedures

The key elements of the Department's quality control procedures include:

- establishment of explicitly defined quality objectives for the national greenhouse accounts together with annual evaluations of the inventory against these objectives;
- automated and systematised quality control processes built within AGEIS for all data handling and emissions estimation procedures, principally aimed at ensuring time series consistency and accuracy;
- prioritisation of quality control processes built within AGEIS to ensure effort is principally directed toward key categories;
- separation of data handling and data approval roles within the Department to improve accountability;
- auditability of quality control tools to improve accountability;
- reconciliation checks for emissions data with reference to Australia's national greenhouse accounts structure—national emissions estimates are reconciled with the aggregation of state and territory emissions estimates;
- reconciliation of IPCC emissions estimates with economic sector classification estimates; and
- reconciliation checks for emissions data to ensure completeness of activity data for fossil fuels, biomass, carbonates and synthetic gases.

Tier 1 quality control checks

Emissions estimation is conducted through the use of the AGEIS software (apart from the LULUCF sector). Management of the AGEIS is conducted in accordance with the Control Objectives for Information and related Technology (COBIT) framework.
The AGEIS was subject to a performance audit by the Australian National Audit Office in 2009.

Key tier 1 quality control procedures for the inventory compilation process have been systematically built into the operation of AGEIS. Standardised and auditable checks are undertaken, for example, to reduce the risks of errors associated with the input of activity data, missing data, recalculations, and the time series consistency of generated emissions estimates. Tier 1 checks are also implemented during the pre-processing of input data.

Extensive internal verification of emissions estimates as well as external acceptance testing of system integrity and functionality was undertaken during the development of AGEIS. Emissions estimated by AGEIS were compared with those previously reported using traditional spreadsheets to ensure that:

- emissions were calculated correctly;
- parameter and emissions units were correctly recorded; and
- data were correctly aggregated from lower to higher reporting levels.

Implementation of new estimation methodologies are undertaken using a dual estimation approach, which ensures that AGEIS emissions estimates are verified independently.

Mass balance checks have been undertaken for all years to assess completeness and accuracy. All carbon entering the economy in fuels is accounted for—either as emissions from fuel combustion, emissions from the use of fossil fuels as reductants, non-energy uses, use of biomass sources of energy or international bunkers.

Carbon balances for biomass and carbonates consumption and mass balances for synthetic gases have been constructed. Input data and implied emission factors are checked for time series consistency before submission using AGEIS software.

Tier 2 quality control checks

Category-specific quality control (tier 2) checks are conducted for all sectors to test for completeness, international comparability and verification of country-specific parameters.

Completeness and accuracy are tested through the operation of mass balance checks. The application of mass balance constraints for carbon in fuels, carbonates, biomass wastes, and HFCs and nitrogen balances for domestic and commercial wastewater constitute tier 2 quality control measures. All carbon entering the economy in fuels is accounted for, either as emissions from fuel combustion, emissions from the use of fossil fuels as reductants, non-energy uses, use of biomass sources of energy, or international bunkers. Carbon balances for biomass, carbonates and synthetic gas consumption have also been implemented. The results of these checks against the principal quality objectives are set out in the *National Inventory Report*.

International comparability of emission estimates is systematically tested through comparisons of the international emission factors obtained for significant sources of the Australian inventory with the distribution of international emission factors for all other Annex I parties.

For the energy, industrial processes and waste sectors, systematic verification tests are undertaken for country-specific parameters, such as emission factors utilising data collected under the NGERS. Country-specific parameters are tested against the NGERS datasets that meet the prescribed conditions. If the mean of the NGERS dataset is significantly different to the country-specific parameter, the parameter may be revised to reflect the new information.

The empirical research program set out in the National Inventory Improvement Plan is designed to generate information to provide the basis for verification tests for parameters in either tier 2 or tier 3 methods where private measurement activity is not undertaken.

In addition, country-specific parameters may also be subjected to verification tests on an ad hoc basis as new information is obtained.

Quality assurance procedures

Australia's quality assurance systems operate at a number of levels. Quality assurance controls that are implemented annually include:

- the Department's preparation of the inventory is overseen by the National Inventory Systems Executive Committee;
- the National Inventory Report is reviewed prior to submission to the UNFCCC by the National Greenhouse Gas Inventory Committee, which comprises representatives of state and territory governments, and the CSIRO. This is the principal formal external review mechanism for the report before it is finalised;
- inventory improvements are prioritised and reviewed by the National Inventory Users Group;
- Department estimates are reconciled by external consultants for specified sectors, including mineral, chemical and metal products within industrial processes, and agricultural soils within agriculture;
- remote sensing imagery and data inputs for the LULUCF undergoes quality assurance;
- the inventory is potentially subject to audit by the Australian National Audit Office (ANAO). The ANAO is an independent office established under The Auditor-General Act 1997. It conducts performance audits of government agencies operating under the Standard on Assurance Engagements ASAE 3500 Performance Engagements issued by the Australian Auditing and Assurance Standards Board (AUASB). ANAO reports are tabled in the Australian Parliament and subject to review by the Joint Committee of Public Accounts and Audit (JCPAA). The ANAO undertook a performance audit of the national inventory in 2009;
- inventory emission estimates and methods are open for public review through the release of transparent and easily accessible information via the Department and AGEIS webpages. Industry and public feedback is encouraged. Submissions are made through the inventory email facility: nationalgreenhouseaccounts@climatechange.gov.au;
- a public consultation process (review of the NGER Measurement Determination: Discussion paper, August 2010) provided feedback from the public on key emission factors used; and
- the government participates in UNFCCC expert review team processes that aim to review and improve the quality of all Annex I inventories in an open and facilitative manner. Australia's inventory has been reviewed by in-country teams in 2002, 2005, 2008 and 2010, with centralised reviews utilised in other years.

3.4 National registry

The Australian National Registry of Emissions Units (ANREU) is a system designed to meet one of Australia's commitments under the Kyoto Protocol. The Protocol requires each country with an emissions reduction target to establish a national registry to ensure accurate accounting of the issuing, holding, transfer, acquisition, cancellation, retirement and carryover of Kyoto units.

The ANREU was initialised with the International Transaction Log—an international system that links registries from different countries— on 19 December 2008. This system is managed by the UNFCCC Secretariat. It verifies the validity of transactions of Kyoto units including issuing, transfer, and acquisition between registries. Formal notification for Australia to issue 2 957 579 143 assigned amount units (AAUs) was received from the International Transaction Log on 14 July 2009. Australia's AAUs were issued into the registry under instruction from the then Minister for Climate Change and Water, the Hon Senator Penny Wong, on 28 July 2009.

Organisations or individuals that wish to hold Kyoto units in Australia are required to have an ANREU account. The Australian Government authorises legal entities to transfer and acquire Kyoto units using the ANREU. Each entity is required to comply with the applicable provisions of the Kyoto Protocol and the decisions of the Parties to the Protocol, including the decision 'Modalities, rules and guidelines for emissions trading under Article 17 of the Kyoto Protocol'.

This decision, along with the decision 'Modalities for the accounting of assigned amounts under Article 7, paragraph 4, of the Kyoto Protocol' provides the basis for the rules that underpin the operation of the ANREU. In addition, the Government passed the *Australian National Registry of Emissions Unit Act 2011* and the *Australian National Registry of Emissions Unit Regulations 2011*, which covers the management and operation of the ANREU.

The ANREU is administered by the Clean Energy Regulator, a statutory agency of the Government. The web address for the Australian National Registry of Emissions Units is: https://nationalregistry.cleanenergyregulator.gov.au/ .

The above decisions of the Kyoto Protocol require Australia to maintain a list of entities authorised by the Government to participate in international emissions trading and make that list available through the ANREU. Australia is also required to make certain information publicly available, and to provide an online publicly accessible user interface that allows people to query and view the information. This can be found at: https://nationalregistry.cleanenergyregulator.gov.au/report/listPublicReports

Publicly available information includes the following:

- all authorised ANREU Account Holders;
- current holdings of eligible Kyoto Protocol emission units for each Authorised Account;
- the type of account (holding, cancellation or retirement);

- the commitment period with which a cancellation or retirement account is associated; and
- authorised representatives associated with each account.

Personal information of Account Authorised Representatives, including their identification numbers, names, addresses, email and phone and fax numbers, is confidential and is not published, in accordance with Decision 13/CMP.1 Paragraph 44 of the Conference of the Parties to the Kyoto Protocol and Regulation 50 of the *Australian National Registry of Emissions Units Regulations 2011*.

Name and contact information for the Australian National Registry:

Mr Shaun Calvert
Registry Systems Administrator
Regulatory Division,
Carbon Price Operations Branch
Clean Energy Regulator
GPO Box 621
Canberra ACT 2601
Tel: +61 2 6159 3398
Email: shaun.calvert@cleanenergyregulator.gov.au

The Australian National Registry is not operated in a consolidated system with any other Party's registry.

3.4.1 Database structure and capacity of the Australian National Registry

The following is an extract from the software specifications for ANREU.

Front end server

The ANREU runs Microsoft Internet Information Services 7 (IIS) for its front-end web server. All incoming requests enter, and outgoing responses exit, though the IIS server. The IIS server rewrites URLs, then either passing it to the application server or back to the client. Secure Socket Layer (SSL) termination happens on this tier. SSL provides a secure connection between the ANREU and a client's web browser or the International Transaction Log. SSL uses a certificate which has been issued by a security authority to encrypt data moving over the unsecured internet. Beyond this point data travels unencrypted between this front-end server and the application server. This is considered internal to the application. The IIS server converts all inbound and outbound HTTP communication to HTTPS secure communications.

Requests from the International Transaction Log and responses from the ANREU follow the same pattern. However, the front end server is not used for outgoing connections to the International Transaction Log initiated by the ANREU.

Application server

The middle tier serves the ANREU web application and uses Apache Tomcat 7.0. Apache Tomcat is an open source implementation of the Java Servlet and JavaServer

Pages specifications that originally started as Sun Microsystems' original reference implementation. Tomcat runs the compiled Java Bytecode and allows for external access to application. Tomcat also provides externalized configuration for the application such as database connection details.

For outgoing requests to the International Transaction Log initiated by the ANREU web application, SSL origination occurs in the ANREU web application itself. Encrypted responses from the International Transaction Log return directly to the web application.

Database

Microsoft SQL Server 2008 provides a relational database back-end for persistent storage of data for the application.

International transaction log service

Transactions performed between the ANREU and the International Transaction Log take place through web service interfaces, following the Data Exchange Standards for Registry Systems under the Kyoto Protocol (DES). These web service interfaces are implemented using Apache Axis1 (Axis) which is an open source implementation of the Simple Object Access Protocol (SOAP). Axis supports generation of Java stub code based on the RPC/Encoded Web Service Definition Language (WSDL) specified by the DES. SOAP web services map to an internal service layer, isolating the web service code from the application code so that changes to the application can be made without affecting the International Transaction Log web service contract.

There are two web service interfaces: the client interface which allows the sending of messages to the International Transaction Log; and the server interface which allows the ANREU to receive messages from the International Transaction Log. Both of these interfaces are defined as WSDLs in the DES.

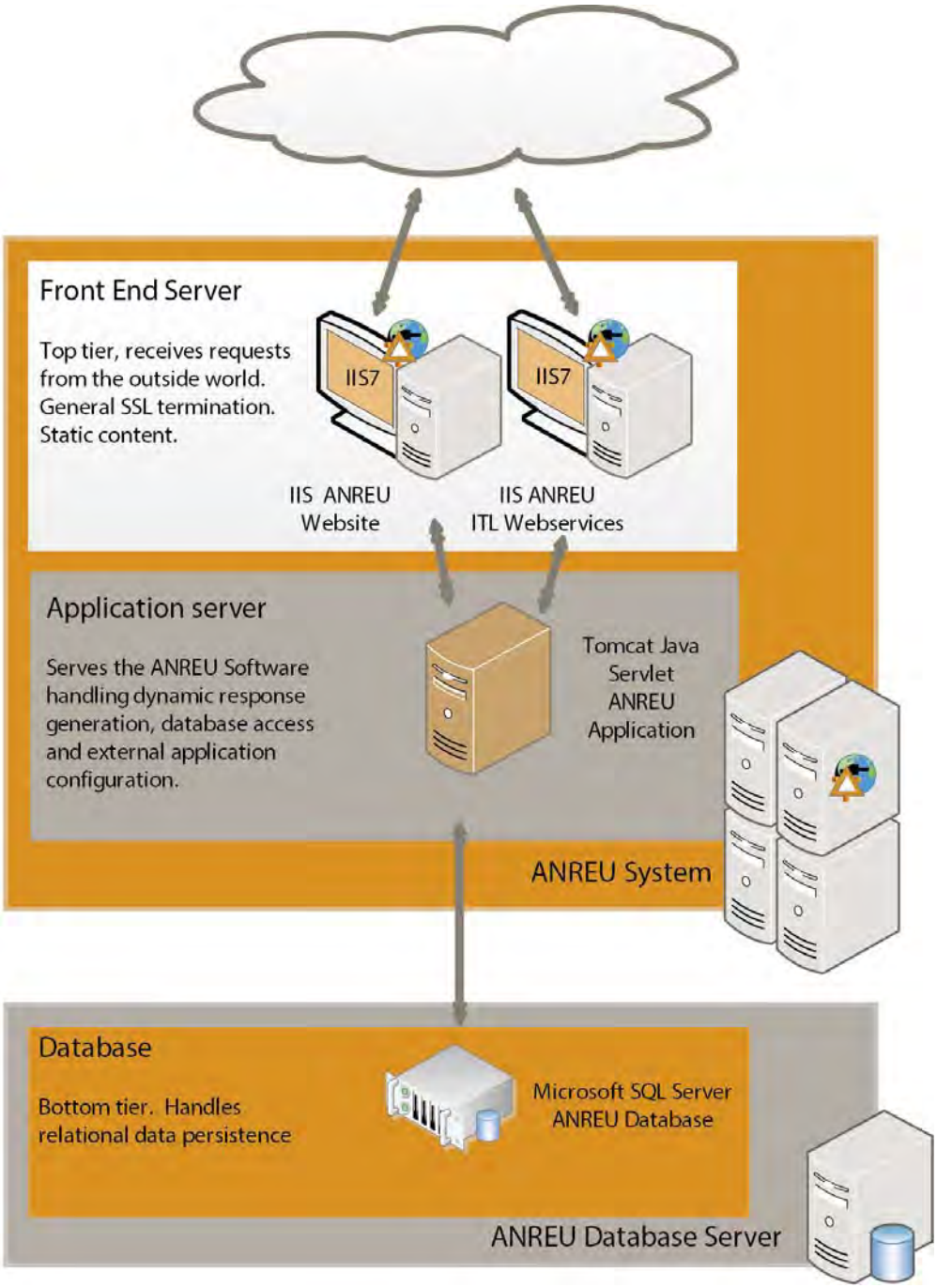

Figure 3.5 ANREU Logical Network Topology (Production Environment)

The ANREU contains the functionality to perform issuance, conversion, external transfer, (voluntary) cancellation, retirement and reconciliation processes using XML messages and web-services as specified in the latest version of the Data Exchange Standards for Registry Systems under the Kyoto Protocol (DES).

In addition, the ANREU also contains: 24 Hour Clean-up, Transaction Status enquiry, Time Synchronisation, Data Logging requirements (including, Transaction Log,

Reconciliation Log, Internal Audit Log and Message Archive) and the different identifier formats as specified in the DES.

In order to minimise discrepancies between the ANREU and the International Transaction Log, the following approach has been adopted:

- Communications between the registry and the International Transaction Log are via web services using XML messages—as specified in the DES 1.1. These web services, XML message format and the processing sequence are checked by the registry to ensure the compliance with DES;
- The registry validates data entries against the formats of information as specified in Annex F of the DES;
- The registry implements internal controls in accordance with the checks performed by the International Transaction Log, as documented in Annex E of the DES;
- All units that are involved in a transaction are earmarked internally within the registry; thereby preventing the units from being involved in another transaction until a response has been received from the International Transaction Log and the current transaction has been completed;
- The web service that sends the message to the International Transaction Log for processing ensures that a message-received acknowledgement is received from the International Transaction Log before completing the submission of the message. Where no acknowledgement message has been received following a number of retries, the web service terminates the submission and rolls back any changes made to the unit blocks that were involved;
- Where a 24-hour clean-up message is received from the International Transaction Log, the existing web service rolls back any pending transactions and the units that were involved, thereby preventing any discrepancies in the unit blocks between the registry and the International Transaction Log; and,
- Finally, if an unforeseen failure were to occur, the data discrepancies between the registry and the International Transaction Log can be corrected via a manual intervention function within the registry. Following this, reconciliation would be performed to validate that the data is in sync between the registry and the International Transaction Log. If a discrepancy reoccurs in the registry, the following measures are applied:

    - identification and registration of the discrepancy;
    - identification of the source of the discrepancy (DES, registry specifications, erroneous programming code);
    - elaboration of a resolution plan and testing plan;
    - correction and testing of the software; and
    - release and deployment of the corrected software.

For the ANREU, the following security measures have been implemented. Access to the registry is allowed via a personal username and password—allocated as a part of a registration process performed by the Clean Energy Regulator.

Users of the ANREU are divided into four security groups. These groups control the access and security at the application level. A user's login information is assigned to a user group, which determines what the user can and cannot do within the system. The registry supports the following user groups.

The **system administrator group** has global authority throughout the registry. This user is responsible not only for the day-to-day functionality of the system, but also for administrative support. This group has access to all functionality that can be provided through the registry interfaces, but does not have direct access to the database tables and the web-application server. The registry administrator is responsible for such policy-based activities as account creation, approval of forwarding instructions, monitoring notifications and messages logs, and coordinating with the International Transaction Log for reconciliations. This may include user management, managing and setting batch jobs, and reviewing audit and transaction logs.

This group is also responsible for maintaining the technical environment of the ANREU, including all hardware, software, and network concerns. This includes scheduling regular data backups and restoring data in the event of a system.

The **account administrator group** key function is to establish and maintain all account information within the ANREU. This group does not have the permissions to perform transactions, nor undertake any technical responsibilities within the application.

Provisions are made for **account holders** to have access to the registry web application. The registry provides the capability to create users with restricted levels of access by which users would only be permitted to access data relevant to their own holdings and activities. These permissions can be configured using the system administration functions. In order to prevent operator errors, the registry software incorporates validations on all user inputs to ensure that only valid details are submitted for processing. The registry displays confirmation of user input to help the user to spot any errors that had been made and implements an internal approval process (input of relevant password details) for secondary approval for relevant operations before submitting the details to the International Transaction Log for processing.

The fourth group is a read only access – **ANREU auditor** – which provides auditors the appropriate access to view all transactions and holdings to ensure compliance with the DES and Government requirements.

Information publicly accessible through the user interface to the national registry

The following public reports are available through the user interface—no logon procedures are required to view these reports:

- a list of all accounts held within the national registry;
- a list of all Authorised Account Holders;
- a report detailing current Kyoto unit holdings for each account;
- a list of all Joint Implementation projects— including details of such projects; and
- a summary report of total unit holdings and transactions for the past calendar years.

Publicly available information can be found at:
https://nationalregistry.cleanenergyregulator.gov.au/report/listPublicReports

Measures to safeguard, maintain and recover data in the event of disaster

The servers (main and backup sites) that host the ANREU are in physically secure data centres fitted with secure access control systems. All data centres are fitted with smoke detection and automatic fire suppression systems. Anti-virus software upgrades are downloaded and installed autonomously on to the servers as soon as they are released. A full backup of each database and an hourly transaction log backup during business hours takes place every day with the backup media being held at an off-site third-party secure-storage facility. The database content is also replicated at a minimum of 30 minute intervals to a secondary data centre location when the clustering environment is implemented. This serves as the hosting platform for disaster recovery.

In the event of a disaster, a decision will be taken (between the Clean Energy Regulator and the information technology contract supplier) to invoke disaster recovery. This will involve:

- stopping all transactions to the main platform;
- ensuring that the committed transactions are replicated to the disaster recovery site; and
- switching all external interaction with the main site over to the secondary location.

The information technology contract supplier is committed to resuming the service for the Clean Energy Regulator operators within eight hours of the decision being made.

Results of previous test procedures

Australia's independent assessment report is available from the UNFCCC website.

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CHAPTER 4

Policies and Measures

4.1 Policy-making process 71
4.2 Policy and measures at the national level 76
4.3 Policy and measures at the at the state, territory and local levels 111
4.4 Policies and measures no longer in place 114

Key Developments

Since the Fifth National Communication on Climate Change, Australia has implemented a broad based carbon price and refined the suite of complementary climate change policies. This comprehensive policy package provides a clear pathway for reducing Australia's greenhouse gas emissions, ensuring Australia plays its part in global action. Australia has agreed to unconditionally reduce its greenhouse gas emissions by 5 per cent on 2000 levels by 2020 and 80 per cent by 2050.

The Australian Government embarked on a renewed effort to price carbon post the federal election in 2010. A number of analysis and consultation activities were instigated to inform an updated climate change response, and build the support necessary to secure its implementation. Specifically, the Government:

- Established a Multi-Party Climate Change Committee (the MPCCC) chaired by the Prime Minister comprising Government, Greens and independent members of parliament. The MPCCC was charged with exploring options for implementing a carbon price and building consensus on how Australia will tackle the challenge of climate change;
- Requested Professor Ross Garnaut, an eminent Australian economist, update his landmark assessment of the impacts of climate change on the Australian economy and the options for medium to long term policy frameworks; and
- Commissioned updated economic modelling from the Australian Treasury to assess the impact of carbon price options on the Australian economy.

These activities underscored the importance of a comprehensive climate change response for securing Australia's future prosperity. The Australian Government's comprehensive response is the Clean Energy Future Plan – a plan to transition Australia's economy to a low emission future inclusive of a number of significant new climate change measures, including:

- An emissions trading scheme commencing on 1 July 2012 with a two-year fixed price period, which covers approximately 60 per cent of Australia's emissions;
- The Clean Energy Finance Corporation – a legislated $10 billion fund dedicated to investing in clean energy in order to drive the biggest expansion in the clean energy sector in Australian history;
- The establishment of the Australian Renewable Energy Agency to coordinate over $3 billion of funding for research, development and demonstration of new renewable energy technologies;
- The creation of an Energy Security Fund currently worth $2.5 billion to maintain secure energy supplies and underpin a successful energy market transition to a carbon price;
- A $9.2 billion Jobs and Competitiveness Program to assist emissions-intensive trade-exposed industries as they transition to the emissions trading scheme.
- A Clean Technology Program worth more than $1 billion to the Australian

manufacturing sector for energy efficiency and low emission technology upgrades; and
- The establishment of a Biodiversity Fund worth nearly $450 million and other land-based measures to help protect Australia's ecosystems, support climate change action on the land, and build land sector resilience to the impacts of climate change.

The new measures in the Clean Energy Future Plan were designed to operate in concert with a range of successful existing policies such as the Renewable Energy Target, the newly established Carbon Farming Initiative, and targeted appliance, equipment, building and industrial energy efficiency programs. A corresponding process was initiated across levels of government to identify and phase out non complementary policies upon the introduction of a carbon price.

This chapter provides a detailed overview of the evolution of Australia's climate change response and the major mitigation policies and measures at the national and sub-national level. It evidences Australia's mitigation action, demonstrating Australia's commitment to meet its obligations under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, and play its full and fair part in global efforts to prevent dangerous climate change.

Taking action on climate change is one of the Australian Government's highest priorities. As one of the hottest and driest continents on earth, unmitigated climate change poses severe threats to Australia's unique natural assets and future economic prosperity. The Australian climate system is characterised as one of extremes but the prevalence of extreme climate events and conditions in recent decades mirrors the growth trend experienced across the globe. Since the 1950s, each decade has been warmer than the last, and the summer of 2012-13 was the hottest on record - over 100 temperature records were broken across all parts of the continent. Climate change is imposing economic costs on the Australian community; taking concerted action to reduce carbon pollution now will ensure the transition to a clean energy future is more manageable and affordable.

Major changes have been made to climate change policy settings since Australia's Fifth National Communication on Climate Change. The current policy framework builds on the measures implemented by previous Australian, state, territory and local governments, and rests on three pillars: reducing Australia's emissions; adapting to unavoidable climate change; and helping to shape a global solution.

This chapter focuses on the first pillar by outlining the governance structures, policy context and policy-making processes that underpin Australia's efforts to reduce emissions, and describing the major mitigation measures. This includes those in the Clean Energy Future Plan and associated complementary and transitional measures to support all parts of the Australian community to take action.

4.1 Policy-making process

Australia's climate change policies have been informed by an extended period of research, analysis and review. These policies have been developed in close consultation with key stakeholders from government, industry, non-government organisations, environmental groups, scientists and members of the Australian public.

The period between Australia's Fifth and Sixth National Communication realised major changes in Australia's climate change policy landscape. In July 2011, the Government released the Clean Energy Future Plan; its comprehensive plan for tackling climate change comprising four key elements: a carbon price - the central element - augmented by targeted renewable energy, energy efficiency and land sector action. The Clean Energy Future Plan details how the Government will support Australian households, businesses and communities to transition to a clean energy future.

The development and implementation of the Clean Energy Future Plan, and in particular the emissions trading scheme that commenced on 1 July 2012, resulted from extensive consultation, modelling and independent advice. The foremost activities include: the Garnaut Climate Change Review and 2011 update; the Carbon Pollution Reduction Scheme White Paper, economic modelling commissioned from the Australian Treasury, policy complementarity reviews across levels of government, and the outcomes from the Prime Minister's Task Group on Energy Efficiency.

Following the formation of a minority Government after the August 2010 federal election a Multi-Party Climate Change Committee, made up of the Government, the Greens and independent members of parliament, was established to explore options for implementing a carbon price and tackling the challenge of climate change. Changes were also made to streamline governance processes across levels of government in Australia, including those relating to climate change policy.

This research, analysis, consultation and governance context is outlined in the following sections to explain the evolution of Australia's mitigation policies and measures.

4.1.1 Climate change policy making responsibility

The whole-of-government response to climate change is currently coordinated by the Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education. The Department is responsible for policy development and advice on climate change issues, both domestically and internationally, and works closely with other national agencies and other levels of government on the delivery of a national approach to climate change. The Department also liaises extensively with Australian business, the non-government sector and the community.

In the representative sphere, the forum for cooperation between the Commonwealth, state and territory governments, the Council of Australian Governments, is supported by a number of Ministerial Councils. The Ministerial Council structure was reformed in February 2011 and at this time a Select Council on Climate Change (SCCC) was

established. The purpose of the SCCC was twofold; to support an effective response to climate change policy issues with national implications, and to provide a forum for the Government to engage with states, territories, local government and New Zealand on program implementation issues. Of particular concern to emission reduction policies, the SCCC developed a national approach to assess the complementarity of existing and future climate change measures with the emissions trading scheme. This assessment methodology was used by Commonwealth, state and territory governments to rationalise policies and measures that were not considered complementary to the emissions trading scheme or were ineffective, inefficient or imposed duplicative reporting requirements on business.

Upon the implementation of the main components of the Clean Energy Future Plan, and as policy action on climate change has matured, the need for a stand-alone SCCC has dissolved. The relevant Commonwealth, state and territory Ministers recently agreed to transfer the responsibility for climate change action to the sector or issue specific Ministerial Council most relevant to the particular climate change policy consideration. This development demonstrates the continued enmeshing of climate change policy within the core policy activities of the long standing, traditional areas of government. Key Ministerial Councils that will take carriage of specific climate change matters include:

- Standing Council on Energy and Resources;
- Standing Council on Environment and Water; and
- Standing Council on Transport and Infrastructure.

4.1.2 Multi-Party Climate Change Committee

The Multi-Party Climate Change Committee (MPCCC) was formed after the Australian federal election in September 2010 resulted in a minority government.

The Prime Minister chaired the Committee, with the Deputy Prime Minister and Minister for Climate Change and Energy Efficiency (who served as co-Deputy Chair) participating with a number of the independent members of the Parliament. The Committee was advised by a panel of four independent experts, and supported by a Secretaries' Group comprised of Secretaries of Commonwealth departments involved in implementing climate change policy.

The Committee considered that an emissions trading scheme was the most cost-effective and economically responsible way of reducing Australia's carbon pollution, and that its introduction would enable Australia to play its part in global efforts to reduce the risks posed by climate change.

The Committee consulted, negotiated and reported on agreed options. On 10 July 2011, the Committee released a Clean Energy Agreement which provided essential directive and input for the Clean Energy Future Plan.

4.1.3 Key policy analysis and advice mechanisms

To develop Australia's comprehensive suite of mitigation policies and measures, the Government has employed a process of expert modelling, research and policy analysis. Some activities span back to the Fifth National Communication reporting period but many have been updated or extended since the Australia's report was submitted in 2010. All are important in understanding the development of the Clean Energy Future Plan and the streamlining of Australia's climate change policies and measures over this time. The following sections provide a chronological overview of these activities.

The Garnaut climate change review and review update

The Garnaut Climate Change Review was first commissioned by Australia's Commonwealth, state and territory governments in 2007. Professor Ross Garnaut, a distinguished Australian economist, was tasked with conducting an independent study of the impacts of climate change on the Australian economy and recommending medium to long-term policies and frameworks for addressing climate change to improve the prospects of sustainable prosperity.

Released in September 2008, the final report of the Garnaut Review represented the most extensive examination ever undertaken of how Australia is likely to be affected by climate change, and how it can best contribute to mitigation efforts while adapting to the unavoidable impacts. In producing the report, Professor Garnaut consulted a wide range of experts and stakeholders in Australia and overseas: academics; officials; government departments and public bodies; business leaders and representatives; and non-government organisations. The process was also informed by a series of public forums and specialist lectures for more than 10 000 participants around Australia, as well as a formal submission process that attracted almost 4000 submissions. Further, a number of specialist reports were commissioned on the impacts of climate change on Australia.

The Garnaut Review made clear that the costs to Australia of not acting on climate change would be greater than the costs of responsible mitigation. Moreover, the aggregate costs of action were estimated to be modest, whereas the benefits of action (and the costs of inaction) would increase over time, becoming more pronounced in the second half of the 21st century and beyond. The Garnaut Review observed that 'the overall cost to the Australian economy from tackling climate change is manageable and in the order of one to two-tenths of 1 per cent of annual economic growth' (Garnaut 2008, p. 296). It concluded that 'the costs of well-designed mitigation, substantial as they are, would not end economic growth in Australia, its developing country neighbours, or the global economy. Unmitigated climate change probably would' (Garnaut 2008, p. 268).

The Garnaut Review found that it is in Australia's national interests for a fair and effective global agreement to be negotiated and secured to deliver deep cuts in emissions consistent with stabilising concentrations of greenhouse gases at around 450 parts per million or lower. It also found that the most prospective pathway to this goal would be to embark on global action that reduces the risks of dangerous climate change and builds confidence that deep cuts in emissions are compatible with continuing economic growth

and improved living standards. The report concluded that a well-designed emissions trading scheme at the centre of a targeted suite of complementary measures represented the most efficient and effective way for Australia to achieve its mitigation objectives.

The Australian Government accepted these findings in its December 2008 White Paper for the development of the Carbon Pollution Reduction Scheme. Attempts to legislate this scheme were halted in May 2010 after three unsuccessful attempts to pass the Australian Parliament. However, after the August 2010 federal election, the Government again moved to prosecute a carbon price. To support these efforts, Professor Garnaut was asked to revisit his findings in light of the developments since September 2008 which included the Copenhagen and Cancun Conferences of the Parties, as well as the ramifications of the Global Financial Crisis. Accordingly, the Garnaut Climate Change Review—Update 2011 released a series of papers in February and March 2011 addressing developments across a range of areas including: climate change science and impacts; international mitigation progress; carbon pricing; land; innovation; and the electricity sector.

Professor Garnaut found that 'developments in science, global emissions profiles and shifts in the structure of global climate change agreements have all strengthened the national case for a stronger mitigation effort' (Garnaut 2011, p. xiv)

The report again recommended a carbon price framework be established as quickly as possible and the substantive part of the report detailed specific design parameters of a proposed emissions trading scheme with a fixed price start, including a commencement price in the range of $A20 to $A30 per tonne of greenhouse gases.

Professor Garnaut's findings fed directly into the policy deliberations in developing the emissions trading scheme and broader Clean Energy Future Plan.

Economic analysis of an emissions trading scheme

In October 2008, the Australian Treasury published *Australia's Low Pollution Future: The economics of climate change mitigation*, a report modelling the potential economic impacts of reducing greenhouse gas emissions over the medium and long term. In partnership with many of Australia's leading economic modellers of climate change, the Treasury conducted one of the largest and most complex economic modelling projects ever undertaken in Australia. The modelling spanned global, national and sectoral scales and examined distributional impacts, including the implications of emissions pricing for the goods and services that households consume.

The Treasury modelling indicated that, with efficient policy settings, Australia and the world would continue to prosper while making the emissions cuts required to reduce the risks of dangerous climate change. The report examined four different scenarios in which Australia and the world followed pathways to a low-emissions future with varying global stabilisation goals and requirements. In all four scenarios, the modelling showed prosperity increasing, albeit at a marginally slower rate than would occur under current policy settings, while ambitious stabilisation goals were achieved (CofA 2008a, p. vi).

The key conclusions from the modelling were that:

- early global action would be less expensive than later action—that is, in the event the world was to act, the countries that acted early would be advantaged;
- a market-based approach would allow robust economic growth into the future, even as emissions fell; and
- many of Australia's industries would maintain or improve their competitiveness under an international agreement to combat climate change.

The report noted that Australia's comparative advantage would change in a low-emissions world, presenting new opportunities for some sectors of Australia's economy, and that—with coordinated global action—most sectors of the economy would grow, with low-emissions sectors growing strongly and some emissions-intensive sectors maintaining or improving their international competitiveness.

The Treasury completed an updated modelling project with the results released as the *Strong Growth, Low Pollution*: *Modelling a Carbon Price* report on 10 July 2011.

While the scenarios modelled were not the same as the first exercise, the findings were broadly similar:

- the Australian economy and the global economy both continue to grow strongly as the world acts to reduce carbon pollution;
- early action is cheaper than delayed action;
- pricing carbon will drive structural change in the economy, moving production towards less emission-intensive industries. Many of Australia's industries will maintain or improve their competitiveness in a carbon constrained world; and
- the structural change in the economy driven by a market-based emissions trading scheme will be modest compared to other changes facing the economy, such as those driven by the terms of trade or demographic change.

The modelled scenarios investigated the distributional impacts of a fixed carbon price commencing in the range of $A20 per tonne moving to a floating world price of around $29 per tonne in 2015-16. They investigated a number of global mitigation pathways in terms of the resultant atmospheric concentration of greenhouse gases, commencing with the pledges made by countries at the Copenhagen and Cancun Conferences of the Parties. The analysis was particularly important in informing price setting for the fixed price period of the emissions trading scheme and the assistance for the household and emission-intensive trade-exposed sectors.

Complementary Policy Analysis

In December 2007, all jurisdictions committed to meeting a Council of Australian Governments request to review and streamline their existing climate change mitigation measures. The Strategic Review of Australian Government Climate Change Programs developed principles of complementarity and assessed whether climate change programs are efficient, effective, appropriate and complementary to the proposed Carbon Pollution Reduction Scheme.

The policy complementarity process was revisited at the beginning of 2012 through the Select Council on Climate Change leading up to the introduction of the emissions trading scheme on 1 July 2012. The original complementarity principles developed through the Strategic Review of Australian Government Climate Change Programs were revised and utilised by all jurisdictions to assess nominated measures for complementary to the emissions trading scheme. Both of these review processes identified a number of non-complementary measures, measures that would be transitional upon the introduction of a carbon price and also measures that while complementary would require some reform. The reviews resulted in streamlining of measures across Australian jurisdictions.

Prime Minister's Task Group on Energy Efficiency

The then Prime Minister, the Hon Kevin Rudd MP established a Task Group on Energy Efficiency to advise the Government, by mid-2010, on options to improve Australia's energy efficiency by 2020. The Task Group submitted a report to Government detailing recommendations to deliver a step-change improvement in energy efficiency and place Australia at the forefront of Organisation for Economic Co-operation and Development energy efficiency improvement by 2020. The report findings informed the set of energy efficiency measures that were kept in place or expanded through the Clean Energy Future Plan.

4.2 Policy and measures at the national level

At the national level, the Government's primary climate change mitigation measure is the Clean Energy Future Plan. This Plan, which cuts carbon pollution and drives investment in clean energy, has four major elements:

- **Putting a price on carbon and returning every dollar to assist households, support jobs and tackle climate change**: The central element of the Clean Energy Future Plan is the emissions trading scheme. The scheme operates in two stages. During the fixed price period the Government directly sets the carbon price (beginning at $23 a tonne for 2012-13). Then, beginning in 2014, the carbon price will be set by the market. The carbon price reduces carbon emissions by encouraging individuals and businesses to move their consumption and investment towards less emissions-intensive products. It covers more than 60 per cent of Australia's total greenhouse gas emissions across a range of sectors.
- **Promoting innovation and investment in renewable energy**: The 20 per cent by 2020 Renewable Energy Target (RET) continues to encourage the deployment of large scale renewable energy projects such as wind farms, as well as the installation of small-scale systems, including solar panels and solar water heaters. The RET is expected to drive $20 billion of investment in large-scale renewable energy by 2020, with much of this in regional and rural Australia. In addition, a new $10 billion commercially oriented Clean Energy Finance Corporation has been created to further invest in renewable energy, low pollution and energy efficiency technologies; and the Australian Renewable Energy Agency (ARENA) is providing funding of over $3 billion for research and development of renewable energy technologies.

- **Encouraging energy efficiency**: Households and local communities are improving their energy efficiency through the Living Greener website, the Community Energy Efficiency Program, the Local Government Energy Efficiency Program and the Low Income Energy Efficiency Program. In addition, the $1 billion Clean Technology Programs are providing grants for manufacturers to support investments in energy efficient capital equipment and low-pollution technologies, processes and products. And framework energy efficiency measures such as nationally consistent Greenhouse and Energy Minimum Standards, more stringent building codes, mandatory disclosure of commercial building energy performance, and smart grids technology trials will work together as a package to improve the energy productivity of the Australian economy.
- **Creating opportunities in the land sector to cut pollution and improve productivity, sustainability and resilience**: Between now and 2050, around 460 million tonnes of carbon pollution will be reduced or stored under the Carbon Farming Initiative – a domestic land sector-based offsets scheme. In addition, the Government has introduced an approximately $1 billion Land Sector Package. This measure builds on the Government's existing natural resource management activities, and makes it easier for the land sector to benefit from reducing emissions and managing carbon in the landscape – in turn creating new job opportunities and assisting to improve land sector productivity and sustainability.

The Clean Energy Future Plan will drive cuts in Australia's carbon pollution of at least 5 per cent compared with 2000 levels by 2020, which will require cutting net expected pollution by at least 23 per cent in 2020. The Government has committed to make larger cuts in pollution (up to 25 per cent by 2020) if there is stronger global action. By 2050, the Government is committing to cut pollution by 80 per cent below 2000 levels.

The remainder of this chapter details the specific elements of the Clean Energy Future Plan – beginning with the emissions trading scheme.

4.2.1 Clean Energy Legislation

The legislation underpinning the emissions trading scheme comprises:

- The *Clean Energy Act 2011* established the emissions trading scheme and contains rules for who is covered, who can elect to be covered (the "Opt-in Scheme") and what sources of carbon pollution are included. It also covers the issuance, surrender and legal status of emissions units (including the application of penalties following failure to surrender); caps on the amount of carbon pollution in the flexible price period; linking with other international emissions trading schemes; monitoring, compliance and enforcement arrangements; and information disclosure. In addition, it provides an assistance regime for emissions-intensive trade-exposed industries and the coal-fired electricity generation sector.
- The *Clean Energy Regulator Act 2011* established the Clean Energy Regulator as an independent statutory agency to administer the emissions trading scheme; the National Greenhouse and Energy Reporting Scheme; the Australian National Registry of Emissions Units; the Renewable Energy Target; and the Carbon Farming Initiative.

- The *National Greenhouse and Energy Reporting Act 2007* created a national system for the collection, reporting, assurance and dissemination of information about energy production, energy consumption and greenhouse gas emissions.
- The *Australian National Registry of Emissions Units Act 2011* created the Australian National Registry of Emissions Units – a secure electronic system designed to accurately track the location and ownership of emissions units in Australia.
- The *Climate Change Authority Act 2011* established the Climate Change Authority to advise the Government on key aspects of the emissions trading scheme (such as the price ceiling and the setting of emissions reduction targets and caps), conduct periodic reviews of climate change measures and report on Australia's progress in meeting national emissions reductions targets.

4.2.2 Emissions Trading Scheme: Key features

The emissions trading scheme is the centrepiece of the Clean Energy Future Plan. A carbon price will reduce carbon pollution in the cheapest and most effective way, and incentivise investment in clean energy sources such as solar, wind and gas. The emissions trading scheme commenced on 1 July 2012. Since that date, liable entities comprising around 370 of the biggest polluters in Australia are now required to pay a price for each tonne of carbon pollution they put into the atmosphere.

Implementation of the emissions trading scheme will occur in two stages. The first stage is a fixed price period for two years,. The carbon price started at $A23 per tonne on 1 July 2012 and rose to $A24.15 per tonne on 1 July 2013. On 1 July 2014, the carbon price will transition to a fully flexible 'cap and trade' emissions trading scheme, with the price determined by the market.

Coverage

Broad coverage of emissions ensures that the economy as a whole starts moving towards a clean energy future and that the cheapest ways of reducing pollution are implemented. Accordingly, the emissions trading scheme covers around 60 per cent of Australia's total emissions including emissions from the stationary energy sector, waste, industrial processes and fugitive sources. From 1 July 2014, coverage will be extended to include heavy on-road vehicles. Emissions from agriculture and other land-based activities are not covered by the emissions trading scheme.

Liable entities required to pay the carbon price are those that either:

- produce over 25,000 tonnes of CO2-e of greenhouse gas emission a year (excluding emissions from transport fuels and some synthetic greenhouse gases), or
- are end-use suppliers of natural gas, who are liable for the embodied emissions in the natural gas they supply to customers.

Pollution Caps

In the flexible price period, an overall limit (or cap) will be placed on Australia's annual greenhouse gas emissions from all sources of pollution covered by the emissions trading scheme. The Government will set annual caps that are consistent with Australia's national targets and international obligations. In setting pollution caps, the Government will also consider recommendations made by the Climate Change Authority.

Before the start of the flexible price period (1 July 2014), the Government will set out the caps for the first six years of the scheme's operation. From 2016, the caps will be extended each year through regulations, so that there will always be five years of pollution caps set in place. The timeline for the cap setting arrangements is outlined in Table 4.1.

Deadline	Pollution cap announced for financial year(s) beginning
31 May 2014	2014, 2015, 2016, 2017, 2018 and 2019
30 June 2016	2020
30 June 2017	2021
Pollution caps will continue to be set annually	

Table 4.1 Timeline for setting pollution caps

Emissions Trading Scheme Governance

Clean Energy Regulator	Climate Change Authority	Productivity Commission
administers	*reviews, recommends and tracks*	*reviews and reports on*
• Carbon Pricing Mechanism • Carbon Farming Initiative • Renewable Energy Target • National Greenhouse and Energy Reporting System	• Level of pollution caps • Operation of the carbon pricing legislation • Other climate change mitigation initiatives including the Renewable Energy Target and Carbon Farming Initiative • Progress towards pollution reduction targets	• International pollution reduction actions • Jobs and Competitiveness Program • Fuel excise and taxation regime

Figure 4.1 Emissions Trading Scheme Governance

Clean Energy Regulator

The Clean Energy Regulator was established on 2 April 2012 as an independent statutory agency through the *Clean Energy Regulator Act 2011*. The Clean Energy Regulator is responsible for administering the emissions trading scheme, the National Greenhouse and Energy Reporting Scheme, the Australian National Registry of

Emissions Units, the Renewable Energy Target and the Carbon Farming Initiative. In this role, it performs the following functions:

- providing education on the regulatory schemes for which it is responsible;
- operating an emissions unit registry;
- administering the National Greenhouse and Energy Reporting Scheme by requiring reporting on and disseminating company information about greenhouse gas emissions, energy production and energy consumption;
- administering the Carbon Farming Initiative by educating participants, assessing applications and issuing credits;
- administering the Renewable Energy Target by maintaining the registries for large-scale generation and small-scale technology certificates and the clearing house for small-scale technology certificates, and monitoring compliance with the *Renewable Energy (Electricity) Act 2000*;
- monitoring, facilitating and enforcing compliance with the regulatory schemes for which it is responsible (the Clean Energy Regulator's monitoring and enforcement powers include powers to conduct independent audits, information gathering and inspections; suspend or revoke permissions; accept enforceable undertakings from a regulated entity; issue infringement notices; or pursue legal action for breaches of civil penalty provisions);
- allocating units, including freely allocated units;
- accrediting auditors for the Carbon Farming Initiative, the emissions trading scheme and the National Greenhouse and Energy Reporting Scheme; and
- working with other national law enforcement and regulatory bodies, including the Australian Securities and Investments Commission, the Australian Competition and Consumer Commission, the Australian Transaction Reports and Analysis Centre, the Australian Federal Police and the Commonwealth Director of Public Prosecutions.

Climate Change Authority

The Climate Change Authority was established on 1 July 2012 as an independent statutory agency through the *Climate Change Authority Act 2011*. The Climate Change Authority conducts climate change research, advises the Government on key aspects of the emissions trading scheme (such as the price ceiling and the setting of pollution caps), conducts periodic reviews of climate change measures and reports on Australia's progress in meeting national emissions reductions targets.

The Climate Change Authority is currently conducting a review into Australia's pollution caps (the "Caps and Targets Review"). This review will recommend a 2020 target for emissions reductions in Australia, as well as annual pollution caps (or limits) for Australia's emissions trading scheme for the period 2014-15 to 2019-20. The review must be presented to the Government by 28 February 2014. In addition, the Climate Change Authority is conducting a review of Australia's progress in achieving medium-term and long-term emissions reduction targets and any national carbon budget. This review – which will be the first in a series of annual reviews – must be presented to the Government by February 2014.

Productivity Commission

Under the clean energy legislation, the Productivity Commission will conduct reviews to ensure that:

- industry assistance offered under the Jobs and Competitiveness Program and the Coal Sector Jobs Package continues to support local jobs and production and encourage industry to invest in cleaner technologies; and
- the merits of a fuel excise and taxation regime based on carbon and energy content of fuels is considered.

The Carbon Market

Eligible Emissions Units

Businesses acquit their liabilities under the emissions trading scheme by surrendering eligible emissions units. Each eligible emissions unit represents one tonne of carbon pollution emitted. Emissions units are classified as personal property and are regulated as financial products.

There are a number of different types of eligible emissions units under the emissions trading scheme:

- Carbon units are issued under the *Clean Energy Act 2011* for the purposes of acquitting liability under the emissions trading scheme.
- Australian carbon credit units (ACCUs) are issued for greenhouse gas abatement activities undertaken as part of the Carbon Farming Initiative. In the fixed price period, liable entities can surrender eligible ACCUs totalling no more than 5 per cent of their carbon liabilities (unless the majority of their liability comes from landfill emission – in this case, entities can surrender ACCUs up to their full liability during the fixed price period). In the flexible price period, there will be no limit on the surrender of ACCUs.
- Eligible international emissions units include Kyoto units such as certified emission reductions (other than temporary or long-term certified emission reductions), emission reduction units and removal units. They also include prescribed international units. Liable entities cannot use eligible international emissions units to satisfy liability in the fixed price period. In the flexible price period, liable entities in Australia will be able to meet up to 50 per cent of their liabilities through purchasing eligible international units; however, only 12.5 per cent of their liabilities will be able to be met by Kyoto units (6.25 per cent in 2014-15).

International Linking

Australia's emissions trading scheme has been designed to allow linking with other carbon markets over time. This will allow reductions in carbon pollution to be pursued globally at the lowest cost.

From 2014, the Australian and European emissions trading schemes will be linked. For the first four years an interim link will operate, under which Australian businesses will be able to purchase European Union allowances to help meet their Australian liabilities.

From 2018, a full link will be established to enable Australian and European Union permits to be used to meet liabilities in either system.

Beyond official linking arrangements, Australia works closely on a bilateral level with other jurisdictions to help deliver effective global responses to climate change, by supporting the development and future inter-connection of carbon markets.

Australia undertakes regular technical information exchanges with a host of other countries. These are designed to share Australia's technical expertise and experience in development of a carbon market, acquired through the establishment of the emissions trading scheme. For example, under the Australia-China Climate Change Partnership, Australia has supported a number of activities, including:

- the Australia China Climate Change Forum (2011 and 2013), which brought together leading academics, policy-makers and business experts from both countries to discuss, among other things, carbon market development;
- several emissions trading technical workshops; and
- academic collaboration in areas such as economic modelling and policy analysis to develop cost-effective market mechanisms.

Australia also works plurilaterally, to support the growth of international carbon markets. Australia has worked with other jurisdictions through the World Bank Partnership for Market Readiness (PMR) to support the development of domestic carbon market instruments. The PMR is made up of 28 countries plus the European Commission. Participant countries within our region include China, Indonesia, Vietnam, Thailand, Japan and the Republic of Korea. Australia is also engaged in the Asia Pacific Carbon Market Roundtable (APCMR), which focuses on building a shared understanding of design elements key to building confidence in the environmental integrity and harmonisation of domestic carbon markets.

Market Stability

The emissions trading scheme has design features that will limit carbon price volatility and enhance business and consumer confidence. To avoid price spikes and reduce the risk for businesses as they gain experience in having the market set the carbon price, a price ceiling will apply from 2014-15 and end no later than 20 June 2018. The level of the price ceiling will be set in regulations, following consultation.

To enhance the efficiency of the carbon market, unlimited banking of carbon units is allowed in the flexible price period, so that carbon units created in one year can be used in a future year. There will be limited borrowing of units such that, in any particular compliance year, a liable entity can "borrow" units from the following vintage year by surrendering them to discharge up to 5 per cent of their liabilities.

Allocating Emissions Units

During the fixed price period, liable entities will be able to purchase carbon units from the Clean Energy Regulator at the fixed price up to their emissions liability. During the

flexible price period, the Clean Energy Regulator will issue a number of carbon units equal to the cap for each year. Any units not provided as transitional assistance to key sectors will be allocated by auctioning. The Government will advance auction future vintage carbon units, including the advance auction of flexible price period carbon units in the fixed price period.

Transitional Assistance

The revenue raised from the emissions trading scheme will be used to assist households, support jobs in the most affected industries, and build a new clean energy future.

Supporting Households

The emissions trading scheme has an effect on the prices of the goods and services that all households use, where goods that are emissions-intensive to produce generally become more expensive. Treasury estimated this impact overall at around 0.7 per cent of the consumer price index. To help households adjust to the emissions trading scheme, more than half of the revenue raised is provided to households, primarily in the form of tax cuts, higher family payments and increases in pensions and allowances.

This assistance is permanent and has been specifically designed to ensure that low and middle income households receive assistance to offset price increases. The Household Assistance Package includes a number of components, including:

- Tax reform – from 1 July 2012 the tax free threshold has more than tripled, and taxpayers with an income below $80,000 now receive a tax cut.
- The Clean Energy Supplement – In March 2013, around 3.5 million pensioners began receiving their ongoing Clean Energy Supplement in their fortnightly payments. These pension increases are worth around $350 a year for singles and around $530 a year for couples combined.
- Around one million allowance recipients, such as Newstart Allowance and Parenting Payment recipients, also started receiving ongoing household assistance from March 2013.
- From 1 July 2013 more than 1.6 million families who receive Family Tax Benefit payments have started receiving ongoing increases in their fortnightly family payments.
- Other income support recipients such as youth and students are also receiving ongoing assistance, starting with a second lump sum payment from 1 July 2013 and an ongoing Clean Energy Supplement from 1 January 2014.

Because these payments and tax cuts are not linked to the actual amount of electricity or goods used, they do not alter the incentive for households to become more energy efficient or take up renewable energy options like solar panels.

The Australian Government is also supporting households to adopt their own energy and cost saving measures. By adopting such measures, households are able to save money as well as contribute to Australia's clean energy future.

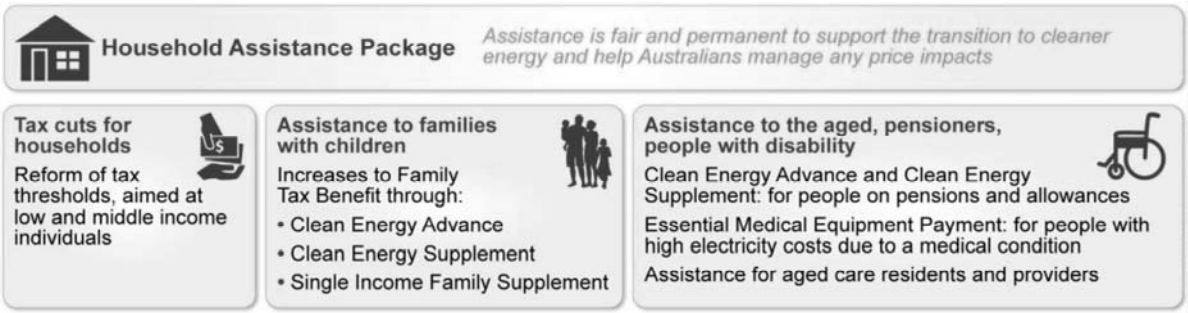

Figure 4.2 Overview of the Household Assistance Package

Emissions-intensive Trade-exposed Industries and Emissions-intensive Electricity Generation

In addition to those sold at auction, some carbon units will be administratively allocated as transitional assistance under the Jobs and Competitiveness Program (to businesses conducting emissions-intensive trade-exposed activities) and under the Energy Security Fund (to highly emissions-intensive coal-fired electricity generators).

Australia's adoption of a carbon cost ahead of many other countries may have a considerable impact on its businesses that produce significant levels of emissions and are trade-exposed. The Government is providing assistance to these businesses to reduce the risk of them relocating offshore and using production processes or inputs that are more emissions-intensive.

Targeting assistance to these businesses also helps to smooth the transition of the economy. From 2012-13, free emissions units have been provided to emissions-intensive trade-exposed industries at an initial assistance rate of 94.5 per cent for the most emissions-intensive activities and at a rate of 66 per cent for activities that are moderately emissions-intensive. The level of assistance declines at a rate of 1.3 per cent per year.

The Government is also assisting highly emissions-intensive coal-fired generators to adjust to the introduction of the emissions trading scheme and prepare for a lower emissions future through a limited transitional administrative allocation of permits and cash provided over five years. Administrative allocations of free emissions units and cash are limited to generators with emissions intensity above 1.0 tonne of CO_2-e per MWh of electricity on an 'as generated' basis.

4.2.3 Complementary Policies and Measures

Energy Sector

The Government has developed the Clean Energy Future Plan to reshape the future development of the electricity sector by shifting its current reliance on high-pollution energy sources towards clean energy sources. Reflecting the historical availability of low-cost coal in Australia, coal-fired generation currently accounts the majority of Australia's electricity.

The Clean Energy Future Plan will facilitate the transition of the energy sector to cleaner emissions sources by driving innovation and investment worth billions of dollars in clean energy through measures such as the carbon price, the Renewable Energy Target, the Australian Renewable Energy Agency and the Clean Energy Finance Corporation while securing energy supplies and market stability through the Energy Security Fund. Targeted energy efficiency, information and behaviour change programs will further address greenhouse gas emissions by affecting energy demand**.**

Renewable Energy Target

The Government is committed to ensuring the equivalent of at least 20 per cent of Australia's electricity supply comes from renewable resources by 2020. This commitment is being pursued through the Renewable Energy Target (RET), which is a key component of the Australian Government's Clean Energy Future plan.

The RET is a legislated scheme that creates a guaranteed market for additional renewable energy deployment using a mechanism of tradable certificates that are created by renewable energy generators (e.g. wind farms) and owners of small-scale renewable energy systems (e.g., solar PV). Demand for certificates is created by placing a legal obligation on entities that buy wholesale electricity (mainly electricity retailers) to source and surrender these certificates to the Clean Energy Regulator to demonstrate their compliance with annual obligations.

Since 1 January 2011, the RET has operated as two schemes – the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). The LRET supports large-scale renewable energy projects, such as wind farms and commercial solar, by helping to bridge the cost between renewable and fossil-fuel generation. The SRES assists households, small business and community groups with the upfront cost of installing small-scale renewable technology systems.

The RET brings forward significant renewable energy investment by both households and electricity generators, helping to prepare Australia's economy for targeted emissions reductions and diversification of its energy mix. With a carbon price in place, the RET is expected to drive around $20 billion in private sector investment in renewable energy by 2020. The RET has already supported the installation of over 1 million solar panels and 800,000 solar water heaters.

The Climate Change Authority completed a statutory review of the RET in December 2012. The Government agreed with the Climate Change Authority's recommendations to leave the broad design of the scheme intact and implement minor changes to contain costs and improve scheme efficiency.

Clean Energy Finance Corporation (incorporating Low Carbon Australia)

The Clean Energy Finance Corporation (CEFC), announced as part of the Clean Energy Future Plan is a $10 billion corporation that will invest in clean energy projects from 1 July 2013. These investments will deliver the financial capital needed to help Australia's economy transition to cleaner energy sources.

The CEFC will seek to co-finance clean energy projects with the private sector, working with the market to build industry capacity. The CEFC's investments will be divided into two streams, each with half of the allocated funding.

- The renewable energy stream will invest in renewable technologies, which may include geothermal, wave energy and large scale solar power generation.
- The clean energy stream will invest more broadly; for example, in low-emissions co-generation technology, but will still be able to invest in renewable energy.

The CEFC will operate with the expectation of minimal budgetary assistance and make its investment decisions, independently of the Government, based on rigorous commercial assessments.

A variety of funding tools will be used to support projects, including loans on commercial or concessional terms and equity investments. To ensure that the CEFC has continuing and stable funding, capital returned from its investments will be reinvested.

In 2010, the Australian Government established Low Carbon Australia Limited (LCAL), a small pilot investment fund to work within the marketplace to develop finance and invest in projects which provide strong demonstration effect to boost private sector investment in energy efficiency and carbon reduction.

As it was intended that the CEFC and LCAL finance low carbon investments in the same areas, and with similar intent, the Government announced it would merge LCAL's activities under the CEFC, creating a single organisation that provides new and bigger energy efficiency financing opportunities.

Australian Renewable Energy Agency

On 10 July 2011, the Government announced the establishment of the Australian Renewable Energy Agency (ARENA), as a part of its Clean Energy Future Plan. ARENA is an independent statutory authority with the objectives of improving the competitiveness of renewable energy technologies and increasing the supply of renewable energy in Australia.

From its commencement on 1 July 2012, ARENA became responsible for the administration of committed projects and measures from initiatives formerly administered by the Australian Centre for Renewable Energy and the Department of Resources, Energy and Tourism (RET). ARENA also became responsible for projects formerly administered by the Australian Solar Institute (ASI) on 1 January 2013.

ARENA administers over $3 billion of funding for:

- the research, development, demonstration, deployment and commercialisation of renewable energy and related technologies; and
- the storage and sharing of knowledge and information about renewable energy technologies.

ARENA released its General Funding Strategy in late 2012 that outlines ARENA's principal objectives and priorities for the financial year and the next two financial years, and determines how ARENA is able to provide financial assistance. ARENA also released its Investment Plan, which details the specific initiatives that ARENA will focus on during this period. Both documents are reviewed annually. The new initiatives announced in the 2012 ARENA Investment Plan are:

- Regional Australia's Renewables.
- Deploying Utility Scale Renewable Energy.
- Supporting High-value Australian Renewable Energy (SHARE) Knowledge.
- Building Australia's Next Generation Solar.

This is in addition to managing existing initiatives such as the Emerging Renewables program and the Renewable Energy Venture Capital Fund.

Australia's Action on Carbon Capture and Storage

It is clear from International Energy Agency analysis that fossil fuels will continue to play a significant role in meeting global energy demand for some time. As a large exporter of coal and a significant user of fossil fuels, Australia has a strong interest in helping to facilitate the uptake of technologies to reduce emissions from their use.

The development of low-emissions fossil fuel technologies, including carbon capture and storage (CCS), is important for any least-cost transition to a low-carbon economy and the ongoing strength of Australia's energy exports. The Government is investing in a range of measures to support the development of CCS technologies both domestically and internationally.

Carbon Capture Storage Flagships program

The CCS Flagships program was announced in May 2009 as part of the Government's Clean Energy Initiative. It aims to support the construction and demonstration of large-scale integrated CCS projects in Australia. To date, two projects have been selected for funding under the program:

- The CarbonNet project, with combined funding of $100 million ($70 million from the Australian Government and $30 million from the Victorian Government) for a feasibility study program to demonstrate an integrated capture, transport and storage hub to service the emissions-intensive Latrobe Valley and prospective storage sites in the Gippsland Basin.
- The South West Hub CCS project, which aims to capture, transport and store CO_2 from the nearby industrial centres of Kwinana and Collie, located south of Perth. The project has been allocated $52 million from the Australian Government and almost $12 million from the Western Australian Government for the first phase of project development – the completion of a detailed storage viability study.

Energy Security Fund

An Energy Security Fund was established to smooth the transition of the energy sector to a carbon price and maintain energy security. The Government assisted generators that face sizeable asset value losses under the emissions trading scheme. Under the Energy Security Fund, the Government is providing transitional assistance to highly emissions-intensive generators to assist them to adjust to a carbon price. Eligible generators shared in $1 billion of cash assistance in 2011-12 and will continue to share in around 120 million free carbon units from now until the year 2014-15.

To further underpin energy security, and recognising the difficult borrowing conditions faced by coal-fired generators, the Government, on advice from the Energy Security Council may offer loans to emissions-intensive coal-fired electricity generators for the refinancing of existing debt where a coal-fired generator needs finance but is unable to obtain it from the market on reasonable terms. Loans will also be offered for a limited period for the purchase of future vintage carbon permits. Loans will be offered on terms that encourage generators to seek private finance in the first instance.

The Energy Security Council was established to provide assurance to the Government that energy supply security is maintained during the transition to a clean energy future and to help manage any residual energy security concerns.

The Council comprises energy and financial market experts that will advise the Australian Government on emerging risks to energy security from financial impairment from any source, not just from carbon pricing. The Energy Security council will also be able to recommend a range of support measures and advise on the provision of loans to electricity generators for the refinancing of existing debt.

Smart Grid, Smart City

The National Energy Efficiency Initiative: Smart Grid, Smart City is a $100 million partnership between the Government and the energy sector to develop a commercial-scale smart grid demonstration project. Launched in 2009, Smart Grid, Smart City was designed to:

- Deploy a commercial-scale rollout that tests the business case for key applications and technologies of the smart grid
- Build public and corporate awareness of the economic and environmental benefits of smart grids and obtain buy-in from industry and customers
- Gather robust information and data to inform broader industry adoption of smart grid applications across Australia
- Investigate synergies with other infrastructure (such as gas and water) and the National Broadband Network.

Up to 30 000 households will participate in the project which runs between 2010 and 2013. The project is now in its final year with data, analysis and results of the various smart grid technologies becoming available to Government, industry, research and educational institutions and residential consumers. Key achievements to date include

the installation of over 12 500 smart meters, more than 30 000 remote sensors and monitoring infrastructure across the project area and the purchase and operation of 20 Mitsubishi iMiev Electric Vehicles.

Energy Efficiency – including the National Strategy on Energy Efficiency

Using energy more efficiently can lower carbon pollution and save money for households, businesses and community organisations. Small actions can make a big difference and there is considerable scope to improve energy efficiency throughout Australia's economy. That is why promoting energy efficiency is a key part of the Australian Government's plan for a clean energy future.

Through its package of energy efficiency programs under the Clean Energy Future Plan, the Government is helping households to use energy more wisely and save money on their energy bills. The Government is also helping businesses become more energy efficient. These programs will not only drive smarter energy use in business, local government, households and communities, but will create new job opportunities and build stronger local economies.

The Government is working cooperatively with the states and territories through the National Partnership Agreement on Energy Efficiency that agreed in 2009 under the auspices of the Council of Australian Governments. The agreement outlines a comprehensive suite of measures under the National Strategy on Energy Efficiency (NSEE) that is a 10 year plan to accelerate energy efficiency improvements and deliver cost-effective energy efficiency gains across all sectors of the Australian economy.

The strategy aims to streamline roles and responsibilities across government by providing a nationally consistent and coordinated approach to energy efficiency and sets out a range of measures designed to help households and businesses prepare for carbon pricing. In March 2013, the Select Council on Climate Change agreed to a revised and streamlined NSEE that consolidated similar measures and removed measures that had been completed.

Energy Efficiency Opportunities Program

The Energy Efficiency Opportunities program is targeted at addressing information barriers to the uptake of energy efficiency. Under the program the Government requires Australia's largest energy using corporations that use more than 0.5 petajoules (PJ) of energy per year (equivalent to 10,000 households) to undertake comprehensive assessments of their energy use. Over 300 corporations, representing 65 per cent of Australia's energy use, are required to identify cost effective energy efficiency opportunities with up to a four year payback period and report publicly on their business response.

The underpinning program legislation came into effect in July 2006 and the program underwent a significant review at the end of the first five year cycle. The review found the program had contributed to significant improvements in energy efficiency understanding, focus and management in participating corporations, particularly in the areas of data

analysis, opportunity identification and decision-making. Barriers to the uptake of cost effective energy efficiency opportunities, specifically relating to information, skills and organisational practices, had been significantly reduced. At the same time the review also found that some capital and non-capital barriers to implementing the identified opportunities remain, and that there is still scope to better embed energy management in core business practice.

The independent review found the program was complementary to the carbon price, as it addresses information market failures not targeted by a carbon price. The Government is making some changes to improve the program's flexibility and reduce the compliance and reporting burden on business. Medium-sized businesses are also able to participate in the program voluntarily.

After the first five-year cycle of the program, participating corporations reported they were implementing energy saving opportunities with a net financial benefit of $808 million per annum. This represents a saving of 1.5 per cent of Australia's total energy use, equivalent to 8.2 million tonnes per annum in emissions reductions, or 1.5 per cent of Australia's total greenhouse gas emissions. The independent review estimated that 40 per cent of these reported savings had been directly enabled by the program.

The Industrial Energy Efficiency Data Analysis Project

The purpose of the project is to estimate the potential for energy efficiency improvement in different industrial sectors through quantifying the scale and value of untapped energy efficiency potential across a range of key technologies, processes and fuel types.

The project has resulted in the construction of a comprehensive, national industrial energy use and energy savings dataset. The dataset is based on real world data reported by companies through existing energy efficiency programs able to inform industry on areas of cost effective investment in energy efficiency and facilitate more prudent decision making.

A detailed barriers analysis was conducted to better understand what may be preventing greater uptake of energy efficiency projects. This would inform how these opportunities could be unlocked, and which policies may best achieve this.

Buildings

The energy used by Australian buildings accounts for approximately 20 per cent of Australia's greenhouse gas emissions, split fairly evenly between homes and commercial buildings. The Australian Government is working with the states and territories on a range of building initiatives aimed at reducing emissions and is working to improve energy efficiency across Government operations.

Commercial Building Disclosure Program

Commercial Building Disclosure (CBD) is a national program designed to improve the energy efficiency of Australia's large office buildings. Under the *Building Energy*

Efficiency Disclosure Act (2010), offices and office spaces in Australia that are sold or leased must disclose their energy performance.

Affected buildings must receive a Building Energy Efficiency Certificate (BEEC), which includes the base building efficiency through a National Australian Built Environment Rating System (NABERS) rating and a Tenancy Lighting Assessment.

The NABERS rating must be disclosed in all advertising material, and the BEECS are publicly available online (www.cbd.gov.au).

More than 1000 buildings now have BEECS, and energy performance is now an important part of office building assessment. Companies are also using BEEC information to identify properties most likely to benefit from upgrades. The CBD program is providing a large, publicly available database of office building performance that encourages benchmarking and identifies business opportunities for energy efficiency service providers.

National Australian Built Environment Rating System

The National Australian Built Environment Rating System (NABERS) is a national rating system that measures the environmental performance of Australian buildings, tenancies and homes including energy efficiency, water usage, waste management and indoor environment quality. It is focused on commercial buildings, especially offices, retail and hotels.

NABERS rates buildings on a 0-6 star scale based on industry benchmarking. It was developed as a voluntary set of tools, but is now used in some regulatory functions.

In 2013, NABERS released a new leading edge tool to rate data centres both for the energy used directly by the computing equipment, and the supporting heating ventilation and air conditioning systems.

NABERS is owned by the New South Wales Government and managed by a national steering committee chaired by the Australian Government.

National Construction Code

In 2010, energy efficiency standards for residential and non-residential buildings were increased in the National Construction Code (formerly the Building Code of Australia). Since 2003, residential energy efficiency standards have undergone three increases in stringency, with two enhancements for non-residential buildings. Most states and territories now require energy performance equivalent to 6-stars on a 10-star scale for new residential construction.

Nationwide House Energy Rating Scheme

The Nationwide House Energy Rating Scheme (NatHERS) provides a framework that allows various computer software tools to rate the potential energy efficiency of Australian homes. It is now widely used to assess compliance with residential building

energy efficiency standards. NatHERS is an initiative of Commonwealth, State and Territory Governments of Australia.

Energy Efficiency in Government Operations

The Energy Efficiency in Government Operations (EEGO) policy sets out a range of requirements for energy efficiency in Australian Government operations. This includes a requirement for new office building leases to perform at or above the 4.5 star NABERS level, and inclusion of Green Leases. These requirements have helped drive significant change in the commercial building sector due to the importance of government sector leasing.

Australian Government agencies also have energy performance targets for Office - Central Services and Office - Tenant Light and Power. Agencies report annually on their performance against these and nine other categories of energy use, and a compiled government report has now been produced for more than a decade.

Equipment and appliances

Energy Efficient Appliances and Equipment

The *Greenhouse and Energy Minimum Standards (GEMS) Act 2012* came into effect on 1 October 2012 and implements a commitment by the Council of Australian Governments to achieve nationally consistent regulation of equipment energy efficiency supplied or used within Australia. Regulated products include key items of mass-produced equipment used in the residential, commercial and industrial sectors.

The GEMS legislation replaced seven overlapping pieces of state legislation and replaced four state regulators with one national energy efficiency regulator. The national legislation also allows for the expansion of the Equipment Energy Efficiency (E3) Program into new product areas, which will drive greater efficiency in products that use energy or affect the energy use of other products (e.g. insulation and glazing). In the past the E3 Program has focused on electrical products, rather than products that use gas and fuel or products that affect energy use.

These improvements will ensure the E3 Program addresses three of Australia's most important policy objectives: reducing Australians' energy bills, simplifying transactions for business, and reducing greenhouse gas emissions. The improved E3 Program under the GEMS legislation is forecast to save households and businesses over $5 billion in power costs in the year 2020 alone.

Products with energy labelling requirements	Products with Minimum Energy Performance Standards
Air Conditioners	Air Conditioners
Clothes Dryers	Ballasts

Clothes Washers	Chillers
Computer Monitors	Close Control Air Conditioners
Dishwashers	Commercial Refrigerators
Refrigerators/Freezers	Lighting (Compact Fluorescent Lamps, ELV Lighting, Incandescent Lamps, Linear Fluorescent Lamps)
Televisions	Distribution Transformers
	Electric Motors
	Converters/Transformers
	External Power Supplies
	Hot Water Heaters (Electric and Gas)
	Set Top Boxes

Table 4.2 Labelling and standards for energy efficient equipment and appliances

Inefficient incandescent lighting phase-out

As part of its program of improving the energy performance of appliances and equipment, the Australian Government, working with states and territories, is gradually phasing out inefficient light bulbs. The phase-out will deliver considerable savings to the environment and the economy.

Across the country, the move to more efficient lighting, such as compact fluorescent lamps (CFLs), is expected to save around 30 terawatt hours of electricity and 28 million tonnes of greenhouse gas emissions between 2008 and 2020. This is equivalent to permanently decommissioning a small coal-fired power station or taking more than 500 000 cars off the road.

It is expected to result in savings to the Australian economy of around $380 million per year by 2020 and net savings of more than $50 per year for each household that changes all of its incandescent light globes to CFLs.

The phase-out of inefficient light bulbs has been implemented over a number of stages, with minimum energy performance standards being introduced for an increasing range of lighting classes.

Preliminary analysis of import data and results from a recent household survey indicate that, since the announcement of the phase-out until the end of calendar year 2012, the residential stock of CFLs has increased by more than 60 million lamps.

Greenhouse gas savings from this transition, as well as from the installation of higher efficiency halogen replacement lamps, are estimated to be approximately 2 million tonnes per annum, with total consumer energy savings of around $400 million each year. These savings can be attributed to the phase-out regulations and various activities aimed at promoting the use of CFLs, such as state-based lamp replacement schemes.

Heating ventilation and air conditioning high efficiency systems strategy

The Heating Ventilation and Air Conditioning High Efficiency Systems Strategy (HVAC HESS) is an active partnership between industry and government to drive reductions in HVAC energy use and emissions through improved systems, processes and people.

It takes a whole of life perspective in targeting HVAC efficiency improvement, encompassing the design, manufacture, installation, operation and maintenance stages of the HVAC lifecycle. It recognises that large efficiency gains can be achieved through the maintenance and operation of existing systems in existing building stock, and seeks to establish national system standards of documentation for design, installation, operation and maintenance of HVAC equipment/systems.

The installed base of non-residential HVAC systems in Australia is estimated to consume 9 per cent of electricity produced in Australia (representing more than 3.6 per cent of Australia's greenhouse gas emissions), create more than 55 per cent of electrical peak demand in central business district buildings, consume billions of litres of water per annum in cooling towers, and is part of an industry worth $7 billion per annum that employs more than 95 000 people.

The strategy was developed through extensive consultation with the HVAC Industry, and includes development of rating tools, equipment performance standards, improved record-keeping, and enhanced training for relevant industries. A key next step is development of a facilitation strategy to move leading practice to the mainstream in a sustainable way.

Energy Savings Initiative

The Australian Government's Clean Energy Future Plan included a commitment to examine how a national Energy Savings Initiative (ESI) scheme may assist households and businesses to adjust to rising energy costs. This examination involved additional detailed design, quantification of costs and benefits, public and industry consultation, and discussions with state and territory governments.

An ESI is a market-based tool for driving economy-wide improvements in energy efficiency. It places a requirement on obligated parties (typically energy retailers) to find and implement energy savings in households and businesses. An ESI would help energy consumers to save money by encouraging the identification and take-up of energy efficient technologies.

The Australian Government has not yet made a final decision on whether to adopt a national ESI. However, the adoption of a national scheme would be conditional on the endorsement of the Council of Australian Governments and agreement that existing and planned jurisdiction-based schemes are folded into any national scheme.

Information and Support Programs

Australia's carbon price will provide incentives for all parts of the Australian community to reduce energy consumption. To assist the community transition to the carbon price the

Government is helping households, small business, local government, community and non-government organisations identify and implement technologies to improve their energy efficiency and reduce their vulnerability to changing electricity prices.

There are a number of specific programs including: the Energy Efficiency Information Grants Program; the Community Energy Efficiency Program; the Home Energy Saver Scheme; the Low Income Energy Efficiency Program; the Charities Maritime and Aviation Support Program; the Remote Indigenous Energy Program; and the Local Government Energy Efficiency Program. These programs are outlined in more detail below.

Energy Efficiency Information Grants Program

The Energy Efficiency Information Grants (EEIG) Program is a competitive, merit-based grants program established by the Government to assist industry associations and non-profit organisations provide practical, tailored energy efficiency information to small and medium enterprises (SMEs) and community organisations to improve their energy efficiency.

The SMEs targeted are those entities with up to 200 full-time equivalent employees. Community organisations targeted are those non-profit entities with an annual turnover of less than $10 million.

- 46 projects have been awarded grants under the program totalling $34.3 million. Grants range from $109 900 to $1 873 000.
- 24 of the projects will be delivered at a national level and target a range of sectors including agriculture, automotive, manufacturing, tourism and retail.

Local Government Energy Efficiency Program

The Local Government Energy Efficiency Program (LGEEP) is a $24 million one-year non-competitive grants program supporting local governing authorities to install energy efficient solar or heat pump hot water systems in local community facilities. The program has particularly focused in low socio-economic or otherwise disadvantaged areas.

All local governing authorities in Australia are eligible to apply for a maximum grant amount according to their size and socio-economic status. Local governing authorities considered to be located in low socio-economic areas are eligible to apply for additional funding and lower co-funding amounts. Small regional and rural local governing authorities are also eligible to apply for up to $1000 to meet project management costs. Local governing authorities are required to co-fund all projects. Grant applications closed on 31 May 2013 and projects must be completed in the 12 months following the execution of the funding agreement. Over 250 applications were received, which are currently being processed.

Community Energy Efficiency Program

The Community Energy Efficiency Program (CEEP) is providing $112 million in competitive, merit-based grants to assist local governing authorities and non-profit community organisations to improve the energy efficiency of non-residential council and

community buildings, facilities and lighting. It aims to remove the barrier of up-front capital costs by co-funding large community-based projects. In addition to reducing emissions, these projects will benefit communities by improving amenity and services, minimizing energy consumption and costs, demonstrating and encouraging smarter energy use, and supporting local energy and manufacturing industries.

Energy efficiency measures eligible for funding under the program include:

- energy audits or assessments
- upgrades or retrofits to buildings or facilities to improve energy efficiency, such as upgrades to ventilation, heating, air-conditioning systems and hot water supply
- upgrades to outdoor lighting, such as street and traffic lights
- the purchase and installation of energy efficiency items, such as light bulbs, low-flow shower heads, smart energy meters and pool blankets
- the replacement of inefficient electric hot water systems with more efficient systems
- the purchase and installation of energy monitoring systems; and
- educational and community awareness activities, such as website development, surveys, and workshops to build skills in energy efficiency.

Grants are being made between $10 000 and $2 million for single applicants, or up to $5 million for group applications. Under the first round of CEEP there were 63 successful applicants that received grants of between $20 000 and $5 million (totaling over $42 million).

After the success of Round One, the funding and co-contribution amounts for Round Two prioritise assistance for projects which would benefit low socio-economic and other disadvantaged communities, or support energy efficiency in regional and rural councils. Under the second round of CEEP, 107 successful applicants are getting grants totaling $70 million.

Charities Maritime and Aviation Support Program

The Government recognises the important role that charitable organisations play in providing essential services to communities, in particular aero-medical and search and rescue services. An effective carbon price has been applied to fuels that these organisations use, through an increase in the aviation fuel excise and reductions in Fuel Tax Credits that may be claimed for petrol and diesel used for maritime purposes. Charities have no ability to pass on these additional costs.

The Charities Maritime and Aviation Support Program (CMAS) is assisting eligible charities to offset 100 per cent of this carbon price impact. To be eligible, organisations must be registered as a charity, endorsed by the Australian Taxation Office as a deductible gift recipient (DGR) and provide maritime and aviation services in respect of their DGR status. Payments are provided to eligible charities that are able to produce evidence of direct expenditure on aviation or maritime fuels for which an effective carbon price was paid. Rebates are paid up-front, to cover the estimate of the coming year's fuel

cost increases. This amount is reviewed at the mid-point and end of the rebate period, with a reconciliation process undertaken where necessary.

As of 30 June 2013, the CMAS program has provided a total of $893 000 to 30 different aero-medical or search and rescue services around Australia.

Low Income Energy Efficiency Program

The $100 million Low Income Energy Efficiency Program (LIEEP) is a four-year competitive, merit-based grants program established by the Government to provide grants to consortia of community organisations, business and government to trial approaches to improve the energy efficiency of low income households and enable them to better manage their energy use.

LIEEP will trial and evaluate a number of different approaches in various locations that assist low income households to be more energy efficient and to capture and analyse data to inform future energy efficiency policy and program approaches.

Under the first round of LIEEP, 10 funding agreements have been executed and a further 15 projects have been approved for funding under Round Two. Grants range from $387 781 to $9 400 300 and total $63 million.

Home Energy Saver Scheme

The Home Energy Savers Scheme (HESS) entails funding of $50.5 million over four years to assist low-income households to find more sustainable ways to manage their energy consumption. HESS is provided through community organisations around Australia and can help by offering low-income households with:

- information about easy and affordable ways to use less energy in the home
- one-on-one budgeting assistance
- information on whether households are getting the right rebates and assistance
- help to understand energy bills and the energy market
- advice, advocacy and support
- links to other services that may be able to assist households, and
- help to access no or low interest loans to purchase energy efficient appliances (some appliances are available for purchase under a national buying scheme to further reduce costs.

Information and advice is provided online, through a free telephone hotline and through funded community talks and workshops. HESS also offers free home visits to eligible households to provide tailored energy and financial management information.

Remote Indigenous Energy Program

The Remote Indigenous Energy Program is providing $40 million over five years to install renewable energy generation systems in around 55 remote Australian Indigenous communities. It also includes training in basic system maintenance and the provision of energy efficiency information to encourage ongoing energy management. The program

will ensure that these Indigenous communities can access clean, affordable and reliable 24-hour power supply, manage their energy efficiently and contribute to improvements in health, education and long-term economic viability.

Land Sector

The Australian Government is committed to a clean energy future, and realises that the land sector has an important role to play in reducing emissions. The risks and impact of climate change provide a strong incentive for the land sector to manage the land sustainably and consider opportunities to reduce emissions and store carbon on the land.

In Australia's response to climate change, the land sector is excluded from carbon price obligations. Farmers are exempt from paying a carbon price for emissions from livestock, soils or fertiliser use. At the same time, farmers and land managers who use their skills, experience and knowledge of the land to lower carbon pollution have opportunities under the emissions trading scheme to be rewarded for their efforts.

Around $1 billion of carbon revenue is being reinvested in the land sector as part of the Australian Government's Clean Energy Future Plan to help the land sector transition to a low-carbon future.

The Land Sector Package comprises a range of measures, including the Carbon Farming Futures Program and the Biodiversity Fund. These encourage participation in the Carbon Farming Initiative, a voluntary emissions offsets scheme, and low emissions practices.

The land sector measures support action by farmers, Indigenous Australians and other landholders to reduce emissions and manage carbon in the landscape. The package is creating new and innovative job opportunities, and assisting to improve land sector productivity and sustainability.

An independent Land Sector Carbon and Biodiversity Advisory Board was also established as a key overseer of Australia's Land Sector Package. The board is the central source of review, coordination, and advice to Government for ensuring the effectiveness of its suite of land sector measures

Carbon Farming Initiative

The Carbon Farming Initiative (CFI) is a voluntary carbon offsets scheme that was legislated in 2011. The scheme commenced operation on 8 December 2011 and has been administered by the Clean Energy Regulator (CER) since 2 April 2012.

Under the CFI, farmers and land managers are able to generate credits for activities undertaken on their land that lead to reductions in carbon emissions or increase the removal of carbon from the atmosphere. These carbon credits can then be sold through the carbon market.

The CFI provides the land sector with a key opportunity to contribute to Australian emission reductions, and in turn creates multiple flow-on benefits:

- improving productivity and employment,
- protecting the environment,
- increasing resilience to the impacts of climate change, and
- generating an alternative revenue stream through the carbon market.

CFI credits that are recognised for Australia's obligations under the Kyoto Protocol on climate change can be sold to companies to offset liabilities under the Emissions trading scheme. In May 2013, the Australian Government enhanced opportunities for landholders to participate in carbon markets by broadening land sector coverage under the Kyoto Protocol.

Some important land sector activities – including soil carbon activities and revegetation – had not been able to benefit from the carbon pricing market while they remained outside coverage of Australia's Kyoto target.

Cropland management, grazing land management and revegetation will now be counted towards Australia's national emissions target. The Government's decision to include these additional land sector activities will enhance opportunities for farmers and other landholders to participate in the CFI and access the carbon pricing market.

The CFI covers projects that occur in the agriculture and land use sectors, as well as projects to reduce emissions from waste deposited at landfill before the start of the emissions trading scheme on 1 July 2012 ('legacy' landfill waste). The CFI covers activities such as reforestation, savannah fire management and reductions in pollution from livestock and fertiliser. The CFI does not cover abatement in sectors that are covered by the emissions trading scheme, including the food processing and waste sectors (other than legacy waste).

The Government consulted extensively on development of the regulations underpinning the CFI, and has continued to make amendments to relevant legislation that further strengthens its scope and validity.

To be eligible to receive Australian Carbon Credit Units (ACCUs) under the CFI, abatement projects need to meet scheme eligibility criteria and apply an approved CFI methodology. These methodologies set out the rules and instructions for undertaking projects, estimating abatement and reporting to the Clean Energy Regulator.

The Government places high importance on ensuring that abatement is measurable, verifiable and meets internationally recognised offsets integrity standards. This is important in achieving genuine environmental outcomes and ensuring consumer confidence in CFI credits.

The Government has developed reforestation modelling and CFI mapping tools, which are freely available to the public, to assist project proponents in meeting the CFI's stringent requirements in a cost-effective manner. A soil carbon modelling tool is also in development. All the modelling tools released and under development use the same data and parameter values as those used in Australia's national greenhouse gas inventory.

The Government works with land managers, industry, research organisations, technical experts, not-for-profit organisations and other government agencies to develop CFI methodologies to ensure that they are robust, underpinned by appropriate research, and are supported by industry.

An independent expert committee (the Domestic Offsets Integrity Committee - DOIC) is responsible for rigorously assessing methodology proposals and eligible activities for use under the scheme, and provides advice to the Federal Minister for Climate Change on methodology approval. The DOIC also provides advice to the Minister on activities that are eligible under the CFI which are then introduced in legislative amendments.

Carbon Farming Futures

Carbon Farming Futures (CFF) is providing $286 million over six years towards the research, on farm trials and extension of abatement technologies and practices to assist land managers reduce agricultural greenhouse gas emissions from livestock and cropping and horticulture productions systems and increase storage of carbon in the landscape while enhancing sustainable agriculture production. These advances will allow the land sector to benefit from the economic opportunities of the CFI while assisting Australia in achieving its long-term emission reduction targets. The CFF comprises of five key programs.

Methodology Development Program

The Methodology Development Program is providing $20 million over six years to convert research, including outcomes from the Filling the Research Gap, into practical methodologies approved for use in the CFI. Approximately $7.2 million of this funding has been allocated to collaborative grants to support projects which will prepare CFI methodologies, including measurement techniques and models. In the first round of the Program, the Government approved more than $2 million in funding over three years for five projects, including more than $400 000 in grants for 2012-13. The balance of the funding for the program will support methodology development by the Government and the provision of expert advice and tools.

Action on the Ground

The Action on the Ground (AotG) program is investing $52 million over six years, July 2011 to June 2017, to assist land managers to undertake on farm projects to test and apply research outcomes, under real farming conditions that can reduce agricultural greenhouse gas emissions while maintaining farm productivity. AotG projects are underpinned by sound peer reviewed science. All projects are required to carefully measure emissions abatement and/or soil carbon, using standardised procedures, to ensure delivery of consistent, comparable data that could be used to the development of CFI methodologies.

To date the program has provided investment of $44 million for 89 projects involving trails on over 530 farms. These projects are investigating abatement technologies and

farming practices that can be adopted by land managers to reduce agricultural greenhouse gas emissions and increase carbon sequestration in soils.

Projects include on-farm trials to reduce methane emissions from intensive and extensive livestock production systems; reduce nitrous oxide emissions from horticultural and cropping production systems and increase carbon sequestration in soils.

Filling the Research Gap

The Filling the Research Gap (FtRG) program is investing $124 million over six years, July 2011 to June 2017, to support research into a range of innovative on-farm abatement technologies and practices that can assist land manager reduce agricultural emissions of greenhouse gases and sequester carbon in soil.

To date the program has provided investment of $74 million in 88 research projects. These projects are investigating ways to measure (including modelling) and reduce; methane emissions from intensive and extensive livestock production systems; reduce nitrous oxide emissions from horticultural and cropping production systems and increase carbon sequestration in soils. Research outcomes from FtRG are being used to support the development of technically robust and verifiable CFI methodologies.

The program also funds the $30 million national Land Management Practices Survey (LAMPS) that is undertaken by 50 000 farm businesses on a biannual basis. The first LAMPS was completed in 2012 and providing detailed information on current land management practices and will through future surveys allow identification of trends in changes in land management practices overtime.

Extension and Outreach

The Extension and Outreach (E&O) program is investing $45 million over six years, July 2011 to June 2017, to delivering technical information and support to land managers to enable them to reduce land sector greenhouse gas emissions, sequester carbon in the landscape and participate in the CFI.

To date the program has provided investment of $21 million for 24 projects involving 71 extension organisations and 90 on-ground extension officers nationally. The program is also delivered a range of communication materials and activities, including workshops and two videos, to help farmers and land managers to take action on the land and participate in the CFI.

Conservation tillage Refundable Tax Offset

The conservation tillage Refundable Tax Offset program, is investing $44 million over three years, between 1 July 2012 and 30 June 2015 to assist land managers purchase eligible conservation tillage and seeder equipment. The program is designed to encourage land mangers adopt conservation tillage practices to help protect and improve the management of soils in Australia.

Indigenous Carbon Farming Fund

Indigenous Australians manage around 20 per cent of Australia's land mass, with traditional knowledge of the landscape and its responses to fire, flooding and drought being an essential aspect of the land sector's climate change response.

The Indigenous Carbon Farming Fund (ICCF) is providing $22.3 million over five years to assist Indigenous communities to benefit from the CFI, earning carbon credits by undertaking projects to reduce emissions or store carbon. These activities can be used to complement Biodiversity Fund projects that are seeking to participate in the CFI. Types of projects can include early season savanna burning, reforestation and land management in a way that increases soil carbon. Funding for the ICCF is being delivered in two streams.

Research and Development Stream

The Research and Development stream provides funding for the development of CFI methodologies that are both low-cost and likely to have high Indigenous participation, helping to create real and lasting opportunities for Indigenous Australians. Of a total of $5.2 million for the first five years, $4.4 million has been allocated to grants, with more than $600 000 worth of grants over five projects approved in Round One of this stream.

Capacity Building and Business Support Stream

The Capacity Building and Business Support stream ($17.1 million over five years) is assisting Indigenous organisations and individuals assess, establish or participate in CFI projects.

This funding provides support for Indigenous organisations to access carbon farming specialists, business development expertise and legal advice for developing governance and contractual arrangements for carbon farming projects. Under Round One of this stream, 44 projects to the value of $4.2 million have been approved for funding over the next three years. 35 of these grants are funding feasibility assessment projects (up to $50 000) with a further nine grants to support the implementation of carbon farming businesses and development of carbon projects (up to $300 000).

Biodiversity Fund

Australia has unique native ecosystems which are highly diverse. Biodiversity plays a crucial role in maintaining the productive capacity of our landscape. Australia's ecosystems can act as a buffer against a harsh and variable climate by binding and nourishing soils, and filtering streams and wetlands. These ecosystems create significant benefits for important industries like agriculture, forestry, fisheries and aquaculture, and tourism. Our ecosystems are at risk from climate change.

A changing climate is expected to result in a number of issues for our native ecosystems, including loss of biodiversity, declines in river and wetland health, reduced water quality and quantity, difficulty in flood control, erosion and reduced productivity. Restoring native

vegetation and soil carbon can build and protect biodiversity, increasing the resilience of the landscape to the impacts of a changing climate.

The ongoing Biodiversity Fund is improving the resilience of Australia's unique species to the impacts of climate change, enhancing the environmental outcomes of carbon farming projects, and helping landholders protect biodiversity and carbon values on their land. It involves funding of nearly $450 million for the land sector to undertake projects that establish, restore, protect or manage biodiverse carbon stores on public and private land, including:

- reforestation and revegetation in areas of high conservation value such as wildlife corridors, rivers, streams and wetlands
- management and protection of biodiverse ecosystems, including publicly owned native forests and land under conservation covenants or subject to land clearing restrictions
- action to prevent the spread of invasive species such as foxes and rabbits, across connected landscapes.

The Biodiversity Fund complements other government policies by encouraging proposals from applicants who are seeking to improve the biodiversity outcomes of CFI projects, and those building landscape connectivity under the Australian Government's Caring for our Country initiative.

Round One of the Biodiversity Fund (2012-13) encouraged broad participation, and resulted in 312 successful projects being funded, worth over $270 million. Collectively these projects will revegetate, rehabilitate and restore over 18 million hectares of the Australian landscape over six years.

Regional Natural Resource Management Planning for Climate Change Fund

The Regional Natural Resource Management (NRM) Planning for Climate Change Fund is providing $44 million over five years for improving existing regional planning for climate change. The fund will help to guide where biosequestration and carbon farming projects should be located in the landscape to maximise the benefits for biodiversity, water and agricultural production.

These updated plans can be used by landholders to identify and develop activities to reduce carbon pollution. The Fund is also being used to support research and analysis to develop scenarios on regional climate change impacts which can be used for natural resource management and land use planning. The Fund complements the Biodiversity Fund and the CFI by supporting planning that will help guide the types and locations of activities under these initiatives, primarily reforestation activities and the management of remnant vegetation.

The Regional NRM Planning for Climate Change Fund is divided into two streams.

Stream One

Stream 1 of the fund is providing $28.9 million over five years to support the revision of existing regional NRM plans. Funding will help identify where in the landscape climate change adaptation and mitigation activities should be undertaken.

Stream Two

Stream 2 of the fund is providing $15 million over five years to support development of regional-level information in the form of scenarios about the impacts of climate change (water, temperature, storms) which can be used for medium term regional NRM land use planning. It is also supporting regional NRM organisations to utilise this information in updating their regional NRM plans.

Stream 2 funding is being delivered through two elements:

- Element 1 is delivering regional climate projections for the whole of Australia based on the next generation of global climate models, and making existing projections information easy to access and interpret. This project is part of a broader Government goal to deliver a comprehensive National Climate Change Information Service that will empower and support adaptation and mitigation information. It also complements work that the Australian Government is doing with State and Territory jurisdictions to develop a National Climate Projections Program.

  Element 1 is being led by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in collaboration with the Australian Bureau of Meteorology (BoM).
- Element 2 (the NRM Climate Change Impacts and Adaptation Research Grants Program) is providing $8 million over four years for research institutions to work with regional NRM organisations. These collaborations will deliver information on climate change, its impacts and potential adaptation responses, and provide guidance on how to use that information in NRM planning.

Industrial Sector

Jobs and Competitiveness Program

Without appropriate assistance arrangements, applying constraints on emissions in Australia before other countries could risk ‘carbon leakage’, that is emissions intensive trade exposed activities could relocate from Australia to countries where those activities may not be subject to comparable carbon constraints. The ongoing Jobs and Competitiveness program provides partial assistance in the form of free carbon units to these activities as they transition under carbon pricing. The most emissions-intensive trade-exposed activities receive assistance to cover 94.5 per cent of industry average carbon costs in the first year of the carbon price. Less emissions-intensive trade-exposed activities receive assistance to cover 66 per cent of industry average carbon costs. The program is designed to maintain strong incentives for firms to reduce emissions over time. Assistance is reduced by 1.3 per cent each year to encourage industry to cut

emissions. Regular reviews of the program will be conducted by the Productivity Commission, with the first commencing 2014-15 to ensure that the JCP.

Coal Sector Assistance Package

The Australian Government's Coal Sector Assistance Package aims to support Australia's coal mining sector by providing targeted assistance to its most emissions-intensive coal mines and supporting the development of emissions abatement technologies. It is comprised of two programs:

1. The Coal Sector Jobs Package will provide transitional assistance to some of Australia's gassiest coal mines to ease the transition to a carbon price. This assistance provides an incentive for mine operators to explore opportunities to reduce fugitive emissions through the implementation of abatement technologies and the development of lower-emissions seams.
2. The Coal Mining Abatement Technology Support Package aims to ensure the competitiveness and viability of the Australian coal mining sector under the emissions trading scheme and constraints on greenhouse gas emissions. Around $38.5 million in Government funding supports industry efforts to develop and demonstrate technologies that will provide future solutions to safely reduce fugitive methane emissions from coal mines.

Steel Transformation Plan

The Steel Transformation Plan is a $300 million program operating over six payment years from 2011-12 that aims to encourage investment, innovation and competitiveness in the Australian steel manufacturing industry in order to assist the industry to transform into an efficient and economically sustainable industry in a low carbon economy.

Clean Technology Program

The Australian Government's Clean Technology Programs provide incentives, worth more than $1 billion, for manufacturing businesses to reduce emissions, improve energy efficiency and invest in clean energy, as well as for innovative businesses, in all sectors, to develop new clean technologies and services. The program has three key components, all of which are delivered by AusIndustry, the Government's business program delivery division, and which are supported by Innovation Australia, an independent statutory body.

The Clean Technology Programs comprise:

- up to a combined $865 million under the Clean Technology Investment Program and the Clean Technology Food and Foundries Investment Program; and
- the $173 million Clean Technology Innovation Program.

The two Investment Programs are supporting manufacturing businesses to invest in energy efficient capital equipment and low emissions technologies, processes and products to reduce their carbon emissions intensity and maintain their business competitiveness in a carbon constrained economy. The programs offer merit-based

grants ranging from a minimum of $25 000 to more than $10 million. Funding is provided on a co-investment basis, with tiered grant funding ratios that vary according to project size and applicant turnover.

Eligible projects must improve the carbon and energy efficiency of the applicant's manufacturing process. This can involve replacement, modification and/or changes to the energy sources of manufacturing plant, equipment and processes. Examples of projects include:

- adoption and deployment of technologies to reduce energy use and/or carbon emissions at manufacturing facilities;
- process re-engineering involving the adoption of energy or carbon
- efficient manufacturing tools;
- support the conversion of facilities from coal to natural gas;
- investing in co-generation plants; and
- assistance with the implementation of energy efficiency opportunities.

The Clean Technology Innovation Program is a competitive, merit-based grants program, providing $173 million for eligible businesses to undertake applied research and development, proof-of-concept and early-stage commercialisation activities to develop new products, process and services that reduce greenhouse gas emissions.

The Clean Technology Innovation Program provides grants of between $50 000 and $5 million on a co-investment basis of one dollar of government funding for each dollar of the applicants investment. The grants are available to businesses in all sectors including spin-off companies from universities and public sector research organisations.

The Clean Technology Innovation program assists in the development of new clean technologies and associated services, including low emission and energy efficient solutions that reduce greenhouse gas emissions. A broad range of project applications and technologies are eligible under the program, including (but not limited to):

- Renewable and/or low emission energy generation;
- Methods, equipment, technology and associated services to reduce energy demand or increase energy efficiency; and
- Product components that contribute to a reduction in greenhouse gas emissions when installed and used in a larger product or system.

As part of the merit assessment process, applicants need to demonstrate the extent of the reduction in greenhouse gas emissions that their new clean technology will deliver. To do so, applicants must provide baseline data and evidence of greenhouse gas emissions for an existing product, process or service that their new clean technology is aiming to replace.

Other industry incentives

The Research & Development (R&D) Tax Incentive and Commercialisation Australia also offer further general industry incentives that can be applied to assist in the development

of clean technology and services to reduce emissions. Industry also benefits from investments by the Clean Energy Finance Corporation.

R&D Tax Incentive

The R&D Tax Incentive is a targeted tax offset designed to encourage more companies to engage in research and development in Australia. It offers a 45 per cent refundable tax offset to eligible entities with an aggregated turnover of less than $20 million per annum, or a non-refundable 40 per cent tax offset to all other eligible entities. This incentive is available to all areas of research and development. Eligibility to claim expenditure under this incentive may be affected for those already receiving assistance under the Clean Technology Innovation Program.

Commercialisation Australia

Commercialisation Australia is a government organisation that runs a competitive, merit-based grants program offering funding and case management to accelerate commercialisation. Businesses wanting to commercialise clean technology can either choose to apply for this program, or the Clean Technology Innovation Program depending on their funding and resource needs. Commercialisation Australia also facilitates networking opportunities for businesses.

Transport Sector

Transport under the emissions trading scheme

Transport fuels (including Household transport fuels, light vehicle business transport and off-road fuel use by the agriculture, forestry and fishing industries) are excluded from the emissions trading scheme. However, an equivalent carbon price is being applied through changes in fuel tax credits or excise for domestic aviation, domestic shipping, rail transport, and non-transport use of fuels. The Australian Government is also seeking to establish an effective carbon price for heavy on-road liquid fuel use from 1 July 2014.

Green Vehicle Guide

The Green Vehicle Guide website is a tool to assist consumers in making informed decisions regarding the environmental performance of new vehicles. It covers all light vehicles (up to 3.5 tonnes) released onto the Australian market since late 2004, and is regularly updated as new models are released. The Green Vehicle Guide provides consumers with user friendly ratings on the environmental performance of specific models, addressing greenhouse emissions, air pollution emissions and overall environmental performance. The guide also provides data on fuel consumption and enables annual fuel costs to be estimated. It enables side-by-side comparisons of individual models on a common basis, as all the vehicles undergo the same standard emissions tests.

The Green Vehicle Guide is recognised as the definitive source for assessing the environmental performance of light vehicles in Australia, and is increasingly used by

fleets, in both government and industry, to determine the environmental benchmarks in their purchasing criteria.

Fuel Consumption Labelling

The Fuel Consumption Label is a Government initiative to promote consumer demand for vehicles with good fuel efficiency. Encouraging consumer preferences toward vehicles of greater fuel efficiency is helping to reduce greenhouse gas emissions from transport and raises consumer awareness of the impacts of different fuels and role of fuel efficient vehicles in emissions reductions.

Since 2001, all new cars, four-wheel drives and light commercial vehicles up to 3.5 tonnes gross vehicle mass have been required to display a Fuel Consumption label on their windscreen at the point of sale. This label indicates how many litres of fuel a vehicle will use to travel 100 kilometres and how many grams of carbon dioxide the vehicle would emit for each kilometre. The label has been progressively improved to provide more useful comparative information on both fuel consumption and CO_2 emissions of different vehicle models. Since March 2011, labelling has also been required for plug-in and hybrid electric vehicles (energy consumption in Watt hours/kilometre, expected range when fully charged, fuel consumption in litres/100 kilometres and CO_2 emissions in grams/kilometre). All information is based on standardised tests that new vehicles undergo prior to their supply to the market, meaning that the performance of different models can be compared under identical conditions.

Fuel Consumption Labelling in Australia links with and complements the Green Vehicle Guide, with the fuel consumption and CO_2 data displayed on the label matching that which is provided through the guide.

Australian Engagement on International Transport Emissions

Australia is working with other countries to develop goals and measures for reducing emissions from international aviation and shipping through the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Effective action on international aviation and shipping emissions requires a concerted effort by all countries due to the integrated, global and commercial nature of these sectors.

International aviation emissions

Domestically and internationally, Australia actively supports ICAO's efforts to secure a global sectoral approach to effectively address international civil aviation emissions. At the ICAO President's request, Australia serves on ICAO's High Level Group on International Aviation and Climate Change, initiated in November 2012. This Group was charged with developing measures to address international aviation emissions, focused on market-based measures, for consideration by the ICAO Assembly in 2013.

In October 2012, Australia also submitted its action plan "Managing the Carbon Footprint of Australian Aviation" to ICAO. The Plan provides an overview of ongoing and planned domestic initiatives by the Australian Government and aviation industry to manage Australia's aviation carbon footprint. Initiatives range from financial and tax incentives to

encourage investment in aircraft efficiency improvements, sustainable biofuels or deployment of best practice satellite-based navigation, to ongoing fleet renewal and improvements in the efficiency of on-ground operations.

International shipping emissions

Australia is proud to have worked closely with like-minded developed and developing countries to secure adoption of mandatory emission reduction measures for the international shipping sector at a key IMO meeting in July 2011. The measures amend aspects of the International Convention for the Prevention of Pollution from Ships (MARPOL) and apply to ships of 400 gross tonnage and above. They mandate an Energy Efficiency Design Index for new ships, a Ship Energy Efficiency Management Plan for all ships, and a requirement for all ships to carry an International Energy Efficiency (IEE) Certificate. The measures entered into force on 1 January 2013. Australia has given effect to the measures through amendments to a range of national maritime Acts.

A study commissioned by IMO estimated that, by 2020, these measures will achieve an annual average of 151.5 million tonnes of annual carbon dioxide reductions. This figure could be expected to increase to an average of 330 million tonnes annually by 2030. The measures will also result in a significant reduction in fuel consumption, delivering cost savings to the shipping industry**.**

4.2.4 Management of Ozone Depleting Substances and Synthetic Greenhouse Gases

Australia meets its obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer (the Montreal Protocol) and the United Nations Framework Convention on Climate Change, for synthetic greenhouse gases, through the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (the Act). The key objectives of the Act are to institute a system of controls on the manufacture, import, export, distribution and use of substances that deplete ozone in the atmosphere and contribute to climate change; achieve a faster and greater reduction in the levels of production and use of ozone depleting substances than are provided for in the Vienna Convention and the Montreal Protocol; and promote the responsible management of scheduled substances so as to minimise their impact on the atmosphere.

Ozone Depleting Substances

Ozone depleting substances are those substances which deplete the ozone layer and have historically been widely used in refrigerators, air conditioners, fire extinguishers, dry cleaning, solvents, aerosols, foam products and as agricultural fumigants. Ozone depleting substances can also have significant global warming potentials.

In November 2010, amendments to the Act were made to further strengthen Australia's ozone protection regime as Australia moves towards its final phase-out of hydrochlorofluorocarbons (HCFCs) – the last major ozone depleting substance to be phased out. Key amendments to the Act include banning importation and manufacture of

refrigeration and air conditioning equipment containing HCFCs, while allowing exemptions where no practical alternative technology exists, strengthening enforcement powers and streamlining licensing to reduce costs for industry. These key changes were strongly supported by Australian industry, which has worked closely with government to ensure Australia continues to meet its obligations under the Montreal Protocol.

Since ratifying the Montreal Protocol in 1987, Australia has met or exceeded all of its phase out obligations. The 2010 amendments to the Act provide important additional controls to assist in the final phase-out of HCFCs. Australia will largely phase out consumption of HCFCs by 2016, four years ahead of the schedule required under the Montreal Protocol. In achieving this accelerated phase out Australia will consume 61 per cent less HCFCs in the period to 2020 than permitted under the Montreal Protocol. This accelerated approach was determined by a government and industry initiative agreed in the early 1990s.

Australia continues to take an active role in ongoing Montreal Protocol negotiations, ensuring that further actions to protect the ozone layer are scientifically based and technically feasible, and that developing countries are supported in their efforts to phase out ozone depleting substances.

Synthetic greenhouse gases

Synthetic greenhouse gases have often been used to replace ozone depleting substances however, while these gases do not deplete the ozone layer, many have very high global warming potential. The most common synthetic greenhouse gas used in Australia is HFC-134a, which has a global warming potential of 1 300 (1,300 times as potent as carbon dioxide). Other synthetic greenhouse gases are even more powerful global warmers, with hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) having global warming potential between 140 and 14 800 and sulfur hexafluoride (SF_6) having a global warming potential of 23 900.

Synthetic greenhouse gases are industrial chemicals used for a variety of purposes, but mainly as refrigerant gases in air conditioning and refrigeration equipment. Under the Clean Energy Future Plan the Australian Government is committed to reducing emissions of the synthetic greenhouse gases listed under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol).

The international community has agreed that synthetic greenhouse gases are potentially harmful if released into the atmosphere, and has listed them under the Kyoto Protocol. In the Clean Energy Future Plan, the Australian Government committed to reducing its greenhouse gas emissions by 5 per cent from 2000 levels by 2020. In October 2011, the Act was amended to provide for an equivalent carbon price on synthetic greenhouse gases manufactured in, or imported into, Australia. The equivalent carbon price is based on the carbon price and global warming potential for each gas, relative to carbon dioxide. The Act was also expanded to include SF_6 and cover all equipment containing HFCs, PFCs and SF_6.

The equivalent carbon price on synthetic greenhouse gases commenced on 1 July 2012. The equivalent carbon price on synthetic greenhouse gases is designed to encourage the use of alternatives which are less harmful to the environment, improve installation and servicing to minimise leaks and recover and recycle synthetic greenhouse gases. The equivalent carbon price has been in place for 12 months, and industry has been quick to respond. Many sectors have shown changes in behaviour and innovation to promote climate friendly alternatives and technologies. This includes improved practices to minimise HFC leaks; and encourage recovery, recycling, reclamation, and destruction of HFCs.

Destruction Incentives Program

Announced as part of the Clean Energy Future Plan, the Destruction Incentives Program provides financial incentives for the destruction of waste synthetic greenhouse gases, HFCs, PFCs, SF_6 and ozone depleting substances. From 1 July 2013, the Australian government will provide an incentive payment of $1.50 per kilogram of waste synthetic greenhouse gases and ozone depleting substances destroyed to refrigerant contractors. This payment is in addition to the current incentive payment made by the industry funded refrigerant product stewardship program operated by Refrigerant Reclaim Australia. This is a 50 per cent increase on the $3.00 per kilogram payment by Refrigerant Reclaim Australia for waste gas recovered and provided to the organisation for destruction.

The Government recognises the important role that Refrigerant Reclaim Australia has played in the recovery and destruction of synthetic greenhouse gases and ozone depleting substances since its commencement in 1993. In providing additional incentives the Government builds on the continued operation and success of the existing industry scheme.

From 1 July 2015, the -Government will introduce a further destruction incentive which will increase the total amount paid by industry and the government for the destruction of synthetic greenhouse gases to 70 per cent of the equivalent carbon price where the gas species and quantity can be verified.

4.3 Policy and measures at the at the state, territory and local levels

There have been significant shifts in state and territory government climate change policies and measures since the Fifth National Communication on Climate Change was submitted. There are several factors that have contributed to these changes. The Global Financial Crisis has presented fiscal challenges for all levels of government. Secondly, four of the eight states and territories in Australia have changed government since 2009 resulting in policy reform and changes. Lastly, the introduction of the emissions trading scheme on 1 July 2012 was a natural catalyst for review of existing policies and measures to avoid complementarity.

Most states and territories have developed or adapted their policies and measures within the auspices of an overarching climate change strategy. The policies and measures implemented by state and territory governments broadly seek to;

- Improve energy efficiency within the community and business sectors;
- Provide region-specific information about climate change impacts and adaptation;
- Reduce greenhouse gases; and
- Exchange best practice policy and research.

For example, in 2011, the Tasmanian Government released its *Action Plan to Reduce Emissions* which outlines priority actions for responding to climate change. The plan identified six priority action areas for the Tasmanian government over the next two years including working more intensively with the State's biggest emitters to better understand their opportunities to reduce emissions and investing over $1 million in a new program to help low-income Tasmanian households reduce their electricity use and costs.

The New South Wales Government developed *NSW 2021: A plan to make NSW number one* which outlines priority actions to assist local government, business and the community build resilience to future extreme events and hazards by helping them understand and prepare for the impacts of climate change.

In July 2009, the Council of Australian Governments (COAG) agreed to the National Partnership Agreement on Energy Efficiency, which outlines a comprehensive suite of measures (the National Strategy on Energy Efficiency or NSEE) to provide a nationally consistent and coordinated approach to improving energy efficiency.

As part of the NSEE, all state and territory governments have developed regulatory and voluntary energy efficiency and sustainability policies and measures to improve energy efficiency efforts across a range of sectors including for buildings, appliances and equipment, industry and business, government, transport, skills, innovation, advice and education. Most states and territories have implemented sustainability and energy efficiency policies and measures that improve the energy efficiency of Australia's building stock.

In 2012, the Australian Government passed the Greenhouse and Energy Minimum Standards (GEMS) legislation which replaced seven state and territory legal frameworks with a single, consistent national law. The GEMS legislation transferred Australia's existing Equipment Energy Efficiency Program to a national framework, which is forecast to save households and businesses over $5 billion in power costs in the year 2020 alone.

State and territory governments are supporting the uptake of energy efficiency by businesses and householders by providing energy, water and waste efficiency information, energy audits and energy savings action plans. Some programs are specifically designed to assist low-income households and small businesses in remote communities to become more energy efficient. Many of these energy audit and assessment programs are complemented by rebate or refit programs to encourage the implementation of recommended energy efficiency improvements. Rebate initiatives are designed to offset the costs of buying or installing energy efficiency measures such as small-scale energy efficiency hardware, solar hot water systems and insulation.

States and territories have stipulated providers of electricity and gas must contribute to energy efficiency measures to improve the energy efficiency of residential homes. In New South Wales, this is achieved through programs that acquire and surrender energy efficiency certificates. Other states have placed conditions on electricity and gas retailers to install energy savings measures in residential homes through their operating licenses. The Victorian Government is leading the roll-out of smart meters, which provide real-time information about electricity use to help householders and small business operators manage their energy use and reduce emissions. By the end of 2013 every home and small business in Victoria will have a smart meter installed.

State and territory governments have developed policies and measures to expand their renewable energy sectors. The South Australian Government has a legislated renewable energy target, and has introduced land use planning policies which represent national best practice for accommodating wind farms.

The Queensland government co-founded the Queensland Geothermal Centre of Excellence in partnership with the University of Queensland. This $15 million partnership aims to develop the technical capacity and skill base needed to realise the potential of large-scale zero emission geothermal power generation. Some states are also implementing clean energy projects to change the way energy is supplied to remote communities, including exploring renewable energy options.

State and territory government investment in research and development extends beyond renewable energy to include funding for new technologies such clean coal, carbon capture and storage and geothermal technologies. The New South Wales Government's Coal Innovation Fund provides a total of $13 million for nine different projects to drive technological developments in low emissions coal technologies.

State and territory governments are responsible for road and transportation service delivery and have developed public transport planning tools, infrastructure and facilities, and state-of-the-art transport systems to improve traffic flow to reduce emissions. They have designed policies and measures that encourage the use of smaller and cleaner vehicles, such as stamp duty concessions for low-emissions vehicles, and lower-emissions fuels.

Other complementary programs address policy needs relative to each state and territory's particular circumstance. The Northern Territory Government, for example, developed the West Arnhem Land Fire Abatement Project in partnership with traditional owners and Indigenous ranger groups to facilitate strategic fire management. This project reduces greenhouse gas emissions by around 100 000 tonnes per year. The Northern Territory is now leading the world in this practice and by 2020 it is expected that 20 per cent of the Northern Territory will be managed this way.

4.3.1 Policies and measures of local governments

The Australian Government has a number of initiatives that recognise and promote local government leadership and participation in climate change initiatives. For example,

through the Local Adaptation Pathways Program, the Government provided approximately $2 million in funding to help councils undertake climate change risk assessments and develop action plans to prepare for the likely local impacts of climate change.

The Government hosts the Australian Council of Local Government meeting annually. All Australian council mayors and shire presidents are invited to a forum with government leaders to discuss key issues affecting local governments and the communities they serve. Climate change adaptation and mitigation have been high-priority topics at these meetings since the inaugural forum was held in 2008. This forum will continue to be used to inform and advance the Government's policy and support in relation to impacts on local government of climate change.

Many local councils are taking actions to address climate change risks. For example, Townsville City Council is the first Queensland council to develop an adaptation strategy for coastal hazards. The landmark pilot project provides guidance for other coastal councils to develop strategies for their own local government areas.

4.4 Policies and measures no longer in place

The Fifth National Communication described a range of climate change policies and measures that were facilitating the mitigation of greenhouse gas emissions. In July 2011, the Australian Government announced its new Clean Energy Future Plan. The Plan brought existing policies together and introduced several critical new initiatives. In light of this, the Government replaced or removed a number of measures that had similar objectives to initiatives introduced under the Clean Energy Future Plan. The Government also transferred the administration of a number of existing programs to agencies established as part of the Plan. Furthermore, a number of measures previously announced by the Government were not proceeded with as these measures were unlikely to deliver value for money.

Policies and measures that were no longer in place by June 2013 include:

- A Cleaner Future for Power Stations
- Advanced Electricity Storage Technologies Program
- Australian Centre for Renewable Energy Solar Projects
- Clean Energy Initiative - Education and Investment Fund Component
- Clean Energy Trade and Investment Strategy
- Climate Ready Program
- Climate Research Program
- CSIRO Climate Change Related Research (excluding Energy Flagships)
- Education Investment Fund – Sustainability Round
- Energy Efficient Homes Package: Home Insulation Program and Solar Hot Water Rebate
- Forest Industries Climate Change Research Fund
- Geothermal Drilling Program
- Green Building Fund

- Green Car Innovation Fund
- Greenhouse Friendly™
- Green Loans Program
- Green Precincts Program
- Indigenous Emissions Trading
- National Agriculture and Climate Change Action Plan 2006–2009
- National Climate Change and Commercial Forestry Action Plan 2009–2012
- National Energy Efficiency Skills Initiative
- Renewable Energy Bonus Scheme
- Renewable Energy Demonstration Program
- Renewable Remote Power Generation Program
- Re-tooling for Climate Change
- Second Generation Biofuels Research and Development Program
- Solar Flagships Program

Table 4.3a **Policies and measures aimed at limiting and reducing greenhouse gas emissions- covered sectors**

Covered Sectors

Measure or policy name	Objective and/or Activity Affected	Type of instrument	Status	Start date	End date	Implementing entity or entities	Total CO_2-e impact in 2015	Total CO2-e impact in 2020	Composition					
									CO_2	CH_4	N_2O	SF_6	HFCs	PFCs
Emissions trading scheme	Emissions trading scheme	Regulator, Economic, International	Impleme nted	July 2012	N/A	Administered by the Clean Energy Regulator	57.6	148.3	Y	Y	Y	Y	Y	Y

Table 4.3b **Policies and measures aimed at limiting and reducing greenhouse gas emissions- uncovered sectors**

Uncovered Sectors

Measure or policy name	Objective and/or Activity Affected	Type of instru ment	Status	Start date	End date	Implementing entity or entities	Total CO_2-e impact in 2015	Total CO_2-e impact in 2020	Composition					
									CO_2	CH_4	N_2O	SF_6	HFCs	PFCs
Queensland and New South Wales land clearing legislation	The legislation reduces land-use change emissions from clearing of native vegetation in New South Wales and Queensland	Regulat ory	Implem ented	1997	N/A	New South Wales and Queensland Government	19.6	18.4	Y					
Greenhouse Gas Abatement Scheme	Requires liable entities (electricity retailers and large electricity users who choose to participate) to meet mandatory annual targets for reducing or offsetting greenhouse gas emissions from the	Regulat ory	Comple ted	2003	June2012	New South Wales Government	1	1	Y					

	production of electricity that they supply or use.													
Greenhouse Gas Abatement Program - WA Smart Travel	A program that provided communities, workplaces and the local government with the information, tools and resources needed to reduce their impact on the environment.	Voluntary	Implemented	1996	N/A	Western Australia Government	0.5	0.4	Y	Y	Y			
Greenhouse Friendly	Designed to help meet the challenge of climate change by certifying carbon-neutral products and services and approving abatement credits for sale on the voluntary market.	Voluntary	Implemented	2001	July 2010	Australian Government program with private industry participants	0.4	0.3	Y	Y	Y	Y	Y	Y

Table 4.3c **Policies and measures aimed at limiting and reducing greenhouse gas emissions- Carbon Farming Initiative**

Carbon Farming Initiative

Measure or policy name	Objective and/or Activity Affected	Type of instrument	Status	Start date	End date	Implementing entity or entities	Total CO_2-e impact in 2015	Total CO_2-e impact in 2020	Composition					
									CO_2	CH_4	N_2O	SF_6	HFCs	PFCs
Deforestation Activities	A baseline and credit scheme that allows farmers and landholders who take steps to reduce carbon pollution to generate carbon credits. Credits can be traded into the CPM.	Fiscal	Implemented	2011	N/A	Australian Government with private participants	3.70	4	Y	Y	Y	Y	Y	Y

Reforestation Activities	A baseline and credit scheme that allows farmers and landholders who take steps to reduce carbon pollution to generate carbon credits. Credits can be traded into the CPM.	Fiscal	Implemented	2011	N/A	Australian Government with private participants	<0.1	0.2	Y					
Waste Activities	A baseline and credit scheme that allows farmers and landholders who take steps to reduce carbon pollution to generate carbon credits. Credits can be traded into the CPM.	Fiscal	Implemented	2011	N/A	Australian Government with private participants	1.60	1.1		Y	Y			
Agriculture Activities	A baseline and credit scheme that allows farmers and landholders who take steps to reduce carbon pollution to generate carbon credits. Credits can be traded into the CPM.	Fiscal	Implemented	2011	N/A	Australian Government with private participants	1.70	1.9		Y	Y			

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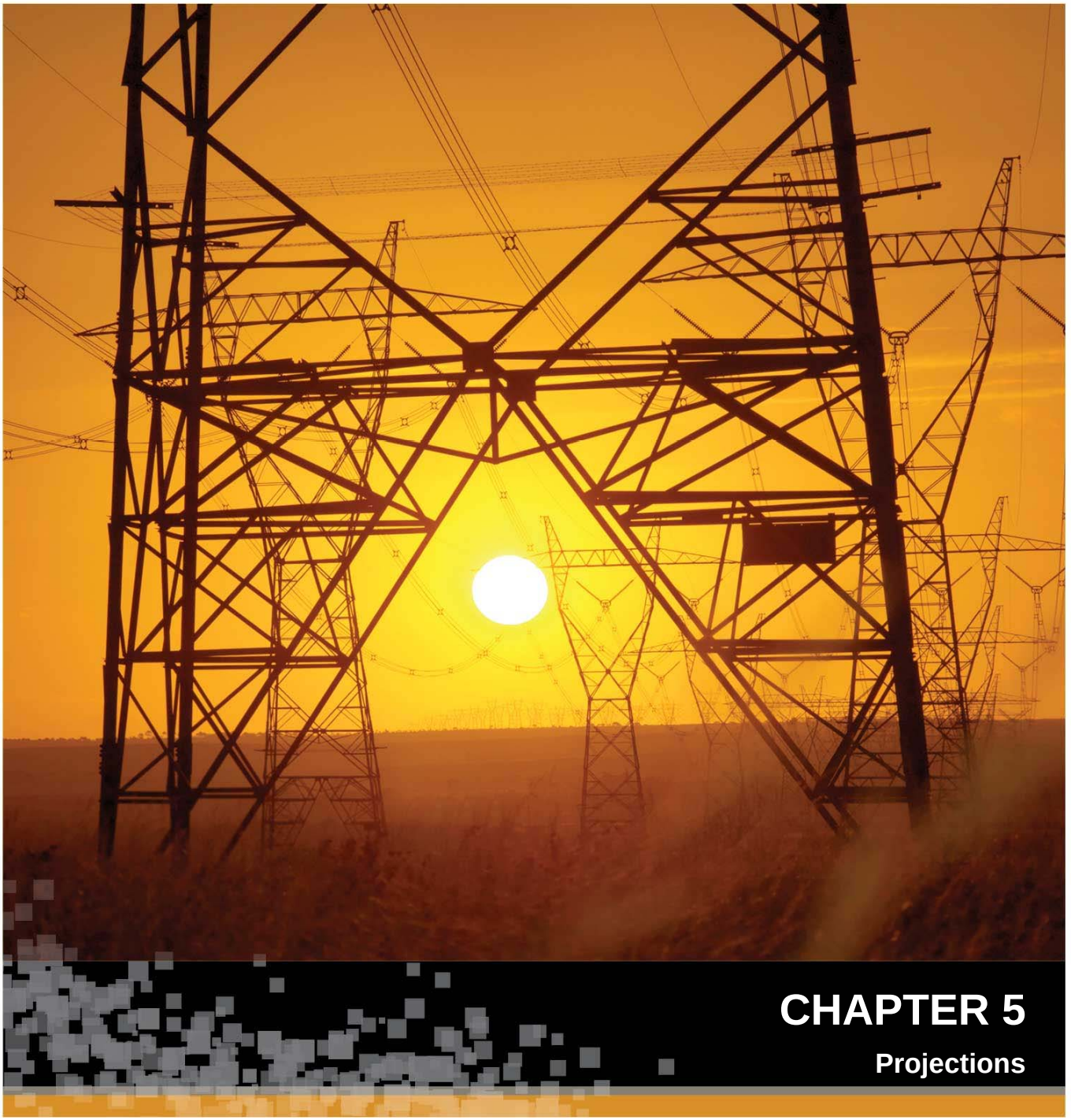

CHAPTER 5

Projections

5.1 Australia's approach to emissions projections 123
5.2 Summary of projections 124
5.3 With carbon price projections in detail 127
5.4 Projections by sector 129
5.5 Projections methodology 151

Key Developments

Australia's Emissions Projections 2012 shows that Australia remains on track to meet its Kyoto protocol first commitment period target of limiting emissions to 108 per cent from 1990 levels. Australia's emissions on a Kyoto Protocol accounting basis are likely to have averaged 575 Mt CO_2-e per year over the first commitment period (2008–12), which is 105 per cent of 1990 levels.

Since the Fifth National Communication, Australia has brought together new and existing policies to reduce emissions: an emissions trading scheme, renewable energy target, energy efficiency measures and action on land.

The emissions trading scheme, the Carbon Farming Initiative (CFI) and Australia's existing suite of policy measures, including the Renewable Energy Target (RET) and energy efficiency measures (see Table 4.3 for full details of measures) are projected to limit Australia's net emissions to 537 Mt CO_2-e in 2020. This is consistent with Australia's unconditional commitment to reduce emissions by 5 per cent below 2000 levels in 2020, which could increase to up to 15 or 25 per cent depending on actions taken by other countries.

The emissions trading scheme and CFI are projected to drive 155 Mt CO_2-e of abatement in 2020. In 2020, based on the 2012 projections 55 Mt CO_2-e of abatement is expected to occur domestically, including 7 Mt CO_2-e achieved by the CFI. The emissions trading scheme is also forecast to drive the sourcing of a further 100 Mt CO_2-e of abatement from overseas. The Australian Government is currently updating these projections.

In 2020, Australia's net emissions are projected to be 22 per cent below where they would otherwise be without a carbon price or the CFI. The 22 per cent is on top of considerable abatement from a wide range of measures put in place before the carbon price in energy efficiency, renewable energy and the land sector.

This chapter presents projections of Australia's greenhouse gas emissions. Projections are reported for each National Greenhouse Gas Inventory sector, focusing on the Kyoto first commitment period and 2020. These sectoral projections were prepared and published in 2012 by the former Department of Climate Change and Energy Efficiency (DCCEE), now the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education and use the 100-year global warming potentials (GWPs) contained in the Intergovernmental Panel on Climate Change's Second Assessment Report. Projections of emissions presented here are in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) guidelines for national communications for UNFCCC parties.

Emissions projections under Kyoto Protocol accounting rules are also reported in order to track Australia's progress towards meeting its Kyoto Protocol first commitment period

target of limiting emissions over the first commitment period (2008–12) to 108 per cent of 1990 levels (see Annex III).

The approach to preparing inventories and emissions projections under the Kyoto Protocol differs from the UNFCCC accounting approach in relation to land use, land-use change and forestry. This difference in accounting means that the emissions projections for UNFCCC accounting and for Kyoto Protocol accounting are different; as such projections are presented under both accounting treatments.

The following sections present a summary of Australia's approach to emissions projections, an assessment of the 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 approaches adopted, key assumptions and results. The final section of this chapter describes Australia's emissions projections methodology in more detail. Details of the overall projections using Kyoto Protocol accounting rules are shown in Annex III.

5.1 Australia's approach to emissions projections

With the introduction of the *Clean Energy Act 2011*, the focus of Australia's 2012 projections has been the impact of the emissions trading scheme and the CFI on reducing Australia's greenhouse gas emissions. The emissions trading scheme will be the primary means by which Australia will meet its emissions reduction targets.

Australia produces a 'with carbon price' emissions projection for each sector, reflecting the likely level of emissions, including the impact of all existing policies and measures (see Table 4.3 for full details of measures). The 'with carbon price' emissions projection corresponds to the UNFCCC 'with measures' scenario.

Australia also produces a 'without carbon price' projection of emissions, which refers to the level of emissions that would have occurred in the absence of the emissions trading scheme and CFI. The 'without carbon price' projection incorporates a range of existing policies and measures such as the RET and energy efficiency measures which were in place at 1 July 2012.

The 'without carbon price' projection of emissions does not separately identify abatement from each measure. Australia does not produce a 'business as usual' scenario where emissions are projected in the absence of all measures. This is due to the difficulty of forecasting this counterfactual scenario, especially given that some polices and measures to reduce greenhouse gas emissions have been in place since before 2000.

In the 'with' and 'without' carbon price scenarios, projections have been developed for the energy sector (stationary energy, transport and fugitive emissions sectors), and the agriculture, industrial processes, waste, land use, land-use change and forestry sectors. Historical emissions data for 2011 from the Update of Australia's National Greenhouse Gas Inventory, December Quarter 2011 was used as the base year for the 2012

projections for most sectors. In the agriculture, waste and forestry sectors, a base year of 2010 was used, with data sourced from the 2010 National Greenhouse Gas Inventory.

Since the release of the 2010 National Greenhouse Gas Inventory and Australia's National Greenhouse Gas Inventory, December Quarter 2011, the Australian Government has submitted to the UNFCCC its final Australian National Greenhouse Accounts, National Inventory report 2011. This latest information will be incorporated in Australia's 2013 Emissions Projections however they have not been incorporated into the historical and projected emissions estimates in Chapter 5.

Australia's 'with' and 'without' carbon price emissions projections are consistent with the Government's policies as at October 2012. The projections do not incorporate recent policy changes including the Government's announcement that it plans to bring forward the commencement of Australia's emission trading scheme to 1 July 2014.

Since the release of Australia's 2012 Emissions Projections the Government has joined the Kyoto Protocol second commitment period. The Government has also further elected to broaden coverage of the land sector to include net emissions from cropland management, grazing land management and revegetation activities. These changes will be incorporated in Australia's 2013 Emissions Projections, however they have not been incorporated into the Kyoto Protocol emissions estimates in Chapter 5. Estimates of the overall impacts on Australia's emissions reductions targets have been published in The Impact of the Kyoto Protocol accounting changes on Australia's quantified emission limitation or reduction objective (QELRO) and targets.

Sectoral emissions projections use a mix of computable general equilibrium and partial equilibrium models and sector-specific models. For some sectors, emissions projections are undertaken in-house by the Australian Government using publicly available data and data obtained from external consultants. The projections process also involves consultation between the Government, consultants and stakeholders. Further details on the full range of scenarios and projections are published in Australia's 2012 Emissions Projections.

Australia has an ongoing program to update and improve its emissions projections. Areas of continuous improvement include further integration of top down and bottom up models, reconciliation of results from different models within sectors and improvements to estimation of the impact of measures.

5.2 Summary of projections

Australia's 2012 Emissions Projections shows that Australia remains on track to meet its Kyoto Protocol first commitment period target (of 108 per cent of 1990 levels), without the use of flexibility mechanisms or imported emissions permits. Australia's emissions on a Kyoto Protocol accounting basis are projected to have reached an average of 575 Mt CO_2-e per year over the first commitment period (2008–12), which is 105 per cent of 1990 levels.

Without the emissions trading scheme and CFI, emissions are projected to continue to increase. In 2020, emissions are projected to be 693 Mt CO_2-e on a Kyoto Protocol accounting basis, equivalent to 122 per cent of 2000 levels (see Table 5.1). The 'without carbon price' projection is used to define Australia's 'abatement challenge' — the amount of additional abatement or avoided emissions required to achieve Australia's 2020 target options. The abatement challenge under Australia's minus 5 per cent unconditional target is estimated to be 155 Mt CO_2-e in 2020.

The Australian Government has committed to a 5 per cent reduction in emissions from 2000 levels by 2020, which could increase to up to 15 or 25 per cent depending on actions taken by other countries. The unconditional 5 per cent reduction target equates to a 22 per cent reduction from projected levels without the carbon price or carbon farming initiative in 2020. The Australian Government committed to a new long-term target of an 80 per cent reduction in emissions from 2000 levels by 2050 in the Clean Energy Future Plan.

Under a minus 15 per cent target the abatement challenge is estimated to be 212 Mt CO_2-e, while under a minus 25 per cent target it is estimated to be 269 Mt CO_2-e.

With the introduction of the emissions trading scheme and CFI, Australia's national emissions in 2020 (including the purchase of international permits) are projected to decline to 537 Mt CO_2-e under the minus 5 per cent target, 481 Mt CO_2-e under the minus 15 per cent target, and 424 Mt CO_2-e under a minus 25 per cent target. This is presented in Figure 5.1, which also shows illustrative 'straight line' reductions in emissions allocations from 2012 to the different 2020 target options.

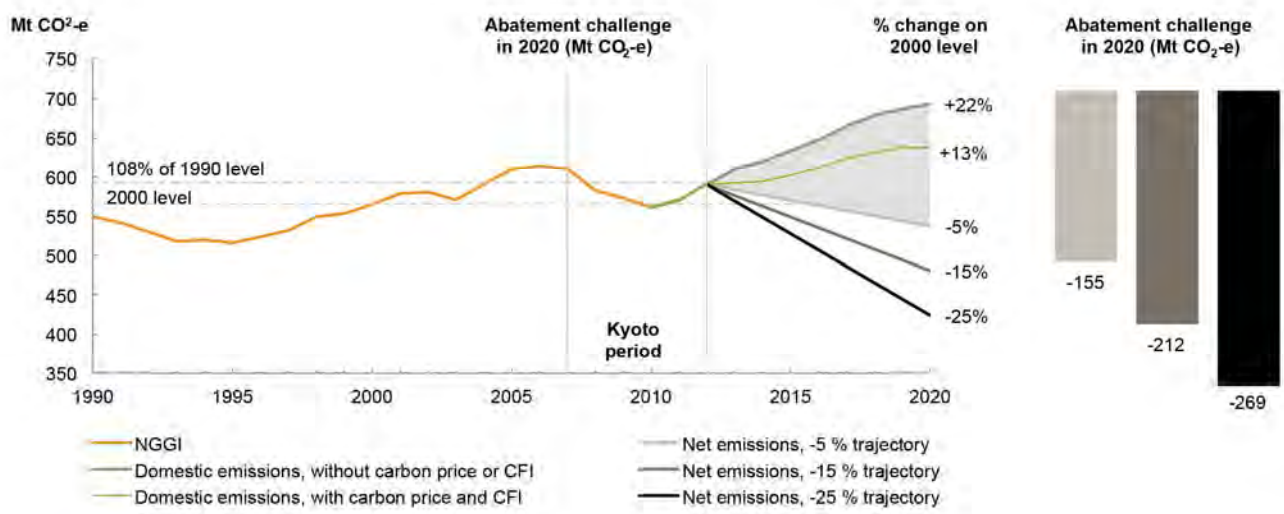

Figure 5.1 Historical and projected emissions, 1990 to 2020 (Mt CO_2 e) and comparisons with Australia's emissions reduction targets of 5, 15 and 25 per cent below 2000 levels

	1990 (Kyoto first commitment period base)	Kyoto first commitment period average 2008-2012	2020
Without a carbon price and CFI and with other measures	548	575	693
With a carbon price and CFI and with other measures. Including internationally sourced abatement	548	575	537
Targets			
Minus 5 target			537
Minus 15 target			481
Minus 25 target			424

Table 5.1 - Summary of Australia's emissions projections, Mt CO_2-e (Kyoto Protocol accounting basis)

The 'with carbon price' emissions projection incorporates adopted policies and measures including the emissions trading scheme, CFI, RET and energy efficiency measures. Compared with the 'without carbon price' scenario this shows a projection of 155 Mt CO_2-e of abatement from policies and measures in 2020. This Includes domestic abatement of 55 Mt CO_2-e, of which around 48 Mt CO_2-e is sourced from the emissions trading scheme and 7 Mt CO_2-e is sourced from the CFI. A further 100 Mt CO_2-e of abatement is projected to be sourced from overseas.

The emissions trading scheme and CFI will limit growth in Australia's domestic emissions over the period to 2020. Domestic emissions are projected to be 637 Mt CO_2-e in 2020, 8 per cent lower than they would have been without a carbon price. Projected emissions growth to 2020 is dominated by direct combustion and fugitive emissions associated with the production of energy resources which is driven by expected strong export demand for Australia's natural resources, particularly Liquefied Natural Gas (LNG). Declining levels of carbon sequestration from reforestation are also projected to increase domestic emissions by 2020.

The 'without carbon price' scenario projects Australia's emissions, including abatement sourced from a range of existing policies and measures including the RET and energy efficiency measures, but excluding the emissions trading scheme and CFI. With the introduction of the emissions trading scheme, abatement from other measures that operate in sectors covered by the emissions trading scheme are not separately identified. However, these measures can assist in lowering the cost of achieving the abatement and change the relative abatement achieved by different sectors.

Estimates of additional abatement achieved through existing policies and measures not covered by the emissions trading scheme are outlined in Table 5.2.

	2020 Mt CO_2-e
Queensland and New South Wales land clearing legislation	18.4
Greenhouse Gas Abatement Program - WA Smart Travel	0.4
Greenhouse Friendly	0.3
Greenhouse Gas Abatement Scheme	1
Total	**20.1**

Table 5.2 **Policies and measures additional to the with carbon price projection in 2020**

Emissions covered by the emissions trading scheme include those from stationary energy, industrial processes, production of coal and gas, and emissions from non-legacy waste. An equivalent carbon price will also be applied to some transport fuels through the existing fuel tax regime and to synthetic greenhouse gases through the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*. Emissions *not* covered by the carbon price include agricultural and forestry sector emissions, some transport emissions and emissions from the combustion of biofuels and biomass.

5.3 With carbon price projections in detail

Based on the Australia's 2012 Emissions Projections, under UNFCCC accounting rules for the treatment of LULUCF, Australia's total domestic emissions are projected to be 614 Mt CO_2-e in 2020 with all sectors and greenhouse gas abatement measures included.

Australia is on track to meet its Kyoto Protocol first commitment period target. Using Kyoto Protocol accounting, the projections indicate that between 2008 and 2012, emissions would be 105 per cent of 1990 levels on average. Details of the overall Kyoto Protocol accounting basis projections are shown in Annex III.

Under Kyoto Protocol accounting, the emissions trading scheme and CFI are projected to deliver 55 Mt CO_2-e of domestic abatement in 2020 across all UNFCCC sectors (energy, industrial processes, agriculture, waste, land use, land use change and forestry) and 100 Mt CO_2-e of internationally sourced abatement. This is in addition to pre-existing measures including the renewable energy target and energy efficiency measures.

5.3.1 Main sectoral contributions

Sectoral contributions to total emissions include energy, industrial processes, agriculture, waste, land use, land-use change and forestry, as detailed in Table 5.3.

- The energy sector, which is composed of the stationary energy, transport and fugitive emissions sectors, continues to be the most significant source of greenhouse gas emissions, representing approximately 73 per cent of total domestic emissions on average over the Kyoto first commitment period and in 2020.
- Industrial process emissions are expected to contribute approximately 5 per cent of projected domestic emissions in average over the Kyoto first commitment period and 6 per cent in 2020.
- Agriculture emissions are expected to grow, contributing around 15 per cent of emissions on average over the Kyoto first commitment period and 14 per cent of domestic emissions in 2020.
- The contribution of the waste sector is projected to fall and contribute around 2 per cent of emissions on average over the Kyoto first commitment period and in 2020.
- On a UNFCCC accounting basis, emissions from land use, land use change and forestry sector are projected to be around 19 Mt CO2-e in 2020. On a Kyoto Protocol accounting basis deforestation and reforestation is projected to average 27 Mt CO2-e over the Kyoto first commitment period and 43 Mt CO2-e in 2020. Deforestation accounts for around 8 per cent of Australia's total greenhouse gas emissions in 2011.

	1990 (Kyoto first commitment period base)	2000	Kyoto Protocol first commitment period average 2008-2012	2020
Energy	286	361	420	463
Stationary energy	195	251	293	318
Transport	62	75	85	92
Fugitive	29	36	42	53
Industrial processes	24	26	31	31
Agriculture	87	92	83	91
Waste	19	14	14	10
Deforestation and reforestation (Kyoto Accounting basis)	132	71	27	43
Total domestic emissions	**548**	**565**	**575**	**637**
Internationally Sourced abatement	N/A	N/A	N/A	100
Total net emissions	548	565	575	537

Table 5.3.a Net with carbon price greenhouse gas emissions projections (Mt CO_2-e), 1990 to 2020 (Kyoto Protocol accounting method)

	1990	2000	2020
Energy	286	361	463
Stationary energy	195	251	318
Transport	62	75	92
Fugitive	29	36	53
Industrial processes	24	26	31
Agriculture	87	92	91
Waste	19	14	10
Land use, land use change and forestry (UNFCCC Accounting basis)*	101	35	19
Total domestic emissions	**519**	**530**	**614**

Table 5.3.b. With carbon price greenhouse gas emissions projections (Mt CO_2-e), 1990 to 2020 (UNFCCC accounting method) *LULUCF does not include emissions and removals due to wildfire and includes a five year moving average

5.3.2 Reconciliation with the previous projections

The projections included in Australia's Fifth National Communication projected a 6 per cent increase in emissions between 1990 and the Kyoto Protocol first commitment period average using Kyoto Protocol accounting rules and a 25 per cent increase using UNFCCC accounting rules.

Since the Fifth National Communications, new inventory data and updated sectoral projections together with the impact of measures show that Australia is still on track to meet its Kyoto Protocol first commitment period target of limiting emissions to 108 per cent of 1990 levels from 2008 to 2012.

5.4 Projections by sector

This section discusses the 'with' and 'without' carbon price projections for each sector.

5.4.1 Projections of the energy sector (stationary energy)

Stationary energy is comprised of the electricity generation and direct combustion subsectors. Emissions from the electricity subsector are associated with fuels combusted to generate electricity, while emissions from direct combustion are associated with fuels combusted to generate energy used directly; mainly to generate heat, steam or pressure.

Direct combustion emissions occur in nearly all sectors of the economy. Sources of direct combustion emissions include fuels used for mining, energy industries such as petroleum refining, and manufacturing such as the production of metals and chemicals. They also include the use of fuels such as natural gas for heating and other purposes in the government, commercial and residential sectors.

Factors influencing stationary energy emissions projections

Growth in emissions from this sector is attributable to a range of factors, including energy demand. Energy demand is influenced by income growth and changes including in:

- gross domestic product (GDP);
- population growth;
- sectoral activity and structural change;
- major resource projects;
- ongoing improvements in energy efficiency; and
- changes in the 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 electricity and direct combustion subsectors have been modelled separately, however both incorporate assumptions from the Australian Treasury's top-down, computable general equilibrium (CGE) model of the Australian economy. These include GDP and population growth, output of key energy-intensive industries, and domestic prices for wholesale electricity and gas.

Sinclair Knight Merz McLennan Magasanik Associates (SKM-MMA) and ROAM Consulting were employed to conduct detailed, bottom-up modelling of electricity sector emissions, using inputs from the CGE model, such as overall electricity demand. These models were iteratively run with the CGE model until they achieved internal consistency.

The direct combustion emissions were modelled using the CGE model supplemented with detailed information about production across a range of economic sectors.

Assumptions

Assumptions around GDP and population growth, the projected output of key energy-intensive industries, rates of energy efficiency improvement and domestic prices for wholesale electricity and gas are all important factors underpinning the stationary energy emissions projection. This projection relies on assumptions used by the Australian Treasury in the 2011 modelling exercise Strong growth, low pollution: Modelling a carbon price (SGLP).

Projections

Average annual emissions in the Kyoto Protocol first commitment period are estimated to have been 293 Mt CO_2-e, an increase of 50 per cent from 1990. Under the 'with carbon price' scenario, domestic stationary energy emissions are projected to be 318 Mt CO_2-e in 2020, 22 Mt CO_2-e lower than without a carbon price. Under the 'without carbon price' scenario, emissions are projected to be 340 Mt CO_2-e in 2020.

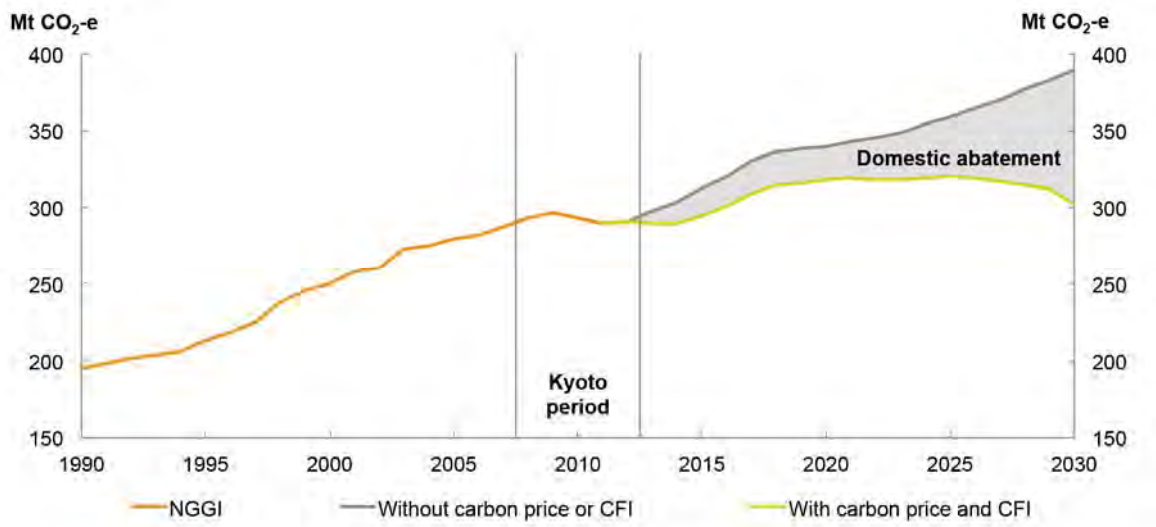

Figure 5.2 Historical and projected emissions from the stationary energy sector (Mt CO_2 e), 1990 to 2030

Effects of policies and measures already in place

The stationary energy sector projections are modelled on a 'cap and trade' emissions trading scheme commencing from 1 July 2015, after an initial fixed price period. From this date, emissions in the stationary energy sector are modelled to be covered under the scheme cap and any emissions reductions occurring in the sector as a result of other measures will not reduce net emissions beyond the level achieved by the cap, which in effect acts as a 'ceiling' on net abatement. This cap will now apply from 1 July 2014.

Both the 'with' and 'without' carbon price scenarios include an estimate of the aggregate domestic abatement achieved by key measures within the stationary energy sector. While it is possible to disaggregate this figure to apportion an amount of domestic abatement to individual measures, this is a complex task, particularly in the presence of an economy-wide carbon price. In the electricity sector, the most significant measure other than the emissions trading scheme is the RET.

Given that all measures in the stationary energy sector target emissions covered by the cap and the complexity associated with producing disaggregated abatement estimates for measures other than the carbon price, abatement estimates for other measures have not been published in the stationary energy projection.

It is also noted that there have been a number of significant changes in the largest interconnected electricity system in Australia, the National Electricity Market, over recent years driven by state and federal policies, macro-economic trends and customer response to rising electricity prices. For example, data from the Australian Energy Market Operator indicates that demand was around 2.5 per cent lower in 2012-13 than the previous year and the emissions intensity of electricity generation improved by around 4.5 per cent. Their preliminary data indicates this represents around a 7 per cent reduction in emissions from 2011-12, which is lower than the 2012 projection. These changes will be taken into account in future projections.

5.4.2 Projections of the transport sector

Greenhouse gas emissions from the transport sector are from the direct combustion of fuels in road transportation, railways, domestic shipping, domestic aviation and off road recreational vehicle activity.

Emissions from military transport, miscellaneous non-recreational off road vehicles, mobile utility engines, electricity used in electric vehicles and refining of oil-based fuels, including biofuels, are accounted for in other sectors.

Factors influencing sectoral emissions projections

Historically, the key driver of transport emissions has been changing activity levels (measured by aggregate travel distance), which in turn are driven by population, income, fuel prices and economic growth. Activity levels in rail and shipping have been driven primarily by bulk commodity production.

Other important determinants of emissions growth have included improved fuel efficiency resulting from technological change, changes in the mix of vehicles (for example smaller cars), and switching between the major transport modes (for example from road to air).

Analytical approach followed

The transport projection uses a combination of top-down and bottom-up economic models. The Australian Treasury's top-down, CGE model of the Australian economy was used to estimate demand for all major modes of transport. The transport subsectors in the CGE model are disaggregated to road (passenger and freight), rail (passenger and freight), water and air.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) was employed to conduct bottom-up partial equilibrium modelling of the road transport sector using the Energy Sector Model (ESM) of the Australian energy sector. ESM includes detailed representation of the road transport sector, and has an economic decision-making framework based around the cost of alternative fuels and technologies.

Emissions growth rates from the CGE model were used to project road, domestic aviation, domestic shipping and rail transport sector emissions. The CSIRO modelling was then used to project emissions for the subcategories of road transport by partitioning CGE model road transport emissions growth.

Assumptions

Key assumptions underpinning the transport sector projection include GDP and population growth, the international oil price, and growth in key commodities. This projection relies on assumptions used by the Australian Treasury and the CSIRO in SGLP.

Projections

Transport emissions are projected to have averaged 85 Mt CO_2-e over the Kyoto Protocol first commitment period, a 36 per cent increase on 1990. Transport emissions are projected to be 92 Mt CO_2-e in 2020 with the carbon price, 5 Mt CO_2-e lower than without a carbon price. *Without* the carbon price, transport emissions are projected to be 97 Mt CO_2-e in 2020.

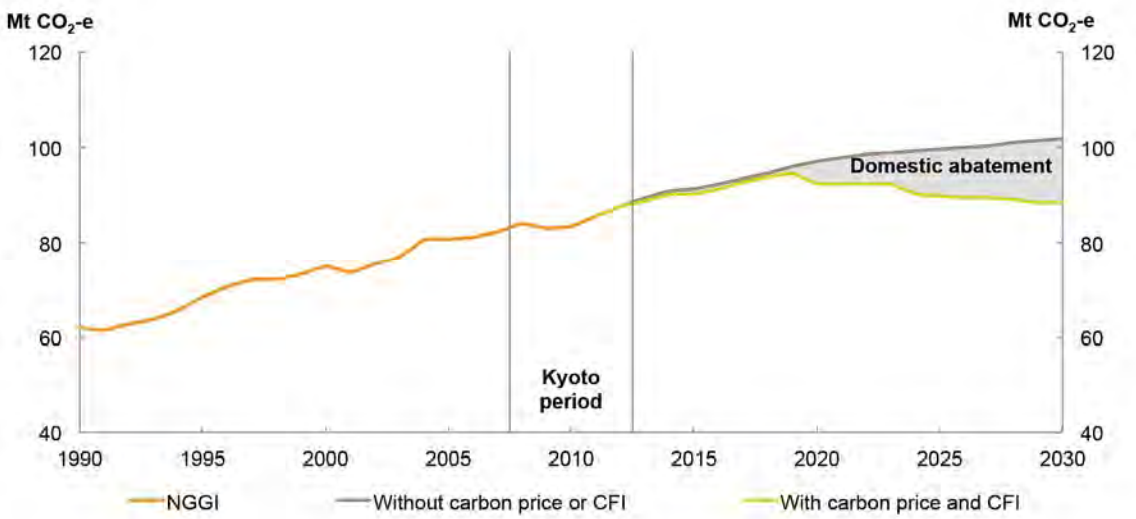

Figure 5.3 Historical and projected emissions from the transport sector (Mt CO_2 e), 1990 to 2030

Effects of policies and measures already in place

The transport sector projections are modelled on a 'cap and trade' emissions trading scheme commencing from 1 July 2015, after an initial fixed price period. From this date, some transport sector emissions are modelled to be covered under the scheme cap and any emissions reductions occurring in the sector as a result of other measures will not reduce net emissions beyond the level achieved by the cap, which in effect acts as a 'ceiling' on net abatement. Other transport emissions covered by an effective carbon price through the fuel tax system or not subject to any carbon price will not fall under the cap. The cap will now apply from 1 July 2014.

Both the 'with' and 'without' carbon price scenarios include an estimate of the aggregate domestic abatement achieved by key measures targeting covered emissions within the transport sector. While it is possible to disaggregate this figure to apportion an amount of domestic abatement to individual measures this is a complex task, particularly in the presence of an economy-wide carbon price. Given this complexity, estimates for measures other than the carbon price that abate covered emissions have not been published in the transport projections.

The Greenhouse Gas Abatement Program (GGAP) targets emissions from light vehicles and therefore abates emissions not covered by the carbon price. Funding was provided to the Western Australian Government for WA Smart Travel. Abatement estimates for GGAP – WA Smart Travel are presented in Table 5.4. This measure could be expected

to achieve domestic abatement in addition to the abatement achieved by the carbon price.

Name	Kyoto protocol first commitment period average 2008-2012	2020
	Mt CO_2-e	Mt CO_2-e
Greenhouse Gas Abatement Program – WA Smart Travel	0.5	0.4
Total	**0.5**	**0.4**

Table 5.4 **Transport measures abatement of uncovered emissions**

5.4.3 Projections of the energy sector (fugitive emissions)

Fugitive emissions are emissions of greenhouse gases associated with the production, processing, storage, transmission and distribution of fossil fuels such as coal, oil and natural gas. The sector also includes emissions from decommissioned underground coal mines.

Emissions arising from combustion of fuel for energy purposes, transportation and the decomposition of organic waste in landfills are accounted for in other sector.

Factors influencing sectoral emissions projections

Fugitive emissions from the coal subsector depend on the level of overall production, the emissions intensity of production associated with the type of mine, and the volume of greenhouse gases contained in the particular coal seam. Emissions from coal mining arise from mining and post-mining activities as well as from decommissioned mines.

Australia is currently the world's largest exporter of metallurgical coal and the second largest exporter of thermal coal. Australia is expected to remain a major source of world coal supplies to at least 2030 (International Energy Agency, 2011).

Fugitive emissions from oil and gas production are considered separately based on whether they are deliberate or unintended. About two-thirds of fugitive emissions from oil and gas production are deliberate emissions.

Deliberate emissions arise from venting and flaring, which are controlled methods to dispose of waste gases arising from oil and gas production. Unintended emissions arise from equipment leaks, evaporation and storage losses in oil and gas handling (transmission and distribution).

The main factor influencing the level of fugitive emissions from the oil and gas subsector is strong growth in the production of natural gas, particularly LNG. The Australian LNG industry is forecast to undergo rapid expansion over the projection period in response to

strong demand from the Asian export market. The steepest growth in fugitive emissions from the oil and gas subsector is projected to occur late in the decade to 2020, corresponding to accelerated LNG production.

Fugitive emissions – other than emissions from decommissioned coal mines – are covered emissions under the carbon price. Strong export demand and Government assistance means that the carbon price is not expected to significantly affect LNG production levels. Coal production is projected to be 2 per cent higher in 2020 in the 'without carbon price' scenario compared to the 'with carbon price' scenario and gas production is projected to be 2 per cent higher. The carbon price is expected to have less than a 0.1 per cent effect on oil production in 2020.

Analytical approach followed

Emission projections for the coal subsector are based on mine-specific production data from Wood Mackenzie's Coal Supply Service forecasts. These are combined with mine-specific emissions factors to project emissions on an individual mine level. The total projection is the sum of these individual mine emissions projections. Recent events like flooding, capacity utilisation and infrastructure constraints that impact on coal production are taken into account in these projections. The projections include emissions caused by post-mining processes and decommissioned mines.

The projections with a carbon price also take into account the effect of a carbon price on emissions intensity and production based on analysis undertaken by the Australian Treasury in SGLP.

Emissions from LNG were projected using a bottom-up model which includes the latest production, emissions and reservoir gas concentration for each LNG project included in the projection. Production data was based on the Wood Mackenzie LNG Supply Service and cross-checked against other production forecasts available at the industry level, such as the Bureau of Resources and Energy Economics (BREE) and International Energy Agency. The use of Wood Mackenzie's LNG Supply Service enabled a consistent, independent analysis to be applied to the production and demand forecasts for coal and LNG, the commodities which make the greatest contribution to emissions within the sector.

Emissions factors for LNG were calculated using reservoir gas content data and data in environmental impact statements. Factors were determined for three emissions types: venting, flaring and other fugitives (encompassing emissions from storage and process leaks).

Emissions from each of the domestic gas and oil subsectors were calculated with top-down models. Production data were based on Australian energy projections 2034-35 (BREE, 2011). Emissions factors were determined from historical emissions and production data obtained from the Australia's National Inventory.

Assumptions

Fugitive emissions projections are based on mine-specific production and emissions data. Coal production forecasts are estimated using Wood Mackenzie's Coal Supply Service and the emissions factors for each mine are taken from Australia's National Inventory (where available). The projections are the sum of the individual mine emissions projections.

In 2012, new projections models were developed for the oil and gas subsector. A bottom-up model was constructed for LNG emissions, incorporating project-specific information on emissions factors, production and emissions forecasting, while top-down estimates were generated for domestic gas and oil fugitive emissions.

For each subsector of fugitive emissions, the effect of the carbon price was imposed through changes to coal, oil, or gas production and emissions intensities consistent with the Australian Government's scenario modelled in SGLP.

Projections

Fugitive emissions are projected to have averaged 42 Mt CO_2-e over the Kyoto Protocol first commitment period, 43 per cent above 1990 levels. Fugitive emissions are projected to be 53 Mt CO_2-e in 2020 in the 'with carbon price' scenario, 14 Mt CO_2-e lower than the 'without carbon price' scenario. 'Without' the carbon price, fugitive emissions are projected to be 67 Mt CO_2-e in 2020, an increase of 87 per cent relative to 2000.

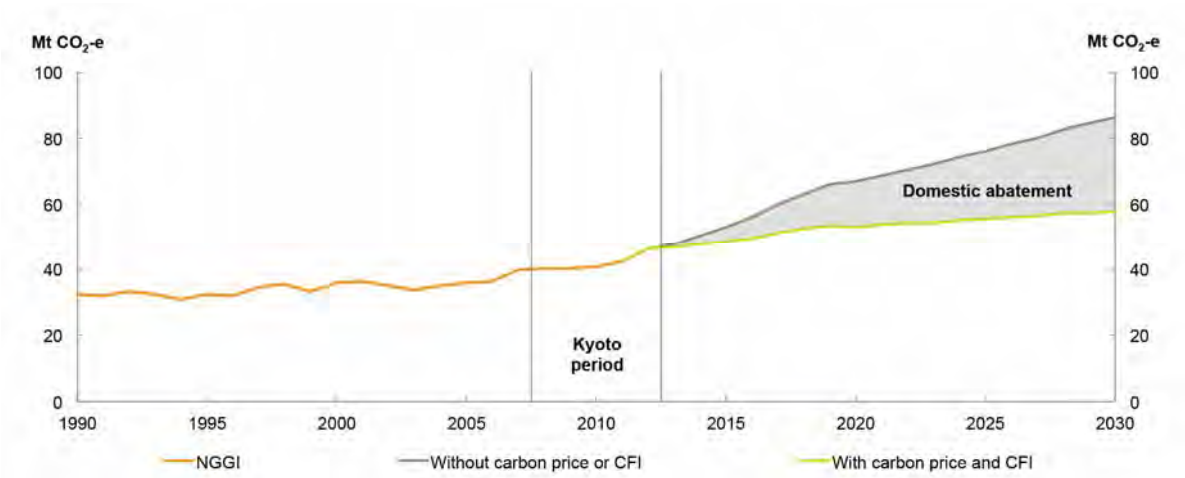

Figure 5.4 Historical and projected fugitive emissions from the energy sector (Mt CO_2 e). 1990 emissions shown are from the inventory that was current at October 2012, not the Kyoto Protocol first commitment period base year.

Effects of policies and measures already in place

The fugitive sector projections are modelled on a 'cap and trade' emissions trading scheme commencing from 1 July 2015, after an initial fixed price period. From this date, some fugitive sector emissions are modelled to be covered under the scheme cap and any emissions reductions occurring in the sector as a result of other measures will not reduce net emissions beyond the level achieved by the cap, which in effect acts as a 'ceiling' on net abatement. This cap will now apply from 1 July 2014.

Both the ‘with’ and ‘without’ carbon price scenarios include an estimate of the aggregate domestic abatement achieved by key measures within the fugitives sector. While it is possible to disaggregate this figure to apportion an amount of domestic abatement to individual measures this is a complex task, particularly in the presence of an economy-wide carbon price.

Given the complexity associated with producing disaggregated abatement estimates for measures other than the carbon price, abatement estimates for other measures have not been published in the fugitives projection.

5.4.4 Projections of the industrial processes sector

The industrial processes sector includes process greenhouse gas emissions from mineral products; chemical industries; metals production; consumption of halocarbons; sulphur hexafluoride (SF6) used in electrical circuit breakers and switchgear; and food and drink production.

Non-process greenhouse gas emissions from these industries are counted in other sectors.

Factors influencing industrial process emissions projections

Greenhouse gas emissions from industrial processes are the by-products of the use of non-energy related materials and reactions in production processes.

In the mineral products, chemical, metals and food and drink production subsectors, production levels of the relevant product largely influence annual fluctuations in emissions.

Over time, technological change in production processes can have a significant impact on process emissions. For example, improved process monitoring and control has resulted in a substantial reduction in perfluorocarbon emissions from aluminium smelting.

Nonetheless, the chemistry of the processes involved places a physical limit on emissions reductions. Once minimum greenhouse emissions intensity is achieved, further reductions in emissions factors can occur only through technological changes that fundamentally alter the chemistry of the production processes. Major changes of this type are infrequent and difficult to predict.

Emissions from consumption of halocarbons are associated with leakages from equipment charged with synthetic greenhouse gases. Growth in these emissions has been rapid since 1990, as these gases have replaced ozone-depleting substances in equipment such as refrigerators and air conditioners. Growth is projected to slow in future as it appears that this transition is almost complete. The key drivers of these emissions include:

- 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.

Emissions consumption of halocarbons can be reduced through improved sealing, handling and maintenance of equipment.

Analytical approach followed

The projection for the industrial processes sector used an in-house model. The model is consistent with the methodology used in Australia's National Inventory.

Assumptions

Industrial process emissions projections are heavily dependent on commodity production forecasts. Key commodities include aluminium, iron and steel, cement, limestone, and ammonia and ammonium nitrate.

Projections

Average annual emissions in the Kyoto first commitment period are estimated to have been 31 Mt CO_2-e, an increase of 29 per cent from 1990. 'With' the carbon price, domestic industrial process emissions are projected to be 31 Mt CO_2-e in 2020, 6 Mt CO_2-e lower than without a carbon price. 'Without' the carbon price, emissions are projected to be 36 Mt CO_2-e in 2020.

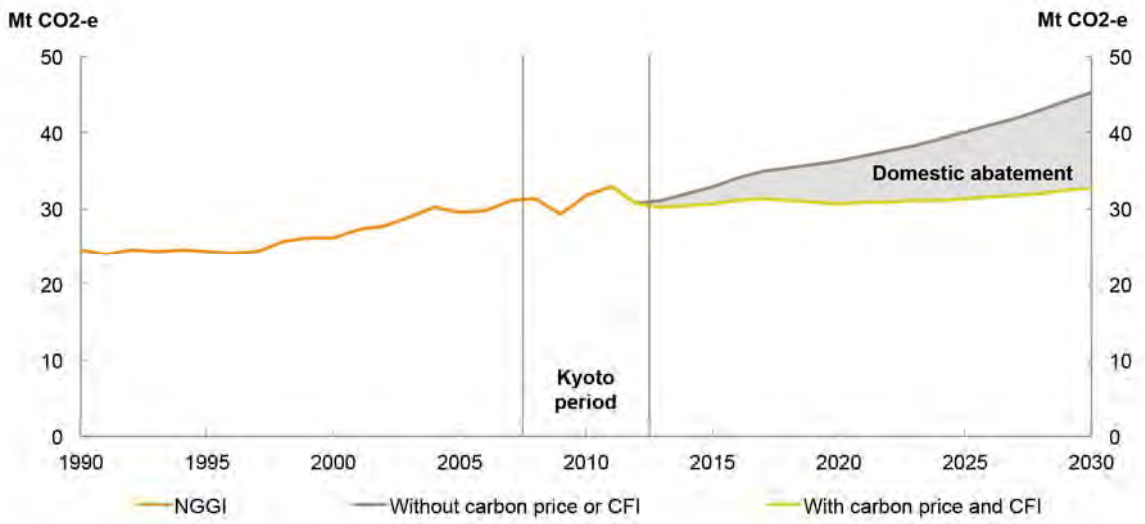

Figure 5.5 Historical and projected emissions from the industrial processes sector (Mt CO_2 e), 1990 to 2030

Effects of policies and measures already in place

Overall, the carbon price is projected to achieve 6 Mt CO_2-e of abatement in 2020. The carbon price is projected to drive abatement through improvements in the emissions intensity of production of industrial process products.

On 14 May 2013, the Australian Government announced details of a program to provide additional incentives for the destruction of waste synthetic greenhouse gases (SGGs) and ozone depleting substances (ODS). Additional domestic abatement is expected through this program, and will be estimated in future projections.

5.4.5 Projections of the agriculture sector

Sources of greenhouse gas emissions from the agriculture sector include non-CO_2 gases from livestock enteric fermentation, manure management, rice cultivation, agricultural soils, burning of savannas and field burning of agricultural residues. Livestock is the primary source of agricultural emissions representing over 70 per cent of agricultural emissions.

Factors influencing sectoral emissions projections

Water availability and global demand for Australian agricultural commodities are key elements in projecting agricultural activity and emissions in Australia, particularly through their impact on the size of the livestock herd. Climate conditions also affect savanna fires in the Northern Territory and Western Australia, another source of agriculture emissions.

Analytical approach followed

The methodology for calculating projections from the agriculture sector involves multiplying estimates of agricultural activity levels (such as livestock numbers and areas of crops sown) by emission factors. Agricultural models are used to estimate activity levels and the emission factors are drawn from Australia's National Inventory. The impact of the carbon price on agricultural activity is based on modelling for the SGLP report.

The agriculture projections incorporate the long-term forecasts of agricultural activity by the Centre for International Economics (CIE) and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) which were produced for projections released in early 2011. The current projections calibrate these forecasts for the December Quarter 2011 update of Australia's National Inventory.

The inventory provides preliminary data for 2011 for some sectors based on activity and emissions trends. However for agriculture, the preliminary estimates for 2011 may not fully capture the recovery in livestock and cropping activity following generally improved seasonal conditions in Western Australia and south-eastern Australia. As such, unlike some other sectors in these projections, the agriculture projections are based on inventory data up to 2010 rather than the 2011 preliminary estimate. Short-term forecasts have instead been updated using more recent estimates from ABARES' Australian Commodities: March Quarter 2012 and internal analysis. The projections also incorporate the additional growth in agricultural activity under the carbon price as modelled in the SGLP report.

Savanna burning is the exception to this methodology. Projections for savanna burning are not formally modelled. Due to the inherent lack of predictability of future rainfall patterns, projections are instead calculated by taking a long-term average of past emissions, before incorporating forecast abatement from the CFI.

Assumptions

The key driver of agriculture emissions is growth in agricultural activity.

The most significant agricultural activity in terms of emissions is the rearing of livestock. In the projections, trends in flock and herd sizes are determined by modelling of the growth in demand for Australian commodities. Demand is determined by supply conditions and productivity growth in Australia and competing export markets, as well as income and population growth in consuming countries. Consideration is also made of breeding constraints and expected average weights of each animal. Similar assumptions are made regarding the average productivity per animal for dairy and wool commodities.

The projections take into account fluctuations in seasonal conditions and the possibility of future drought. Forecasts of commodities and agricultural activity are based on seasonal conditions averaged over long historical periods.

Emission factors are consistent with the 2009-10 national inventory. Livestock and fertiliser emissions factors differ by region to capture variations in conditions and farming practices. Emission factors for livestock may change with an increase in slaughter weights. However, such changes have historically been very slight and are difficult to isolate from other impacts such as the age profile of livestock populations. For projections purposes, these emission factors are assumed to remain constant over the projections period.

Projections

Agriculture emissions are projected to have averaged 83 Mt CO_2-e over the Kyoto first commitment period, a 4 per cent reduction from 1990. Agriculture emissions are projected to be 91 Mt CO_2-e in 2020 'with' the carbon price and CFI. The carbon price is projected to achieve 1 Mt CO_2-e of domestic abatement in the agriculture sector through the CFI in 2020. 'Without' the carbon price and CFI, agriculture emissions are projected to be 92 Mt CO_2-e in 2020.

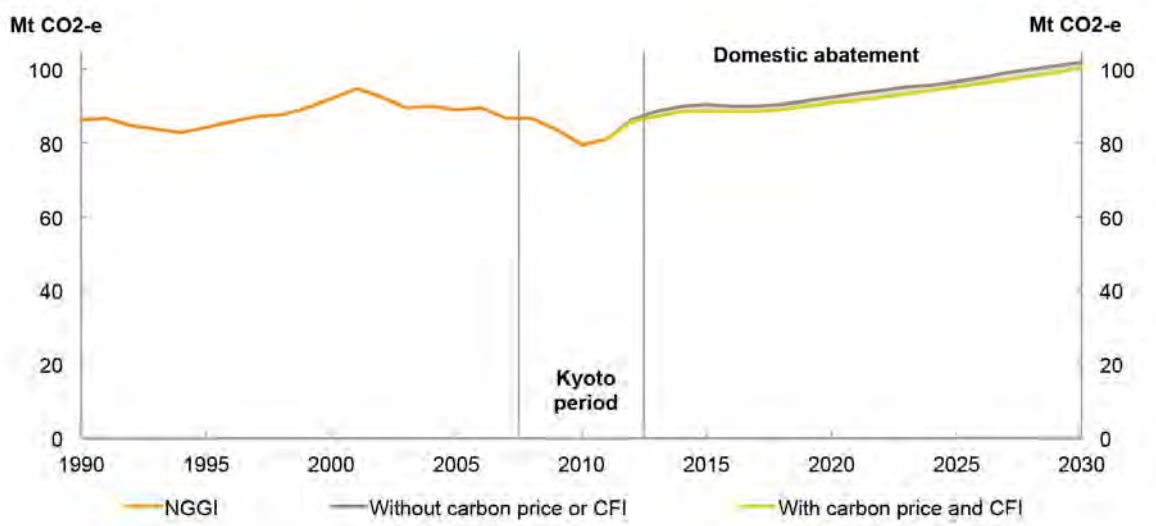

Figure 5.6 Historical and projected emissions from the agriculture sector (Mt CO_2 e), 1990 to 2030

Effects of policies and measures already in place

Emissions in the agriculture sector are not covered by the emissions trading scheme. Any abatement attributed to measures in this sector will be additional to the domestic abatement achieved by the emissions trading scheme.

The key abatement measure in the agriculture sector is the CFI. The CFI is a unique type of measure in that it provides abatement in sectors not covered by the carbon price and allows liable parties under the carbon price to use CFI credits to offset their emissions. Because of its link to the emissions trading scheme, the CFI does not lead to additional *net* abatement beyond that which would be delivered by the emissions trading scheme. However, the CFI does increase the amount of abatement achieved domestically (as distinct from international sources) and lowers the cost of achieving abatement targets. Thus it has a similar effect to measures in sectors covered by the carbon price.

Modelling suggests that agricultural activity will grow faster with the carbon price than without. This acceleration is driven by the exemption of agriculture from the direct impact of the carbon price and the carbon price effect on the exchange rate. Abatement achieved through the CFI is projected to more than offset emissions from additional agricultural production in the 'with' carbon price scenario. As such, the abatement attributable to the CFI is greater than the reduction in emissions between the *with* carbon price and 'without' carbon price scenario.

The CFI is expected to achieve 1 Mt CO_2-e of abatement in the agriculture sector in 2020.

5.4.6 Projections of the waste sector

The waste sector includes emissions from the disposal of organic materials to landfill and wastewater emissions including domestic, commercial and industrial wastewater. Emissions are predominately methane-generated from anaerobic decomposition of organic matter. The primary greenhouse gas emitted is methane; carbon dioxide and nitrous oxide are also emitted.

Factors influencing sectoral emissions projections

The main factors influencing solid waste emissions are population growth and rates of waste generation, waste diversion and methane capture. The main factors affecting emissions from wastewater are population growth and the proportion of population sewered.

Overall, the growth in waste generation that arises from population growth and consumption is projected to be generally outweighed by increasing waste diversion and methane capture.

Analytical approach followed

The projection for the waste sector was prepared by the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (formerly the

Department of Climate Change and Energy Efficiency) using an in-house model, consistent with the methodology used for Australia's NGGI. Three subsectors are modelled: solid waste, domestic and commercial wastewater, and industrial wastewater.

The projections calculate emissions generated from waste to landfill (solid waste) at a state level by combining Australian Government population forecasts with estimated future waste generation and diversion rates from environmental consultancy Blue Environment. Waste diversion rates were projected by waste type and state or territory, according to jurisdictional recycling targets.

Domestic and commercial wastewater emissions are projected at a jurisdictional level based on population forecasts, the proportion of population serviced by a sewer, the biological oxygen demand of wastewater, and the proportion of wastewater treated anaerobically. Industrial wastewater emissions are projected on a national level based on forecasts of industry outputs, wastewater generation rates, the chemical oxygen demand (COD) of industrial wastewater, and the fraction of COD anaerobically treated.

The projections incorporate methane capture rate forecasts for the three waste subsectors. Blue Environment provided analysis of the potential for methane capture rate improvements in each subsector by state and territory. The projections combine this analysis with modelling of the impact of the CFI.

Assumptions

Per capita generation rates for all organic waste types except paper are projected to remain constant over the projections period. Historical analysis by environmental consultant Blue Environment shows a trend to stabilising waste generation per capita in Australia. During the same historical period, paper and cardboard consumption has grown slowly with a late decline corresponding to the global financial crisis. As such, the projections assume an annual growth in paper waste generation rates of 1 per cent per year.

Waste generation rate estimates are based on 2009 levels, using the latest waste diversion data from the Australian Commonwealth Department of Sustainability, Environment, Water, Population and Communities and waste to landfill data from Australia's NGGI.

The projections include estimates of state specific waste diversion rates over the projections period. The projections assume that jurisdictions will meet their existing targets for waste diversion. This assumption is consistent with the recommendation of Blue Environment and with jurisdictional progress reports on waste diversion targets.

All jurisdictions are also projected to achieve minimum improvements in recycling by 2030 even in the absence of jurisdictional targets. The improvements are estimated for jurisdictions grouped according to population size and density. It is expected that waste diversion will continue to improve over the projections period due to bipartisan support for enhanced recycling infrastructure and processes, and improved technologies for sorting recyclable materials.

States and Territories	2010	2020
ACT	72	85
NSW	53	66
NT	10	25
QLD	46	65
SA	64	66
TAS	25	40
VIC	64	66
WA	38	47

Note: Waste diversion assumptions are based on a combination of analysis by Blue Environment analysis and data provided under NGERS and may differ from other publically available estimates of waste diversion. Source: December 2011 NGGI, Blue Environment (2011), DCCEE analysis.

Table 5.5 Percentage of waste diverted from landfill, without carbon price or CFI

Methane recovery rates are expected to increase even in the absence of a carbon price, driven by renewable energy markets, technological improvements and jurisdictional regulations. Table 5.6 presents projected jurisdictional methane capture rates without the impact of the carbon price. The carbon price is projected to accelerate the growth in methane capture, as discussed below.

States and Territories	2010	2020
ACT	48	51
NSW	24	29
NT	25	30
QLD	16	21
SA	29	34
TAS	34	39
VIC	33	38
WA	28	33

Source: December 2011 NGGI, Blue Environment (2011), DCCEE analysis.

Table 5.6 Percentage of methane recovered from solid waste, without carbon price or CFI

Waste facilities with direct emissions of 25 000 tonnes CO_2-e a year or more will be liable under the emissions trading scheme. The carbon price will not apply to emissions from solid waste deposited prior to 1 July 2012 (known as legacy waste). However, legacy waste emissions will count towards determining facility thresholds for liability for the carbon price. Covered emissions from sources other than the decomposition of waste will also affect whether a facility meets the carbon price liability threshold.

The projections assume that around 80 per cent of non-legacy solid waste will be deposited in landfills that are above the 25 000 tonnes CO_2-e threshold for carbon price liability. This proportion is assumed to remain constant across the projections period. The projections also assume that around 25 per cent of emissions from domestic and commercial wastewater will be from facilities liable under the carbon price, with a similar proportion of industrial wastewater. Most wastewater emissions are expected to be generated in facilities below the 25 000 tonnes CO_2-e threshold for carbon price liability.

Carbon pricing provides an incentive for waste facility operators to reduce the emissions-intensity of their operations. For SGLP, a marginal abatement cost curve was used to represent and model this reduction. The projections apply the relevant SGLP marginal abatement cost curve to the revised emissions baseline, in addition to the uptake of legacy waste abatement through the CFI. Assumptions about legacy waste abatement achieved through the CFI are the same as in SGLP.

Projections

Waste sector emissions are projected to have averaged 14 Mt CO_2-e over the Kyoto Protocol first commitment period, a 27 per cent reduction from 1990. In 2020, waste emissions are projected to be 10 Mt CO_2-e 'with' the carbon price and CFI. Emissions from solid waste are projected to account for 73 per cent of total waste emissions in 2020, 'with' the carbon price and CFI. 'Without' the carbon price and CFI, waste emissions are projected to be 13 Mt CO_2-e in 2020.

The biggest sources of abatement in the waste sector are expected to be methane capture for electricity generation or flaring and the diversion of waste from landfill for recycling and composting.

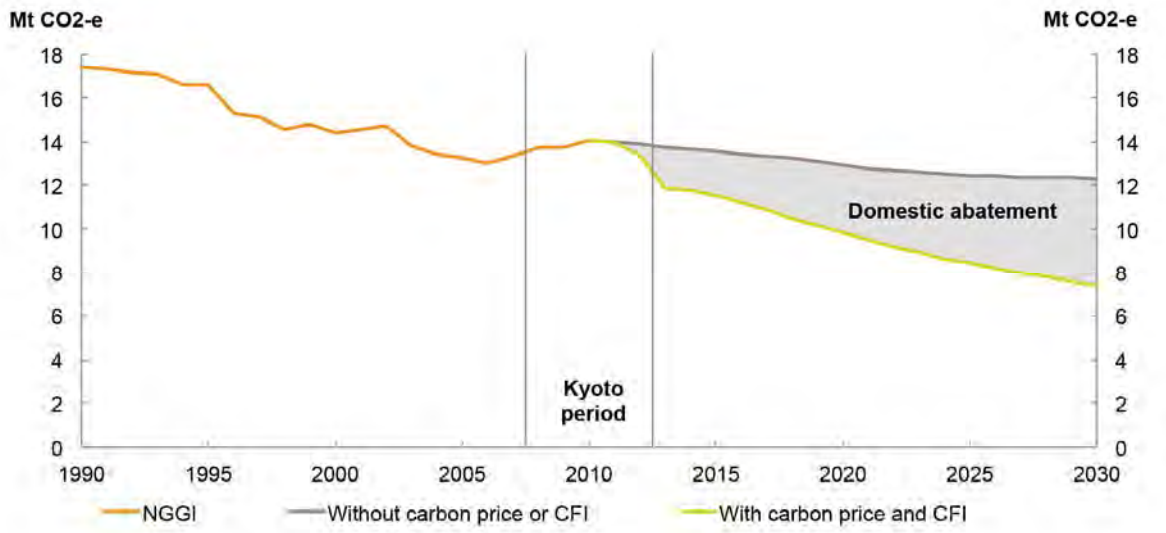

Figure 5.7 Historical and projected emissions from the waste sector (Mt CO_2-e), 1990 to 2020

Effects of policies and measures already in place

The waste sector projections are modelled on a 'cap and trade' emissions trading scheme commencing from 1 July 2015, after an initial fixed price period. From this date, it is estimated that 16 per cent of emissions in the waste sector will fall under the carbon price cap and any abatement of covered emissions in the sector as a result of other measures will not reduce net emissions beyond the level achieved by the cap, which in effect acts as a 'ceiling' on net abatement. This cap will now apply from 1 July 2014.

Both the 'with' and 'without' carbon price scenarios include the aggregate domestic abatement achieved by key measures targeting covered emissions within the waste sector. While it is possible to disaggregate this figure to apportion an amount of domestic abatement to individual measures, this is a complex task, particularly in the presence of an economy-wide carbon price. Given this complexity, estimates for measures other than the carbon price that abate covered emissions have not been published. The exception to this is the CFI.

The CFI is a unique type of measure in that it provides abatement in sectors not covered by the carbon price and allows liable parties under the carbon price to use to CFI credits to offset their emissions. Because of its link to the emissions trading scheme, the CFI does not lead to additional *net* abatement beyond that which would be delivered by the emissions trading scheme. However, the CFI does increase the amount of abatement achieved domestically (as distinct from international sources) and lowers the cost of achieving abatement targets, similar to measures in sectors covered by the carbon price.

The carbon price and CFI are projected to achieve 3 Mt CO_2-e of domestic emissions abatement in 2020.

Abatement estimates for measures in the waste sector that reduce emissions not covered by the emissions trading scheme are presented in Table 5.7. These measures

could be expected to achieve domestic abatement in addition to the abatement achieved by the emissions trading scheme.

Name	Abatement (Mt CO_2-e)	
	2015	2020
Greenhouse Gas Abatement Scheme	1	1
Greenhouse Friendly	0.4	0.3
Carbon Farming Initiative	2	1
Total (excluding CFI)	2	1

Table 5.7 **Abatement of uncovered emissions from waste measures in 2020**

5.4.7 Projections of the land use, land-use change and forestry sector

Projections for the land use, land-use change and forestry (LULUCF) sector are completed for forest lands, croplands, grasslands and other categories based on UNFCCC inventory reporting guidelines.

The projections are current as at October 2012 and do not incorporate the Government's decision to join the second commitment period of the Kyoto Protocol and to further broaden coverage of the land sector to include net emissions from cropland management, grazing land management and revegetation activities. The projects do not include the decision by the Queensland State Government to change land clearing laws. The impact of these decisions will be incorporated in the 2013 Australia's Emissions Projections.

Forest land

Forest land remaining Forest land

Sequestration from commercial forests, environmental plantings and managed native forests is dependent on the area of the forest 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.

The methods used to calculate the emissions and removals underpinning the calculation of the projection of Forest land remaining Forest land are those used by Australia to develop the National Inventory Report. Methods have been developed in the national inventory for the following sub-categories:

- Multiple Use Forests – public native forests managed for multiple uses that include timber production;
- Plantations – plantations established prior to 1990;

- Private harvest native forests - privately owned forests that have been harvested since 1990;
- Other native forests; and
- Fuel wood consumed.

Harvesting in the Multiple Use Forests, the private native forests and the plantations is the key driver of human induced emissions and removals in these forests. Over recent years harvesting in the native forest sector has reached historically low levels. This decline has been associated with changes in supply factors such as the creation of forest reserves and increasing supply from plantations (particularly those established after 1990) and demand factors including the international price of harvested wood products and the value of the Australian dollar as well as shifts in demand patterns, especially between Japan and China. The current assumption for the projection is that harvesting in these forests remains at current levels but this is an assumption that will need to be carefully reviewed as new information on demand and supply factors emerge.

Land converted to Forest land

This projection for Land converted to Forest land is based on the assumption that planting rates, in the absence of the CFI, decline to approximately 12 000 hectares per year by 2013 which corresponds to a 1 per cent expansion rate. Under this assumption the post-1990 plantation estate expands by around 12 000–14 000 hectares per year. There are uncertainties regarding the rate of plantation expansion in the coming years due to shifts occurring in the plantation forestry sector and there is a potential for net declines in area if new forest owners choose to convert land to non-forest land uses.

Cropland

Cropland remaining Cropland

Long term changes in carbon stocks in cropland remaining cropland are largely affected by changes in land management practices. Land management practices that influence cropland soil carbon stocks include tillage, fertiliser, residue and irrigation management, choice of crop and intensity of cropping rotation, and irrigation management.

Data from the Australian Bureau of Statistics document significant changes in management practice since 1990, which impact cropland soil carbon stocks. In particular, the proportion of total cropping area under minimum tillage management practices has increased from 9 per cent in 1990 to 74 per cent in 2010. Further changes in management practices are expected to be encouraged by the CFI, which is designed to provide incentives for landowners to improve carbon outcomes on the land.

Changes in management practices affect soil carbon stocks over a long period of time. Consequently, changes in management practices observed between 1990 and 2010 will continue to have effects on soil carbon stocks if maintained at current levels. The full impacts of these changes will not be realised until after 20 years and, although the changes in carbon stocks through enhanced sequestration are likely to be small on a per hectare basis, across the total area of Australian croplands, the total improvement by

2020 is could expected to be in the order of several million tonnes of carbon dioxide Mt CO_2 per year.

For this Communication, the projection of emissions from Cropland remaining Cropland was extrapolated on the basis of the average emissions recorded from this category in the period 1990-2011.

Grassland

Grassland remaining Grassland

The grassland remaining grassland sub-category covers around 440 million hectares of land. The vast majority of this area occurs in inland Australia and is used for extensive grazing of both sheep and cattle. In Australia, grazing occurs across diverse climate, ecosystem and management systems. The pasture types and associated management intensities range from highly improved and sometimes irrigated pastures to extensive rangeland systems in the semi-arid and arid regions of Australia.

Long term changes in carbon stocks in grassland remaining grassland are largely affected by changes in land management practices. These factors determine the amount of live biomass and dead organic matter as well as the amount of residue, root and manure inputs to soil carbon.

The amount of carbon stored in the soil is the balance between the rate at which organic matter is added and the rate at which it decomposes, releasing CO_2 into the atmosphere. The decay of plants, manure and microbes add carbon to the soil. Carbon is lost from the soil through the conversion of organic carbon to CO_2, by erosion and leaching of dissolved carbon through the soil.

Both natural processes and land management practices influence soil carbon stocks by affecting primary productivity, root turnover, and allocation of carbon between roots and shoots.

Land management practices that influence grassland soil carbon stocks include grazing intensity, fertiliser management, irrigation and pasture management and pasture rehabilitation. Soil carbon stocks are most significantly impacted following a change in land management practise, as this is when the balance between the rate of organic matter input and soil carbon release is altered. If management practices are constant over time, the annual changes in soil carbon stock tend to reach a new equilibrium. Thus, a long-term trend in soil carbon emissions across the continent will emerge if land management practices have changed across a large area of grassland. Current inventory estimates do not reflect explicit or direct changes in management practices.

Data from the Australian Bureau of Statistics document significant changes in area under improved pasture since 1990, which influences soil carbon stocks. In particular, the total area under improved pasture from fertiliser application has increased from 27 million hectares in 1990 to 44 million hectares in 2010.

Since 1990, there has been no significant, discernible trend in emissions from grassland remaining grassland soil carbon.

However, as with croplands, the impacts of these changes will continue for 20 years after the implementation of the new practice and, although the change in carbon stocks is likely to small on a per hectare basis, across the area of Australian grasslands, the total by 2020 could be in the order of several million tonnes.

For this Communication, the projection of emissions from Grassland remaining Grassland was determined as an extrapolation of average emissions recorded from this category in the period 1990-2011.

Land converted to Grassland

The emissions projections for Forest land converted to Cropland and Forest land converted to Grassland were modelled using estimated areas of land clearing activity based on historical averages and projected movements in the farmers' terms of trade (See, Drivers of and clearing fact sheet[1]). Projections of the farmers' terms of trade are from ABARES (2012)[2]. It has been assumed that no changes to vegetation management regulations are introduced in the future. The projected land clearing activity was then used to model emissions due to loss of forest biomass and ongoing emissions from soil carbon.

The farmers' terms of trade are a measure of incentives for land managers to clear vegetation in order to expand agricultural production. The farmers' terms of trade increase when prices received by farmers for agricultural products (e.g. beef) rise or prices paid by farmers for inputs (e.g. fertiliser and diesel) fall.

Data analysis has revealed a statistically significant relationship between movements in the farmers' terms of trade and vegetation clearing, with a lag of one year. Typically, an increase (or decrease) in the farmers' terms of trade is followed by a corresponding increase (or decrease) in land clearing around one year later.

Wetlands, Settlements and Other

Wetlands and Settlements

The voluntary reporting land use categories Wetlands and Settlements are not estimated for UNFCCC reporting in Australia's National Inventory System.

Other

The source category 'Other' includes harvested wood products, agricultural lime application, and N_2O from disturbance associated with land-use conversion to Cropland.

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[1] Australian National Greenhouse Accounts (2011) *Drivers of Land clearing in Australia*, National Greenhouse Accounts fact sheet (http://www.climatechange.gov.au/sites/climatechange/files/files/climate-change/nger/nga-factsheet3.pdf)

[2] Australian Bureau of Agricultural and Resource Economics and Sciences 2012, *Agricultural Commodities, March quarter 2012*.

Emissions associated with land-use conversion to Cropland are included in the Forestland converted to Cropland projection.

Emissions associated with Agricultural lime application were estimated as the average emissions from this source in the period 2002-2011.

Projected supply of harvested wood products to the Australian economy the period 2012-2020 are included in the projection with input data derived from an extrapolation of the most recent historical wood product consumption statistics (ABARES 2012[3]).

Projections

By 2011, the net emissions from land use, land use change and forestry had decreased significantly (Figure 5.8). The underlying trend of declining emissions from LULUCF since 1990 has been mainly driven by the decline in emissions from forest land converted to cropland and grassland (NIR 2013). The results from the projections' modelling assumptions show a small decline in net emissions over the projection period with declines in emissions from forest conversion to grasslands largely offset by declines in net sequestration from recent grassland conversion to forests.

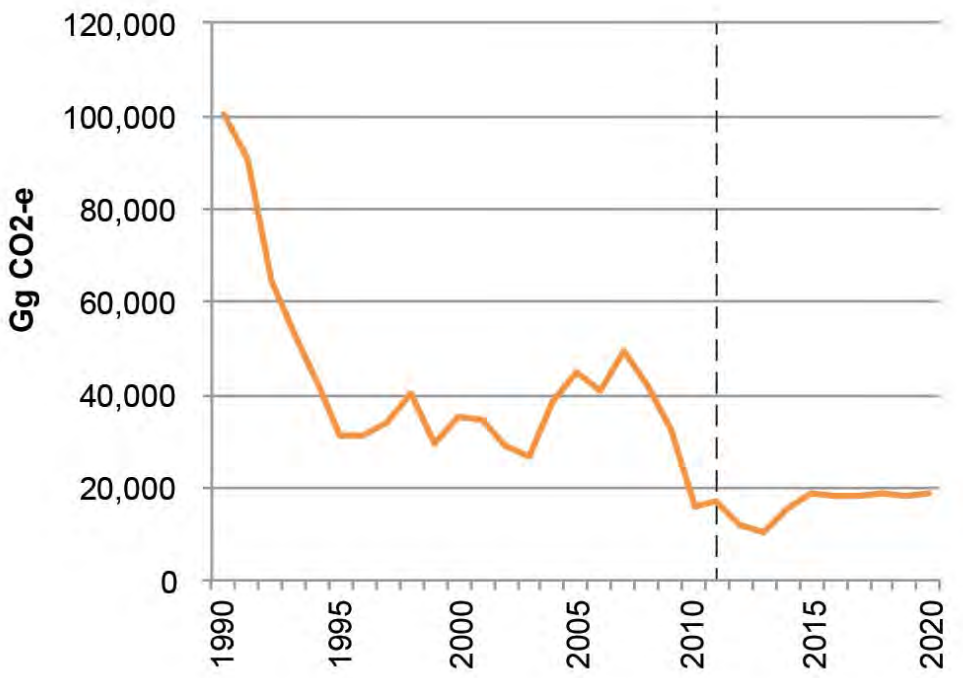

Figure 5.8 Net emissions from the land use, land-use change and forestry sector between 1990 and 2020 (Mt CO_2-e)

[3] ABARES (2012) Australian forest and wood product statistics: March and June quarters 2012, Australian Government, Canberra

Effects of policies and measures already in place

The emissions trading scheme is projected to achieve 4 Mt CO_2-e of abatement in the LULUCF sector through the CFI in 2020, with most of this occurring due to reduced conversion of Forest land to Cropland and Grassland.

5.4.8 Projections of the international bunker fuels emissions

International bunker fuels are fuels used for the purpose of international trade and travel between Australia and other nations, and are dominated by aviation fuel. Emissions over the Kyoto first commitment period from this sector are projected to be almost double the 1990 level, and are projected to continue to increase to 2020. The expected increase is a result of rapid projected growth in trade and international travel. In line with UNFCCC accounting rules, emissions from international bunker fuels are not counted in the total emissions for Australia.

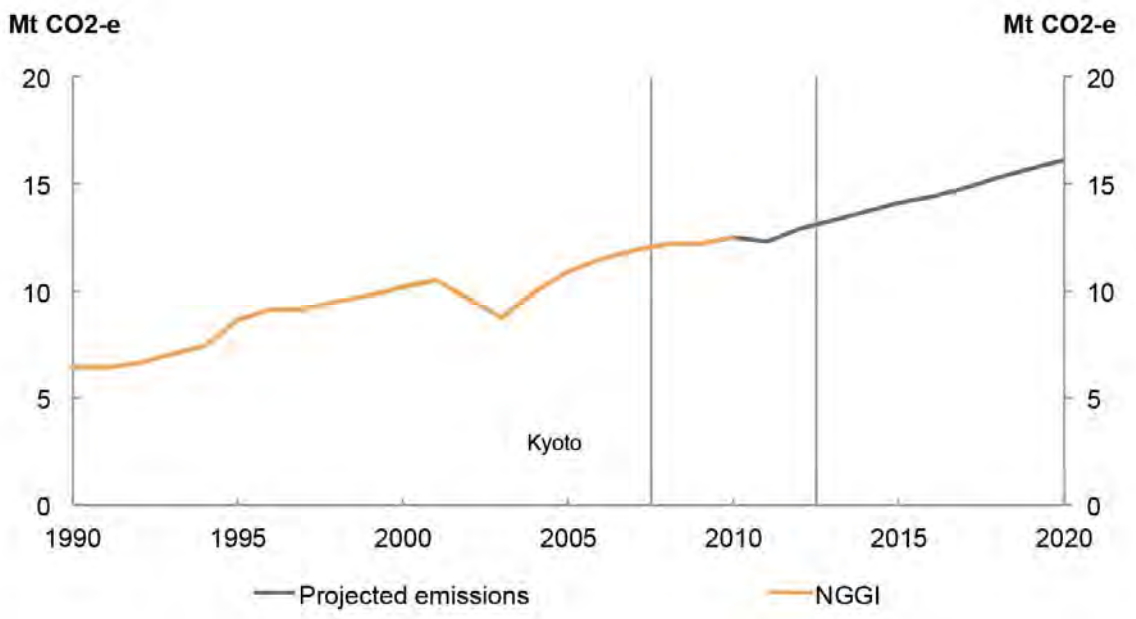

Figure 5.9 Historical and projected emissions from international bunkers fuels (Mt CO_2-e), 1990 to 2020.

5.5 Projections methodology

Australia's broad approach to emissions projections was discussed earlier (see 5.1). Emissions are projected by aggregating the various sectoral projections, which were also described individually in earlier sections of this chapter. However, some methodological points are common to all projections and are briefly discussed here.

The dominant approach used to project emissions for each sector is to project the relevant sectoral activity levels and to convert these into emissions using Australia's National Inventory.

Thus, the historical emissions 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 emissions factors.

The projections are largely based on the results of the Australian Treasury's SGLP report. The SGLP modelling used a suite of models including an economy-wide computable general equilibrium model and partial equilibrium models in key sectors, to analyse the impact of the carbon price on the Australian economy and Australia's emissions.

The projections supplement the SGLP results with new data and modelling, and emissions estimates from Australia's latest National Greenhouse Accounts. The supplementary data is used to incorporate developments in sectors since SGLP, as well as provide greater sectoral detail.

The 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 incentives, or other policy initiatives at the Australian, state and territory or local government level.

In the projections, the abatement achieved by key measures has been incorporated into both the 'with' and 'without' carbon price scenarios. Due to the complexities in attributing abatement to specific measures in the presence of an economy-wide carbon price, abatement estimates for measures operating in sectors covered by the carbon price have not been published. For this reason, no business as usual scenario has been modelled.

More detail on the projections is presented in Australia's Emissions Projections 2012. This includes information that reconciles the current and earlier projections, and details of the relevant methodologies for each sectoral projection. Stakeholders are consulted for projections in each sector to provide their views and ensure quality.

5.5.1 Uncertainty and sensitivity analysis

Emissions projections are inherently uncertain, involving judgments about the growth path of global and domestic economies, the implementation of policy actions, technological innovation and human behaviour. The uncertainty increases the further into the future emissions are projected.

The same uncertainty applies in predicting the domestic abatement achieved by the carbon price. As a market-based mechanism, the carbon price does not stipulate how or where in the economy abatement occurs, and could achieve domestic abatement beyond, or short of, the levels represented in the projections. For example, the carbon price combined with a range of other factors has resulted in electricity sector emissions in 2012-13 being lower than estimated in the 2012 projections.

High and low scenarios are published for the majority of sectors to provide a plausible range of emissions outcomes that reflect 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. Since the key assumptions vary from sector to sector, different assumptions and variables are adjusted in the sensitivity analysis across the sectors.

The aim is to provide greater understanding of the key risks related to the projections, to complement the emphasis placed within each sectoral projection on understanding the key drivers of the projection. Scenario analysis can aid policy makers by providing a tangible link from changes in key drivers to their potential impact on the projection.

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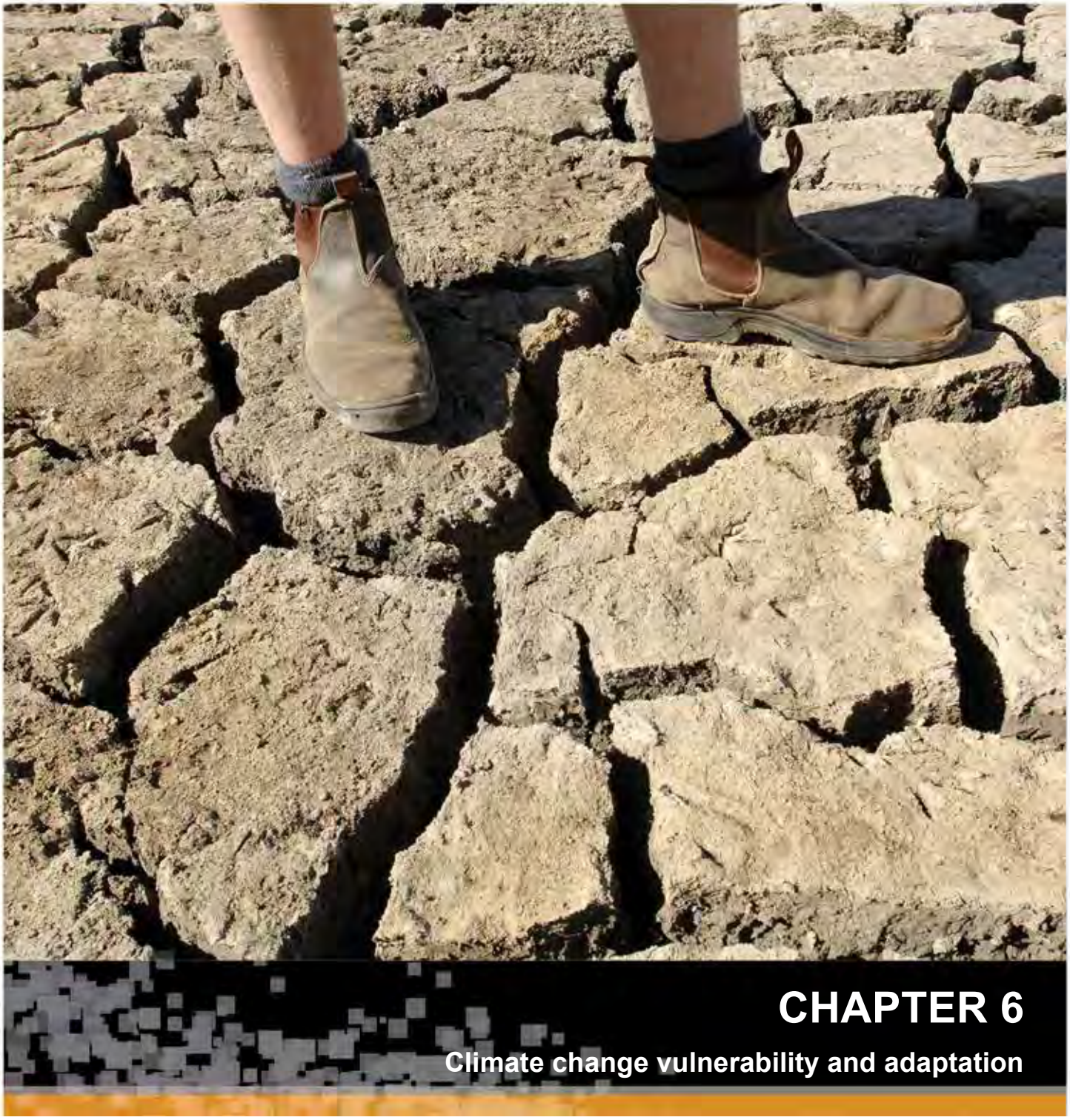

CHAPTER 6

Climate change vulnerability and adaptation

6.1 Expected impacts of climate change on Australia 156
6.2 Vulnerability assessment 161
6.3 Adaptation measures 165

Key Developments

- Climate system observations and impacts since Australia's Fifth National Communication underscore the need for a coherent adaptation framework that focuses the efforts of all parts of Australian society – all levels of government, business and the wider community.
- Substantial foundation work has been developed under the Climate Change Adaptation Framework (2007) – transitioning to embedding the insights into core government, business and community practices.
- A national vision and policy framework for adaptation has been outlined in Adapting to Climate Change in Australia—An Australian Government Position Paper (2010).
- The Productivity Commission has completed an inquiry into barriers to effective climate change adaptation (2012).
- The Australian Government has also recently released its Climate Adaptation Outlook: A proposed national adaptation assessment framework (2013).

6.1 Expected impacts of climate change on Australia

Adapting to the impacts of climate change is a substantial on-going challenge for all Australians. Governments, businesses and the community have important, complementary and differentiated roles in managing risks from a changing climate. In 2012 the Select Council on Climate Change, comprising ministers from the Australian Government and all state and territory governments as well as a representative from the Australian Local Government Association agreed on **ROLES AND RESPONSIBILITIES FOR CLIMATE CHANGE ADAPTATION IN AUSTRALIA**.

Given their greater role in service delivery, land use planning, and management of assets, state and territory and local governments have a major role in direct adaptation action. The Australian Government has stewardship of the national economy and is responsible for promoting Australia's national interests more broadly and therefore takes a leadership role in positioning Australia to adapt to climate change impacts that may affect national prosperity or security. The Australian Government's actions focus on building the tools and information needed to underpin sound decision-making and coordinating the economic and regulatory reforms needed to better address climate change risks.

The Australian Government has been working with state, territory and local governments, through the Select Council on Climate Change, to develop actions to respond to the impacts of climate change in areas where cross-jurisdictional collaboration is necessary.

Since the Fifth National Communication all levels of government have worked to build Australia's capacity to adapt to the impacts of climate change, including through programs that deliver information to help decision-makers understand and manage climate change risks, and by supporting partnerships to facilitate adaptation in highly vulnerable sectors and communities. Leading businesses and communities have also taken steps to manage risks to their assets and activities from the changing climate.

6.1.1 Water resources and supply

Water and its availability are crucial to Australia's economic, social and cultural prosperity. From droughts to floods, Australians are often subject to the vagaries of the water cycle. Many of Australia's natural ecosystems are driven by this natural variation in water flows. Climate change, and its impact on water resources, will only increase the complexity of water management in Australia.

The Murray-Darling Basin is one of the largest river systems in the world and one of the driest, and supports a vast array of environmental life and economic activity. It contains 30,000 wetlands with over 60 fish species and 98 species of waterbirds. The Basin also contributes an annual average of $15 billion worth of agricultural produce towards the national economy. However, the impact of climate change on the Murray-Darling Basin may be severe. The Garnaut Climate Change Review projected that with continued irrigation and no greenhouse gas emission mitigation, water availability would diminish and the irrigation system that is at the heart of economic activity in the Basin would have to be fundamentally restructured beyond 2050.

Changes in rainfall patterns also affect urban areas. Since the 1970s, the heavily populated areas of southwest Western Australia and the southeast of the continent have become drier and CSIRO modelling indicates that this trend is likely to continue. A series of 'sustainable yields' studies across Australia found that climate change is likely to reduce streamflow across most of Australia by 2030, but that wetter conditions cannot be ruled out in most regions.[1] The results are summarised in Table 6.1.

	Median projected change in streamflow	Driest case projected change in streamflow	Wettest case projected change in streamflow
Murray–Darling Basin[a]	9% lower	33% lower	16% higher
Tasmania[b]	3% lower	8% lower	2% higher
South-west Western Australia[c]	24% lower	49% lower	4% lower
Northern Australia	Little change		

Table 6.1 **Projected changes in streamflow by 2030**

a CSIRO, Water availability in the Murray–Darling Basin, report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project, CSIRO, Australia, 2008.
b CSIRO, Climate change projections and impacts on runoff for Tasmania, report two of seven to the Australian Government from the CSIRO Tasmania Sustainable Yields Project, CSIRO Water for a Healthy Country Flagship, Australia, 2009.
c CSIRO 2009, Water yields and demands in south-west Western Australia, summary of a report to the Australian Government from the CSIRO South-West Western Australian Sustainable Yields project, p. 7.

[1] CSIRO, *Water availability in the Murray–Darling Basin*, report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project, CSIRO, Australia, 2008.

The predicted likelihood of more frequent extreme rainfall events also impacts on urban areas, with the potential to affect the capacity and maintenance of urban stormwater drainage and sewerage infrastructure.

6.1.2 Coasts

Australia has approximately 35,000km of coastline and approximately 85 per cent of its population lives within the coastal zone. All Australian state capitals (except for the nation's capital) are located on the coast and many of the country's commercial activities occur in these areas.

The IPCC found that sea level could rise between 0.18 and 0.59 metres, and depending on how large the rapid dynamic responses of the Greenland and Antarctic ice sheets are; an additional 0.1 to 0.2 metre rise is expected.

Sea-level rise will almost certainly cause greater coastal inundation, erosion, loss of wetlands and saltwater intrusion into freshwater sources, with impacts on infrastructure, coastal resources and existing coastal management programs.

The frequency of extreme sea-level events may also increase with even modest sea-level rise. With a mid-range increase of 0.5m, a once in a century event will increasingly become more common. This will have serious implications for coastal zone management, including for communities, infrastructure, planning regulation, aquaculture and coastal ecosystems.

Along with sea-level rise, the coastal zone faces potential impacts from changes to weather patterns, ocean currents, ocean temperature and storm surges. Ocean acidification is also likely to impact on commercial fisheries and coastal natural systems, particularly coral reefs.

6.1.3 Infrastructure

Australia's current infrastructure will be tested to various degrees by extreme weather events, droughts, increased temperatures and sea-level rise as a result of climate change. The risk to infrastructure is increased and made more complex due to the interdependencies between critical infrastructure sectors. For example, as highlighted by the Productivity Commission, telecommunications and transportation infrastructure are partly dependent on the continuance of electricity supply, such that if an extreme event damages the electricity network, telecommunication and transportation infrastructure is also likely to be affected.

Australia's coastal infrastructure has significant legacy risk which makes it particularly vulnerable to sea level rises, especially when combined with storm surges and king tides . The high end scenario of sea level rise of 1.1 metres by 2100 would potentially expose greater than $226 billion in commercial, industrial, road and rail, and residential assets to inundation and erosion hazards.

Figure 6.1: Coastal squeeze: built structures can prevent landward migration of intertidal ecosystems such as mangroves and saltmarshes.

Outside of extreme weather events and natural disasters, day-to-day risks to infrastructure are also likely to arise. For example, the 2008 Garnaut Climate Change Review estimated the impact of climate change on water supply infrastructure under different greenhouse gas emissions mitigation scenarios. Without mitigation, the cost of supplying urban water would rise by 34 per cent, largely due to extensive supplementation of urban water systems with alternative water sources. Stabilising global emissions at 550 parts per million CO_2-e or 450 parts per million CO_2-e would result in cost increases of only 5 per cent or 4 per cent respectively.

Resources infrastructure can be highly vulnerable to impacts from increased rainfall and extreme events (e.g. storm surges, inundation, erosion, bridge and rail damage, flooding of mine and associated infrastructure, including waste dumps, and tailing storage facilities, and these impacts can lead to considerable days of lost production and associated considerable economic impacts.

6.1.4 Agriculture

In 2011, 53 per cent of Australia's landmass was managed by farmers producing commodities valued at over $46 billion. This included approximately 120,000 businesses, with nearly 40,000 beef cattle farmers and over 10,000 sheep farmers.

Drought, the most pervasive of these extremes, disrupts cropping, reduces stock numbers, and erodes the resource base of farms.

Climate change influenced the severity and duration of the 'Millennium Drought' in south-eastern Australia from 1997 to 2009, its impact on irrigated agriculture was severe. In the Murray-Darling Basin, irrigated rice production fell by 99 per cent between 2002 and 2009, and cotton production fell 84 per cent over the same period.

To date, the observed effects of climate change on agriculture have been varied. Reduced rainfall in south-west Western Australia (partly due to anthropogenic greenhouse gases, see above) has had limited effects on wheat yields because rainfall

has fallen most in months where it usually exceeds requirements for wheat growing. Reduced rainfall may have helped reduce the spread of dryland salinity.[2]

Other extreme events such as severe storms, hailstorms, cyclones and floods destroy crops, damage infrastructure and interfere with activities such as harvesting and planting. In 2010-11 extreme weather conditions had significant effects on the production of cereals, sugar, fruit and vegetables, cotton and grain sorghum resulting in an estimated loss of $2.3 billion.

Managing climate variability may become increasingly problematic for Australian primary producers. Projected changes in mean temperature and precipitation will be superimposed on large climate variability, making it even more difficult for farmers to anticipate and manage for climate associated risks.

6.1.5 Iconic and productive natural systems

Australia has some of the world's most important natural wonders, such as Kakadu National Park and the Great Barrier Reef. Yet these ecosystems and their rich in biodiversity are highly vulnerable to the impacts of climate change. Estimating the impact that climate change will have on these unique environments is difficult because climate change is likely to exacerbate the effects of existing threats and greatly enhance the potential cumulative impacts.

For example, in Kakadu National Park, likely climate change impacts include rising sea-levels, saltwater intrusion, changing fire patterns and invasive flora and fauna.

Similarly, Australia's iconic Great Barrier Reef will be exposed to the impacts of climate change through increasing air and sea temperatures, ocean acidification, nutrient enrichment, altered light levels, more extreme weather events, changes to ocean circulation and sea level rise. While increasing sea temperatures will have the greatest short-to-medium term impact because of damage to coral systems, in the long-run, ocean acidification is predicted to be the greatest threat as it will adversely affect oceanic calcifying organisms. Sea-level rise may be a relatively minor issue for the reef itself, yet is likely to significantly impact adjacent mangroves and other coastal environments.

The Ningaloo and Shark Bay world heritage areas are examples of marine ecosystems in Western Australia that are particularly vulnerable to climate change impacts. Key observed impacts on Western Australia's marine ecosystems and fisheries impacts include an increase in water temperature off the lower west coast, an increase in salinity, a change in the frequency and location of storms, an increase in marine heatwaves and a change in the frequency of cyclones in the northwest.

[2] F Ludwig, SP Milroy & S Asseng, 'Impacts of recent climate change on wheat production systems in Western Australia', *Climatic Change, vol.* 92, 2009, pp. 495–517.

6.1.6 Health

The health of Australians is impacted by the country's environmental conditions including extreme climate. Common challenges faced by the community include heatwaves, droughts, cyclones, floods and other natural disasters, which can cause immediate injuries and long-term mental health problems. Climate change is likely to increase temperatures and heighten the risk of natural disasters, intensifying the risk of such health concerns for the Australian population.

One of the most noticeable effects of climate change in Australia will be increases in the frequency, duration and severity of hot days and heatwaves. These changes will have a significant impact on the health of Australians as the population is exposed to abnormal temperatures. If body temperatures exceed a relatively narrow band of around 37°C, people risk suffering heat exhaustion, heat stroke, and sometimes death.

The health impact of climate change will not be spread evenly across all Australians, with those already at risk, such as the very young and the elderly likely to bear much of the increased risk as climate change exacerbates existing conditions and vulnerabilities. Children under 15 years old are less able to cope with adverse weather as their bodies are yet to fully develop. Equally, elderly people are vulnerable due to increased isolation, and reduced physical strength.

6.2 Vulnerability assessment

Since the Fifth National Communication the Australian Government has built on previous coastal vulnerability assessments, extending them to include development of better methods for adaptation planning, and undertaken some new assessments.

6.2.1 National-level vulnerability assessment

Australia's Coastal Areas

In 2009 the Australian Government released Climate Change Risks to Australia's Coasts: a first pass national assessment. Since then, it has built on this work by extending the assessment to a broader range of assets and funding a suite of innovative local studies to develop better resources for coastal adaptation decision-making.

In 2011, the Australian Government released Climate Change Risks to Coastal Buildings and Infrastructure*;* a supplement to the first-pass risk assessment. The report concluded that more than $226 billion in infrastructure was at risk of inundation and erosion under a sea level rise scenario of 1.1 metres. Coastal assets at risk from the combined impact of inundation and shoreline recession include:

- Between 5,800 and 8,600 commercial buildings, with a value ranging from $58 to $81 billion (2008 replacement value);
- Between 3,700 and 6,200 light industrial buildings, with a value of between $4.2 and $6.7 billion (2008 replacement value); and

- Between 27,000 and 35,000 km of roads and rail, with a value of between $51 and $67 billion (2008 replacement value).

The Australian Government has invested $4.5 million on 13 Coastal Adaptation Decision Pathways projects (CAPs) to support partnerships between local governments, infrastructure operators and major utilities to assist local decision-making in the coastal zone. The outputs of CAPs provide notable examples of best practice management of coastal climate change risks across Australia.

An example under this program was a partnership with the Tasmanian Government. The Local Government Association of Tasmania, the Tasmanian Office of Climate Change, the Tasmanian Planning Commission, the University of Tasmania, and four coastal councils (Break O'Day, Clarence, Kingborough and La Trobe) formed a partnership in 2011 to improve the ability of Tasmanian decision-makers and communities to plan for and respond to likely climate scenarios for coastal communities.

Box 6.1. Climate change and Brisbane Airport

Brisbane Airport is the principal international and domestic gateway to Queensland and Australia's third-largest airport by passenger volume, handling more than 21 million passengers annually. Passenger volumes have grown strongly since the airport was privatised in 1997 and the owners decided that building a new runway was the best option for keeping up with passenger demand. Brisbane Airport is built on a low-lying coastal site susceptible to flooding events. The new runway was expected to be in service for several decades, so rising sea levels were an important consideration in its design. The airport commissioned the Antarctic Climate and Ecosystems Collaborative Research Centre to evaluate the various runway height options in light of the most recent climate and sea level data available. After considering a range of design, regulatory, stakeholder and financial factors, the owners decided to build the runway at a height of 4.1 metres above sea level. This exceeded the minimum level recommended by engineering consultants (3.5 metres) and the current 1-in-100 year storm tide level (2.3 metres). The runway development will also include tidal channels and a new seawall along the northern boundary of the airport to hold floodwater out of the site.

Box 6.2. Australian Government departments considering climate change risk in the coastal zone

The Department of Defence is undertaking an assessment of climate change impacts on its coastal assets. Recognising the challenges posed by climate change, the Department of Defence initiated a two-stage climate change assessment process in 2011. The first stage involved a high-level assessment of the sites' likely risk exposure to climate change (sea level rise and coastal flooding), which enabled the department to decide which sites required detailed investigations. The second stage involves a more detailed study to enable the department to determine their next steps — from knowing which bases are likely to be at most risk, to understanding in greater detail their actual risk exposure and which adaptation measures are likely to minimise these future risks.

Other vulnerability assessment reports

In 2011, the Australian Government released Kakadu: Vulnerability to climate change impacts. This report examines the potential impacts of climate change and sea level rise on the South Alligator River system in Kakadu National Park. Modelling undertaken in this study suggests that future saltwater intrusion within the South Alligator River is likely to occur, and there will be significant alteration in the frequency, duration, and extent of large floods. Climate change is expected to impact on the key environmental, cultural, and economic values of this area.

In 2010, the CSIRO in consultation with state, territory and Commonwealth agencies released Interactions between Climate Change, Fire Regimes and Biodiversity in Australia: A Preliminary Assessment to help increase understanding of the complex interactions between climate change, fire regimes and biodiversity for future fire management. The report found that fire weather will become more severe in many regions, particularly southern Australia, and that the interactions between biodiversity and fire regimes are complex. It developed a national framework to assess the likely impacts of climate change on fire regimes and biodiversity for different bioregions, using a case study approach.

From 2010 to 2012, the National Climate Change Adaptation Research Facility (NCCARF) released a series of five reports assessing the vulnerability of Australian forests to climate change. The objective of the Forest Vulnerability Assessment is to provide governments, natural resource managers and the business sector with:

- an improved understanding of current knowledge of the likely biophysical and socio-economic consequences of climate change for Australia's native and planted forest regions;
- an assessment of the vulnerability of Australian forests from the perspective of both resource use and of ecosystem services – identifying particularly vulnerable forests and the communities in major forest areas;
- an understanding of what is already being done in Australia with regard to understanding and managing climate related risk in relation to forests; and
- guidance on key gaps to assist climate change adaptation.

The Australian Bureau of Agricultural and Resource Economics (ABARES) produces publications that assess the vulnerability of climate change for Australia's primary industries. In 2011 ABARES released two climate change vulnerability assessments focused on the fisheries sector and the forestry sector. The first, Fisheries and climate change: potential challenges and opportunities for Commonwealth fisheries, identified how the predicted impacts of climate change may influence fisheries policy and management using three Commonwealth fisheries as case studies. The second, Potential effects of climate change on forests and forestry in Australia, is an integrated study drawing together climate modelling, forest growth, economic analysis and community vulnerability assessments in order to try and understand the effects of climate change on forest industries at a regional and subregional level.

6.2.2 Regional vulnerability assessments

The three levels of governments in Australia have different responsibilities and therefore have differentiated, yet complementary, roles in helping Australia adapt to the impacts of climate change. In many cases climate change adaptation will be most effectively managed by a single State, Territory or local government. In other cases, a combined response by several governments or tiers of governments will be required. Ensuring that the community has a good understanding of the risks posed by climate change for areas of settlement is an essential step in establishing acceptable levels of risk. State, territory and local governments around Australia have been proactive in undertaking vulnerability assessments to inform the development of holistic adaptation policies.

The New South Wales (NSW) Government has developed:

- An Integrated Regional Vulnerability Assessment initiative, or IRVA. An IRVA is designed to develop a shared understanding among stakeholders of the likely vulnerability to climate change and stimulate them to undertake planning and adaptation measures
- a Climate Impact Profile (2010), the first integrated assessment of the biophysical changes projected for the state as a result of climate change outlining some of the risks that NSW faces to help decision-makers develop their planning and response strategies;
- new, fine-scale climate projections for NSW and the Australian Capital Territory (ACT) using a regional climate model called the NSW and ACT Regional Climate Model or NARCliM, which will provide improved projections of the changes in temperature, wind and rainfall in the state which, in turn, will provide critical information to manage the impacts of climate change on health, settlements, agriculture, weather extremes and services, such as water and energy supplies;
- **Impacts of Climate Change on Natural Hazards Profiles** for a number of NSW state regions to inform decision makers about the current exposure of each region to eight natural hazards (fire, wind, lightning, hail, flash flooding, riverine flooding, heatwaves, and coastal erosion and inundation where regionally applicable), and projections of future changes to these natural hazards due to climate change; and

- **PRIORITIES FOR BIODIVERSITY ADAPTATION TO CLIMATE CHANGE**, outlining priority measures between 2010 and 2015 to minimise the impacts of climate change on the state's native species and ecosystems.

The Victorian Government has invested $13.7 million in the Future Coasts program to help Victoria better understand and plan for the risks associated with sea level rise and storm surges. The program has developed a range of tools to help assess coastal vulnerability to climate change including the Victorian Coastal Inundation Dataset and the Victorian Coastal Hazard Guide.

The Australian Capital Territory Government is developing a 2011-2021 Climate Change Vulnerability Assessment Framework for Infrastructure (the Framework) to provide government with a diagnostic tool that can assist in considering climate change and its impacts during the planning, development, renewal, maintenance and management of public infrastructure. The Framework addresses adaptation to climate change to ensure the viability and sustainability of Australian Capital Territory Government infrastructure assets under climate change risk.

The Tasmanian Government, in partnership with the Antarctic Climate and Ecosystem Cooperative Research Centre, developed the Climate Futures for Tasmania project to provide climate change projections at a local scale. The projections generated provide information about climate across a range of areas including the Tasmanian coastal zone and agricultural sector. The Climate Futures Project developed a software tool 'ClimateAsyst', to aid owners, managers and planners to assess the susceptibility of their infrastructure to projected changes in climate at a local scale.

In 2012, CSIRO released the report Queensland's biodiversity under climate change: impacts and adaptation – synthesis report. The report identifies key challenges for Queensland ecosystems and provides recommendations to help manage climate risks across the state.

The South Australian Government has adopted the Guidelines for Developing an Adaptation Action Plan and Undertaking an Integrated Climate Change Vulnerability Assessment developed by the Local Government Association of South Australia. The guidelines provide the basis for all regions in the state to undertake adaptation planning. Over half of the state has already commenced adaptation planning consistent with the guidelines, with the remainder to commence in the next twelve months.

6.3 Adaptation measures

Adaptation activity across all levels of government continues to be backed by the National Climate Change Adaptation Framework, which was agreed upon by the Council of Australian Governments (COAG) in April 2007. Since Australia's Fifth National Communication, the COAG Select Council on Climate Change (the SCCC) was established to oversee cross-governmental climate change policy, including adaptation. In May 2012, the SCCC agreed to seven national priority areas for climate change adaptation: water resources; coasts; infrastructure; natural ecosystems; agriculture;

emergency management; and vulnerable communities. The SCCC also established a cross-jurisdictional adaptation working group to develop work plans for these priority areas. In November 2012, The SCCC agreed on Roles and responsibilities for climate change adaptation in Australia. This document sets out principles for allocating the management of climate change risks, and roles and responsibilities for adapting to climate change within the federal, state, territory and local governments, business and private individuals.

6.3.1 Australian Government measures

The Australia Government is responsible for providing national science and information, managing Commonwealth assets and programs, providing leadership on national adaptation reform and maintaining a strong, flexible economy and a properly targeted social safety net.

Since the Fifth National Communication, the Australian Government strengthened national capacity to manage the impacts of climate change through well-coordinated climate science, policy development for effective national adaptation, and coordination of climate change adaptation measures across jurisdictions.

In particular, the Australian Government's 2010 position paper **ADAPTING TO CLIMATE CHANGE IN AUSTRALIA** and its response to the 2012 Productivity Commission report: Barriers to Effective Climate Change Adaptation, set out the Government's priorities for adapting to the impacts of climate change and propose practical steps to realise that vision. Together, they outline the Australian Government's role in adaptation, which includes building community resilience and establishing the right conditions for people to adapt through leading national reform, taking climate change into account in the management of Commonwealth assets and programs, and providing sound scientific information.

The National Climate Change Adaptation Research Facility (NCCARF) produced a significant body of work, including 144 peer-reviewed adaptation research projects and nine National Adaptation Research Plans, covering topics such as emergency management, human health and infrastructure. NCCARF also built an expansive membership (over 5,000 members) in eight adaptation research networks, which delivered theme-specific workshops, capacity-building activities and a wide variety of publications targeted at end users.

The National Climate Change Adaptation Program also included an investment of $8 million to deliver climate risk information and tools. These included sea level rise mapping products derived from high-resolution digital elevation data for key urban areas, $25 million to enhance the capacity of coastal communities and local governments to manage climate change risks and analyse adaptation pathways, and vulnerability assessments for areas of major national significance, including the Great Barrier Reef, World Heritage areas and northern Indigenous communities (see section 6.2-vulnerability assessments). A further $2 million has funded the Australian Government's Climate Change Adaptation Skills for Professionals Program, which assisted tertiary

education, training institutions and professional associations to revise or develop professional development and accreditation programs for architects, planners, engineers and natural resource managers.

In 2012, the Australian Government committed an additional $3 million to extend the Program in support of its climate change adaptation agenda, particularly in the national priority areas of the coastal zone and infrastructure. This extension included:

- developing practical guidance for the Government agencies on how to manage climate change risks to Government coastal assets;
- improving Australia's ability to assess coastal erosion risk and develop a more integrated approach to managing the coastal zone;
- assessing adaptation policy options across a range of climate and demographic change scenarios; and
- promoting adaptation good practice, particularly among local government councils.

The $15 million per annum *Australian Climate Change Science Program* is a partnership between the Government's science and innovation department (DIICCSRTE), CSIRO and the Bureau of Meteorology (BoM) is the largest and longest running climate change science program, and is crucial to helping us understand how Australia's climate has changed, and what it will be like in the future.

The CSIRO Climate Adaptation Flagship is equipping policy makers, industries and communities with practical adaptation options to climate change and variability, with a focus on sustainable cities and coasts, natural ecosystems and primary industries. This flagship is being supported by $28 million in funding from the Australian Government and $18 million from external sources.

From 2012-2016, the Government's Regional Natural Resource Management (NRM) Planning for the Climate Change Fund (CCF) is providing $43.9 million to improve regional planning for climate change and help guide the location of carbon and biodiversity activities. The CCF is producing regional-level climate change information, providing guidance on the integration of that information into regional NRM and land-use planning, and supporting regional NRM organisations to revise their existing plans to help identify where adaptation and mitigation activities should be undertaken.

In 2013, the Australian Government set up the National Insurance Affordability Initiative to invest $100 million over two years in targeted flood and other natural disaster mitigation measures, as well as establish a National Insurance Affordability Council.

In February 2013, the Prime Minister announced Australian Government funding of $47 million over eight years (from 1 July 2013) for a new Bushfire and Natural Hazards Cooperative Research Centre. This funding is contingent on states and territories making similar commitments, at a level at least equivalent to their current financial support for the existing Bushfire Cooperative Research Centre. The new entity will ensure that the valuable work done by the Bushfire Cooperative Research Centre continues while

developing a complementary natural hazards research program into flood, earthquake, cyclone and tsunami events.

The Australian Government is producing a **CLIMATE ADAPTATION OUTLOOK** report to assess how well Australia is placed to deal with the impacts of unavoidable climate change. The first instalment of this report was released in June 2013. It outlines a framework for assessing Australia's national adaptation progress, and develops a set of indicators to assess national progress against the framework. This framework will be applied to different sectors in future instalments of the report.

6.3.2 State and territory government measures

A number of sub-national governments have developed climate change adaptation plans and frameworks to address the challenges of a changing climate and to manage risk.

Below the state and territory level, many local councils are also considering adaptation frameworks. For instance, Redland City Council in Queensland engaged consultants to undertake a climate change risk assessment in 2009. A total of 31 council services were considered subject to climate change risks, including the provision of infrastructure (such as coastal infrastructure, transport, and buildings), planning and development, environmental management, community and social planning (such as aged care, emergency services and recreation services), and corporate services (such as workplace health and safety, and legal and financial services).

To address these risks, the Redland City Council developed a Climate Change and Energy Action Plan 2010–2015, which identifies adaptation and mitigation actions to be taken during this five-year period. These include further research and risk analysis, a review of existing plans, and conducting cost-benefit analyses on risk management options.

The Queensland Government is investing heavily in programs and actions to build greater resilience across the state. As part of this, it has allocated $10.3 million over four years under the Creating Australia's Most Disaster Resilient State to improve community actions to prepare for extreme weather events. This initiative brings together government, the private sector and community organisations to implement practical actions to improve self-reliance and resilience. The Queensland Government is also providing additional funding of $3.9 million over three years and approved the reallocation of $0.55 million for the establishment of the Community Resilience Team. As part of their role, the team will oversee community resilience activities across Queensland.

The Victorian Adaptation and Sustainability Partnership (VAS Partnership) is a Victorian Government initiative that includes funding for local governments to adapt to the effects of climate change.

The South Australian Research and Development Institute similarly runs a Climate Applications science program and the Goyder Institute for Water Research supports research into the security and management of South Australia's water supply.

In Tasmania, the state government provides 'ClimateConnect' grants of up to $20,000 to local councils for communities and industry to adapt to the opportunities and risks from climate change.

The Indian Ocean Climate Initiative (IOCI) is a Western Australian based climate change science research partnership of the State Government, CSIRO, and the Bureau of Meteorology. Formed by the Western Australian Government in 1997, the third stage of the initiative was completed in 2012. IOCI has improved understanding of the climate drivers affecting Western Australia to inform improved climate modelling, better characterised past and current climate trends, and produced climate change projections for key regions of the state. It has supported informed decision-making on climate variability and change in Western Australia. Key research from the partnership includes temperature, rainfall and extreme event projections for the north-west and south-west of Western Australia and tropical cyclone forecasting.

6.3.3 Sectoral measures

Australian governments at the national, regional and local levels have carried out a range of adaptation actions in the key sectors identified in the National Climate Change Adaptation Framework as most vulnerable to the impacts of climate change. This section briefly outlines the adaptation measures implemented in these sectors since the Fifth National Communication.

Biodiversity and natural ecosystems

The first phase of Caring for our Country 2008-12, saw the Australian Government invest more than $2 billion to protect and build the resilience of our environment. A review of this initiative found that it has been effective in delivering outcomes and contributed to improving the condition of Australian natural resources at the landscape scale.

In 2012, the Australian Government announced more than $2 billion in funding for the second phase of Caring for our Country (2013–2018), which will be delivered through two separate, but complementary streams: Sustainable Agriculture and Sustainable Environment.

In addition, the Australian Government has established the following programs targeting climate change adaptation of biodiversity and ecosystems:

- the $43.9 million Regional Natural Resource Management (NRM) Planning for Climate Change Fund (as mentioned above, refer page 13);
- the Biodiversity Fund supports land managers to revegetate, rehabilitate and restore biodiverse carbon stores across the country. Round One of the Biodiversity Fund supported 312 projects worth over $270 million. Current rounds of the Biodiversity

Fund, including Round Two, are proceeding and will build on the significant investments made under Round One;

- an additional $44 million over five years from 2013–14 will support existing Working on Country groups in Northern Australia for activities that deliver on Biodiversity Fund objectives. These projects are being managed under a separate set of guidelines through the Working on Country program (part of the Caring for our Country program);
- the Indigenous Carbon Farming Fund ($22.3 million over five years), an Australian Government commitment under the Clean Energy Future Plan, provides support to Indigenous Australians to participate in the Carbon Farming Initiative;
- the Australian Government's Indigenous Protected Area program has supported Indigenous communities to develop and declare 59 Indigenous Protected Areas (IPAs) covering more than 47 million hectares of land contributing to landscape scale connectivity, particularly in central and northern Australia. These large areas managed for conservation provide potential space for species migration under climate change influences; and
- the $10 million National Wildlife Corridors Plan (Corridors Plan, 2011) to retain, restore and manage ecological connections in the landscape and increase the resilience of Australia's native plants and animals and agricultural landscapes to the impacts of climate change.

The Western Australian Department of Environment and Conservation's Science Division is undertaking several climate change and biodiversity research projects, and is also a partner in the state government funded Western Australian Centre of Excellence for Climate Change, Woodland and Forest Health.

In NSW, the Priorities for Biodiversity Adaptation to Climate Change report was released in 2010 to address the impacts of climate change on biodiversity. A draft NSW

Biodiversity Strategy was also developed, which aims to coordinate and guide investment and effort in biodiversity conservation in NSW until 2015.

The Victorian Government plans to plant two million trees across Victoria between 2012 and 2014 as well as working with Victoria's NRM agencies to implement systems and standards for clear and consistent statewide monitoring and reporting on Victoria's land, water and biodiversity assets. Through initiatives such as Land for Wildlife (Victoria), EcoTender, BushBroker and BushTender programs, the Victorian Government acquires land for conservation, and funds the Arthur Rylah Institute for Environmental Research (ARI) to map and measure Victorian biodiversity, and conduct research on fire ecology and recovery, rural and urban landscapes, threatened species, forest and woodland ecosystems, invasive species, and water ecology.

South Australia leads the Transect for Environmental Monitoring and Decision-making (TREND). This project uses a transect running north from the lower Fleurieu Peninsula through medium rainfall cooler sites to low rainfall warmer sites in the Northern Flinders

Ranges to see how effective space can be used as a proxy for time in climate change impacts and adaptation options.

The Queensland Government administers the $12 million *Everyone's Environment* community grants program to build environmental resilience over three years. It is also providing increased funding of $8 million over four years under Healthy Waterways to improve water quality and waterway resilience across South East Queensland including Moreton Bay.

Coastal Zone

The Australian Government is working across jurisdictions to ensure adaptation measures are in place for Australia's vulnerable coastal zones. In 2012, the inter-jurisdictional Standing Committee on Climate Change (SCCC) agreed on a Work Program for Management of the Coastal Zone to further inter-jurisdictional work on climate change adaptation.

In July 2013, the SCCC agreed to develop a set of best practice principles and approaches for planning to manage climate change risks in the coastal zone, including guidance on a range of options such as risk-based land zoning, mandatory risk disclosure, setback provisions, conditional development approvals, use of protective structures, and changes to building codes and design standards.

The government recently funded 13 projects worth $4.5 million under the Coastal Adaptation Decision Pathways between 2011 and 2012. These assisted decision-makers in the coastal zone, including local government, infrastructure operators and major utilities to explore how planning and investment decisions can recognise the increasing impacts of climate change over time. Collectively, the projects provided leadership that has significantly extended adaptation practice in Australia to manage future coastal risks.

At the sub-national level, state planning policies are taking the lead in ensuring adaptation in the coastal zone. For example, in Tasmania, Sea Level Rise Planning Allowances for 2050 and 2100 are informing mapping and planning approaches for the coastal zone and a Coastal Protection and Planning Framework is currently being developed which will provide guidance for planning, managing and protecting Tasmania's coastline.

The Queensland Government provides coastal hazard maps and guidelines to help individuals, communities and local government identify and manage coastal erosion and storm tide inundation. Under the Coastal Adaptation Decision Pathways program, Queensland engaged in a collaborative project between the Local Government Association of Queensland, Townsville City Council and the Queensland Government to develop a Coastal Hazard Adaptation Strategy for Townsville, released in 2013. This was a pilot project intended to guide local governments in adapting their coastal communities for current and emerging coastal hazards of sea erosion and storm tide inundation.

As part of its stage one coastal management reforms, the NSW Government announced that councils would have the flexibility to determine their own sea level rise projections to

suit their local conditions. The Office of Environment and Heritage has released guidelines on incorporating sea level rise into flood risk and coastal hazard assessment.

These documents will be revised as part of the ongoing reform process.

The Victorian Coastal Hazard Strategy outlines a five-stage coastal hazard risk management framework which provides brief guidance on avoiding, reducing, sharing or transferring coastal hazard risks. Victoria's $13.7 million Coastal Settlements of the Future program aims to manage these risks in practice. In partnerships with local governments, the initiative is supporting adjustment strategies and new land use planning tools, assessment of the vulnerability of assets and infrastructure, an audit of current land use commitments in coastal areas and guidelines for future settlement growth.

Western Australia's draft State Coastal Planning Policy (draft SPP 2.6) is intended to provide a framework for coastal hazard risk management and adaptation planning where existing or proposed development is in an area at risk of being affected by coastal hazards. The policy also includes a risk based approach to managing and adapting to potential adverse impacts from coastal hazards. The policy advocates adaptation options that maintain a wide range of potential future risk management strategies, based upon a hierarchy of adaptation measures; avoid, retreat, accommodate and protect (where coastal protection works are only to be considered where fully justified). This policy applies to new developments (including in-fill development), and provides a framework for local governments to use where desired for existing settlements.

In South Australia the Coastal Adaptation Decision Pathways Project (CAP) is a partnership between key stakeholders including the Local Government, State Government Agencies and community bodies. This project has delivered an integrated decision support tool that includes financial software to enable Local Government to determine which management options will be most cost effective in the face of climate change.

Many local councils are also targeting coastal adaptation as a priority. For example, the Peron Naturaliste Partnership is a group of nine local governments in the south-west of Western Australia that formed in 2011 to provide a regional mechanism to facilitate effective and timely adaptation responses to climate change. The project has produced hazard mapping for the region, an economic-based regional analysis of adaptation options to treat identified impacts of coastal climate change and detailed demonstration of several coastal adaptation pathways and options in local area case study sites.

Another example is the Sydney Coastal Councils Group, which has been established since 1989 and consists of 15 councils adjacent to Sydney marine and estuarine environments and associated waterways. Recently, it has investigated risks to Sydney's beaches, explored systems approaches to regional climate change adaptation, options for adaptation actions for local government and ways of monitoring and evaluating those actions.

Settlement and Infrastructure

The Climate Change Adaptation Program provided targeted funding to five projects through its Integrated Assessment of Settlements Sub-Program. These help build the capacity of local governments to identify climate change challenges and develop responses. For example, the Western Port Greenhouse Gas Alliance, located in southern Victoria, has found that around 18,000 properties (with a value of almost $2 billion) are currently vulnerable to flood events, and more than 73,000 people and 35,000 properties are currently in bushfire prone areas.

The Australian Building Codes Board (ABCB) completed a review of possible modifications to the Building Code of Australia that takes into account adaptation measures for climate change in 2010. This review outlined the major risks from climate change to Australia's building stock, investigated required nationally consistent or state-specific responses, and identified areas for further research. Since this report, the National Construction Code (NCC) was successfully introduced in 2011 and heralded the first step in a major COAG building regulatory reform. The NCC has a particular focus on safety matters, and ongoing work of the ABCB aims to further improve the resilience of buildings to potentially adverse societal risks associated with climate change.

Figure 6.2: Increase in frequency of extreme tidal events with 50 cm of sea level rise

The impacts of changes in extreme rainfall, flooding and storm surge pose major risks to public infrastructure, water resources and emergency management. Technical

information and methods that account for climate change are fundamental to the efficient and safe design of Australia's roads, bridges, dams and drainage systems. The Australian Rainfall and Runoff (ARR) handbook is the primary source of technical information used to design infrastructure to withstand the impacts of extreme rainfall, flooding and storm surge. It is also an important reference document for water resource use and emergency management. The peak professional body, Engineers Australia, is updating this handbook to consider climate change impacts. Total government funding for this three stage process is $10.7 million, with Engineers Australia contributing $4.8 million in-kind. The final ARR handbook will be published in 2015.

Numerous sub-national governments have additionally focused on adaptation of settlements and infrastructure. In the Australian Capital Territory the Climate Change Vulnerability Assessment Framework for Infrastructure is a diagnostic tool used to assist in considering climate change and its impacts during the planning, development, renewal, maintenance and management of public infrastructure.

In New South Wales, Treasury has prepared economic appraisal guidance on climate change for public assets and infrastructure assessments, and has focused on the challenges that climate change is likely to place on Sydney (Australia's biggest city). The Draft Metropolitan Strategy for Sydney identifies actions the NSW Government will take to build community resilience to climate risk, including:

- reviewing the outcomes of the Towards a Resilient Sydney project to identify opportunities for strategic planning to assist local government and communities to plan for climate change;
- developing guidance on resilient neighbourhood and building design;
- investigating a framework for consolidating and managing natural hazard information for the Sydney Metropolitan area for integration with strategic land use and infrastructure planning; and
- reviewing the effectiveness of current land use planning guidance for managing risk from natural hazards.

The draft plan is currently undergoing public consultation.

The Queensland Government has committed funding of $40 million towards the Betterment Fund which will support the building of stronger, more resilient infrastructure.

Emergency management

The National Strategy for Disaster Resilience completed in 2011 is designed to guide action by all levels of government, as well as businesses, communities and the non-profit sector. The Strategy comprises seven strategic priorities for action, each with identified priority outcomes. It has a particular emphasis on understanding risk, as well as rebalancing recovery towards risk reduction, and the appropriate sharing of responsibility for the community's disaster resilience between all elements of the community.

The Government is currently negotiating a new agreement with States and Territories to align the National Strategy for Disaster Resilience and state-wide natural disaster risk assessments, as drivers for the selection of new projects.

The National Government Flood Risk Information Project is providing Geoscience Australia with $12 million over four years to improve the quality, consistency and accessibility of flood risk information. The Government has also committed additional spending on mitigation. In February 2013, the Government announced the National Insurance Affordability Initiative. This initiative is investing $100 million over two years from 2013-14 to reduce flood risk and bring about real reductions in insurance premiums. The initiative also established a National Insurance Affordability Council which will play a role in the national coordination of flood risk data collection, make recommendations to the Australian Government on flood and other natural disaster mitigation projects and undertake other functions directed at reducing natural disaster insurance premiums.

The Australian Government is continuing its support of emergency management research by committing up to $47 million over eight years for the new Bushfire and Natural Hazards Cooperative Research Centre (CRC), established on 1 July 2013. This CRC is building on 10 years of work done by the previous Bushfire CRC while developing a complementary natural hazards research program into flood, earthquake, cyclone and tsunami events. Increased investment in research will improve approaches to mitigation, operational responses and community resilience to natural hazards.

Finally, in the event of a natural disaster, the Australian Government is continuing to fund the swift restoration of essential public infrastructure through the Natural Disaster Relief and Recovery Arrangements.

In sub-national jurisdictions a wide range of measures are also being implemented to reduce disaster risk associated with climate change. In the Australian Capital Territory, a Territory Wide Risk Assessment has been undertaken to prioritise natural disaster risk in accordance with relevant Australian Standards, including the potential impacts of climate change. Taxes and levies on general insurance and conveyancing duties have also been recognised as a potential barrier to effective climate change adaptation, with the Australian Capital Territory Government announcing that it will phase out insurance taxes and conveyancing duty over coming years.

In Tasmania, a project called Managing Natural Hazards through Land Use is aiming to manage natural hazards (such as coastal erosion and inundation, flooding, storms, bushfires and landslides) through land-use planning.

In Queensland, the Local Government Grants and Subsidies Program has been providing financial support to local governments that demonstrate limited capacity to self-fund an identified priority project. In 2011-12, this program included funding for 21 cyclone and flood warning projects in 11 councils.

The NSW Government has developed the Impacts of Climate Change on Natural Hazards Profiles. The profiles are intended to inform decision makers about the current

exposure of each region to eight natural hazards and projections of future changes to these natural hazards due to climate change. The NSW and ACT Regional Climate Model project will provide more detailed and robust information on the likely impact of climate change on natural hazards in NSW. The NSW Government is currently undertaking work to update data on the impact of climate change on flood and bushfire risks, and has mandated new requirements under its flood policy. In response to catastrophic bushfires in 2009, the Victorian Government has appointed a Fire Services Commissioner to improve bushfire planning and manage the response to major fires, and has provided funding to strengthen the emergency management capacity of local governments, including fire-risk management and early-warning systems.

In South Australia the Emergency Management Planning and Climate Change Project has reviewed the Zone Emergency Management Plan (ZEMP) process and provide clear linkages with the Local Government Association of South Australia, Climate Change Adaptation Planning and Integrated Climate Change Vulnerability Assessment (IVA) methodology that are currently underway as part of the State Climate Change Adaptation Framework.

Local governments are also taking action. For example, Lake Macquarie City Council (New South Wales) is currently updating its Waterway Flood Study, Flood Risk Management Study and Flood Risk Management Plan to incorporate recent flood events and the implications of climate change. The Council undertook a community consultation process before adopting a finalised Management Plan, which included correspondence with all 7000 affected property owners, community workshops, surveys and written submissions.

Through the Flood Risk Management Plan, the Council has identified three categories of flood risk. Proposed development restrictions in these areas include requirements for floor heights and setbacks from the lake, which are supported by a large majority of residents. Property certificates will include a ‘lake flooding’ notation on foreshore properties below three metres and a ‘sea level rise’ notation on properties below one metre of lake levels.

Agriculture, Fisheries and Forestry

The Australian Government’s Climate Change Research Program (CCRP) has provided funding for a variety of projects focused on climate change adaptation. This includes scientific research to:

- test the responses of key Australian crops to increases in temperature and carbon dioxide;
- monitor ways to manage heat stress in livestock;
- examine potential new shrub-based forages for livestock;
- evaluate the relocation of various crops to northern Australia; and
- develop adaptation responses of fishing and aquaculture sectors in south eastern Australia.

CCRP research also delivered consistent national climate projections data for further use in biophysical models investigating different adaptation strategies for primary industries.

The Carbon Farming Futures program is now building on research funded under the CCRP through an investment of over $9 million in new climate change adaptation research. This research includes innovative adaptation strategies that build the resilience of agricultural businesses and provide both economic and environmental benefits. The projects will work across many of Australia's agricultural industries including both livestock production systems and crops, such as sugar, fruit trees and viticulture. In addition, the Carbon Farming Futures program requires that adaptation is considered along with the mitigation actions funded. This will ensure that any mitigation actions developed are successful in the face of a changing climate, and that the chosen actions are compatible with increased resilience to climate change.

In response to the national review of drought policy, the Australian Government, in partnership with the Western Australia Government, invested $81 million in the pilot of drought reform measures between 1 July 2010 and 30 June 2012. These measures were designed to better support farmers, their families and rural communities in preparing for future challenges. The pilot also trialled services for farming families and rural communities that were designed to provide more effective social support. The measures trialled during the first year of the pilot were reviewed by an independent panel of experts in 2011, which confirmed that a move to programs with a focus on risk management and preparedness was appropriate.

Informed by these reviews, in May 2013 the Australian, state and territory primary industries ministers signed the Intergovernmental Agreement on National Drought Program Reform confirming a new package of measures to better support farmers and their families as they prepare for drought and other challenges. The new approach will include:

- a farm household support payment;
- promoting Farm Management Deposits and taxation measures;
- a national approach to farm business training;
- a coordinated, collaborative approach to the provision of social support services; and
- tools and technologies to inform farmer decision making.

The new package is intended to be available at all times, without the need for a formal drought declaration. The new approach will replace the Exceptional Circumstances arrangements from 1 July 2014.

Adaptation in Australia's marine fisheries is being supported by research in the CSIRO's Wealth from Oceans Flagship. The National Climate Change Action Plan for Fisheries and Aquaculture was released in March 2011. This provides fishing industry workers, managers and researchers with a broad, principles-based response framework in which to develop responses appropriate to the diverse needs of various fisheries.

In the forestry sector, the Australian Government has funded over $3.6 million for nine projects on climate change adaptation research as part of the Preparing Forest Industries for the Future program. The research was aimed at developing diagnostic tools and techniques to determine when (and what) specific management intervention is required to respond to the threats and opportunities of climate change. Under this program, a number of projects focused on examining forestry-relevant tree species and determining which species (and their genotypes) are most likely to thrive under predicted climatic changes. In addition, research examined options to mitigate the predicted increase in bush fire risks, and testing and advancing Australia's biosecurity preparedness with regard to major forest pests.

Tourism

Australia's national long-term tourism strategy, Tourism 2020 (released 2011) prioritises engaging tourism businesses in climate change adaptation. The Industry Resilience Working Group, established between 2011 and 2012 as part of this strategy, compiled a comprehensive list of programs designed to best deliver on industry needs and assist businesses in meeting the challenges of adaptation, enhancing resilience and addressing crisis management. The diversity of this list reflects that progress across government on adaptation in the tourism sector has occurred largely through the co-benefits of other adaptation measures, including maintaining Australia's unique natural environments, protecting tourism infrastructure and assisting the resilience of businesses).

Regional areas that rely heavily on the tourism industry are also putting direct measures in place. Victoria's 'Tourism Excellence' website and Tourism Western Australia both include information on sustainability in tourism. In Queensland, CSIRO and Tourism Queensland have trialled an adaptation planning tool ('Climate Futures Tool') to assist tourism operators in two Queensland regions to plan for locally relevant impacts of climate change. The tool supports tourism operators via a structured process designed to provoke thinking on how climate change might affect them and how they could respond. This means an operator can plan to adapt sooner rather than later. Each Tool provides a simple guide to significant environmental change projections and their impacts on in a specific region. These projections were underpinned by a range of climate change scenarios developed by CSIRO based on international scientific assessments. Other practical measures have already been put in place in Queensland to anticipate climate change, such as new runway works at Brisbane airport that take expected sea level rise into account.

Human Health

The Australian Government supported the Climate Commission in publishing the key report The Critical Decade: Climate Change and Health in 2011 as a key starting point for action and is currently developing a national assessment of the health system's preparedness for adapting to the health effects of climate change.

Since the last National Communication, the National Health and Medical Research Council (NHMRC) has been steadily increasing its funding of climate change and health

research. Between 2010 and 2012, nearly $9 million has been committed in funding through to 2015, currently comprising of 15 grants. These projects encompass a range of subjects including adaptation in vulnerable groups (ageing Australians, rural populations, indigenous Australians), developing early warning systems and understanding the spread of climate-related diseases, and adaptation through urban planning.

The Australian Capital Territory (ACT) strategic framework on health for 2010-2015 (Towards a Healthier Australian Capital territory) includes a section on responding to the health impacts of climate change. The ACT's Health Directorate is undertaking strategies to ensure the ongoing development of population health policy takes into consideration climate change impacts. In New South Wales (NSW), a campaign called 'Beat the Heat' has been implemented to inform the population on how to prepare for and stay healthy in the heat, how to recognise and treat heat related illness, and how to care for people who are at risk of heat-related illness.

A threshold study was funded by the South Australian health department (SA Health) which investigated health triggers and thresholds for a heat health warning system. SA Health is also conducting a series of programs to assist residential aged care facilities and country hospitals to be better prepared and resilient against bushfires. Representatives from a number of State and Commonwealth government departments and private industry have partnered in the project.

Water resources

Water for the Future delivers a number of major streams of work to help Australians adapt to a future with less water. The most significant of these deals with issues in the Murray-Darling Basin, with further general streams including: improving the efficiency of irrigation systems to minimise water loss, developing a robust water market, investing in alternative water supplies and water saving initiatives in urban areas, and improving the quality of national water information systems.

The first Murray Darling Basin Plan was made into law in November 2012. The Plan limits water use at environmentally sustainable levels by determining long-term average Sustainable Diversion Limits, and includes an environmental watering plan, a water quality and salinity management plan, requirements for accreditation of state water resource plans, and requirements for monitoring and evaluation of Plan implementation. As it is implemented from 2013-2019, the Plan has an adaptive framework that allows for further improvements in outcomes through a sustainable diversion limits adjustment mechanism and a constraints management strategy. The Plan will be supported by investment in modernizing irrigation infrastructure and voluntary water purchasing through the Environmental Water Recovery Strategy, which has been drafted and is currently being finalised.

To strengthen significant water reform in the future, the Australian Government has been continuing the development of water resource innovation through the research of Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Water for a Healthy Country Flagship. This flagship is the largest research partnership focusing on

water in Australia, funded at approximately $90 million per annum. The Flagship aims to provide Australians with solutions for water resource management, creating economic gains while protecting or restoring major water ecosystems.

Regional Demand and Supply Statements (RDSS) are being developed for each of South Australia's NRM regions by 2014. RDSS's incorporate projections of climate change impacts on the future capacity of water resources, together with other factors that influence water supply and water demand pressures to project the balance between water supply and demand to 2050.

In 2012, the Victorian Government established the Office of Living Victoria to drive reform by coordinating urban and water planning, and has prioritised water resource improvements in its Climate Change Action Plan. Similarly, Western Australia's 2012 plan 'Adapting to our changing climate' similarly suggests approaches to address future water security. These include a move toward water pricing that reflects the true cost of water, actions to strengthen water efficiency and water recycling targets for Perth, strategies to increase the adoption of water sensitive urban design, the development of new opportunities for water recycling, and the trial and implementation of managed aquifer recharge initiatives.

The Western Australian government water utility, the Water Corporation, has developed WaterForever, a 50-year plan to make Perth and surrounding areas water supply more climate resilient, and ensure sufficient and sustainable water supplies for Western Australia, in the context of reduced rainfall conditions in the south-west of Western Australia. The Water Corporation is also providing ongoing major investment in upgrading existing, and developing major new, water sources, including the two seawater desalination plants which are rainfall independent sources.

Local and regional planning

Under the Australian Government's Local Adaptation Pathways Program, around $2.4 million was provided to help local government build their capacity to respond to the likely impacts of climate change from 2008-2011. Round 1 involved more than 60 local governments and funded a total of 33 projects for risk assessments and action plans worth $1.5 million. The majority of these councils were located in coastal and urban areas. In Round 2, 30 councils in regional and remote areas of Australia received $874 000 to complement and build on the work from Round 1.

The Australian Government has also provided funding to five projects through its Integrated Assessment of Settlements Sub-Program to help build the capacity of local governments to identify climate change challenges and develop responses, and the $4.5 million Coastal Adaptation Decision Pathways projects assisted local governments across all states to explore climate change adaptation planning in terms of coastal impacts.

In 2011, the Australian Local Government Association (ALGA) commissioned the Local Council Risk of Liability in the Face of Climate Change - Resolving Uncertainties report.

This key resource identifies areas of potential risk and legal liability that State and Territory local government organisations face in relation to climate change, and discusses barriers to effective adaptation and provides an assessment of potential models or approaches to reduce or mitigate these risks.

The NSW Government provides local planning guidance on their website and published a 'Guide to climate change risk assessment for NSW local government' in 2011 to help strengthen local councils' understanding of the risk management process in climate change adaptation.

Local governments have themselves recognised the need to prepare for and manage the unavoidable consequences of climate change. Some examples of local governments currently implementing climate adaptation action plans include the City of Melbourne, the City of Adelaide Hobart City Council, the City of South Perth and the Redland City Council. Other local governments have developed adaptation measures in response to specific risks, such as Lockyer Valley Regional Council's flood risk relocation policy.

In 2012, the Western Australian Local Government Association and Western Australian Government formed the 'Climate Change in Local Government' Partnership Agreement. This aims to improve the capacity of councils to address climate change issues and includes the Climate Change Management Toolkit and the Adaptation Planning Checklist to assist councils.

Building on the success of the Victorian Local Sustainability Accord (2005), the Victorian Adaptation and Sustainability Partnership was announced in December 2012. This partnership between Victoria's 79 councils and the State Government is a key mechanism to help state and local governments work together on practical climate change adaptation and sustainability actions. The program has allocated over $10 million dollars in grants to the local government sector since it began. Most recently, the Victorian Government announced an that an additional $6 million had been allocated through the VAS Partnership to support the local government sector in a number of ways, including grants and partnership projects to undertake climate adaptation.

In Tasmania, the Southern Tasmanian Councils Authority (representing 12 councils) undertook the Regional Councils Climate Adaptation Project in partnership with the Local Government Association of Tasmania and the Tasmanian Government in 2011-2012. The project developed climate change scenarios at local scales, a regional adaptation plan, adaptation plans for individual councils and a toolkit for adaptation planning. The South Australian Local Government Research and Development Scheme is similarly providing financial support to the South Australian Local Government Association to develop a financial model and tool to guide decision makers about the financial implications of climate change impacts on asset management and investment.

Tools and support for adaptation

The Australian Government is continuing to prioritise national capability to assess coastal risk through investment in a range of tools. The National Coastal Geomorphology dataset

is being developed to provide information on coastal landform types that will inform understanding of the potential erosion of shorelines in response to rising sea levels. The Government partnership between Geoscience Australia and the Cooperative Research Centre for Spatial Information is also developing a Coastal Urban Digital Elevation Modelling project. So far, this project has modelled more than 60,000 square kilometres of high-quality elevation data for nearly all populated areas around the Australian coast. As part of the project, the National Elevation Data Framework online portal will progressively make this data and maps publically available.

The Australian Government has further supported a sea level rise tool developed by the Antarctic Climate and Ecosystems Cooperative Research Centre. The tool is now applicable to the whole Australian coastline and provides users, such as policymakers, planners and asset managers, with estimated likelihoods of future flooding from combined sea-level rise, tides, surges and waves, plus some guidance on resulting erosion potential.

In 2011 Australian Government announced $43.9 million in funding over four years (2011/12 – 2014/15) under its Clean Energy Future Program to support regional Natural Resource Management (NRM) organisations update their existing NRM plans to incorporate climate change considerations. The NRM Fund has two streams:

- Stream 1 provides $28.9 million to support the 54 regional NRM organisations revise existing regional NRM plans to help identify where in the landscape adaptation and mitigation activities should be undertaken.
- Stream 2 provides $15 million for coordination of research to produce regional level climate change information, including climate projections. See Section 8.1.2.

The CSIRO is working to develop several tools for managing water resources and understanding ecological responses to changed water availability in the Murray Darling basin. The year-long, A$12 million research project is the first attempt worldwide to estimate at a basin-scale the impacts on water resources of:

- catchment development
- changing groundwater extraction
- climate variability
- anticipated climate change.

Led by CSIRO, the research is drawing on the expertise of national and State Government agencies as well as the Murray-Darling Basin Commission and Australia's leading industry consultants.

In 2012, Geoscience Australia completed work funded under the National Climate Change Adaptation Centre Program to improve the National Exposure Information System (NEXIS) database so it could better support studies of the national implications of climate change impacts on significant Australian infrastructure. NEXIS now holds new or better information about buildings, roads, waste sites, energy infrastructure, water infrastructure and communications infrastructure. Better models will improve

understanding of how extreme weather events may damage these assets. This information was used to update the national coastal risk assessment and is an ongoing tool available to assist in adaptation planning.

The NSW and ACT Regional Climate Model initiative is facilitating access to a standardised user friendly database containing the most up-to-date, comprehensive, and finest resolution (space and time) climate change data and tools currently available for the region. The initiative's aim is for this information to assist regional governments to manage the risks associated with a changing climate.

The Western Australian Local Government Association (WALGA) and the State Government of Western Australia partnered in 2008 to develop a capacity building online climate change management toolkit for local governments. The website was launched in 2010 and provides a seven step process to help local government managers develop a climate change adaptation strategy. The website is continually updated and maintained by WALGA.

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CHAPTER 7

Financial resources and technology cooperation

7.1 Multilateral activities 187
7.2 Bilateral and regional activities 189
7.3 Adaptation 192
7.4 Mitigation and capacity building 195
7.5 Technology cooperation 203
7.6 Other initiatives 208

Key Developments

Since the Fifth National Communication, Australia has contributed approximately AUD$490 million (to mid-2012) in new and additional support for financial resources and technology cooperation. Australia's three year fast-start finance period ran from the 2010-11 financial year and concluded at the end of the 2012-13 financial year. This fast-start commitment totalled AUD$599 million. Australia's financial contribution was grant based, sourced from the broader aid budget, was appropriately balanced between mitigation and adaptation activities and was delivered through multilateral and bilateral channels.

Adaptation

Through the International Climate Change Adaptation Initiative, Australia provided $328.2 million over five years to deliver policy and technical assistance to multilateral institutions, and targeted assistance through bilateral partnerships with developing countries.

Mitigation and capacity building

Australia contributed $12.5 million, and technical assistance, to the World Bank Partnership for Market Readiness. The Partnership provides funding and technical assistance for the development of domestic carbon market instruments that can scale up emission reduction efforts and support low carbon growth.

The $273 million International Forest Carbon Initiative is Australia's key contribution to global action on REDD+. As part of the initiative, a $13 million research partnership in Indonesia with the Centre for International Forestry Research is helping deliver REDD+ policy and technical research.

Technology cooperation

Australia is a leading partner in the Clean Energy Ministerial Clean Energy Solution Centre – a clearinghouse for clean energy policy reports, data and tools, and interactive expert assistance and training forums. Australia is also an active member of the International Partnership for Energy Efficiency Cooperation. This high-level international forum provides global leadership on energy efficiency by identifying and facilitating implementation of policies and programs that yield high energy-efficiency gains.

Supporting mitigation and adaptation action by developing countries through climate finance, capacity building and technical support is crucial to addressing climate change. This chapter provides an overview of Australia's contribution to the global effort.

Australia's climate finance and technical cooperation – through bilateral, regional and multilateral efforts – reflects the importance of mitigation and adaptation actions. Early investment in mitigation and adaptation can reduce the global costs of climate change and the costs to individual countries. Australia's targeted support is building capacity in developing countries, and improving the development and implementation of national climate policies and measures. Strong domestic efforts can put countries on sustainable and low carbon development pathways and improve access to international finance and carbon markets.

Since the Fifth National Communication in 2010, Australia has contributed approximately AUD$490 million over three financial years from 2009-10 to 2011-12 in support of developing country efforts to mitigate emissions and adapt to the adverse impacts of climate change. Australia's contribution is an increase of over 70 per cent on the average annual expenditure over the previous reporting period.

The Sixth National Communication captures two of the three years of Australia's $599 million fast-start finance commitment (2010-11 to 2012-13), which is delivering effective adaptation and mitigation outcomes, and valuable lessons for future support to developing countries. Beyond the fast-start finance period, Australia remains committed to the global goal of jointly mobilising US$100 billion per year by 2020 from a wide variety of sources – public, private, bilateral, multilateral and alternative – in the context of meaningful mitigation actions by developing countries and transparency on implementation. This global goal was agreed by leaders at the 15th Conference of the Parties (COP) in Copenhagen (2009), confirmed at COP16 in Cancun (2010), and reaffirmed at COP17 in Durban (2011) and COP18 in Doha (2012).

Australia has adopted the United Nations Framework Convention on Climate Change (UNFCCC) agreed common tabular format for the Sixth National Communication to ensure transparency in reporting financial data and promote consistency across all financial contributors.

Australia's climate finance and technology cooperation support for developing countries is managed by a number of government agencies. The Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (the Department) works closely with the Australian Agency for International Development (AusAID), which implements and manages a large number of climate change adaptation, mitigation, capacity building and technology cooperation programs.

Climate change programs and research in the fields of technology, transport, forestry, agriculture, waste management, coastal management and capacity building are managed by a number of other Australian government departments and research centres. These include the Department of the Sustainability, Environment, Water, Population and Communities; the Department of Agriculture, Fisheries and Forestry; the Department of Resources, Energy and Tourism; the Commonwealth Scientific and Industrial Research Organisation; Geoscience Australia; the Bureau of Meteorology; and the Australian Centre for International Agricultural Research.

7.1 Multilateral activities

Australia has made financial contributions to the UNFCCC and the Kyoto Protocol; multilateral institutions such as the Global Environment Facility and the Intergovernmental Panel on Climate Change (IPCC); and to other international financial institutions that fund climate change adaptation, mitigation, capacity building and technology cooperation programs in developing countries.

Table 7.1 details Australia's contributions to these multilateral institutions, organisations and associated programs.

7.1.1 The Green Climate Fund

The Green Climate Fund (GCF) is a new multilateral fund established to make a significant contribution to global efforts to address development challenges posed by climate change. The fund has the potential to become the largest channel for the delivery of international climate finance to developing countries.

The GCF's wide-ranging mandate covers adaptation and mitigation action in developing countries. The fund will help poor people adapt to the major development challenges posed by climate change, and contribute to emissions reductions without compromising development results.

Australia's aim for the GCF is to help developing countries undertake significant climate change action that moves national economies onto climate-resilient and low-emission development pathways. Australia and South Africa are the current co-chairs of the GCF board, with Australia contributing $500,000 in 2011-12 to the administrative costs of the Board's work. The GCF is not yet seeking substantive financial contributions.

7.1.2 UNFCCC and the Kyoto Protocol

Australia contributed approximately $1.8 million to the core budget of the UNFCCC for the period 2009–10 to 2011–12. This included a contribution of $0.74 million to the Kyoto Protocol. Australia has also made voluntary contributions to the UNFCCC totalling approximately $1 million from 2009–10 to 2011–12, including $0.28 million to the UNFCCC Trust Fund for Participation which supports the participation of poorer developing countries in the UNFCCC.

Australia is committed to taking strong action on climate change and is playing its part in the global effort to achieve an ambitious international outcome. In December 2012, Australia agreed to join the second commitment period of the Kyoto Protocol, committing to limit emissions to an average of 99.5 per cent of 1990 emissions between 2013 and 2020.

7.1.3 Global Environment Facility

The Global Environment Facility (GEF) funds projects that protect the global environment and support sustainable development in developing countries. Since the GEF's inception in 1991, Australia has contributed $355 million, including $105 million to the GEF's fifth replenishment (2010-2014).

A significant proportion of GEF activities incorporate climate change into broader programs which address the inter-connected challenges of biodiversity and land degradation. The GEF has supported climate change projects in over 156 developing countries and economies in transition.

7.1.4 Least Developed Countries Fund

The Least Developed Countries Fund (LDCF) was established to address the special needs of Least Developed Countries (LDCs) under the UNFCCC and helps finance the preparation and implementation of National Adaptation Programs of Action (NAPAs). The LDCF is managed by the GEF. Australia has provided $46.5 million to the fund over the period 2007-8 to 2012-13.

The LDCF has financed the preparation of 48 NAPAs, of which 47 are complete. As of June 2012, the Fund had approved US$346 million in funding for 74 projects and programs identified in NAPAs, which is reported as leveraging an additional US$1.59 billion.

7.1.5 Intergovernmental Panel on Climate Change

The IPCC is the authoritative source of information on climate change science, and provides regular assessments of the world's changing climate and the potential environmental and socio-economic consequences. Over the financial years 2009-10 to 2012-13, Australia provided approximately $2.8 million to the IPCC. Funding has supported Australian authors' participation in the development of IPCC reports – including the Fifth Assessment Report and special and technical reports – and the hosting of author meetings in Australia, including the Working Group I Fourth Lead Authors meeting in Hobart in January 2013. Voluntary contributions to the IPCC Trust Fund have also supported developing countries' attendance at IPCC meetings.

7.1.6 Climate Investment Funds

The Climate Investment Funds (CIFs) are a key instrument in Australia's multilateral engagement. AusAID manages Australia's CIFs engagement. The CIFs support transformational, scaled-up climate action that leverages additional finance from the private sector and multilateral development banks to achieve significant climate and development outcomes.

Australia has contributed $187.2 million to the CIFs over five years (2008-09 to 2012-13). Currently, the CIFs have total pledges of US$7.6 billion that are leveraging an estimated US$43.6 billion. The CIFs' climate activities are carried out through four funding windows: large-scale clean technology, adaptation, forestry and small-scale renewable energy. As at 31 December 2012, the CIFs were supporting climate change projects in 49 countries.

7.2 Bilateral and regional activities

Australia works closely with bilateral partners to deliver effective global responses to climate change. Formal bilateral arrangements are in place with China, the European Commission, Indonesia, Japan, New Zealand, Papua New Guinea and South Korea. Australia also undertakes regular exchanges of information with a host of other countries.

Australia supports practical climate action in partner countries through a number of mechanisms, including the Administered Fund: Helping Shape a Global Climate Change Solution ($3 million per annum, which includes UNFCCC core funding) and the AusAID Public Sector Linkages Program. Table 7.2 details the bilateral and regional financial contributions related to the UNFCCC since Australia's Fifth National Communication.

Under the Australia-China Climate Change Partnership, the government has supported the Australia China Climate Change Forum in 2011 and 2013. The Forum has brought together leading academics, policy-makers and business experts from both countries; hosted emissions trading technical workshops; and facilitated academic collaboration between Australia and China in energy efficiency, low carbon urbanisation, and economic modelling and policy analysis with the aim of developing cost-effective market mechanisms.

In April 2013, then Prime Minister Gillard announced the establishment of a carbon trading experts group with China to facilitate the implementation of practical cooperation projects and share information and experience on carbon market issues (See Box 7.1).

Australia and the European Commission established Senior Officials Talks on Climate Change in September 2011. These talks discuss: the mechanics of linking the Australian and the European Union emissions trading schemes; how Australia and the European Union can promote deep, liquid and integrated carbon markets; how to advance climate developments in other fora (including the UNFCCC); and cooperation in the International Maritime Organisation and International Civil Aviation Organisation.

In August 2012, Australia and European Commission agreed on a pathway towards linking the Australian and European emissions trading systems.

Under this arrangement, an interim link will be established from 1 July 2015 which will enable Australian businesses to use European allowance units to help meet liabilities under the Australian system. This will be followed by a full link from 1 July 2018 where units from both systems may be used for compliance in either system.

Australia also maintains strong technical exchanges on carbon markets with other jurisdictions operating or planning emission trading schemes including South Korea, Japan and the US state of California.

Australia works with Indonesia through the Indonesia-Australia Forest Carbon Partnership (IAFCP). Since 2008, the IAFCP has supported Indonesia through policy development and capacity building; technical support for forest carbon monitoring and measurement; and a REDD+ demonstration activity in Kalimantan.

Australia is providing $12.7 million over three years from 2012-13 to support Kenya's design and implementation of a measurement, reporting and verification system for land sector emissions. The System for Land-based Emissions Estimation in Kenya (SLEEK) will allow evaluation of different land-use scenarios for sustainable development and inform policy decisions on resource use, including planning for forest restoration,

protection of forest resources, improved agricultural productivity, and enhanced water availability.

Alongside an annual contribution to the UNFCCC, Australia has provided financial support to other plurilateral meetings and expert groups. These include: the Cartagena Dialogue for Progressive Action (developed and developing countries with a shared national interest in securing ambitious global action on climate change and a truly global new agreement); the Asia Pacific Seminar on Climate Change; the Organisation of Economic Cooperation and Development Climate Change Expert Group; the Earth Negotiations Bulletin; the World Bank Partnership for Market Readiness; and the Asia Pacific Carbon Market Roundtable.

Box 7.1 Australia-China collaboration on Emissions Trading Scheme design

Australia is working with China on emissions trading scheme (ETS) design, as both countries embark on this cost-effective mitigation pathway. Australia commenced its ETS on 1 July 2012. China is establishing seven pilot schemes from 2013, with a view to developing a national ETS after 2015.

The Department received $250,000 funding through AusAID's Public Sector Linkages Program to fund three technical workshops on ETS design and implementation through the Australia-China Emissions Trading Experts' Dialogue. The first workshop was held in Beijing in July 2012, the second in Canberra in March 2013 and the third in Beijing in July 2013.

The workshops have enabled a two-way exchange of information and experiences between Australia and China in carbon market development. Experts from both countries have discussed complex policy and technical issues relevant to the development of emissions trading in China, including cap-setting, coverage, permit-allocation methods, measurement, reporting and verification of emissions, data quality, governance arrangements and compliance frameworks. These elements are critical for a robust, effective and internationally credible ETS. Australia has expertise in these elements from designing and implementing its domestic ETS.

Through the workshops, experts in China have identified policy options and key principles applicable to the design and implementation of China's national and pilot emissions trading schemes.

7.2.1 Volunteers and fellowships

Australia has supported a program of volunteers and fellowships that have assisted developing countries' efforts to adapt to and mitigate climate change, including several countries in the Asia-Pacific, as well as Bangladesh, Ethiopia, Lesotho, the Philippines, Mongolia and Timor-Leste. Volunteers have assisted climate change adaptation in the agricultural sectors in Cambodia and Lesotho and climate change communications in Kiribati. In Vietnam, a fellowship position and volunteers have contributed to climate change education and research, improved adaptation to climate change and reduced emissions from deforestation and forest degradation.

7.3 Adaptation

Australia is committed to adaptation support for developing countries that are particularly vulnerable to climate change.

Studies show that the extent to which effective adaptation is incorporated into decision-making will influence the long term growth and development trajectory of communities and nations. However, many developing countries face enormous challenges adapting to the impacts of climate change. Climate change may push many countries beyond their thresholds of resilience in areas like food security or coastal stability.

Effective adaptation solutions need to take into account the sensitivity of sectors, community preferences and the need for decision pathways that recognise the changing nature of climate change risk. Thus, formulating sound adaptation solutions will require a significant shift in how many governments currently plan for climate related risks.

7.3.1 The International Climate Change Adaptation Initiative

Australia provides adaptation assistance through the $328.2 million International Climate Change Adaptation Initiative (ICCAI). The ICCAI focuses on the Pacific, as well as countries in South Asia, Southeast Asia, Africa and the Caribbean.The ICCAI aims to:

- Establish a sound policy, scientific and analytical basis to help partner countries adapt to the impacts of climate change;
- Increase understanding in partner countries of the impacts of climate change on their natural and socioeconomic systems;
- Enhance capacity in partner countries to assess climate vulnerabilities and risks, formulate appropriate adaptation strategies and plans, and mainstream adaptation into decision making; and
- Identify and help finance priority adaptation measures to increase the resilience of partner countries to the impacts of climate change.

Through the ICCAI, Australia provides policy and technical assistance to multilateral institutions, and targeted assistance through bilateral partnerships that support adaptation in developing countries. Australia's $78 million ICCAI investment in 2011-12 funded efforts in 23 developing countries to reduce their vulnerability to climate change.

Many disaster risk reduction activities supported through Australia's Official Development Assistance (ODA) program yield climate change adaptation benefits by integrating the consideration of climate change impacts with approaches to address and manage disaster risk.

7.3.2 Climate change adaptation and preparedness in the Pacific

Australia is focused on providing adaptation assistance to neighbouring Pacific island countries and Timor-Leste through existing development programs. These programs recognise the particular vulnerability of small island developing states to climate change.

Approximately $160 million from the ICCAI has been allocated to the Pacific region. A significant proportion of this funding has been allocated toward three regional science and adaption programs. From 2008 to 2011, Australia supported the $12 million Pacific Adaptation Strategy Assistance Program (PASAP) and the $20 million Pacific Climate Change Science Program (PCCSP). From 2011-2013, the $32 million Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) program continued to build the capacity of Pacific Island countries to manage future climate risk.

PACCSAP is supporting partner countries to adapt through: 1) improving scientific understanding of climate change; 2) better communicating climate science and adaptation knowledge to decision makers; and 3) improving adaptation planning in key development sectors. These programs have worked with Pacific island country scientists, decision-makers and planners to better understand past and future climate change, and to apply the information and tools to adaptation responses (see Figure 7.1).

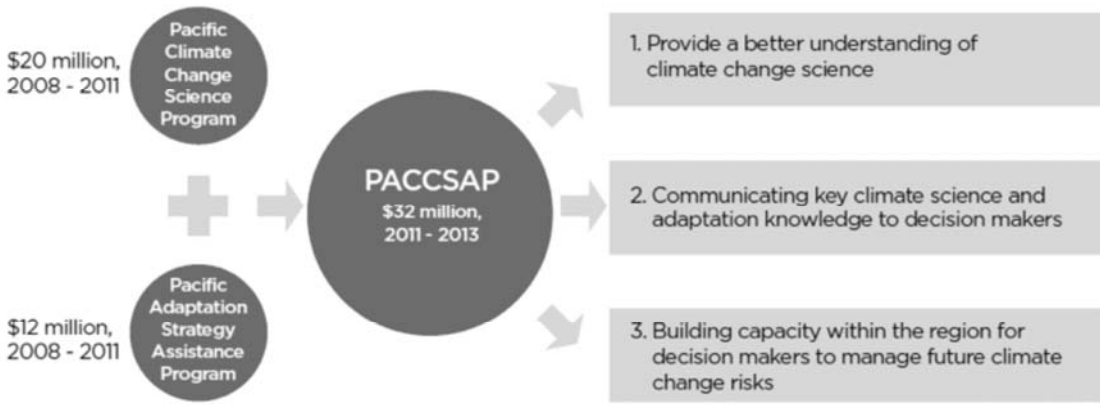

Figure7.1 the Pacific Climate Change Science, Program and the Pacific Adaptation Strategy Assistance Program and the Pacific-Australia Climate Change Science and Adaptation Planning Program

Australia invested $20 million from 2008 to 2011 in PCCSP to address fundamental climate change science research gaps in the Pacific revealed by the **IPCC FOURTH ASSESSMENT REPORT**. Fourteen[1] Pacific countries and Timor-Leste now have, for the first time, nationally specific information on climate change projections covering temperature, rainfall, cyclone events, sea-level, and ocean acidity.

The information generated through the PCCSP is assisting governments and development partners make informed decisions about climate change adaptation policies and management. The research outcomes were disseminated in the December 2011 report, Climate Change in the Pacific: Scientific Assessment and New Research. The report can be accessed at: http://www.cawcr.gov.au/projects/PCCSP/publications1. Information brochures in 15 local languages and web-based tools were also produced to provide easy access to the climate science and data.

[1] Cook Islands, Federated States of Micronesia, Fiji Islands, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

Australia has also delivered $12 million from 2008 to 2011 through PASAP to Pacific island countries and Timor-Leste to assess climate change impacts and manage climate risks in planning and development strategies. PASAP invested in a regional analysis of major climate risks to the Pacific, with a focus on coastal management, food and water security, and infrastructure. PASAP has also conducted country-specific vulnerability assessments in Timor-Leste (groundwater); Federated States of Micronesia (food security); Cook Islands (institutional strengthening, coastal vulnerability); Tonga (coastal erosion and sea level rise) and Solomon Islands (social and ecological resilience).

Caption: Water resource managers Osorio Belo Da Piedade (left) and Filomeno Maia Dos Santos (right) monitor the quality and quantity of groundwater under Dili.

These vulnerability assessment projects have highlighted the need to combine new science with traditional knowledge to engage communities and drive change. PASAP reports can be accessed at: http://www.climatechange.gov.au/climate-change/grants/pacific-adaptation-strategy-assistance-program

Joint National Action Plans in nine countries, and a major national climate change and development summit in Kiribati, were also supported by PASAP. The national action plans are building awareness about climate risks, strengthening institutional arrangements across government sectors, coordinating donor country investment, and harnessing in-country commitments.

PACCSAP formed the next phase of collaboration on climate change science and adaptation planning, continuing to build on the work of its predecessor programs, PCCSP and PASAP. This program continues to improve scientific understanding by conducting further research into areas such as seasonal predictions and large-scale climate

features, and carrying out in-country training courses and workshops. A good example of this science in application is the integration of tropical cyclone wind risk modelling into the Pacific Catastrophe and Risk Assessment and Financing Initiative (PCRAFI) climate hazard models.

In recognition that successful adaptation is built on engaged Pacific island decision makers and communities, PACCSAP continues to raise awareness and understanding through activities such as media training for journalists and developing products and media to communicate complex climate change science. Activities in support of building resilience through adaptation planning continue to be carried out, in particular in relation to infrastructure, coastal zone management and cross-sectoral planning. For example, integrating climate change considerations into decision-making such as developing climate resilient design standards for infrastructure and improving the understanding of impacts to coastal and groundwater resources.

These programs have collectively sought to improve climate change science and adaptation planning capacity across Pacific countries.

7.4 Mitigation and capacity building

Australia is helping build capacity in developing countries to mitigate and manage the impacts of climate change. Australia has committed resources that are creating enabling environments for private sector investment, strengthening national and regional institutional and regulatory frameworks, and assisting developing countries to take practical actions to cut emissions and access carbon markets.

7.4.1 Reducing emissions from deforestation and forest degradation in developing countries

Deforestation, mostly in developing countries, accounts for around 18 per cent of global greenhouse gas emissions. Reducing emissions from deforestation and forest degradation in developing countries (REDD+) can help avoid the worst impacts of climate change and contribute to global climate change efforts.

Effective REDD+ markets can provide cost-effective abatement opportunities, and have the potential to contribute to the Millennium Development Goals by supporting broader sustainable development and a range of environmental and social co-benefits.

Australia has worked with other countries to advance global awareness of REDD+, improve developing countries' ability to overcome barriers to the advancement of REDD+, facilitate a dialogue on leveraging finance with the private sector, and continue work to further understand the drivers of deforestation.

Australia has worked with the Global Canopy Programme (GCP), a not-for-profit research group, to improve the accessibility, transparency and utility of REDD+ information. With Australia’s support, GCP has produced several publications and resources, including the Little Forest Finance Book and the Little Book of Agricultural

Drivers, which provide a snapshot of REDD+ and forest activities, investments and strategies in participant countries.

7.4.2 The International Forest Carbon Initiative (IFCI)

The $273 million International Forest Carbon Initiative (IFCI) is Australia's key contribution to global action on REDD+. The IFCI is jointly administered by the Department and AusAID. The IFCI is helping developing countries build capacity to participate in a future REDD+ mechanism, and to support the inclusion of REDD+ in the 2020 new global agreement that will be applicable to all countries.

Through the IFCI Australia is working closely with developing countries to find practical ways to reduce forest emissions. This includes collaborative Forest Carbon Partnerships with Indonesia and Papua New Guinea that focus on addressing technical and policy hurdles to REDD+. Lessons learned from the partnerships support international efforts under the UNFCCC to design a REDD+ financial mechanism.

As part of the IFCI, a $13 million research partnership in Indonesia with the Centre for International Forestry Research (CIFOR) is supporting policy and technical research on REDD+. The CIFOR supports REDD+ efforts that deliver efficient and equitable benefits to communities. Research areas include the quantification of drivers of deforestation and forest degradation, and methods to reduce the vulnerability of forest communities to increased climate variability.

Through the IFCI, Australia has contributed $80.1 million to World Bank funds in support of multilateral action to address REDD+. Australia has invested $44.6 million in the Forest Carbon Partnership Facility (FCPF), which is a global partnership of governments, businesses, civil society, and indigenous peoples established to provide financial and technical assistance to countries seeking to build their capacity to effectively implement REDD+. Australia's $44.6 million investment is comprised of a $27.1 million investment in the Readiness Fund and a $17.5 million investment in the Carbon Fund – the two funds that operate under the FCPF.

Australia has also invested $35.5 million in the Forest Investment Program (FIP), which operates within the CIFs. The FIP utilises grants and near-zero interest credits to complement large-scale investments and leverage additional resources, including through the private sector.

The $13 million Asia Pacific Forestry Skills and Capacity Building Program (APFCSB) is part of the IFCI. The APFCSB supports efforts in the Asia-Pacific to improve forest governance, as well as law enforcement and regulatory frameworks that assist REDD+ and other development objectives. The APFCSB has supported projects in Indonesia, Papua New Guinea (with the United Nations Food and Agricultural Organization), Vietnam and Fiji. The APFCSB is also supporting the International Tropical Timber Organization's Thematic Programme on Forest Law Enforcement Governance and Trade.

Australia has provided $20 million to support the Energising Development partnership (EnDev) in developing sustainable markets for improved cooking technologies in developing countries. The unsustainable collection of fuel wood is an important driver of forest degradation. Australia's support will promote sustainable cooking technologies and a better understanding of the relationship between fuel wood use and deforestation and forest degradation.

7.4.3 The Indonesia-Australia Forest Carbon Partnership

The Indonesia-Australia Forest Carbon Partnership (IAFCP) commenced in 2008. The IAFCP builds on long-term practical cooperation between Australia and Indonesia on REDD+, and operates in three key areas: strategic policy dialogue on climate change; development of Indonesia's National Carbon Accounting System; and implementation of an incentive-based REDD+ demonstration activity in Central Kalimantan.

Under the IAFCP, the Kalimantan Forests and Climate Partnership (KFCP) has produced useful lessons on REDD+ approaches. The KFCP is trialling the use of incentives for local communities to protect and rehabilitate peat swamp forest in Central Kalimantan; developing the science to measure and account for the amount of greenhouse gas emissions from peat; and measuring, reporting and evaluating impacts with a view to replication elsewhere. The KFCP has:

- Raised over 2.6 million seedlings for planting in the KFCP area;
- Provided livelihoods support for local communities by helping farmers improve forestry and farming methods;
- Delivered additional income support for 1,600 households through payments for the raising and planting of seedlings; and
- Established one of the largest and most rigorous tropical peat monitoring systems in the world.

The Indonesia National Carbon Accounting System (INCAS) is part of the IAFCP. The INCAS is a central component of Australia's funding and technical support for Indonesia's progress towards developing and operating a sovereign national level forest carbon accounting system. The INCAS has:

- Developed annual land cover change maps for Kalimantan, Sumatra and West Papua, showing detailed forest loss and gain for the period 2000 to 2009;
- Assisted in the development and publication of methods for estimating biomass content in Indonesian forests; and
- Almost completed a pilot forest carbon accounting system for the island of Kalimantan. The system is being developed in line with international best practice guidance and could be applied across Indonesia.

7.4.4 The World Bank Partnership for Market Readiness

The World Bank Partnership for Market Readiness (PMR) is a global partnership of 28 developed and developing countries plus the European Commission. The PMR provides

funding and technical assistance for the development of domestic carbon market instruments to scale up emission reduction efforts and support low carbon growth.

Since Australia's Fifth National Communication on Climate Change, Australia has contributed $12.5 million (including the 2012/13 financial year) to the PMR, shared its expertise and experience in developing and implementing its national emissions trading scheme and domestic offset mechanism (the Carbon Farming Initiative) and hosted the PMR's Partnership Assembly (See Box 7.2).

Box 7.2 World Bank Partnership for Market Readiness

The PMR is building countries' capacity to develop domestic carbon market instruments to scale up emission reduction efforts and support low carbon development. In addition to financial support, the PMR runs technical workshops, policy dialogues and virtual knowledge platforms on the essential "readiness" components of carbon market instruments such as data management, measurement, reporting and verification systems, and the creation of policy and regulatory frameworks. Through this support, the PMR also helps countries create effective enabling environments for private sector action on climate change. Well-designed carbon market instruments can incentivise the private sector to change investment and production behaviour to drive low emissions development.

Progress to date

Since its establishment in 2011, the PMR has demonstrated its effectiveness in helping countries explore innovative, cost-effective ways to scale up emissions reduction through carbon market instruments. All 16 "implementing partners" (countries eligible to receive financial assistance) have presented frameworks outlining anticipated PMR activities and have been allocated funding to identify capacity building gaps and to prepare a plan for the implementation of domestic carbon market instruments.

The first plans, known as Market Readiness Proposals (MRP) have been finalised by Chile, China, Costa Rica, Mexico and Turkey. The PMR has since approved funding for these countries to implement their MRPs. As at June 2013, the World Bank reported that PMR countries have committed US$119 million to its Trust Fund, exceeding its target of US$100 million.

Keys to success

A major contributor to the PMR's success is its country-driven approach, which allows countries to develop their MRPs in line with their specific national circumstances and sustainable development priorities. Through this country-driven approach, the PMRs capacity-building activities are also expected to have a range of social, economic and environmental co-benefits, such as greater energy security, more productive and efficient economies, improved air quality and associated health benefits, and savings for low-income households.

Australia's contribution

Australia co-chaired the PMR Partnership Assembly in October 2012, March 2013 and May 2013. Australia also hosted the October 2012 Partnership Assembly in Sydney, involving over 100 representatives from 31 countries. In addition to the Assembly, Australia hosted workshops to share its expertise and experience in developing and implementing its national emissions trading scheme and Carbon Farming Initiative and provided A$12.5 million in funding for the PMR. In conjunction with the World Bank and International Emissions Trading Association, Australia hosted a business dialogue involving businesses, governments and academia to promote effective private sector engagement on measures to reduce emissions and support low emissions development.

7.4.5 Capacity Building

Through the aid program, the Australian Government is helping improve the capacity of developing countries to reduce their emissions and build resilience to climate impacts, particularly for countries in the Asia–Pacific.

The CSIRO-AusAID Research for Development Alliance is a strategic partnership that aims to tackle important development challenges in the Asia-Pacific through improved knowledge of climate, water and energy systems. The Alliance builds partner capacity to inform development decisions that will improve people's resilience to climate shocks and provides adaptation and environmental management options.

Under the Alliance, the Mekong Region Futures project is assessing national and regional decision-making about energy, water and food investments. The project aims to provide integrated, alternative scenarios of long-term future development to support the needs of Mekong region decision-makers who have to consider energy, water and food security in the context of changes in climate, land use, technology, urbanisation and populations.

Also under the Alliance, the Climate Adaptation Strategies for Rural Livelihoods project is working with the Government of Indonesia and Indonesian scientists to assess vulnerabilities to climate change in the Indonesian province of Nusa Tenggara Barat.

Detailed local climate projections will help different sectors, including agriculture and coastal fisheries, to develop adaptation strategies. The project will enhance the capacity of local scientists to undertake multidisciplinary climate adaptation research and planning through the development of a centre of excellence at the University of Mataram.

Australia's capacity building efforts under the PACCSAP are also supporting new country-specific research in the Pacific on past, current and future climate changes. Work has also begun on helping Pacific countries apply climate change projections to planning adaptation measures.

Australia's Climate and Oceans Support Program in the Pacific is supporting Pacific meteorological services to use climate science to support planning in various sectors including agriculture, water security and health. The program is also continuing the collection of meteorological and oceans data across the Pacific and works with Pacific meteorological services to make information accessible and useful to their governments and communities. Data are used by a range of other projects including the IPCC and Australia's PCCSP, as well as in developing environment vulnerability indices. Regional technical organisations and other donors also use the data for disaster risk assessments, coastal zone management and in NAPAs.

Australia's support to the Secretariat of the Pacific Community has helped Pacific island countries improve their resilience to the impacts of climate change. Countries now have access to over 100 climate resilient varieties of staple Pacific crops through the Pacific Centre for Crops and Trees. In 2012, more than 8,300 seedlings were distributed to Pacific countries. Countries also have better capacity to monitor and track climate change impacts on coastal fisheries through the training of staff, the formation of a network of coastal fisheries experts, and completion of surveys and baseline data sets.

Through the United Nations Development Programme's Pacific Adaptation to Climate Change project**,** Australia has helped enhance the capacity of participating countries to adapt to climate change in the food security, water and coastal management sectors. Participating nations include the Cook Islands, Federated States of Micronesia, Fiji, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu and with the addition of AusAID funds, Tokelau.

In a partnership with the University of the South Pacific, Australia is supporting the development of a workforce of tertiary educated Pacific islanders, necessary to manage Pacific island responses to climate change. The partnership has seen the development of degree programmes and five new courses in climate change and related areas. Since 2010, scholarships for Postgraduate Diploma and Masters Degrees have been awarded to 40 students.

Australia's Community-based Climate Change Action Grants scheme is a new program supporting non-government organisations to work with local communities to build their capacity and resilience to climate change, focussing on disaster risk reduction, food and water security, agricultural productivity and ecosystem-based adaptation. Activities will be implemented in Vietnam, Timor-Leste, the Philippines, Papua New Guinea, Solomon Islands, Vanuatu, Kiribati, Republic of Marshall Islands, Tonga and Fiji.

Australia has partnered with Germany and the Government of Vietnam under the Vietnam Climate Change and Coastal Ecosystems Program. This program helps communities in the Kien Giang province to adapt to climate change and improve the management of coastal environments through new technologies, including building innovative fences to prevent erosion, rehabilitating coastal forests, promoting new mangrove planting techniques and improving dyke management. Achievements include:

- planting more than five hectares of mangroves and installing 650 metres of fences to improve their survival and growth;
- introducing new sustainable livelihood activities for communities such as growing salt tolerant crops;
- increasing community awareness of climate change impacts in the community, from 3 per cent to 77 per cent; and
- establishing a teaching program and resources for primary schools on climate change, biodiversity and waste management which are now incorporated into school curricula across the province.

Capacity building for climate change research

Australia provides significant technical advice and assistance to countries in the Asia-Pacific to improve climate data management and monitoring capabilities. The $20 million PASAP was a significant investment into regional climate change research that provided country specific climate projections in the region and has been well received by Pacific countries, their development partners and the international community.

The program has delivered a significantly enhanced understanding of the nature and direction of change for climate variables and major regional climate drivers for the Pacific. Understanding and capacity to use the research has been built in-country through reports on individual country climate change projections, training and in-country workshops for meteorology staff to use and understand the science and web based tools. The program also ran climate change science workshops and training activities which reached 500 people across 15 partner countries. This research has been published in peer-reviewed journals to build international capacity to understand the climate science for the Pacific and inform future IPCC assessment reports.

Australia's adaptation support has helped countries understand climate risk and plan adaptation responses. The delivery of high resolution elevation data in Tonga and Papua New Guinea (with data also to be delivered to Vanuatu and Samoa), as well as training and capacity building will facilitate detailed modelling of climate impacts in the coastal zone and support urban planning and emergency management more broadly.

The Australian Government has also developed a range of tools for use in the Pacific region including a climate database management system, a climate data portal and a tropical cyclone web portal, accompanied by training for country users. Pacific island countries and Timor-Leste can now use these tools to manage their climate information and inform risk management strategies.

The $32 million PACCSAP is also helping connect policy makers, scientists and researchers to take action on climate change. The program is improving research capacity in the Pacific through improving the science base, awareness and understanding in the region, including a specific focus to build the capacity of national meteorological services. The program is undertaking activities to build the capacity of Pacific countries to identify and manage future climate risks, for example through providing support for in country resources to develop climate resilient infrastructure design standards in Vanuatu and the Solomon Islands.

Low Emissions Capacity Building Programme

Australia's $5 million investment in the United Nation's Development Programme's Low Emissions Capacity Building Programme (LECBP) is supporting robust measurement, reporting and verification (MRV) systems, Nationally Appropriate Mitigation Actions (NAMAs), and Low Emissions Development Strategies (LEDS).

Australia is supporting 25 countries through the LECBP to strengthen their institutional and technical capacity to plan and undertake mitigation actions, through the formulation

of LEDS and NAMAs. The programme is also assisting countries to establish the national greenhouse gas inventory and MRV systems required to underpin mitigation actions.

Acknowledging that the responsibility for responding to climate change extends beyond national governments, the LECBP is supporting selected industrial sectors within partner countries to identify appropriate mitigation actions.

7.5 Technology cooperation

Australia is actively participating in a range of international technology-based partnerships and programs aimed at strengthening information networks, training and resource tools, and practical collaboration on climate change actions.

7.5.1 Technology cooperation under the UNFCCC

Through the UNFCCC Technology Executive Committee, Australia is providing strategic advice to the UNFCCC on technology issues and promotes information exchange on technology between Parties.

Australia is engaged in a number of additional plurilateral forums on technology and is committed to securing an agreement under the UNFCCC that complements and supports the extensive range of international and national technology related initiatives, including by the International Energy Agency (IEA), the Global Carbon Capture and Storage (CCS) Institute, the International Renewable Energy Agency (IRENA), the International Partnership for Energy Efficiency Cooperation (IPEEC) and the World Bank's Clean Investment Framework.

7.5.2 Global carbon capture and storage institute

The Global CCS Institute was established by the Australian Government in 2009 with a mandate of addressing the barriers to the commercial deployment of CCS through fact-based advocacy and knowledge-sharing activities.

The Institute shares lessons learnt from CCS projects around the world to enhance understanding of the technical, economic, financial, commercial, and engagement issues facing CCS. The Institute has developed a diverse global membership representing project proponents, policymakers, researchers and many others with an interest in the successful deployment of CCS, and is supported by $270 million from the Australian Government to 2012-13.

The Global CCS Institute works with its global members to:

- share practical knowledge and experience to help overcome the barriers to the broad deployment of CCS;
- drive the CCS agenda in the developing world, including through capacity development programs in countries like China, India and Malaysia;
- publish the annual Global Status of CCS report, the most authoritative and comprehensive reference source on the status of CCS projects and trends worldwide;

- build confidence in CCS through fact-based advocacy activities to drive international momentum; and
- influence international decision making through leadership and close collaboration with a number of multilateral forums.

7.5.3 Cleaner development pathways

Engaging in international complementary initiatives

Through the Major Economies Forum, Australia is contributing to the development of a new action agenda on energy efficiency in the building sector. The action agenda recognises the sector offers potential for many other benefits associated with energy efficiency, including reducing household energy costs, managing energy infrastructure needs, improving health and increasing productivity.

Australia is a partner of the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants (CCAC). Australia contributes expertise and support to the design and implementation of CCAC initiatives that aim to reduce emissions of short-lived pollutants, such as methane and black carbon and some hydrofluorocarbons. In addition to climate benefits, action on short-lived pollutants also delivers important co-benefits in the areas human health, air quality, agricultural yields and ecosystems.

The Clean Energy Ministerial

The Clean Energy Ministerial (CEM) was announced by the United States in 2009 to bring together ministers from major economies with key institutional and corporate stakeholders to collaborate on policies and programs that accelerate the deployment of clean energy technologies.

The CEM comprises thirteen clean technology initiatives, of which Australia is a member of seven: the Carbon Capture, Use and Storage (CCUS) Action Group, the Clean Energy Solutions Centre (CESC); the Super-efficient Equipment and Appliance Deployment (SEAD) initiative; the International Smart Grid Action Network (ISGAN); the Clean Energy Education and Empowerment (C3E) Women's Initiative; the Multilateral Solar and Wind Working Group; and the Global Superior Energy Partnership (GSEP).

Many of these initiatives also work under the guidance and in cooperation with other multilateral organisations like the IRENA and IPEEC. Australia participates across these international forums to provide strategic advice around identifying opportunities for enhanced cooperation across the range of technology cooperation activities.

The CESC is a cross cutting CEM initiative launched by Australia and the United States in April 2011. The CESC is an online portal of clean energy policy information and tools, offering peer-to-peer learning, remote expert assistance, and online training. The CESC has a comprehensive library of resources for policy makers, an online webinar platform that brings together a community of energy policy experts and an expert assistance service for policy makers – with the majority of users in developing countries. The expert

assistance service is expanding through cooperation agreements between the United Nations, IRENA and IPEEC.

Australia co-leads the CCUS with the United Kingdom. The CCUS brings together over 25 members including governments, institutions and industry who work collaboratively to make recommendations to the CEM on concrete, near-term actions to advance the global deployment of CCS.

The International Renewable Energy Agency

IRENA is a treaty-level inter-governmental organisation of more than 150 member states. IRENA aims to work with member countries and other international organisations to accelerate the development and deployment of renewable energy. The Australian Government ratified the Statute of IRENA in January 2011 and from its inception until April 2013, served as a member of the IRENA Council.

Australia contributes to IRENA's Global Renewable Energy Atlas, as well as a range of other products and resources IRENA is developing to support developing countries develop their own renewable energy resources and industries. Since 2010, Australia has assisted IRENA with its engagement with Pacific Island countries, most notably providing assistance to IRENA's first Pacific Island Renewable Energy Experts Meeting in Sydney. Most recently, IRENA assumed the role of leading renewable energy efforts in the United Nations Sustainable Energy for All (SE4ALL) Initiative.

International Partnership for Energy Efficiency Cooperation

IPEEC, founded in May 2009, is a voluntary forum of developed and developing countries that represent the major economies of the world. IPEEC provides global leadership on energy efficiency by identifying and facilitating government implementation of policies and programs that yield high energy-efficiency gains.

Australia participates in a number of working groups under IPEEC, including SEAD and GSEP. SEAD partners are working to create a common technical foundation to allow governments to more easily adopt cost-effective appliance efficiency policies and programs. GSEP encourages industrial facilities and commercial buildings to pursue continuous improvements in energy efficiency. Australia also contributes to IPEEC's work on non-commercial building energy efficiency and the creation of an energy management action network, as well as joint-IPEEC efforts to implement energy efficiency programmes and mechanisms in collaboration with energy providers.

As a global leader in establishing domestic energy efficiency policies, Australia is also assisting developing countries in our region to legislate and implement policies to improve the energy efficiency of equipment and appliances in residential, commercial and industrial sectors (see Box 7.3).

International Energy Agency technology network

Australia participates in the range of technology activities under the IEA. These include the Implementing Agreements, which are the IEA's framework for coordinating

international research and development on energy technologies; the IEA's Committee on Energy Research and Technology; and the energy technology working groups and experts' groups. Reducing emissions from energy production and use is a key policy objective of the IEA's current work, advanced through their *Energy Technology Perspectives* publication and its associated technology roadmaps.

Australia supports the IEA's work through voluntary contributions, including those to support the special chapter on Renewable Energy in the *World Energy Outlook*, and redevelopment of the Policy and Measures Databases on Renewable Energy, Energy Efficiency and Climate Change to a global audience.

Climate Technology Initiative

Australia is a member of the IEA's Climate Technology Initiative. Member countries undertake a broad range of cooperative activities in partnership with developing and transition countries and other international bodies to accelerate development and diffusion of climate-friendly and environmentally sound technologies and practices.

Activities are consistent with the UNFCCC objectives, in particular the framework for technology cooperation incorporated in the Marrakech Accords and adopted at the Seventh COP to the UNFCCC.

International Institute for Applied Systems Analysis

The International Institute for Applied Systems Analysis (IIASA) is an international scientific institute that conducts transnational policy oriented research on issues including climate change and energy security. IIASA devises strategies for cooperative action. Australia, through the CSIRO, joined IIASA in October 2012. IIASA released the *Global Energy Assessment* (GEA) in 2013 on integrated scientific assessment of energy issues, resources, technologies, and policies, including their relationship with contemporary challenges such as climate change, economic and social development, human well-being, sustainable development, and global security.

Technology partnerships

International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)

The IPHE, established in 2003, aims to advance the transition to a hydrogen economy and provides a forum for international government cooperation and information sharing in advancing hydrogen and fuel cell technologies. The partnership works to progress policies, develop common technical codes and standards, and educate stakeholders on the benefits and challenges of integrating hydrogen technologies into the marketplace.

International Partnership for Geothermal Technology

Australia is a member of the International Partnership for Geothermal Technology (IPGT) with the United States, Iceland, New Zealand and Switzerland. The IPGT accelerates the development of geothermal technologies through international cooperation. Australia has served as the Secretariat for the IPGT since 2012.

Carbon Sequestration Leadership Forum

The Carbon Sequestration Leadership Forum (CSLF), established in 2003, is a Ministerial-level, international climate change initiative focused on cooperation to develop CCS technologies. The CSLF promotes awareness and champions the legal, regulatory, financial and institutional environments conducive to the widespread deployment of CCS. Australia is a founding member of the CSLF, and has contributed $1.2 million to support CCS capacity building activities in developing countries.

Global Methane Initiative

The Global Methane Initiative (GMI) encourages the recovery and use of methane by focusing on the five main methane emission sources: agriculture, coal mines, municipal solid waste, oil and gas systems, and wastewater. GMI projects deploy methane emission-reducing technologies and practices, stimulating economic growth and energy security in partner countries.

The GMI has 41 member countries plus the European Commission, including the 10 largest methane emitters in the world. The GMI has supported more than 700 projects that will reduce emissions by an estimated 30 million tonnes (Mt) of carbon dioxide equivalent (CO_2 e) when the projects are fully implemented. Australia is a leading country in coal mine methane emission reduction innovation and policy.

The GMI addresses methane abatement as well as commercial use of fugitive emissions, and targeting additional emission sources such as wastewater. Expos were held in China in 2007, India in 2010 and Vancouver in March 2013 with delegates from over 45 countries.

Australia-China Joint Coordination Group on Clean Coal Technology

The Australia-China Joint Coordination Group on Clean Coal Technology (JCG) was established in 2007 to facilitate mutually beneficial cooperation on low-emissions coal technology. The Australian Government has contributed $20 million in funding. Under the JCG, Australia works closely with China's National Energy Administration on a range of collaborative activities, including:

- $12 million to support a feasibility study for a post-combustion capture project;
- Six collaborative research projects, completed in 2012;
- The Australia-China JCG Partnership Fund, established to support joint research seminars, workshops and researcher exchanges; and
- Extension of three successful bilateral research projects under the Asia-Pacific Partnership on Clean Development and Climate.

Box 7.3 Pacific Appliance Labelling and Standards Program

Energy efficiency is a powerful and cost-effective method of achieving a sustainable energy future. Energy efficiency measures for buildings, appliances and equipment can reduce the need for investment in energy infrastructure, cut energy bills, improve health, increase competitiveness and improve consumer welfare.

Environmental benefits can also be achieved through the reduction of greenhouse gas emissions and an improvement in local air pollution. Energy efficiency can also improve energy security by decreasing reliance on imported fossil fuels.

Under the $3 million Pacific Appliance Labelling and Standards (PALS) Program, Australia is assisting several Pacific Island Countries and Territories (PICTs) to implement standards and labelling regulations for appliances such as refrigerators, air conditioners, and lighting - reducing energy use, emissions and energy bills.

Australia is delivering the PALS Program in partnership with the Secretariat of the Pacific Community, which represents 22 PICTs. The PALS Program is helping to build capacity for government officials, implement legislation and raise public awareness. The Governments of Kiribati, Samoa, Tonga, Tuvalu and Vanuatu have endorsed the standards and labelling. The commencement of standards and labelling legislation in Fiji in January 2012, and the expansion of PALS to several other PICTs have created a platform for continued expansion in the Pacific region.

Introducing appliance energy efficiency standards and labelling in the Pacific region could reduce emissions by up to 2.2 Mt CO_2-e, and save between US$600 and $900 million dollars, over a fifteen year period (2011-2025).

7.6 Other initiatives

7.6.1 Measures relevant to the impact of response measures

Reviews conducted by Sir Nicholas Stern in the United Kingdom in 2006, Professor Ross Garnaut in Australia in 2008 and 2011, and modelling by the Australian Treasury in 2008 and 2011 demonstrate that the cost of climate action is lower than the cost of not taking action. It follows that curbing emissions and reducing the impact of climate change will have substantial economic, social and environmental benefits, particularly for developing countries that are most vulnerable to climate impacts.

Australia supports other countries in their responses to the impacts of climate change, and in their efforts to build economic resilience and prepare for a carbon constrained future. This includes funding for:

- vulnerable developing countries to adapt to the impacts of climate change (see section 7.3 of this report for more detail);
- efforts to develop and deploy low emissions technologies in developing countries (see section 7.5.3 of this report for more detail); and

- sustainable development through the international aid program.

7.6.2 Australian Centre for International Agricultural Research

Through the Australian Centre for International Agricultural Research (ACIAR), the Australian aid program supports collaborative research for development projects between Australia and developing countries. These projects help solve major agricultural and resource problems and strengthen local research capacity. ACIAR-supported research relevant to climate change includes:

- Technical and social research to support the development of community-based planted forests in Pacific island countries, including Papua New Guinea, Indonesia, Vietnam, Laos and Nepal;
- Research to enhance the adoption of evergreen agriculture in Eastern Africa;
- Research to underpin the implementation arrangements to reduce emissions from deforestation and degradation in Indonesia;
- A research program on adaptation in rain-fed agricultural regions in Laos, Cambodia, Bangladesh and parts of India; and
- Support of irrigated rice-based systems in the Mekong Delta of Vietnam to develop drought and submergence tolerant rice germplasm that can improve farming, reduce fertiliser use and cut emissions.

Table: 7.1: Australia's financial contributions to multilateral institutions and programs 2009-12

Multilateral Organisation	2009-10		2010-11		2011-12		Status	Source	Financial Instrument	Type of Support	Sector
	Core	CC Specific	Core	CC Specific	Core	CC Specific					
Multilateral Climate Change Funds											
Global Environment Facility*	17.40	5.74	22.50	7.43	22.60	7.46	Provided	ODA	Grant	Mitigation	Cross-cutting
Least Developed Countries Fund	-	9.00	-	-	-	15.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Special Climate Change Fund	-	-	-	-	-	-					
Adaptation Fund	-	-	-	-	-	-					
Green Climate Fund	-	-	-	-	-	0.50	Provided	ODA	Grant	Cross-cutting	Cross-cutting
UNFCCC Trust Fund Supplementary Activities	-	-	-	0.16	-	0.61	Provided	ODA	Grant	Other	N/A
Other											
Global Green Growth Institute	-	-	-	-	-	5.00	Provided	ODA	Grant	Cross-cutting	Cross-cutting
UNFCCC – Core	-	0.37	-	0.51	-	0.71	Provided	ODA	Grant	Other	N/A
Kyoto Protocol	-	0.28	-	0.24	-	0.22	Provided	ODA	Grant	Other	N/A
UNFCCC Trust Fund for Participation	-	0.28	-	-	-	-	Provided	ODA	Grant	Other	N/A
Subtotal	*17.40*	*15.67*	*22.50*	*8.34*	*22.60*	*29.50*					

Multilateral Financial Institutions including regional development banks^ **											
World Bank	160.30	N/A	228.40	N/A	185.30	N/A	Provided	ODA	Grant	Other	N/A
Partnership for Market Readiness	-	-	-	-	-	*10.00*	Provided	ODA	Grant	Mitigation	Forestry
Forest Carbon Partnership Facility	-	*21.00*	-	-	-	*11.93*	Provided	ODA	Grant	Mitigation	Forestry
Energy Sector Management Assistance Program	-	-	*1.25*	*0.75*	*2.67*	*1.60*	Provided	ODA	Grant	Mitigation	Energy
Climate Investment Fund – clean technology fund	-	*25.00*	-	*25.00*	-	-	Provided	ODA	Grant	Mitigation	Energy
Climate Investment Fund – Scaling-up Renewable Energy Program	-	-	-	-	-	*9.10*	Provided	ODA	Grant	Mitigation	Energy
Climate Investment Fund – Pilot Program in Climate Resilience	-	*11.62*	-	*2.45*	-	-	Provided	ODA	Grant	Adaptation	Cross-cutting
Climate Investment Fund – Forest Investment Program	-	-	-	*25.50*	-	-	Provided	ODA	Grant	Mitigation	Forestry
International Finance Corporation	-	-	-	-	-	-	-	-	-	-	-
African Development Bank	-	-	-	-	-	-	-	-	-	-	-
Asian Development Bank	54.10	N/A	70.20	N/A	80.90	N/A	Provided	ODA	Grant	Other	N/A
Clean Energy Financing Partnership Facility	-	-	-	*1.25*	-	*2.67*	Provided	ODA	Grant	Mitigation	Energy
European Bank for Reconstruction and Development	-	-	-	-	-	-	-	-	-	-	-
Inter-American	-	-	-	-	-	-	-	-	-	-	-

Development Bank											
Other	-	-	-	-	-	-	-	-	-	-	-
Subtotal	***214.40***	***57.62***	***299.85***	***54.95***	***268.87***	***35.30***					
Specialised United Nations Bodies^ **											
United Nations Development Programme	14.60	N/A	17.90	N/A	23.30	N/A	Provided	ODA	Grant	Other	N/A
United Nations Environment Programme	1.00	N/A	1.10	N/A	1.20	N/A	Provided	ODA	Grant	Other	N/A
Other											
Inter-Governmental Panel on Climate Change		0.80		0.87		0.84	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	***15.60***	***0.80***	***19.00***	***0.87***	***24.50***	***0.84***					
Total	*247.40*	**74.09**	*341.35*	**64.16**	*315.97*	**65.64**					

Funding in AUD$ million.

* Climate change allocations are estimated to be 33 per cent of GEF funding.

^ Australia provides funding to a number of multilateral organisations as implementing partners for regional and bilateral activities. This funding is reported in Table 7(b) and not here.

** A proportion of Australia's core contributions to multilateral organisations may be allocated to climate change activities but Australia is not able to report on these internal decisions.

Table 7.2a: Bilateral and regional financial contributions related to the UNFCCC for the financial year 2009-10

Recipient Country/region	Total Amount (AUD$ million)	Status	Funding Source	Financial Instrument	Type of Support	Sector
	Climate specific					
Asia-Pacific Regional	2.66	Provided	ODA	Grant	Mitigation	Forestry
Pacific Regional	19.43	Provided	ODA	Grant	Adaptation	Cross-cutting
Fiji	0.39	Provided	ODA	Grant	Adaptation	Cross-cutting
FSM, Palau, RMI	0.00					
Kiribati	0.05	Provided	ODA	Grant	Adaptation	Cross-cutting
Nauru	0.00					
Niue & Tokelau	0.00					
PNG	2.80	Provided	ODA	Grant	Mitigation	Forestry
Samoa	0.90	Provided	ODA	Grant	Adaptation	Cross-cutting
Solomon Islands	0.00					
Tonga	0.00					
Tuvalu	0.23	Provided	ODA	Grant	Adaptation	Cross-cutting
Vanuatu	3.00	Provided	ODA	Grant	Adaptation	Transport
Cook Islands	0.00					
East Asia Regional	2.59	Provided	ODA	Grant	Adaptation	Cross-cutting
Timor-Leste	0.15	Provided	ODA	Grant	Adaptation	Water and Sanitation
Indonesia	15.12	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Vietnam	0.57	Provided	ODA	Grant	Adaptation	Cross-cutting

Philippines	0.00					
Laos PDR	0.00					
South Asia Regional	1.50	Provided	ODA	Grant	Adaptation	Water and Sanitation
Bangladesh	1.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Maldives	0.00					
Sri Lanka	0.17	Provided	ODA	Grant	Adaptation	Cross-cutting
Caribbean and other SIDS	0.98	Provided	ODA	Grant	Adaptation	Cross-cutting
East Africa Regional	0.00					
Southern Africa Regional	0.00					
West Africa Regional	0.00					
Global Unspecified	1.36	Provided	ODA	Grant	Mitigation	Forestry
Total	**52.89**					

Table 7.2b: Bilateral and regional financial contributions related to the UNFCCC for the financial year 2010-11

Recipient Country/region	Total Amount (AUD$ million)	Status	Funding Source	Financial Instrument	Type of Support	Sector
	Climate specific					
Asia-Pacific Regional	2.40	Provided	ODA	Grant	Mitigation	Forestry
Pacific Regional	39.58	Provided	ODA	Grant	Adaptation	Cross-cutting
Fiji	0.72	Provided	ODA	Grant	Adaptation	Cross-cutting
FSM, Palau, RMI	0.83	Provided	ODA	Grant	Adaptation	Cross-cutting
Kiribati	4.96	Provided	ODA	Grant	Adaptation	Cross-cutting
Nauru	0.50	Provided	ODA	Grant	Adaptation	Water and Sanitation
Niue & Tokelau	1.00	Provided	ODA	Grant	Adaptation	Cross-cutting
PNG	1.81	Provided	ODA	Grant	Cross-Cutting	Cross-cutting
Samoa	0.69	Provided	ODA	Grant	Adaptation	Agriculture
Solomon Islands	3.99	Provided	ODA	Grant	Adaptation	Transport
Tonga	2.01	Provided	ODA	Grant	Adaptation	Cross-cutting
Tuvalu	1.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Vanuatu	0.00					
Cook Islands	0.50	Provided	ODA	Grant	Adaptation	Cross-cutting
East Asia Regional	4.36	Provided	ODA	Grant	Cross-Cutting	Cross-cutting
Timor Leste	0.48	Provided	ODA	Grant	Adaptation	Cross-cutting
Indonesia	10.75	Provided	ODA	Grant	Cross-Cutting	Cross-cutting
Vietnam	0.00					
Philippines	0.00					

Laos PDR	4.00	Provided	ODA	Grant	Mitigation	Energy
South Asia Regional	4.00	Provided	ODA	Grant	Adaptation	Water and Sanitation
Bangladesh	1.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Maldives	0.00					
Sri Lanka	0.17	Provided	ODA	Grant	Adaptation	Cross-cutting
Caribbean and other SIDS	10.00	Provided	ODA	Grant	Adaptation	Cross-cutting
East Africa Regional	0.00					
Southern Africa Regional	0.00					
West Africa Regional	0.00					
Global Unspecified	1.50	Provided	ODA	Grant	Mitigation	Forestry
Total	**96.25**					

Table 7.2c: Bilateral and regional financial contributions related to the UNFCCC for the financial year 2011-12

Recipient Country/region	Total Amount (AUD$ million)	Status	Funding Source	Financial Instrument	Type of Support	Sector
	Climate specific					
Asia-Pacific Regional	0.00					
Pacific Regional	28.76	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Fiji	0.00					
FSM, Palau, RMI	1.40	Provided	ODA	Grant	Adaptation	Cross-cutting
Kiribati	2.85	Provided	ODA	Grant	Adaptation	Water and Sanitation
Nauru	0.50	Provided	ODA	Grant	Adaptation	Water and Sanitation
Niue & Tokelau	0.42	Provided	ODA	Grant	Adaptation	Other
PNG	1.74	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Samoa	1.70	Provided	ODA	Grant	Adaptation	Cross-cutting
Solomon Islands	1.99	Provided	ODA	Grant	Adaptation	Transport
Tonga	0.00					
Tuvalu	0.80	Provided	ODA	Grant	Adaptation	Water and Sanitation
Vanuatu	1.00	Provided	ODA	Grant	Adaptation	Transport
Cook Islands	0.00					
East Asia Regional	9.80	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Timor Leste	1.40	Provided	ODA	Grant	Adaptation	Cross-cutting
Indonesia	4.47	Provided	ODA	Grant	Cross-cutting	Cross-cutting

Vietnam	17.10	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Philippines	0.27	Provided	ODA	Grant	Adaptation	Cross-cutting
Laos PDR	1.00	Provided	ODA	Grant	Mitigation	Energy
South Asia Regional	7.38	Provided	ODA	Grant	Cross-cutting	Water and Sanitation
Bangladesh	7.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Maldives	0.50	Provided	ODA	Grant	Adaptation	Cross-cutting
Sri Lanka	0.00					
Caribbean and other SIDS*	5.20	Provided	ODA	Grant	Adaptation	Cross-cutting
East Africa Regional	2.60	Provided	ODA	Grant	Adaptation	Agriculture
Southern Africa Regional	5.00	Provided	ODA	Grant	Cross-cutting	Cross-cutting
West Africa Regional	2.90	Provided	ODA	Grant	Adaptation	Agriculture
Global Unspecified	32.87	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Total	**138.64**					

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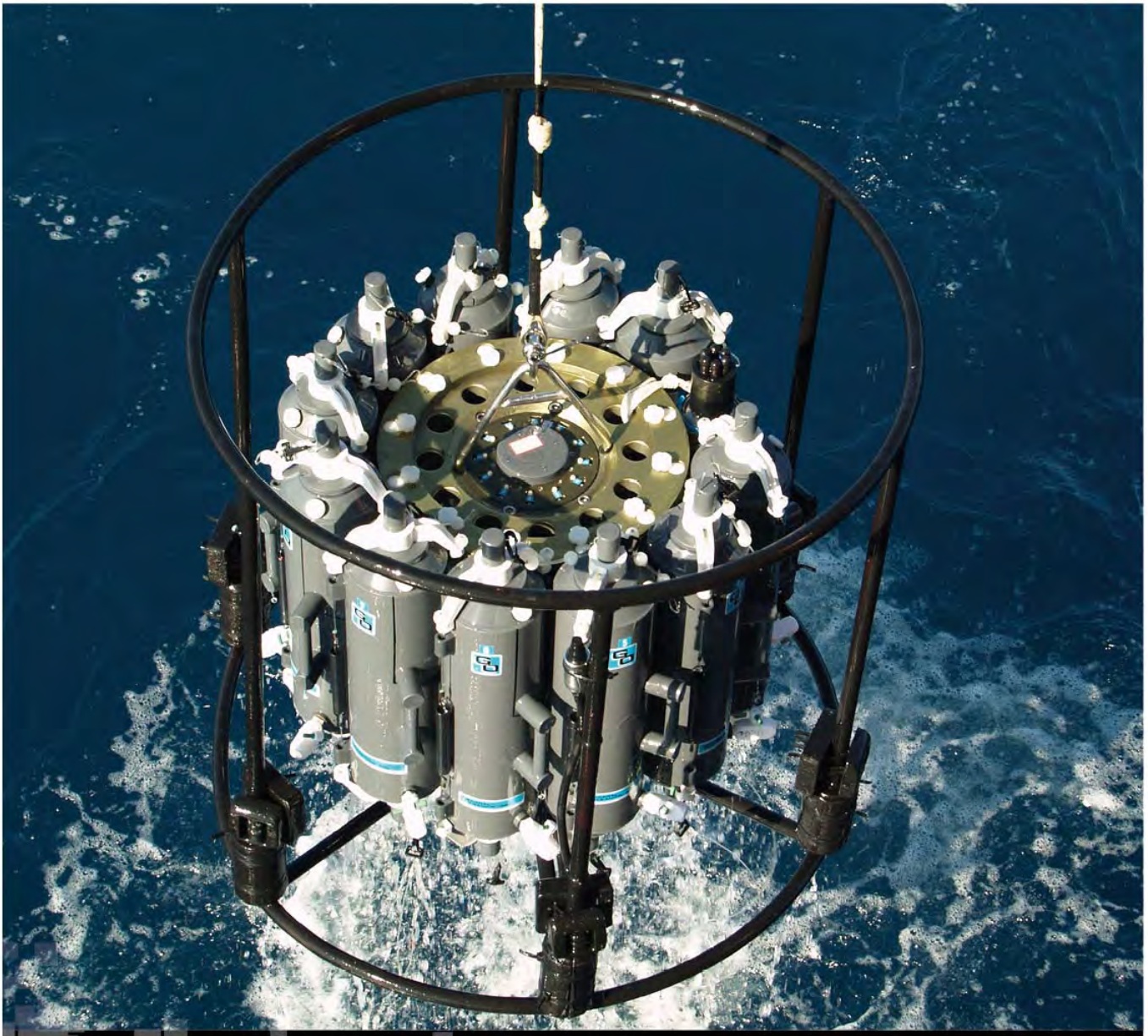


CHAPTER 8

Research and systematic observation

8.1 National Framework for Climate Change Science 222
8.2 Research capability 226
8.3 International cooperation 231
8.4 Research focus 233
8.5 Systematic observation 245

Key Developments

Since the Fifth National Communication on Climate Change (NC5), Australia has made significant progress in coordinating the delivery of climate change science needed to inform mitigation and adaptation policies and to help shape a global solution to climate change.

In July 2012, the Australian Government adopted A Plan for Implementing Climate Change Science in Australia (the Plan) developed by the High Level Coordination Group (HLCG) for climate change science. The Plan sets out the detail required to implement the National Framework for Climate Change Science that was published in 2009 and provides funding and research agencies with a single articulation of science priorities to guide investment decisions and ensure that the maximum national benefit is delivered to the Australian community.

The Australian Government has had a focus on improving the delivery climate change information, and guidance on its use, to inform decision-making and to manage climate risks. The Council of Australian Governments Adaptation Working Group is working to better understand the type of climate change information needed for decision-making so that current and future programs can be tailored to deliver better outcomes.

The government has implemented the Regional Natural Resource Management Planning for Climate Change Fund (the NRM Fund). The NRM Fund is providing $15 million over four years for the coordination of research to produce regional level climate change information to support natural resource management planning. This involves the development, coordination and delivery of a new suite of regional climate projections for Australia.

Australia's climate change scientists are making valuable contributions to global climate change research. Since NC5, 46 Australians have acted as authors and editors on the Intergovernmental Panel on Climate Change (IPCC) reports, including the Fifth Assessment Report. For example, simulations from the Australian Community Climate and Earth-System Simulator (ACCESS) were submitted to the Coupled Model Intercomparison Project Phase 5 (CMIP5) and used in the IPCC Fifth Assessment Report. ACCESS simulations have scored in the upper rank of international climate models, over Australia and globally.

The Australian Climate Change Science Program continues to deliver critical information to improve understanding of the causes, nature, timing and consequences of climate change for Australia and our region. This core program is informing key policy decisions including mitigation targets, adaptation strategies to manage the risks of climate change and international negotiations on climate change.

Through the National Collaborative Research Infrastructure Strategy, the Super Science Initiative and the Collaborative Research Infrastructure Scheme, the Australian Government is investing in projects to support Australia's research

capacity. This includes maintaining Australia's contribution to the Global Climate Observing System through activities such as the Integrated Marine Observing System and the Terrestrial Ecosystem Research Network, and investment of $120 million to construct a new marine research vessel capable of exploring Australia's vast ocean territory.

8.1 National Framework for Climate Change Science

In recent decades Australia has made a strong contribution to global climate change knowledge. Australia has a unique interest in and responsibility for climate change science in the Southern Hemisphere. This differs from most of the developed world, with other developed nations typically focused on the Northern Hemisphere.

The Australian climate change science community is facing increased demand from decision makers and the public for more detailed information on climate change. To meet this demand, the Australian Government recognised the need for a nationally coordinated climate change science effort. The National Framework for Climate Change Science (the Framework) was adopted by the Australian Government in 2009. The Framework articulated the climate science challenges to be addressed in supporting Australia's climate change policy as well as the capabilities required to deliver this science. The Framework was developed in consultation with the research community and stakeholders across government.

The Framework recommended the establishment of a High Level Coordination Group (HLCG) for climate change science, drawn from the scientific community and relevant government agencies, to develop and oversee the planning required to execute the Framework. The HLCG developed A Plan for Implementing Climate Change Science in Australia (the Plan), which was adopted by the Government in July 2012. The aim of the Plan is to develop a single integrated program to address national climate change science priorities over the coming decade.

The Plan provides funding and research agencies with a single articulation of science priorities to guide investment decisions and ensure that the maximum national benefit is delivered to the Australian community. The national benefits from investment in climate change science fall into three overarching policy areas:

1. informing mitigation policy;
2. informing adaptation policy; and
3. helping shape a global solution to climate change.

The Plan outlines a series of key policy questions that when answered will deliver an identified national benefit to Australia. These policy questions help to frame a series of science deliverables (see Figure 8.1). The science deliverables represent the core research that needs to be undertaken in order to answer the policy questions. Articulating the science deliverables allows the research community to align its activities with a

nationally coordinated effort focused on ensuring the most effective and efficient delivery of national benefits.

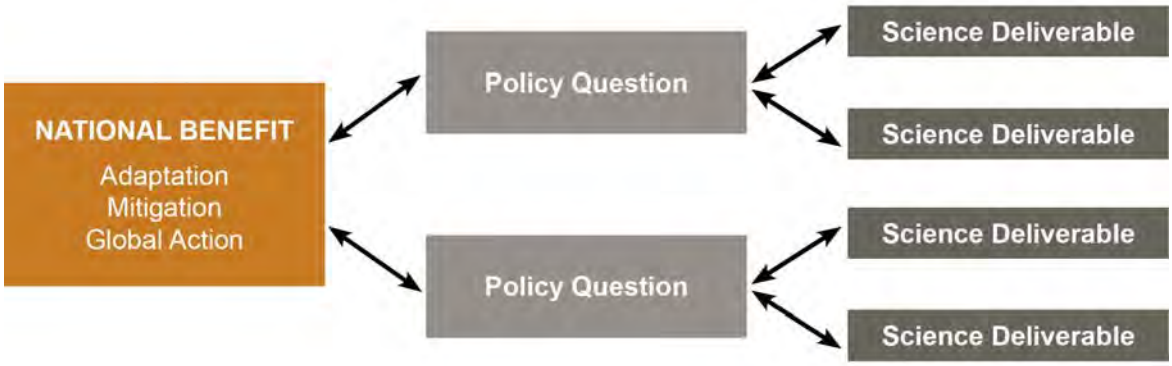


Figure 8.1 Framework for science deliverables

The Plan (and the Framework that underpins it) focuses on fundamental climate system science needed to address the overarching science and research needs for each policy pillar. This means the scope of the Plan does not include the complete suite of research that would be undertaken to address all climate mitigation and adaption policy needs. This fundamental climate system science helps us understand the systems, mechanisms and feedbacks that determine changes over time to the Earth's climate, including changes due to human activity.

The Plan seeks to coordinate science delivered through the Australian Climate Change Science Program (ACCSP) (see section 8.2.2) and allied activities such as the Centre of Excellence for Climate System Science and our national Antarctic Science Program delivered primarily through the Australian Antarctic Division (AAD) and the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC). The governance model established in the Plan allows funding and research agencies to work together to identify the science that can be delivered and ensure this is done in the most effective and efficient way. This will improve prioritisation, integration, coordination and collaboration, and support the delivery of world-class climate change science.

8.1.1 Steps towards a climate information service

The need for accessible, reliable and comprehensive climate information in order to support adaptation and mitigation action is broadly recognised internationally and nationally. The *Global Framework for Climate Services* (GFCS) is a major initiative of the United Nations led by the World Meteorological Organization to 'foster the enhancement and incorporation of climate information and prediction into planning, policy and practice on the global, regional, national and local scales'. The GFCS aims to coordinate actions and measures to improve the provision of climate services for informing decisions across a range of sectors including health, food security, agriculture, water resources and

disaster management. The Australian Bureau of Meteorology is Australia's focal point for the GFCS.

Provision of climate information and guidance on its use to end users comprises a critical national priority that has been identified in the Plan. A climate information service would ensure that maximum national benefit is gained from our investment in fundamental climate change science. The service could compile and distribute observations, research results, model data and projections under different climate change scenarios, and provide guidance on use of the information.

The Australian Government is currently developing a *National Plan for Environmental Information* (NPEI) which is a whole-of-government reform program to improve the capacity to monitor, detect and predict change in the environment. The aim of the NPEI is to build the information base to support government decision making – a climate change information service has been identified as a key priority.

The Australian Government is leading efforts to better understand end user needs for climate change information. Better understanding of end user needs is critical for designing an effective information service. The HLCG is undertaking an end user needs analysis to improve understanding of the type of climate change information that is needed for key sectors to make informed decisions.

Accessible and practical climate change projections will form a significant component of a broader climate change information service. Commonwealth, state and territory governments all play an important role in investing in climate change projections, and in the uptake of approaches to organise and communicate information from these projections.

The Adaptation Working Group of the Council of Australian Governments: Select Council on Environment and Water is developing a *National Climate Projections Program* (NCPP) through an informal working group comprising Commonwealth, state and territory officials, and climate science experts. The objective of the NCPP is to facilitate the collaboration needed to deliver to the Australian community robust projections of climate change that inform decision-making and build national capacity to manage climate change risks. The NCPP, with its particular focus on climate change projections, is an important initial step for demonstrating how a broader climate change information service could work. The informal working group of the NCPP will also provide valuable input into the end user needs analysis for climate decisions.

8.1.2 Delivering climate change information

Stream 2 of the *Regional Natural Resource Management Planning for Climate Change Fund* (NRM Fund), announced as part of the Australian Government's Clean Energy Future Plan, will provide $15 million over four years for coordination of research to produce regional level climate change information to support natural resource management planning. A key component of the NRM Fund involves the development, coordination and delivery of a new suite of regional climate projections for Australia

based on the latest global climate model simulations submitted to the Coupled Model Intercomparison Project Phase 5 (CMIP5) and available for use in the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report*.

The NRM projections provide a platform for demonstrating how a broader climate change information service could work – while activities under the HLCG and the NCPP will inform the pathway for implementing the service.

Further information on Stream 2 of the NRM Fund is provided in the Box below and in Section 8.2.2.

Box 8.1: The Regional Natural Resource Management Planning for Climate Change Fund (NRM Fund)

In 2011, as part of its Clean Energy Future plan, the Australian Government announced $43.9 million in funding over five financial years (2011/12 – 2015/16) to support regional natural resource management (NRM) organisations update their existing NRM plans, to guide planning for climate change impacts on the land and to maximise the environmental benefits of carbon farming projects. The NRM Fund is being provided in two streams:

Stream 1 provides $28.9 million to support the 54 regional NRM organisations revise existing regional NRM plans to help identify where in the landscape adaptation and mitigation activities should be undertaken. This stream is administered by the Department of Sustainability, Environment, Water, Population and Communities.

Stream 2 provides $15 million for coordination of research to produce regional level climate change information to support medium-term regional NRM and land use planning including the delivery of a new suite of regional climate projections for Australia. This Stream is being administered by the Department of Innovation, Industry, Climate Change, Science, Research and Tertiary Education (DIICCSRTE).

Regional NRM organisations in Australia work with a diverse group of stakeholders to plan and deliver integrated strategies to improve landscape connectivity, function and resilience, drawing on biophysical, socio-economic and climate information. They function at a catchment or landscape scale, across sectors, property boundaries and land tenures and play a significant role in enabling communities to adapt to climate change impacts.

In recent years, there has been a strong emphasis from NRM planners on the need for information on how changes to the climate will impact on key assets and management priorities for their region, the potential range of adaptation options, and how impacts and responses may interact and create feedbacks within the overall system.

The NRM Fund will deliver regional climate change projections information and guidance on how to use that information in planning. The integration of appropriate climate change projections into existing and new tools, models and decision-making processes will assist the NRM sector to understand potential changes to species (including invasive species) distribution, refugia locations and composition, changes to landscape productivity and water resources and risks from extreme events and sea level rise.

8.2 Research capability

This section provides an overview of the major Australian research organisations and funding initiatives.

8.2.1 Key research organisations

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) provides fundamental understanding of the climate and atmosphere; and delivers climate adaptation and mitigation research; builds the modelling and observing systems needed to monitor, understand and predict climate variability and change across all time scales; and investigates the impact of weather and climate variability and change on the energy, agriculture, forestry and ocean sectors.

The Bureau of Meteorology is Australia's national weather, climate and water agency. Through regular forecasts, warnings, monitoring and advice spanning the Australian region and Antarctic territory, the Bureau provides one of the most fundamental and widely used services of government. By providing observational, meteorological, hydrological and oceanographic services and by undertaking research into science and environment related issues it contributes to national social, economic, cultural and environmental goals.

The Centre for Australian Weather and Climate Research (CAWCR) is a partnership between the CSIRO and the Bureau of Meteorology. It was established in 2007 with the aim to retain Australia as a world leader in climate and weather research in order to meet the weather and climatic challenges that continue to confront the nation. The Centre delivers a number of advantages, including access to a wide range of research skills, efficient use of resources, and increased potential to develop research relationships with government, industry and other research providers. Following a successful review, the CAWCR partnership is being renewed for a further five years. In its first five years, the Centre delivered, among many other products and findings, the Australian Community Climate and Earth System Simulator (ACCESS), see Section 8.4.2.

The Australian Antarctic Division (AAD) (a Division of the Department of Sustainability Environment, Water, Population and Communities) leads and manages the Australian Antarctic Science Program. Research is undertaken in accordance with the Antarctic Science Strategic Plan 2011-12 to 2020-21 with a strong focus on climate processes and environmental change. Projects in the program are led by researchers from Australian and international institutions and include extensive international collaborations.

The Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) plays a central role in Australia’s national effort to understand Antarctic and Southern Ocean processes and their effects on global and regional climate. The ACE CRC is Australia’s largest centre of Antarctic and Southern Ocean climate change research, and extends to include climate change impacts in Australia and the Pacific. In May 2013, the Australian Government announced an additional $25 million in funding over five years to continue the research of the CRC until 30 June 2019.

The Centre of Excellence for Climate System Science, led by the University of New South Wales Climate Change Research Centre is a major initiative funded by the Australian Research Council. The Centre is an international research consortium of five Australian universities and a suite of outstanding national and international partner organisations. The Centre was established in 2011and builds on and improves existing understanding of the modelling of regional climate to enable enhanced adaptation, particularly in the Australian region.

The Australian Institute of Marine Science supports and contributes to several observational networks, including the Queensland's Integrated Marine Observing System node of the Integrated Marine Observing System. Its goal is to better understand and monitor variability and changes in the tropical marine environment. The institute also engages in collaborative initiatives with institutions such as the Western Australian Marine Science Institution, which researches climate processes, predictability and impacts of a warming Indian Ocean.

The Australian Nuclear Science and Technology Organisation's Isotopes in Climate Change and Atmospheric Systems Project, uses nuclear-based technologies and analytical capabilities to study how the earth's climate systems have changed and how the land surface interacts with the atmosphere.

Universities across Australia are active in various aspects of climate change research, ranging from ocean and terrestrial observational studies to emissions reduction and adaptation responses. This includes a number of climate change–focused centres, such as the Climate Change Institute at the Australian National University and the Climate Change Research Centre at the University of New South Wales.

8.2.2 Major funding initiatives

The Australian Climate Change Science Program (ACCSP) funds research to improve understanding of the causes, nature, timing and consequences of climate change for Australia and our region.

The ACCSP is a partnership between the DIICCSTRE, CSIRO and the Bureau of Meteorology. DIICCSRTE provides $7.8 million per year, and co-investment by CSIRO and the Bureau of Meteorology results in total investment of around $15 million per year for research to meet the shared goals and priorities of the three agencies. The program is administered by DIISCRTE in partnership with CSIRO and the Bureau of Meteorology. A small proportion of the investment directly supports activities and research undertaken by the Australian Academy of Science, the ACE CRC and the Centre of Excellence for Climate System Science.

ACCSP research is undertaken in Australia, nearby oceanic regions and in Antarctica. The program covers seven key areas:

1. *Global and regional carbon budgets* – understanding global and Australian patterns of greenhouse gas sources and sinks, how the Southern Ocean absorbs carbon dioxide, and changes in greenhouse gases within the palaeo-record.

2. *Land and air (observations and processes)* – understanding how climate processes are exacerbating or limiting the impacts of rising greenhouse gases, and understanding and modelling aerosol changes in the atmosphere and their influence on regional climates.

3. *Oceans and coasts (observations, processes, projections)* – improving understanding of ocean change and the influence it has on climate in the Australian region and globally, understanding ocean uptake and storage of carbon dioxide, and impacts from ocean acidification.

4. *Modes of climate variability and change* – understanding the major drivers of climate variability and change (such as the El Niño - Southern Oscillation (ENSO), the Indian Ocean Dipole and the Southern Annular Mode) on Australia.

5. *Earth system modelling and data integration* – undertaking earth system modelling through the ACCESS, and using model simulations to understand the likely changes and their impacts for Australia.

6. *Australia's future climate* – contributing to the science underpinning new Australian climate change projections due for release in 2014-15 and investigating approaches for downscaling projections.

For information on the outcomes of this research investment see Section 8.4.4.

The Regional Natural Resource Management Planning for Climate Change Fund is one of the Land Sector Measures under the Government's Clean Energy Future plan. The Box 8.1 provides further details about the NRM Fund.

Australia's Antarctic Science Program is designed to tackle key challenges in Antarctica. The program is directed by the Australian Antarctic Strategic Plan 2011-12 to 2020-21, which was developed in 2010, and focuses research into four themes:

Theme 1 – Climate Processes and Change

Theme 2 – Terrestrial and Nearshore Ecosystems: Environmental Change and Conservation

Theme 3 – Southern Ocean Ecosystems: Environmental Change and Conservation

Theme 4 – Frontier Science

Themes 1, 2 and 3 address the priority science needs articulated by government policy and resource management agencies. The research in these themes link investment in monitoring, observational and experimental science with process studies, synthesis and integrative modelling in order to deliver policy-relevant scientific input to policymakers, conservation and resource managers. Theme 4 provides an opportunity for high quality science projects that address Australia's national science priorities.

Research undertaken in Theme 1 links strongly to fundamental climate system science funded through other initiatives, while much of the research undertaken in Themes 2 and

3 provides insights into impacts of climate change on Antarctic and Southern Ocean ecosystems.

The National Collaborative Research Infrastructure Strategy (NCRIS) provided $542 million over seven years (2005 – 2011) to fund national collaborative research infrastructure. In 2009, the Australian Government provided a further $1.1 billion over five years through the Super Science Initiative to improve Australia's ability to respond to climate change and to better protect understand Australia's 12 million square kilometres of marine territory. Additional funding of $60 million is also being provided through the Collaborative Research Infrastructure Scheme (CRIS) to support the operations of priority projects during the 2013 and 2014 calendar years.

As part of the 2013 Budget, the Government announced a further $185.9 million over the next two financial years (2013/14 - 2014/15) to continue the operation of research facilities established by earlier investments from NCRIS and the Super Science Initiative.

Investments in research infrastructure supporting climate change science include:

- Support for the Integrated Marine Observing System including $50 million through NCRIS, $52 million under the Super Science Initiative and $7.2 million under CRIS. More details are provided in 8.5.1.
- $120 million under the Super Science Initiative to construct a new marine research vessel capable of exploring Australia's vast ocean territory. The vessel (RV Investigator) will be managed by CSIRO for use by marine researchers across Australia. The Government also provided additional funding of $29.6 million over four years from 2013/14 for operating and project management costs that CSIRO will incur during the construction project. An additional $12.1 million has also been provided to CSIRO in 2013/14 for RV Investigator operations, to allow commissioning and research activities to test the RV Investigator while under the warranty period. This funding will ensure that Australian scientists continue to have access to the research vessel capability required to work at sea to undertake vital research to support climate change science.
- $55 million under the Super Science Initiative to construct new tropical marine research facilities at the Australian Institute of Marine Science in Townsville and Darwin and a further $1.49 million from CRIS to contribute to the operation of the National Tropical Sea Simulator. In May 2013, the Government announced additional funding of $30.9 million over four years for the Australian Institute of Marine Science to support the ongoing delivery of nationally important marine research, including the commissioning and operation of the National Tropical Sea Simulator.
- Support for the Terrestrial Ecosystem Research Network (TERN), including $20 million through NCRIS, $25.63 million under the Super Science Initiative and $3.06 million under CRIS. More details are provided in 8.5.1.

- $50 million under the Super Science Initiative to provide new high-performance computing facilities for use by the Bureau of Meteorology, CSIRO, the Australian National University and leading researchers from around Australia to address climate change, earth systems science and national water management issues. The objectives of the new computing infrastructure are to:
  - provide an internationally significant high- performance computing capability and associated data support to prioritised research endeavours;
  - develop and operate a resource allocation system that gives priority research on-demand access to allocated resources;
  - support meritorious research in all fields through the provision of 'capability' quality computational services; and
  - provide a data centre facility suitable for continuous system upgrade through to 2020.

The Indian Ocean Climate Initiative (IOCI) was established as a collaborative arrangement between the Western Australian Government, CSIRO and the Bureau of Meteorology in 1998 in response to declining stream flow into dams in the south-west and reduced rainfall from the 1970s. IOCI Stage 3, which ended in July 2012, produced high quality climate reference data sets with extended spatial coverage, improved understanding of the climate systems affecting both the south-west and north-west of Western Australia, station scale projections for rainfall and temperature in the south-west, Pilbara and Kimberley regions, as well as projections for changes in frequency and intensity of tropical cyclones over the north-west and intense rainfall events and hot spells in the south-west. A synthesis report which integrates knowledge of climate variability and climate change for Western Australia obtained from IOCI Stage 3 research was released in October 2012.

The Western Australian Government announced an election commitment to provide $4 million over four years, to be matched with Commonwealth funding, for the Western Australian Weather and Climate Program. The program is intended to improve understanding of climate and weather events and their impacts, and underpin strategies to adapt to a changing climate. See 8.4.1 and 8.4.2 for more information about IOCI.

The South-East Australian Climate Initiative (SEACI) was established in 2006 to improve understanding of the nature and causes of climate variability and change in south-eastern Australia in order to better manage climate impacts. SEACI was carried out in two Phases. Phase 1 was a $7.5 million research program that began in January 2006 and concluded in June 2009. Phase 2 was a $9 million research program that began in July 2009 and concluded at the end of 2012. Following the completion of the SEACI, the Victorian Department of Environment and Primary Industries, the Bureau of Meteorology and CSIRO have set up the Victorian Climate Initiative. The initiative is following up on key research directions identified in SEACI. The research is being conducted by the Bureau of Meteorology and CSIRO, and aims to improve understanding of Victoria's past and expected future climate. See 8.4.1 for more information on SEACI.

The Queensland Government, in collaboration with CSIRO, contributed an extensive set of climate change simulations to CMIP5. This new dataset is being used in development of the IPCC *Fifth Assessment Report*, to be released in September 2013. Using the IPCC *Fourth Assessment Report*, the Queensland Government science and policy divisions also developed regional climate change summaries and produced the Inland Flood Study to provide better guidance for decision makers. The Queensland Government will continue to investigate and consider possible initiatives as part of a new climate change adaptation strategy for Queensland, which will focus on building resilience to the impacts of climate change.

The Goyder Institute for Water Research was established in 2010 to support the security and management of South Australia's water supply and contribute to water reform in Australia. The Institute brings together South Australia's leading water research capabilities, in collaboration with CSIRO and aims to provide expert, independent scientific advice that informs good policy decision-making, identifies future threats to water security and assists in an integrated approach to water management.

The Climate Futures for Tasmania project, managed by the ACE CRC, used sophisticated climate modelling techniques to describe the most likely future climate scenarios for Tasmania. The climate projections were computer-simulated and produced data to use in decision-making processes. Climate Futures interpreted climate projections at a local scale, so that communities, industries and individuals could use information in their local planning and adaptation actions.

The NSW/ACT Regional Climate Model (NARCliM) project is a collaboration between the New South Wales and Australian Capital TerritorygGovernments and the University of NSW. NARCliM will deliver an ensemble of regional climate projections for south-east Australia. This ensemble is designed to provide robust projections that span the range of likely future changes in climate. A wide variety of climate variables will be available at high temporal and fine spatial resolution for use in impacts and adaptation research. NARCliM will provide critical information to assist in managing the impacts of climate change on health, settlements, agriculture, weather extremes and services, such as water and energy supplies.

8.3 International cooperation

Australia's climate change scientists make valuable contributions to global climate change research. Recently, 46 Australians have acted as authors and editors on the IPCC reports; the *Fifth Assessment Report*, the *Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (SREX) report, and IPCC methodology reports.

Australian scientists contribute to important international research and have a strong commitment to international bodies that drive the understanding of climate change globally. For example, an Australian scientist acts as the President of the International Union of Geodesy and Geophysics (IUGG), and another is the Chair of the International Geosphere-Biosphere Program (IGBP).

Australian scientists play a leading role in Antarctic and southern ocean science through the ACE CRC and the Australian Antarctic Division. Australian researchers also contribute to international climate research through their participation in the activities of the World Climate Impacts and Response Strategies Program and continue to play prominent roles on the Scientific Committee on Antarctic Research and its subcommittees.

The ACCSP contributes funding for Australia's bilateral and multilateral relationships with other countries. For example, the program facilitates Australian participation in two significant international programs through the Australian Academy of Science: the International Geosphere–Biosphere Program and the World Climate Research Program. The program also supports an Australian-based international project office of the Global Carbon Project of the International Geosphere–Biosphere Program.

In addition, a key aim of the ACCESS model development is to facilitate international collaboration to more effectively build knowledge and understanding of the global climate system. The ACCESS team collaborates with many international agencies, including the UK Met Office, the Korean Meteorological Administration and the New Zealand National Institute of Water and Atmospheric Research.

The Australian Government also supports the $32 million Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) program, and the $31.5 million Climate and Oceans Support Program in the Pacific (COSPPac). For further information see Section 8.5.3.

Through the International Forest Carbon Initiative (IFCI), Australia is working directly with partners in our region, and collaboratively through multilateral institutions, such as the World Bank, to contribute to the shared global effort to address deforestation. Through the IFCI Australia supports in-country capacity to implement REDD+, credible systems for measuring, reporting and verification (MRV) and approaches to REDD+ that provide fair and effective benefits for communities.

The IFCI is:

- assisting 25 developing countries to develop national REDD+ strategies that show how they will reduce carbon emissions from forests (funded through the World Bank Forest Carbon Partnership Facility);
- assisting five developing countries to take practical action to reduce forest emissions, such as through sustainably managing forests and supporting livelihoods for forest communities which do not lead to deforestation (funded through the World Bank Forest Investment Programme);
- procuring and freely distributing archived satellite data in South East Asia and parts of the Pacific for the purposes to tracking deforestation through time;
- helping to establish global systems to support countries to measure, report and verify forest cover and carbon emissions;
- supporting REDD+ bilaterally through the Indonesia-Australia Forest Carbon Partnership and Papua New Guinea-Australia Forest Carbon Partnership;

- directly supporting countries such as Indonesia and Kenya to establish and operate MRV systems for the land sector;
- providing support to summarise and disseminate information on forest finance and REDD+;
- supporting the Centre for International Forestry Research to show how REDD+ can be implemented in a way that is efficient and equitable and brings benefits to local communities.

To encourage shared ownership, Australia's fast-start finance investments through the IFCI have responded to country needs and been informed by common approaches and shared expertise identified through bilateral and multilateral partnerships.

8.4 Research focus

Australian climate change science research focuses on four main areas:

- systematic observations – collecting data that can be used in explaining how different elements of the climate system operate and tracking the drivers of regional and global climate change.
- process studies – examining the mechanisms that drive climate change and its effects
- climate models – using simulations of past, current and future climate scenarios to help Australia better understand climate (including climate variability and change), attribute the causes of climate changes, and project future climate, at both global and regional scales
- emissions reduction technologies – developing technologies that assist in reducing the amount of greenhouse gases emitted into the atmosphere

8.4.1 Process studies – understanding key drivers of climate change

Ocean salinity and rainfall changes

Australian researchers through the ACCSP are leading efforts to understand how the salinity of the world's oceans is changing in response to climate change. Analysis of the patterns of salinity in the world's oceans during the past 50 years indicates that the global hydrological cycle has intensified by 4 per cent from 1950 to 2000. The hydrological cycle drives global rainfall patterns, and the research shows that dry regions have become drier and wet regions have become wetter in response to climate change.

Research indicates that this pattern will continue as the climate warms further. With a projected temperature rise of 3°C by the end of the century, researchers estimate that the hydrological cycle could accelerate by a further 24 per cent and become much more intense – exacerbating the changes in dry and wet regions. For Australia, this means that the northern parts are expected to become wetter, and the southern parts drier in response to climate change.

Ocean processes

Australia's researchers are using new technologies and are collaborating with international organisations to improve ocean monitoring of heat and water freshening (from increased rainfall and melting ice).

An important source of ocean information comes from the Argo project, which collects temperature and salinity observations from around 3,500 free drifting ocean profiling floats and makes it publicly available within hours of collection. There is a shortage of Argo floats in the Southern Hemisphere, and Australia plays a crucial role in deploying floats in this region including the Southern Ocean. Australia contributes the second largest number of floats after the United States.

Researchers are investigating the thermohaline circulation, the 'conveyor belt' that transports heat, nutrients and oxygen around the world's oceans. A major component of this circulation is Antarctic bottom water. Scientists have documented rapid and widespread freshening of Antarctic bottom water in the Indian and Pacific Oceans, an indicator that climate change is already having an effect on global oceanic circulation.

Through the ACCSP, Australian researchers have also set up a full-depth East Australian Current mooring array off Brisbane. The array extends across the continental slope and into the deep ocean. It measures transport of mass, heat and salt from the tropics to the Southern Ocean and monitors changes, contributing to assessments of likely future impacts of these changes on marine ecosystems and coastal populations along the eastern seaboard.

Carbon uptake in ocean

The oceans are a critical long-term sink for atmospheric carbon dioxide, taking up around 26 per cent of annual human-induced emissions. The Southern Ocean is one of the most important regions on Earth for removing carbon dioxide from the atmosphere.

Observations and models are helping researchers determine how carbon dioxide is taken up and stored in the oceans surrounding Australia. Recent research indicates a small reduction in the Southern Ocean's ability to take up carbon dioxide in winter.

However, the Atlantic sector of the Southern Ocean shows enhanced uptake in summer due to increased biological production and the formation of more stable surface water layers compared to the Pacific and Indian Ocean sectors.

Research is examining how physical processes, including ocean currents and winds, combine to produce regions in the Southern Ocean where carbon-dioxide-rich water is carried into the deep ocean. These regions represent one of the major controls on the ocean's capacity to absorb atmospheric carbon dioxide. Researchers are beginning to identify the seasonal and regional patterns of ocean uptake and the mechanisms responsible. These are major steps forward in determining how the Southern Ocean uptake will respond to climate change and influence future atmospheric carbon dioxide concentrations.

Ocean acidification

The increase in carbon dioxide emissions is causing rapid and unprecedented changes in the chemistry of the world's oceans.

Since the beginning of the Industrial Revolution, the pH of surface ocean waters has fallen by 0.1 pH units, which represents an approximate 30 per cent increase in acidity. Ocean acidification is affecting the ability of marine organisms to produce and maintain their shells. When these shelled organisms are at risk, the entire food web may also be at risk.

Researchers at the ACE CRC and the Australian Antarctic Division are investigating past, present and likely future impacts of ocean acidification on Southern Ocean organisms such as calcifying zooplankton (foraminifer, pteropods), zooplankton (krill, copepods) and deep sea corals. For example, researchers have found that some species of zooplankton in the Southern Ocean have 30-35 per cent lighter shells than their counterparts from pre-industrial times. In addition, Antarctic krill *Euphausia superba* show impaired embryonic development and reduced larval survival at high carbon dioxide levels.

Researchers are also developing comprehensive Southern Ocean ecosystem models to identify populations, ecosystems and regions at risk from acidification.

Aerosols

Airborne particles or aerosols such as soot, dust and smoke from industry, motor vehicles and vegetation burning can exert a cooling effect on the climate. However, the extent to which aerosols affect climate is largely unknown. Australian researchers are working to understand the behavior of aerosols over the Australian region, and are using their findings to improve climate models. Analysis of atmospheric-ocean climate processes by Australian scientists suggests that aerosol changes (principally in the Northern Hemisphere) offset some of the effects of increasing greenhouse gases. Rainfall in northern Western Australia has increased over recent decades, and research indicates this is largely the result of elevated aerosols from increased economic activity in Asia. The increase in aerosols may have contributed to a weakening of the winter subtropical jet in the Southern Hemisphere in recent decades, which may be linked to the winter rainfall decline in south-western Australia.

Observations show a clear seasonality in atmospheric aerosols, and this data will be used to refine climate models and help answer questions about the effects of the expected global decrease in aerosols over the next few decades. Researchers have also identified 'super-absorbing' aerosols in northern Australia, which are probably linked with black carbon from widespread burning of vegetation.

Rainfall changes across southern Australia

There have been significant findings on rainfall changes across southern Australia through regional climate programs over recent years, including the:

- South Eastern Australian Climate Initiative – a partnership between CSIRO, the Australian Government Department of Climate Change and Energy Efficiency (now the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education), the Murray-Darling Basin Authority, the Bureau of Meteorology and the Victorian Department of Sustainability and Environment (now the Department of Environment and Primary Industries). Research in SEACI was carried out in two Phases (Phase 1:2006 to 2009; Phase 2: 2009 to 2012).
- Indian Ocean Climate Initiative (IOCI) – a partnership of Western Australia, CSIRO and the Bureau of Meteorology. IOCI was formed in 1998 and Stage 3 completed in 2012.

SEACI research provides evidence that the Millennium Drought that affected south-eastern Australia from 1997 to 2009 was the worst drought of the instrumental record (since 1865). Rainfall across south eastern Australia was the lowest for any 13-year period on record. There appear to be long term reductions occurring in cool season rainfall across south eastern Australia, with these changes at least partly attributed to climate change.

SEACI researchers have identified a clear north–south rainfall divide on either side of a naturally occurring band of high pressure known as the subtropical ridge, which has also been accompanied by significant rainfall declines across southern Australia, including the southern part of the Murray–Darling Basin. These changes are resulting in reduced rainfall and runoff. This research is now continuing as part of the Victorian Climate Initiative.

IOCI research also provides evidence for a long term cool season drying trend in south-west Western Australia since the 1960s, with an expansion and intensification of the drying since 2000. The drying has been shown to be caused by changes in large-scale atmospheric circulation patterns, and these changes are consistent with what would be expected under climate change. In addition, palaeoclimate research through the Australian Antarctic Division provides evidence that the observed decline in rainfall in south-west Western Australia since the 1960s is the largest in 750 years.

IOCI also concluded that local land clearing was unlikely to have been a major factor in this decrease. The wet season rainfall increase in most northern parts of north-west Australia has been tentatively linked to increasing Asian aerosols. The Australian monsoon has also changed, strengthening over parts of north-western Australia.

The cool season is the traditional ‘filling season’ for water supply systems across most of southern Australia, and one of the important implications of SEACI and IOCI research is that this filling season may be less reliable in the future.

The Global Carbon Project

Many of Australia’s coastal communities are vulnerable to coastal inundation, erosion and damage from sea level rise. Understanding how and why the ocean is changing are

critical for improving sea level rise projections. CSIRO scientists have provided improved and updated estimates of global and regional sea level rise.

Global average mean sea level in 2012 was 210 mm (±30 mm) above the level in 1880, and the global average mean sea level rose faster between 1993 and 2012 than during the 20th century as a whole. The acceleration in sea-level rise is consistent with an increase in the contribution from melting glaciers, ice caps, and the Greenland and West-Antarctic ice-sheets. Global sea level rise is near the high end of projections from the 2007 IPCC Fourth Assessment Report.

Rates of sea level rise are not uniform around the globe and vary from year to year. Since 1993, the rates of sea level rise to the north and north-west of Australia have been 7 to 11 mm per year, which is two to three times higher than the global average. Rates of sea level rise on the central east and southern coasts are mostly similar to the global average. Variations are at least in part a result of natural variability of the climate system.

The Australian continental carbon budget

The ACCSP supports research to provide a more thorough understanding of carbon sinks and sources in the Australian biosphere, and how they might respond in a changing climate. It is important to understand how carbon stored in the landscape responds to climate variability. Carbon stored in the land during periods of high plant growth may disappear during the next drought.

The Australian landscape absorbed around 60 million tonnes of carbon annually over the last 20 years, which represents around 60 per cent of the carbon emitted by fossil fuels. Overall, the Australian territory is a small net emitter of carbon dioxide. The capacity for the Australian biosphere to absorb carbon dioxide has increased by around 15 per cent over the last 20 years, largely due to rising carbon dioxide levels.

This research is contributing to the Regional Carbon Cycle Assessment and Processes (RECCAP) project for Australia. RECCAP aims to establish the carbon balance of large regions of the globe at the scale of continents and large ocean basins.

Marine ecosystems

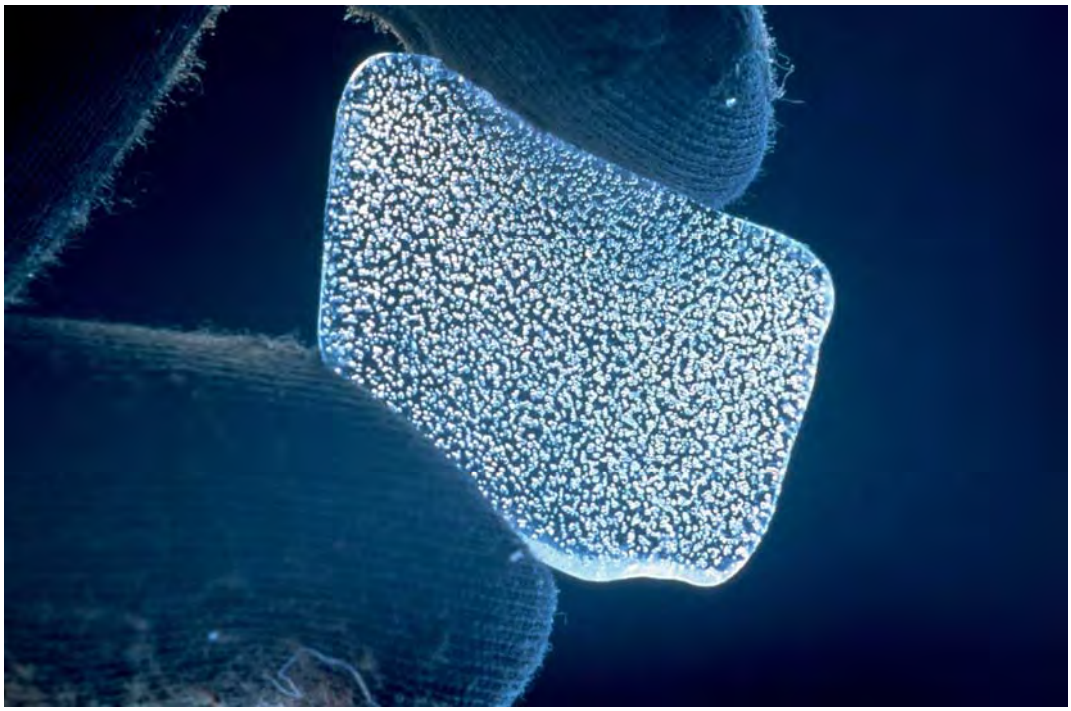
The Australian science community is widely engaged in research, monitoring and observing programs to increase our understanding of climate change impacts to marine ecosystems, and inform management and adaptation planning from the tropics to the Antarctic continent. Australia's oceans generate considerable economic wealth through fisheries, aquaculture, tourism and mining. Marine ecosystems provide irreplaceable services including coastal defence, oxygen production, nutrient recycling and climate regulation.

There is evidence of extensive southward movements of tropical fish and plankton species in south-east Australia, declines in abundance of temperate species, and signs of the effect of ocean acidification on marine species with shells. This information is

being used to assist ocean managers and policy makers to improve and justify actions to help our marine ecosystems adapt to the threat of climate change.

Palaeoclimate research

Ice cores, tree and coral growth rings, and marine and lake sediment cores provide a rich source of information about how the Earth's climate has changed in the past.



Caption: ice cores such as those collected by PAGES provide a rich source of information on past climate changes

A recent achievement within the palaeoclimate research community is the first 2000-year temperature reconstruction for individual continents. This new study is being coordinated by the international Past Global Changes (PAGES) project, under the International Geosphere Biosphere Program. Australian scientists have led the reconstructions for the Australasian region and Antarctica. The PAGES reconstructions demonstrate that nearly all continents (including Australasia and Antarctica) show a gradual long term cooling trend over the last 2000 years, ending in the late 19th century. The long term cooling was caused by a combination of factors including decreased solar radiance and increased volcanic activity. The reconstructions all show recent warming for individual continents, which has reversed the long term cooling, with the last 30 years of the 20th century (1971-2000) warmer than any other 30-year period in the last 1400 years.

Researchers at the Australian Antarctic Division and the ACE CRC have provided insights into the time lag between changes in temperature and changes in atmospheric carbon dioxide levels in the past. The findings indicate that feedbacks in the climate system – in which warming is linked to natural carbon dioxide increases, driving further warming – may operate faster than previously thought. Australian researchers used

Antarctic and Greenland ice cores to examine temperature and carbon dioxide changes during the transition from the last ice age. As Antarctic temperatures increase, ocean circulation was altered and carbon dioxide (most likely from the deep Southern Ocean) was released to the atmosphere. Previous studies had suggested that it took up to 1000 years for this to occur, but the new research from Australian scientists shows that there was a near-synchronous temperature and carbon dioxide increase – likely to have taken no more than 400 years.

There are two significant recent research papers from Australian ice core science that provide insights into connections between conditions in Antarctica and Australian rainfall. One study examined the causes of snowfall increases recorded in ice cores from east Antarctica over recent decades, noting an atmospheric pattern that also explained rainfall decreases in south-west Western Australia over the same period. The atmospheric pattern shows an increase in warm moist air bringing snowfall to east Antarctica while also driving relatively cold, dry air to south west Western Australia. A second study finds a connection between increased summer winds (indicated by increases in sea salts in the ice core record) and La Niña influences in the Pacific Ocean, providing a link between ice core records and rainfall in eastern Australia.

Australian scientists at the Australian Institute of Marine Science (AIMS) used the luminescence records in multiple annually-banded long corals cores from inshore Great Barrier Reef to reconstruct northeast Queensland tropical summer rainfall back to the mid-17th century. This robust reconstruction (which triples the length of the instrumental record) shows an extended drier period from the 1760s to 1850s associated with lower inter-annual rainfall variability. Since the late 19th century, average rainfall and its variability have significantly increased, with wet and dry extremes becoming more frequent than in earlier centuries. Researchers at AIMS and the University of Western Australia are currently developing new long-term reconstructions of sea surface temperatures off Western Australia from the geochemical records contained in massive coral skeletons.

8.4.2 Climate Modelling

ACCESS - Australia's climate modelling system

The approach to modelling of climate change has become increasingly sophisticated. In an effort to more realistically capture actual Earth system processes and feedbacks, many Earth-system models now include the atmosphere, land surface, ocean and sea ice, aerosols, the carbon cycle and atmospheric chemistry. The Centre for Australian Weather and Climate Research is leading the development of the Australian Community Climate and Earth-System Simulator (ACCESS), which is delivering a new generation of Earth-System models to improve weather and climate research in Australia. This development is part of a collaboration agreement with the Hadley Centre at the UK Met Office to adopt its unified atmospheric model, atmospheric chemistry module and data assimilation scheme as the core of ACCESS.

Inclusion of most key physical processes within the ACCESS framework enables its application across all space and timescales, from short-range numerical weather prediction, up to long-term climate projections. This ability to provide “seamless” simulations accelerates model development – improvements derived through the development process for one ACCESS application have a direct path to implementation in all others.

As a relatively new system, it has been important to demonstrate the capability of ACCESS, particularly in comparison with other climate models, and particularly in application to the Australian region. To achieve this, two versions of the climate model were developed; ACCESS 1.0 and 1.3, the latter including significant Australian developments such as a locally-developed land-surface scheme. Simulations from both models were submitted to CMIP5, and subsequent evaluation demonstrated that the ACCESS simulations score in the upper rank of international climate models, over Australia and globally. ACCESS simulations were submitted to the CMIP5 project which is associated with the IPCC *Fifth Assessment Report*, and through this process and others, informs government decision making.

Whilst ACCESS 1.0 and 1.3 represent a significant improvement in Australian climate modelling capability, further improvements are planned. These include development of the current components, enhanced model resolutions, and the introduction of new components (carbon and biophysical processes) to provide a more complete Earth system modelling capability.

The objectives of ACCESS are to create models and modelling outcomes that:

- Assist the Bureau of Meteorology in meeting its statutory requirements in providing the best possible meteorological services;
- Assist CSIRO by providing the best possible science for use in determining climate impacts and adaptation, and related fields;
- Provide information on weather and climate to decision-makers across a range of sectors;
- Develop synergy with research in numerical weather prediction and seasonal forecasting;
- Enable development of climate change scenarios over the 50+ year horizon;
- Provide substantive linkages with relevant university research; and
- Are world-class, and so enable Australia to contribute appropriate climate projections and scenarios for inclusion into the IPCC Fifth Assessment Report and future scientific assessments.

Climate change projections

A new suite of climate projections for Australia based on the next generation of global climate models will be delivered through the NRM Fund. These new national projections are due for release in 2014/2015. Communication of the projections will use the 'Climate Futures' approach - which determines climatic variables of the greatest interest to stakeholders needs and presents projections in an accessible format along with guidance

on their use. Projections provide the best information available on likely future climate conditions. Researchers will provide projections at varying levels of complexity and in various formats. These requirements range from general information about likely change through to datasets on changes to specific climatic variables for impact studies. The information is valuable for decision makers, including government and those investing in infrastructure, agriculture, urban planning and health.

Previously, Australia's national climate change projections have been delivered through the ACCSP. The ACCSP has regularly released national climate change projections since 1992. The last projections, released in 2007, showed that Australian average temperatures were projected to rise by 1.0 to 5.0 °C by 2070, compared to the climate of recent decades. Climate model projections suggest long-term drying over southern Australia during winter and over southern and eastern areas during spring. There is also expected to be an increase in fire weather risk. Intense rainfall events in most locations are expected to become more extreme, driven by a warmer, wetter atmosphere.

Climate change simulations produced under the Indian Ocean Climate Initiative reveal that even with the most optimistic greenhouse gas emissions scenarios, south-west Western Australia is projected to be drier and warmer later this century, with potentially much less water available for storage and for agriculture, ecosystems and industry. The latest, third stage of the initiative focused also on the north-west of the state. Data and results of IOCI are available at www.ioci.org.au.

Regional projections have also been delivered through Climate Futures for Tasmania; NARCLiM and SEACI projects (see Section 8.2.2).

8.4.3 Emissions reductions technologies

Renewable Energy

In July 2011, as part of the Clean Energy Future Plan, the Australian Government announced the establishment of the $3billion Australian Renewable Energy Agency (ARENA).

ARENA is tasked with improving the competitiveness of renewable energy technologies and increasing the supply of renewable energy in Australia. ARENA is also responsible for the activities of the Australian Solar Institute (ASI) and it administers the Solar Flagship Program. The Clean Energy Future Plan includes $140.9 million from the Education Investment Fund (EIF) for research infrastructure for Carbon Capture and Storage (CCS) and Solar Flagships. Research infrastructure funded by the EIF and the associated research program will assist with the design, commissioning and early operation of the main power plants, namely systems optimisation, maintenance regime testing, tracking and energy storage.

The Australian Solar Institute (ASI) was incorporated into ARENA on 1 January 2013. ARENA has committed support for programs under ASI's United States - Australia Solar Energy Collaboration Strategic Research Initiative (SRI). The SRI supports long-term, strategic and collaborative national research programs underpinning researcher capacity

for technologies that are not yet commercially available. ASI joined forces with the ARENA to fund the $33 million US-Australia Institute for Advanced Photovoltaics, led by the University of New South Wales, and the $35 million Australian Solar Thermal Research Initiative, led by CSIRO. ARENA will also support solar PhD scholars and Postdoctoral fellows, following the success of ASI's Skills Development Program.

On 24 February 2012, the Government established the $15 million competitive merit-based Advanced Biofuels Investment Readiness Program. The program supports the development of advanced biofuels technologies by seeking to progress the deployment of pre-commercial demonstration projects for the production of high energy, drop-in advanced biofuels in Australia. Also on 24 February 2012, the Government announced a $5 million foundation grant to James Cook University that will support the High Energy Algal Fuels Project, which will include the research, development and demonstration of biofuels from macroalgal feedstock.

In February 2013, the Government announced $9.8 million for two projects through the Advanced Biofuels Investment Readiness Program. This includes $5,423,155 to Licella Pty Ltd for its *Biomass to Bio-crude: Producing Advanced Drop-in Fuels for Australia* project and $4,398,000 to Muradel for its *Advancing Established and Integrated Marine Microalgae Biofuel to Commercialisation* project.

Cooperative Research Centres

The Government's Cooperative Research Centres (CRC) program supports medium to long-term, end-user driven collaborations to address clearly articulated, major challenges facing Australia, many of which are global challenges. CRC collaborations involve researchers, industries, communities and governments, but must include at least one Australian end user and at least one Australian higher education institution (or a research institute affiliated with a university).

The CRC for Low Carbon Living will receive $28 million in funding from 2012-13 to 2018-19, to bring together leading researchers and key end-users to develop new tools to reduce carbon emissions and transform the built environment to a low carbon future. The research leverages recognised world class expertise from researchers in 5 universities and CSIRO as well as the wealth of knowledge provided by all the CRC participants. It builds on multidisciplinary expertise, existing technology development, social research and national benchmark software tools. The United Nations Environment Program has recognised the world leading capability of the CRC team, and the value of the research, and aims to transfer the results internationally. The CRC has three research programs, reflecting the three pivotal "bridges" that must be crossed in order to deliver a low carbon built environment:

- Program 1: Integrated Building Systems
- Program 2: Low Carbon Precincts
- Program 3: Engaged Communities

The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) is one of the world's leading collaborative research organisations focused on carbon dioxide capture and geological sequestration (geosequestration, carbon dioxide capture and storage, carbon capture and storage, or CCS). Since 1998, as the Australian Petroleum CRC, and from 2003 as the CO2CRC, this centre has been conducting comprehensive research into carbon dioxide capture and geological storage, with support from government, industry and research institutions.

The CO2CRC is a joint venture comprising participants from Australian and global industry, universities and other research bodies from Australia and New Zealand, and Commonwealth, state and international government agencies. Its resources come from the Australian Government Cooperative Research Centres (CRC) Program, other Commonwealth and state government programs, CO2CRC participants, and wider industry.

The CO2CRC will receive $75.6 million in Australian Government funding from 1991-92 to 2014-15, including $18.6 million under the current funding term, to develop CCS technology to reduce emissions through the capture of CO2 from major sources before it is released into the air and for permanent safe storage underground. With approximately 150 researchers undertaking cutting-edge research and demonstration, from nano to macro scale and across the full carbon capture and storage chains, the CO2CRC has conducted a number of significant projects in recent years, such as the $40 million Otway Project.

The CO2CRC Otway Project, which began in 2008, is the country's first demonstration of the deep geological storage or geosequestration of carbon dioxide, the most common greenhouse gas. The project provides technical information on geosequestration processes, technologies and monitoring and verification regimes that will help inform public policy and industry decision-makers while also providing assurance to the community.

The project is of global significance because:

- it is the world's largest research and geosequestration demonstration project; over 65,000 tonnes of carbon dioxide have been injected and stored in a depleted gas reservoir deep underground and further injections into different formations are being planned; and
- it includes an outstanding monitoring program, which international and national scientists believe to be the most comprehensive of its type in the world.

Lessons learned from the project, particularly from the comprehensive monitoring program, will be able to be adopted by other international geosequestration projects.

Geoscience Australia is playing a role in greenhouse gas storage by providing advice to the Government on the geological storage of carbon dioxide, particularly in the areas of policy development and the preparation of legislation and regulations to allow storage to occur under the Carbon Capture and Storage Program. Geoscience Australia also

provides advice on the selection of sites to be released for exploration for carbon dioxide storage and informing the Government on international developments.

Other Major Initiatives

The Government established the National Low Emissions Coal Initiative (NLECI) in July 2008 to foster the development of low-emissions coal technologies at the national level and to ensure their availability for deployment from 2020. Government funding of over $280 million is supporting a national low-emissions coal research program; the acquisition of precompetitive geological data to identify potential storage sites and several medium-scale demonstration projects. The funding is being matched by the relevant states and the coal industry. The Government also established the National CO_2 Infrastructure Plan to complement the identification and development of sites suitable for the long term storage of carbon dioxide in Australia funded under NLECI.

The West Arnhem Land Fire Abatement (WALFA) project was undertaken in the Northern Territory and is Australia's first savannah fire management project using traditional fire management practices together with scientific knowledge and research. The WALFA project, operating on over 28,000 km^2 of remote, biodiversity- and culturally-rich Aboriginal-owned land that is adjoining the World Heritage listed Kakadu National Park, has been developed to address chronic fire management problems in savannah landscapes of western Arnhem Land.

The Queensland Government has invested $15 million in the Queensland Geothermal Energy Centre of Excellence at the University of Queensland. The centre has a research and development focus on energy derived from subterranean hot rocks. Highlights of research undertaken since 2009 include: better tools to identify Queensland's geothermal heat source; carbon dioxide geothermal siphon concept to power future development in Queensland; better power generators for low-temperature geothermal and renewables; advanced condenser technologies for thermal power plants; and metal-foam heat exchangers.

In November 2011, CO_2 Australia Limited was engaged to undertake the Forest Carbon Study (FCS), commissioned by the Tasmanian Government. The FCS assessed the carbon stored in Tasmanian forests, quantifying historical, current and future carbon stocks, emissions and sequestration rates of Tasmania's estimated 3,425,000 hectares of native and plantation forest. In addition to giving a clear picture of carbon stores and fluxes in Tasmania's forests, the FCS provides an accounting framework for this carbon, an analysis of current market opportunities and limitations, and estimates of the value of this carbon. The FCS's final report was publicly released by the Tasmanian Minister for Climate Change in early September 2012.

8.5 Systematic observation

8.5.1 Coordination

Global Climate Observing System

Australia's Global Climate Observing System (GCOS) related activity is coordinated through the Bureau of Meteorology, although there are other organisations that collect GCOS relevant data. Significant planning is undertaken to ensure appropriate correlation between Australian and international needs and the data that are collected.

Integrated Marine Observing System

The Integrated Marine Observing System (IMOS), established in 2007 under the Australian Government's National Collaborative Research Infrastructure Strategy, is a nationwide collaborative initiative with a distributed observing network and information services designed to observe the oceans around Australia, including both the coastal (continental shelf) and open oceans.

The system supports operational forecasting through the Bureau of Meteorology and the BLUElink initiative. Sustained ocean observing under the initiative will inform studies of the role of the ocean in the global climate system, and the impact of major boundary currents on continental shelf environments, ecosystems and biodiversity. IMOS also partly funds Argo Australia, which is described below. See 8.5.6 and Annex IV for more information about IMOS's role in ocean observations.

The University of Tasmania hosts IMOS and oversees the operation of its five nodes and 11 facilities, in conjunction with a number of key partners including CSIRO, AIMS, the Bureau of Meteorology and the Australian Nuclear Science and Technology Organisation, as well as universities and state governments. These nodes and facilities use sophisticated marine observing technology to collect data from across Australian waters and marine shelves. Twenty-seven institutions participate in the facility with vastly different sectoral interests but the coordination provided under IMOS ensures the collection of data that meets all of their needs. Free and open access to IMOS data streams are provided through the IMOS website.

Argo Australia is part of IMOS and is also supported by the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, CSIRO's Wealth from Oceans Flagship, the Bureau of Meteorology, the Royal Australian Navy, the Australian Antarctic Division and ACE CRC. Australia's contribution to the global Argo program is significant, as the third largest contributor to the program behind the United States and Japan. Argo is also a key data source for BLUElink, the system that provides the first operational ocean forecasts for the Australian region.

Australian Ocean Data Network

The Australian Ocean Data Network (AODN) Data Portal is a single access point for marine data published by Australian Government agencies and by a large number of

other data contributors. Generally, direct links from the Portal provide access to standardised data files that are hosted and maintained by the custodian agencies.

In 2010, the IMOS eMarine Information Infrastructure (eMII) became the home of the AODN Development Office and eMII is now responsible for building and maintaining AODN infrastructure, developing and maintaining data and metadata standards and facilitation growth of the AODN. The eMII provides a single integrated framework for data and information management, discovery and access for the IMOS nodes.

BLUElink

The Australian Government, through the CSIRO, Commonwealth Bureau of Meteorology and Royal Australian Navy are continuing to develop Australia's ocean forecasting capability and services through the BlueLink/MOSTE project. The forecasts provide information on the coastal and ocean currents and eddies, surface and subsurface ocean properties that have an impact on, and are linked to, maritime and commercial operations, defence applications, safety at sea, ecological sustainability, and regional and global climate.

The Terrestrial Ecosystem Research Network

The Terrestrial Ecosystem Research Network, (TERN) established in 2007 under the Australian Government's National Collaborative Research Infrastructure Strategy, provides fundamental infrastructure to enable high-level ecosystem science to address issues of national and global importance, including food, water, natural resource and biological security; adaptation to climate change; and the carbon economy.

The University of Queensland hosts TERN and oversees the operation of its nine facilities. TERN provides both physical infrastructure, such as networks of diverse sensors, long-term monitoring plots and transects as well as enabling infrastructure, for example data collection and management methods, data licensing and tools for analysing data. Collectively, TERN will contribute to meeting the needs of terrestrial ecosystem research and natural resource management in Australia for observing and monitoring data related to terrestrial ecosystems and potentially coastal ecosystems. Free and open access to TERN data streams are provided through the TERN website.

International collaborations are being established across all TERN facilities, to ensure they use the best practice and international standard data collection and storage practices. These collaborations will ensure that TERN data are available for use by international communities.

Freshwater resources

Historically, it has been a challenge to quantify at the national level how much water is available in river and storage systems across Australia. Water data are collected by a range of local, state and Australian Government agencies as well as private organisations. These data have not been freely exchanged and have often been inaccessible. A nationally coordinated approach is now being implemented with the

Bureau of Meteorology, which is at the centre of this data management process. Effective water data sharing and licensing arrangements have been established to facilitate the collation of comprehensive water information from more than 200 organisations across Australia.

This water information includes measurements of surface water storage, streamflow, groundwater levels and water quality. Surface water storage volumes for 300 public water storages are now published online and updated daily and integrated reports of the nation's freshwater resources are published biannually.

8.5.2 Data collection, management and access

The Bureau of Meteorology, as the coordinator of Australia's GCOS-related activities, endorses World Meteorological Organization Resolution 40 in its policies on sharing data. The Bureau is committed to supporting the GCOS Global Climate Monitoring Principles. It employs a comprehensive set of metadata practices, such as site and equipment documentation, overlap observations, instrument test reports and data management systems, to satisfy the GCOS principles while keeping pace with changes in technology.

Several external factors affect the integrity of long-term climate stations. The most important are changes in site exposure due to natural environmental development, and finding local observers in rural and peri-urban sites to continue observations. The Bureau is updating site lease provisions and relocating stations where possible. Over the past two decades many manual observing sites have had an automatic weather station installed nearby to help preserve the record of essential climate variables.

The Bureau puts significant effort into maintaining the long-term climate record of meteorological data. Much of its historical records are now in digital form and available for use. However, resource constraints have thus far reduced opportunities to digitise pre-1957 daily and sub-daily synoptic records. Australia is also working collaboratively with Pacific island countries in developing their data management capabilities, acquiring and digitising their data. These projects, which have accelerated in recent years due to support from the Australian Agency for International Development, also help countries to build capacity in maintaining their climate records.

Caption: the Cape Grim Baseline Air Pollution Station in Tasmania provides vital information to the Bureau of Meteorology

The Bureau of Meteorology's Cape Grim Baseline Air Pollution Station located in remote north-western Tasmania provides vital information about changes to the atmospheric composition of the Southern Hemisphere, and supports a scientific research program jointly supervised by CSIRO's Marine and Atmospheric Research Division and the Bureau of Meteorology. As Australia's contribution to the Global Atmosphere Watch Programme (GAW), extensive data are collected for use in studies of sources and sinks of greenhouse and ozone-depleting gases and in assessments of likely future atmospheric concentrations.

The Bureau's other contributions to GAW include the total column ozone network, the ozone sonde network, and the atmospheric transmission network. In addition the Australian Antarctic Division, CSIRO, the Bureau of Meteorology, the New Zealand National Institute of Water and Atmospheric Research collaborate to manage air sampling at Australia's research stations in the Antarctic and subantarctic. The University of Wollongong also manages two sites (Darwin and Wollongong) of the Total Column Carbon Observing Network and part of Australia's contribution to GAW.

The Bureau of Meteorology also operates three sites of the GCOS Baseline Surface Radiation Network to monitor long-term changes in solar and terrestrial irradiance, and thirteen other solar and terrestrial irradiance sites that follow GCOS Global Climate Monitoring Principles.

The Australian Antarctic Data Centre (AADC) manages all data collected within the Australian Antarctic Science Program in doing so it helps fulfil Australia's obligations

under Article (III).(1).(c) of the Antarctic Treaty which states that "*Scientific observations and results from Antarctica shall be exchanged and made freely available*." Data collected from research projects and long term observing projects can be accessed through the AADC.

8.5.3 Capacity building

The Climate and Oceans Support Program in the Pacific (COSPPac) is a $31.5 million project funded by the Australian Agency for International Development and implemented by the Bureau of Meteorology. It will run for four years and commenced in July 2012. It consists of the 5th phase of the South Pacific Sea Level and Climate Monitoring Project (renamed the Pacific Sea Level Monitoring Project under COSPPac), the 3rd phase of the Pacific Islands Climate Prediction Project (renamed the Climate and Oceans Monitoring and Prediction Project under COSPPac), a new Capacity Development and Communications program and a COSPPac Management Unit within the Bureau of Meteorology.

The COSPPac is a major component of Australia's contribution to minimising the impacts of climate variability and change in the Pacific and to meeting the Australian Government's climate change aid objectives. The Program is consistent with international guidelines on best development practice, including the Paris Declaration, the Cairns Compact and the Pacific Plan, and with the *Principles to promote more effective coordination and implementation of climate change adaptation and mitigation actions*, endorsed by Leaders at the 2010 Pacific Islands Forum meeting

The specific outcome for COSPPac is that Pacific island National Meteorological Services (NMS's) (Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu) and other relevant in-country agencies understand and use climate, ocean and sea level products for the benefit of island communities and governments.

This is achieved through three work areas:

- Capacity development and communications (CD&C);
- Climate and ocean monitoring and prediction (COMP); and
- Pacific sea level monitoring (PSLM)

The primary focus of CD&C is to facilitate and support the efforts of Pacific NMS's and Lands and Survey Departments to build their own capacity and to communicate effectively with their stakeholders, so they can continue to increase their contribution to their countries' responses to climate variability and vulnerability. COMP's major objective is the continued development of seasonal prediction capacity and expanded ocean climate services by NMSs. PSLM objective is to ensure the continued operation and maintenance of a network of high resolution sea-level monitoring stations located throughout the South Pacific and to improve tidal and related ocean information in response to Pacific Island Country national and regional requirements.

The Australian Governments $32 million Pacific-Australia Climate Change Science and Adaptation Planning Project (PACCSAP) program is seeking to apply the climate change science and adaptation-ready information to manage future climate risk, with a focus on building in-country capacity of meteorology officers, scientists, decision-makers and planners. The PACCSAP program builds on two former programs: the Pacific Climate Change Science Program and the Pacific Adaptation Strategy Assistance Program and is engaging with 15 partner countries and regional stakeholders to build their capacity to effectively apply the results and to build the climate science knowledge base.

The Bureau has continued to be active in assisting the countries of the Pacific to secure and manage their climate data. Following on from previous efforts (refer to Australia's Fifth National Communication) the Bureau has extended its data rescue activities to 15 partner countries across the north and south Pacific, and including Timor-Leste.

The program has developed a new climate database management system, CliDE (for Climate Data for the Environment), and successfully implemented it in each of the 15 partner countries.

The PACCSAP team has made considerable efforts to migrate all available climate data to the new database, and instigated a number of data digitisation projects in an attempt to transfer data from paper-based forms to much more accessible electronic forms within the new database. There are opportunities to further develop the functionality of CliDE (to assist countries, for instance, to better meet their GCOS reporting requirements) including establishing a means of supporting CliDE on an ongoing basis, and digitising more of the historical records still held by countries in paper-based forms. There is also a need to strengthen communications infrastructure: at present internet access is slow and unreliable such that few Pacific countries are able to remotely back up their climate data, which carries with it an ongoing risk of loss of their climate records

The PACCSAP program will also provide an additional $1.075 million to support science and research activities in Timor-Leste through the East Timor Climate Change Science Program. The program is managed by the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education in collaboration with the Australian Agency for International Development. It is delivered by the Bureau of Meteorology and CSIRO through their research partnership in the Centre for Australian Weather and Climate Research. The program forms one component of Australia's International Climate Change Adaptation Initiative (see Section 7.3.1).

Much of the work under the projects are aligned with GCOS principles and requirements, as many of these island sites form part of the GCOS Surface Network (GSN) and Upper Air Network (GUAN). Each country's meteorological agency has been briefed on GCOS issues relating to observational practices, supply and availability of equipment and the continued support of the Australian Bureau of Meteorology. The Bureau's officers monitor GSN and GUAN outputs in Region V (the south-west Pacific) and provide advice and information on related matters in this region to the GCOS secretariat and the World Meteorological Organization. This work will ensure that Pacific island nations are able to

better manage their meteorological observations through improved systems and to provide better climate-related services and information to government, industry and the general population.

8.5.4 Essential climate variables

The tables in Annex IV contain the data responding to the specific requirements in the UNFCCC reporting guidelines and the responses to the specific points on atmospheric, ocean and terrestrial essential climate variables.

Global atmospheric products requiring satellite observations

While Australia is not a satellite operator, it is highly dependent on satellite data for monitoring the state and composition of the atmosphere. Australia operates an extensive network of satellite reception stations and makes extensive use of indirectly received data.

In 2013, the Australian Government announced its Satellite Utilisation Policy, including policy on Earth observations. The policy includes the development of a National Earth Observations from Space Infrastructure Plan which will drive a whole-of-government approach to the acquisition, utilisation and archiving of satellite data and facilitate closer collaboration between agencies.

The Bureau of Meteorology contributes the data from its ground stations to international satellite data exchange through the World Meteorological Organization Space Programme.

Australia holds comprehensive records of full- resolution Advanced Very High Resolution Radiometer (AVHRR) data from the National Oceanic and Atmospheric Administration satellite series for Australian sites including Antarctica. These records are unique and are shared between national agencies.

In addition the following activities are planned:

- The Bureau of Meteorology will use satellite sounder radiances to augment its in situ upper-air observations, and will archive hyperspectral satellite data for future use in monitoring atmospheric composition;
- The Bureau of Meteorology will record profiles from global positioning system (GPS) radio occultation, providing a bias-free observation of upper-atmospheric temperature and moisture; and
- The Bureau of Meteorology and Geoscience Australia will collaborate on the derivation of total column water vapour from surface GPS networks.

Global products requiring satellite observations – oceans

In addition to in situ observations, Australia is dependent on satellite observations to monitor its surrounding oceans. The Bureau of Meteorology and CSIRO currently archive direct broadcast and imported satellite data, and produce a number of products in the following areas:

- altimetry (a measure of altitude)—processing and archiving altimetry data;
- sea-surface temperature—high-resolution datasets created and being recreated from unique AVHRR archives;
- ocean colour—archiving multi-spectral Moderate Resolution Imaging Spectroradiometer (MODIS) imagery; and
- In addition the Australian Antarctic Division is dependent on satellite observations for ice conditions in the Southern Ocean for operational purposes and also undertakes research to map sea ice change and variability and fast ice that is of importance for climate modelling.

Global products requiring satellite observations – terrestrial

As a large continent, Australia is dependent on satellites for some aspects of terrestrial observation. The unique AVHRR direct broadcast record, of approximately 25 years, is being used to create a time series of Normalised Difference Vegetation Index and other land-cover products. Specific applications include forest fire detection, vegetation analysis, weather analysis and forecasting, climate research and prediction, global sea surface temperature measurements, ocean dynamics research and search and rescue. The time series of geostationary satellite–derived daily solar exposure now extends back to January 1990.

National Dynamic Land Cover Map

The Dynamic Land Cover Dataset of Australia is the first nationally consistent and thematically comprehensive land cover reference for Australia. It is the result of collaboration between Geoscience Australia and the Australian Bureau of Agriculture and Resource Economics and Sciences, and provides a base-line for identifying and reporting on change and trends in vegetation cover and extent. The thematic map product shows the land cover of Australia for the period of April 2000 to April 2008 in 34 International Standards Organisation (ISO) land cover classes.

Land cover maps for the National Carbon Accounting System

Geoscience Australia provides the Department of Industry Innovation, Climate Change, Science, Research and Tertiary Education with continental coverage of Landsat satellite imagery. Since 1999, some 21 epochs spanning 1972 to 2012 have been provided for use in the National Carbon Accounting System. The Landsat imagery is processed by the Department to provide spatially and temporally consistent land cover change mapping. This information is used in the National Carbon Accounting System to account for greenhouse gas emissions and removals from land-use change in Australia. Work is also in progress to detect native forest harvesting and fire events using the time series land cover change products.

The International Forest Carbon Initiative

The International Forest Carbon Initiative is a key part of Australia's leadership on reducing emissions from deforestation and forest degradation in developing countries. Australia is providing satellite imagery to several south-east Asian countries to support

their efforts to measure and account for greenhouse gas emissions from forests (see Section 8.3).

8.5.5 Oceanographic observations

The majority of Australia's ocean observing systems are described in 8.5.1 and Annex IV.

Australia, through IMOS and other programs, contributes strongly to building long term ocean climate records in the Global Ocean Observing System (GOOS) and its component programs.

It maintains several repeat hydrographic lines under the Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP), maintains the second largest active array of floats behind the United States in the global Argo program and runs several coastal and deep ocean mooring sites as part of the OCEANSites program. Carbon and physical parameters are collected at several of these sites.

Caption: floats are deployed as part of the Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP)

The Bureau of Meteorology also operates the eXpendable BathyThermograph (XBT) Ship of Opportunity Programme (SOOP) which monitors long-term trends in major oceanic circulation pathways around Australia and has sustained 6 repeat SOOP XBT sections for over two decades.

The Bureau of Meteorology's National Tidal Centre specialises in sea level monitoring and analysis for the purpose of deriving trends in absolute sea level and producing

national tide predictions, tide streams and related information. The centre provides management and operational support to the Australian Baseline Sea Level Monitoring Array, whose mission is to monitor changes in sea level around Australia. It involves the operation and maintenance of an array of high-resolution sea-level gauges and associated meteorological instruments and management of a quality-controlled national database of observations that is made available to the scientific and wider communities.

The Pacific Sea Level Monitoring Project is funded by the Australian Agency for International Development under the Climate and Ocean Support Program in the Pacific (COSPPac) and managed by the Bureau of Meteorology. Geoscience Australia provides the geodetic monitoring component of the project and operates a network of 12 continuous global positioning system receivers throughout the South Pacific to monitor land motion at sea-level tide gauges. Motion in the earth's crust is known to contaminate relative sea-level observations and the geodetic measurements are modelling this effect to support improved climate and sea-level change studies.

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CHAPTER 9

Education, Training and Public Awareness

9.1 Education and training 258
9.2 Industry 264
9.3 Non-government organisations 265
9.4 Public awareness raising 266
9.5 Public access to information 270
9.6 International activities 272

Key Developments

Since the Fifth National Communication, the Australian Government has undertaken extensive community engagement to explain its vision for a clean energy future and actions to combat climate change. This includes a public awareness campaign to coincide with the launch of the Clean Energy Future Plan, consisting of television and radio advertising, direct mail and a highly detailed online presence.

The Government also established a Climate Commission to provide Australians with an independent and reliable source of information about climate change science, economics and international action. Thousands of Australians have attended Climate Commission community forums around the country since its inception and accessed their high quality publications on a range of important climate change issues.

Across Australia, a range of information, education and training measures have been implemented for specific sectors. A key example is farmer and land manager programs that optimise participation in the Carbon Farming Initiative and develop new abatement opportunities on the land. Targeted programs are also in place for small and large businesses, households and local government.

In the formal education sector, the federal and state governments have implemented a range of climate change education programs for primary, secondary and tertiary students, and vocational measures for tradespeople and professionals.

Internationally, the government has continued to invest in measures to assist developing countries to build their skills and knowledge base in addressing climate change challenges.

Effective information and awareness raising activities are vital to build climate change understanding and to secure the community support and participation necessary to ensure climate change measures are successful. Australian governments at all levels have developed public awareness and education programs to communicate the need to tackle climate change and the best avenues for Australia to pursue mitigation and adaptation action. At the community level, a broad range of research, environment, welfare and other non-government organisations promote public awareness and understanding of climate change through research, advocacy, education, training and media activities.

Climate change will create new challenges and opportunities for Australia's industries, labour market and education and training systems. The transition to a low carbon economy will recalibrate behaviours, production, transportation, distribution and consumption and disposal systems to climate friendly practices. Accordingly, human ingenuity, skills and knowledge are essential ingredients of any successful climate change strategy. Australian governments are acting to ensure that education and training architecture creates a society able to make the required transition. Australia is also working to build global capability through science, research and technology collaboration and build the capacity of developing countries to meet their specific climate change challenges.

Stakeholder engagement is another critical component of developing and evaluating effective climate change policies. The Australian Government undertakes extensive consultation with key stakeholders including industry, non-government organisations, scientists, other experts and the public in order to formulate policy and enhance Australia's climate change response.

This chapter details the major initiatives Australia has instigated to build an informed, resilient and innovative community able to deliver a low carbon future in Australia and abroad.

9.1 Education and training

Under Australia's federal system of government, state and territory governments have responsibility for education and training. They are also responsible for funding the vocational education and training sector, while the federal government has primary responsibility for public funding of the higher education sector.

The government has a leadership role in identifying and promoting national standards and priorities for students. In 2008, all education ministers agreed to the National Declaration on Educational Goals for Young Australians, which frames state and territory curriculum policies and articulates a national vision for schooling. The declaration states that Australians must be able to engage with scientific concepts and principles and approach problem-solving in new and creative ways to respond to complex environmental, social and economic pressures; such as climate change.

Since 2008, the government has rolled out an 'education revolution' to improve educational outcomes and productivity. These reforms have involved collaboration across the public and private sectors and a genuine partnership of parents, children, students, employers and all levels of government. Building on these reforms, the government announced Better Schools: A National Plan for School Improvement (NPSI) in 2013. The NPSI aims to improve Australia's education performance to ensure that schools are ranked among the top five countries globally. The government is currently seeking the agreement of state and territory governments to the NPSI through the Council of Australian Governments (COAG).

As part of the NPSI, a new Australian Curriculum has been developed for primary and secondary school children. Schools will implement the Australian Curriculum in all learning areas from Foundation to Year 10 by 2016, and for Years 11 and 12 by 2018. The Australian Curriculum encompasses five key learning areas: English, mathematics, science, history and geography. Sustainability is identified as a cross-curriculum priority. All levels of Australia's education and training system including primary and secondary schools, universities and the vocational education and training sector are embedding the principles, knowledge and skills required to foster long-term sustainability and prepare for climate change.

Figure 1: Former Parliamentary Secretary for Climate Change and Energy Efficiency, Mark Dreyfus QC MP, talks with some Melbourne students involved in the National Solar Schools program

9.1.1 Schools

The Australian Government is helping schools prepare for climate change by providing educational resources and renewable energy grants. These school-based programs are building Australia's capacity to meet the skill challenges posed by climate change, supporting young people's learning and skills development and aiding their transition to full participation in a future workforce affected by climate change.

The government's National Solar Schools Program assists schools to take practical action to tackle climate change by improving their energy and water efficiency. The program has distributed over $217 million to almost 60 per cent of all Australian schools to install renewable energy systems, rainwater tanks and a range of energy efficiency measures. An education program complements these infrastructure upgrades to equip students with knowledge on renewable energy, energy efficiency and the impacts of their everyday actions on preventing the production of carbon pollution.

Under National Solar Schools, many schools have undertaken detailed audits of their water, waste and energy use and implemented audit recommendations to deliver financial and emissions reduction benefits. Alone, the solar power systems installed under the program are producing enough electricity to power the equivalent of 4600 households. The program allows these schools to sell surplus electricity generated by solar power systems back to the grid on weekends and during school holidays.

Beyond the National Solar Schools Program, the Government launched the Shout Out for Climate Change schools competition in 2010, inviting children from primary school to university students to share their views on climate change and inspire others to take action. The competition was extremely popular and received over 2380 entries. In 2012, the Government provided funding for Future Sparks, a Green Cross Australia project which raised awareness about renewable energy through a national video competition for school children. In the competition, students were invited to outline their ideas for a sustainable energy future.

The government is also supporting climate change outreach to schools through two of its premier science agencies, the Commonwealth Science and Industrial research Organisation (CSIRO) and Questacon. The CSIRO developed CarbonKids, an educational program that combines the latest climate science with education in sustainability. It aims to provide primary and secondary schools with resources enabling them to encourage their community to address climate change through a set of integrated curriculum units. Currently over 240 schools across Australia are registered in the program.

Questacon, the Australian National Science and Technology Centre, runs a number of outreach programs to promote greater understanding and awareness of science and technology within schools. This includes a range of shows for primary school children, including a climate change show which teaches children about the Earth's atmosphere and the greenhouse effect.

A range of other major climate change initiatives are in place that have been developed and implemented by state and territory governments and the non-government sector. Key examples include Victorian and Queensland Government programs such as the Schools' Ecological Footprint Calculator and Water – Learn it for Life. The Victorian Government has established the Schools' Ecological Footprint Calculator to help students, teachers and administrators reduce their school's Ecological Footprint. The Queensland Government's Water – Learn It for Life is an education program targeting early and middle year school children by providing teachers with lesson plans, activities, background research materials and multimedia tools.

From the non-profit sector, Education Services Australia maintains a National Collection of Digital Curriculum Resources (the National Collection), which is commonly known as Scootle. Scootle is a database of over 15 000 digital curriculum resources, including climate change resources, for primary and secondary school children. It includes interactive multimedia learning objects, web resources cleared for free educational use and individual digitised items sourced from Australian and New Zealand cultural and scientific organisations. The National Collection is available to all Australian schools through their licenced educational portal.

At the secondary level, the Vocational Education and Training (VET) in Schools initiative is a partnership between schools, training providers and industry designed to help prepare students for the transition to employment, further education or training. The

training delivered through VET in Schools programs is designed to respond to current industry demand for new skills. The move to a low carbon economy is a core driver of skills development as new industries and technologies emerge and existing industries adapt to a sustainable future.

9.1.2 Universities

The higher education sector is made up of 37 public universities, two private universities and more than 150 other higher education providers. The government supports the sector through policies, funding and programs. This support is important as the sector makes a fundamental contribution to the future of Australia through intellectual, economic, cultural and social development.

Universities are responding to industry and student demand by providing undergraduate and postgraduate qualifications and short courses for climate change professionals. In this field, interdisciplinary research and coursework programs are common at the undergraduate and graduate levels. Course options include climate change policy and economics, environmental management and planning, environmental science, climate change science, climate change vulnerability, climate change adaptation, emergency management and environmental studies.

The Australian University Climate Consortium (UCC) comprises four major universities undertaking significant climate research that are integrating their research and education programs to provide a world-class, strategic, team-based climate science capability for Australia. The participating universities are the Australian National University (ANU), Monash University, the University of Melbourne and the University of New South Wales. The UCC works in collaboration with the Bureau of Meteorology (BoM), CSIRO and colleagues from other universities to ensure that Australia continues to be a contributor of global significance in climate change research and education.

The ANU also hosts the ANU Climate Change Institute which facilitates integrative cross-university collaboration on climate, water and energy research. In 2013, the Institute was awarded a Public Sector Linkages Program by the Australian Agency for International Development to work alongside China in developing a climate change adaptation toolkit for Nepal, India and Bangladesh.

Monash University also hosts a range of climate change initiatives. Monash Weather and Climate integrates climate and meteorological research focusing on regional modelling, extreme events, bushfires, and the urban environment. The Monash Sustainability Institute (MSI) is a multi-disciplinary, cross-faculty institute that delivers solutions to key climate change and sustainability challenges through research, education and action. MSI offers programs in biodiversity, climate, transport, water and energy. MSI has founded and/or developed a range of programs including:

- **Climate Works Australia**: an independent, research-based, non-profit organisation committed to catalysing reductions in greenhouse gas emissions in Australia.

- **Green Steps**: an award winning not-for-profit Australian environmental consulting and training provider. Its programs help participants make their workplaces and work practices more environmentally sustainable.
- **Climate Scientists Australia**: an independent group of scientists working to advance the use of balanced, scientifically-based information in decisions on climate-related issues.
- **Monash Climate, Biodiversity and Health Program**: draws together expertise from across Monash University in partnership with national health and environmental experts to research climate change health impacts.

Through the Melbourne Sustainable Society Institute (MSSI) the University of Melbourne has an active research program in climate change, impacts, adaptation and mitigation. The MSSI mission is to progress sustainability as a societal goal in Australia and the Asia-Pacific region by being a portal to sustainability-related research at the University of Melbourne and a platform to facilitate multi-disciplinary and multi-institutional research. Climate change is one of the MSSI research themes.

The University of New South Wales hosts the Climate Change Research Centre (CCRC) which houses research expertise in the key areas of the Earth's climate: atmospheric, oceanic and terrestrial processes. The CCRC applies basic scientific principles to pressing questions on climate dynamics, global climate change and extremes of weather and climate.

The National Climate Change Adaptation Research Facility (NCCARF), based at Griffith University, was set up in 2008 as an outcome from the COAG National Climate Change Adaptation Framework. The mission of NCCARF is to lead the research community in a national interdisciplinary effort to generate the information needed by decision-makers in the public and private sectors to manage the risks of climate change impacts. This adaptation research effort was one of the most significant globally.

The first phase of NCCARF has ended, with the results of around 140 research projects released in June 2013. The information generated will help Australians understand what adaptation options are available to address future climate threats and spans across the health, ecosystems, infrastructure, agriculture, emergency management, economics and communities domains.

9.1.3 Vocational education and professional training

The VET sector provides training to build specific occupational or work-related knowledge and skills. VET programs are provided by approximately 4808 public Technical and Further Education (TAFE) Institutes, private colleges, schools and universities. They are designed, implemented, funded and endorsed by a mix of public, private and industry sources.

The federal, state and territory governments are working together to enable the VET sector to develop specific education and training to address the growing industry demand for ‘green’ skills and, ultimately, to help achieve a more environmentally sustainable,

productive and lower-carbon economy. Green skills, or skills for sustainability, include the technical skills and knowledge needed in the workforce as a response to the transition to a sustainable, low carbon economy. They also include generic skills (such as sustainable approaches, innovation and problem solving) required to develop and support sustainable social, economic and environmental outcomes.

Green skills will be in high demand across all sectors of the Australian economy. Industries will need workers with these skills to meet the demand for environmentally sustainable products and services from their clients and to maintain their international competitiveness. There is no doubt that new jobs will be created as we move to a greener economy. However, it is also likely that many existing jobs will be made greener. Workers across a range of occupations will need new skills to develop and implement new technologies and practices and to respond to the demand for sustainable design and products.

Examples of how some green skills are likely to be integrated into existing roles include:

- Accountants and economists providing environmental reporting and accounting services;
- Architects, engineers and construction trades workers responding to demand for sustainable and energy-efficient designs and use of green materials;
- Managers changing practices to reduce energy, water and waste costs;
- Plumbers installing and maintaining systems for water and energy efficiency, recycling, rain water harvesting and waste reduction; and
- Electricians and motor mechanics working with different energy systems, such as solar panels and hybrid cars.

The Government is supporting the development of skills for sustainability in the Australian workforce through the Clean Energy and Other Skills Package (the Package). The Package is providing up to $31.7 million over four years (2011-12 to 2014-15).

Embedded within the Package are the Green Skills Agreement, the Skills for the Carbon Challenge initiative and the Workforce Innovation Program in 2011 -12 to 2014-15.

Together these programs support a range of projects which:

- help Australians to access high quality, industry-relevant skills for sustainability and ensure that Australian businesses and industries are equipped to take advantage of the opportunities provided by the transition to a sustainable, low-carbon economy;
- build the capacity of the VET and Higher Education sectors to deliver skills for sustainability training, courses and qualifications to current students and new and existing workers;
- develop teaching and learning resources and enabling tools to support the delivery of skills for sustainability, energy efficiency and clean energy programs; and
- support workforce development initiatives which enable tradespersons and professionals in key industries to develop the skills required to deliver services,

products and advice which promote and contribute to sustainability (incorporating clean energy and energy efficiency).

State government are also investing in building skills and expertise in critical areas to meet low carbon development needs. One example is the Victorian Government's Smarter Resources, Smarter Business program that provides information and financial support to medium sized businesses for projects that reduce greenhouse gas emissions and improve their resource efficiency. Through the program, businesses can access information; tools and resources to help them better understand and improve their energy efficiency. Businesses also have access to funding assistance, a business support program and a recognition program.

9.2 Industry

The government continues to uphold strong communication with key industry and non-government organisation stakeholders on specific policy issues and developments. For example, as part of its Clean Energy Future Plan the Government has undertaken an advertising awareness campaign of Clean Technology Programs within Australian industry and manufacturing businesses. This phased campaign has focused on the $865 million Clean Technology Investment Program and the $173 million Clean Technology Innovation Program. The campaign has been featured in national press, selected industry magazines, websites and digital search. It aims to provide concise information about Clean Technology Programs and direct businesses and manufacturers to more detailed information to help them make informed decisions about eligibility and applications.

The government's business website (www.business.gov.au) provides key information for planning, starting and growing businesses. It includes a Grants and Assistance Finder tool that provides more information about business support from all levels of government on a range of issues including climate change, investment and innovation. It also includes an environmental management section which provides advice on how businesses can lower their carbon footprint, reduce their level of wastage and become more sustainable in order to reduce pollution, achieve energy savings and improve their efficiency, productivity and ultimately their bottom line.

Enterprise Connect is a government initiative that offers comprehensive advice and support to small and medium businesses. Enterprise Connect has a national network of centres equipped with business advisers and facilitators that aim to provide business improvement services. Enterprise Connect's Clean Technology Innovation Centre assists businesses delivering clean technologies, including businesses involved in the generation of energy from renewable and low carbon sources, such as solar, wind, wave, tidal, low emission coal, biofuels or cogeneration.

Commercialisation Australia is a Government organisation that runs a merit-based grants program offering funding and case management to accelerate commercialisation. Businesses wanting to commercialise clean technology can apply for the program depending on their funding and resource needs. As at April 2013, Commercialisation

Australia had announced support for 402 participants with grants valued at over $150 million.

Additionally, the national Small Business Support Line is run by AusIndustry and provides small business owners with a first point of contact to access information and referral to services such as climate change-related programs to improve business sustainability and help better manage businesses.

As part of the Clean Energy Future Plan, the government has established the $40 million Energy Efficiency Information Grants Program to assist industry associations and non-profit organisations that work with small and medium businesses and community organisations to provide information on improving energy use. Under round one of the program, 28 organisations will receive around $20 million for these activities. The organisations are working across many aspects of the small business and non-profit community including chemicals and plastics, wineries, tourism, automotive, hotels, childcare centres and strata management. Another $14 million has been approved under round two.

9.3 Non-government organisations

A wide range of non-government organisations promote public awareness and understanding of climate change through research, advocacy, education, training and media activities. Such efforts at the community level have made significant contributions towards broadening the awareness of the Australian public on the significance of climate change. These non-government organisations cover all sectors of the Australian economy, ranging from industry and business organisations to conservation, research and welfare organisations.

Environmental and climate research organisations such as Earthwatch and the Climate Institute undertake non-partisan and independent research, education and communication activities and work with the community, businesses and government to promote understanding and drive effective climate change solutions.

Community-based environmental organisations such as the Australian Conservation Foundation and the Word Wildlife Fund (WWF) Australia run climate change campaigns that advocate reducing greenhouse gas emissions, improving energy efficiency, investing in public transport, using clean, renewable sources of energy and showing international leadership on climate change. The Australian Youth Climate Coalition undertakes a broad range of activities to educate and engage young people about climate change. Additionally, Climate Action Network Australia (CANA), which is the Australian arm of Climate Action Network International, is a network of over 75 local, state, national and international environmental, development, research and advocacy groups from throughout Australia working for action on climate change. CANA is particularly active in coordinating Australian non-government organisation involvement at the UNFCCC Conference of Parties.

A number of welfare organisations provide assistance to disadvantaged and low income groups to reduce their environmental footprint and save money on household energy bills. Welfare organisations are also building the capacity of disadvantaged sectors such as the long-term unemployed to take up opportunities in greener industries.

Organisations in the welfare and social justice sector are also working to address the social impacts of climate change. For example, welfare groups based in farming and rural communities provide assistance to families that experience the degradation of family and business financial security influenced by the impacts of climate change, such as flood and drought. The Australian Council of Social Services has been active since 2006 as an advocate on behalf of low income and disadvantaged consumers in development and reform of the national energy market.

Religious organisations have also played a role in educating their own congregations and the broader community on climate change issues. In recent times the National Council of Churches in Australia has produced information products, written to political leaders and released public statements calling for action to prevent dangerous climate change. The Australian Religious Response to Climate Change is a multi-faith, member-based organisation of people from around Australia who are committed to taking action on climate change. The organisation's membership represents a variety of religious traditions, and believes that people of all faiths can and should be at the forefront of creating a safe climate.

9.4 Public awareness raising

The success of actions to address climate change will depend, in part, on engendering a shared responsibility for climate change across all levels of government and the broader Australian community; including industry and Australian households. To ensure Australians are informed on the issue and are able to engage meaningfully in climate change responses, the federal, state and territory governments have undertaken a range of activities to broaden public awareness of climate change.

In July 2011, the government launched a national communications campaign in conjunction with the release of the Clean Energy Future Plan (the Plan) to help illustrate its vision for a clean energy future. The campaign provided important information about how the Plan, including the carbon price, will help to cut carbon pollution and create a prosperous and sustainable future for Australia. A core component of this campaign was the development of a 20 page Helping Households booklet which was mailed to every Australian household. This explained why the Government had chosen to implement an emissions trading scheme and what impact it would have on households. The campaign also featured a series of four television commercials, radio advertising and a highly detailed Clean Energy Future website.

The Australian Government also established the Climate Commission in 2011 to provide all Australians with an independent and reliable source of information about climate change science, economics and international action. The Climate Commission consists of six internationally renowned climate scientists, researchers and policy and business

leaders led by Professor Tim Flannery. All of the Climate Commissioners have met with a range of business and industry leaders, community groups, local and state government representatives and the general public.

Thousands of Australians have attended 19 Climate Commission community forums to receive presentations on climate change science, impacts and opportunities, with the majority of time devoted to audience questions. Reactions to the forums have been overwhelmingly positive with 92 per cent of attendees in 2011 finding them to be good or very good.

The Commission has also produced 25 reports including major reports, regional reports and short publications aimed at a broad public audience. They draw on the latest research and are written in consultation with relevant experts and the Climate Commission's Science Advisory Panel.

To complement the work of the Climate Commission and the Clean Energy Future campaign, the government established the $3 million Climate Change Grant Program in 2011. The program's aim was to assist the Australian public to understand the need to act on climate change. The grant-based program provided organisations the opportunity to engage the community on climate change issues and to highlight activities that demonstrate the opportunities associated with Australia moving to a clean energy future.

At the same time, the Government established the Low Income Energy Efficiency Program, a merit-based grant program to provide grants to a consortia of government, business and community organisations to trial approaches to engage low-income households on climate change and to assist them to improve energy efficiency. The Energy Efficiency Information Grants program was also announced at this time – refer to section 9.2 for more information.

Preceding the Clean Energy Future Plan, but providing a strong educative and community awareness raising role, was the Government's commissioning of Professor Ross Garnaut in 2010 to update his landmark Garnaut Climate Change Review (the Review) completed in 2008. The Review examined the impacts of climate change on the Australian economy and recommended medium to long-term policies and policy frameworks to improve the prospects of sustainable prosperity in the context of climate change.

The Garnaut Climate Change Review Update 2011 (the Update) released six papers outlining developments in key climate change policy areas such as carbon pricing, land, innovation and the electricity sector. The Update was subject to intense media attention and broadened awareness of climate change amongst Australian businesses and households. Professor Garnaut visited every state and territory in Australia to address a range of specialist and public forums and lectures and engage businesses and communities in the public policy climate change debate.

Also in 2010, the Government provided funding for the Australian Academy of Science (AAS) to independently produce a report on The Science of Climate Change: Questions

and Answers. This publication explains the current situation in climate science, including where there is consensus in the scientific community and where uncertainties exist. The document was prepared by a working group of nine AAS members and reviewed by an oversight committee of seven AAS members. Since the publication was launched in August 2010, it has been downloaded more than 800 000 times from the AAS website and is currently viewed approximately 27 000 times per month. The AAS has distributed 68 000 hard copies of the booklet, with every Australian high school and all Australian local government authorities receiving a copy.

The Government also holds regular Community Cabinet meetings in various locations around Australia to allow direct engagement with the community on important questions facing Australian society. Community Cabinet meetings comprise of ministerial meetings with small groups or individuals plus a public forum that concludes with questions from the floor. Community Cabinet meetings have provided an excellent opportunity to allow local community groups and individuals to learn more about the government's policy agenda, including the Clean Energy Future Plan and the government's progress in implementing its climate change measures.

Australia's official statistical organisation, the Australian Bureau of Statistics (ABS) oversees a number of programs that include energy statistics, environmental accounts and a range of survey programs across businesses (including agriculture) and households. The ABS Centre for Environment and Energy Statistics seeks to complement and add value to existing statistical activity through active partnerships with key agencies, including the states and territories. Since Australia's Fifth National Communication, the ABS has released a range of reports and data on energy use and conservation, waste management and public perception of environmental issues. A new household survey was announced as part of the Clean Energy Future Plan that will gather and communicate data on household sector energy consumption and expenditure. The survey will collect data to support:

- innovative solutions to improving household energy efficiency;
- the design of new energy efficiency policies which will require granulated and high-quality data on household energy use;
- the design of existing energy efficiency standards for buildings and appliances; and
- a better understanding of power pricing options.

9.1.4 State and territory programs

State and territory government public information campaigns tend to focus on educating and driving behavioural change in local communities and businesses. The campaigns inform people about simple actions they can take to save energy, reduce water use and minimise waste in their daily lives. A number of the major activities are outlined below.

The Australian Capital Territory (ACT) Government initiated the Home Energy Advice Team (HEAT) Energy Audit in December 2004, which provided a comprehensive home energy audit delivered to households in the territory. Each audit included a detailed written report with a list of practical actions a household could take to make a home more

comfortable and energy efficient. The ACT Government provided a rebate when priority recommendations in a HEAT Energy Audit report were addressed. The program concluded in April 2013 and some 7,297 households benefited over the life of the program.

The ACT Government also currently provides support to low income households to improve energy and water use through the Low Income Program delivered in partnership with a number of community organisations. All households can utilise a do-it-yourself Home Energy Action Kit to perform an energy audit. The kit was fine-tuned through experience gained through the delivery of the HEAT Energy Audit program and comprises equipment, instructions and worksheets that assist households to find practical ways to save energy around their home and to reduce energy bills and greenhouse gas emissions.

The Queensland Government, through industry collaboration with the Chamber of Commerce, Industry Queensland and the Australian Centre for Sustainable Business and Development at the University of Southern Queensland, is supporting the ecoBiz program. The ecoBiz program provides self-assessment tools, training and information to assist Queensland businesses to improve their energy, water, waste and financial efficiency.

Since 2009, the South Australian Government has operated a Residential Energy Efficiency Scheme (REES). The REES is an energy efficiency scheme that assists South Australian households to reduce energy consumption, lowering their energy costs and greenhouse gas emissions. It requires larger energy providers to achieve targets in helping households to save energy. Energy providers met these targets by delivering energy audits and energy efficiency activities such as installing energy efficient light globes, water efficient showerheads and stand-by power controllers.

The Tasmanian Government offers two grants programs to help communities adapt to climate change and reduce their carbon footprint. The ClimateConnect grants program has awarded 30 grants of up to $20,000 over five funding rounds. Projects range from assessment of the vulnerability of Tasmanians to the risk of new vector-borne diseases and regional climate change adaptation planning. The Earn Your Stars program has awarded 23 grants of up to $15,000 over four funding rounds. Projects range from a state-wide behaviour change campaign to educate Tasmanians about sustainable food practices to educating Tasmania's graphic design community about the value of incorporating eco-design principles into every aspect of their work.

The Tasmanian Government has also committed $6 million to provide ongoing energy efficiency programs for public housing tenants during 2012-13 and 2013-14. This measure is designed to overcome information barriers that prevent the uptake of energy efficiency measures. The measure also addresses a range of other policy objectives including responding to cost-of-living pressures.

The Western Australian Government runs Switch the Future jointly with the Future Energy Alliance; Western Power, Synergy and Horizon Power. This alliance has been

working together since 2010 with the goal of encouraging Western Australians to be mindful of their energy use through provision of tips and tools on energy use and options for enhanced efficiency.

The Northern Territory Government funds COOLmob, a sustainable living project of the Environment Centre NT which works with households and the community to help them reduce greenhouse gas emissions through a range of activities. In 2013, COOLmob are running the NT Solar Summit, which features keynote speakers on implementing residential and commercial solar projects, and COOLmob's Sustainable Living Family Day, which hosts workshops, games and activities and interactive talks for children on sustainable initiatives.

9.5 Public access to information

Australians are increasingly seeking access to information on climate change. Indeed, providing and disseminating knowledge is a key part of building Australia's response to climate change. The federal, state and territory governments have supported the development of online information, tools and resources that individuals, communities and business groups can access to help them understand climate change and to facilitate direct action to address climate change.

9.5.1 Public resources and information

Information materials and websites are regularly updated to provide the Australian public with the latest information about government action on climate change and to help stakeholders and the general public better understand the purpose and requirements of climate change legislation and policies.

A core component of the Clean Energy Future campaign in 2011 was the development of a 20-page Helping Households booklet that was mailed to every Australian household. This booklet and explained why the Australian government had chosen to implement a carbon price and what impact it would have on households. The campaign also featured the highly detailed Clean Energy Future website (www.cleanenergyfuture.gov.au) which provides a key avenue to distribute information products about the comprehensive array of climate change measures the government has implemented.

In early 2013, the Government released the Clean Energy Future Map (www.cleanenergymap.gov.au): an interactive, online, map-based tool that brings together government initiatives that are helping shape Australia's clean energy transformation. The Clean Energy Future Map shows the extent of the transformation already taking place across businesses, communities and households as Australia pursues a low-carbon future.

The CSIRO and BoM provide a range of relevant climate information on their websites including user-friendly summaries of historical and recent climate trends in Australia. The two organisations have jointly published two State of the Climate reports that provide a summary of observations of Australia's climate, and analysis of influencing factors. The

State of the Climate 2012 notes that the long-term warming trend has not changed, with each decade having been warmer than the previous decade since the 1950s.

There are also specific online resources that are designed to help the Australian public navigate the substantial volumes of information on climate change and related issues. The LivingGreener website (www.livinggreener.gov.au) provides the Australian community with a single entry point to relevant federal, state and local government energy, water, waste and transport efficiency programs. The online portal makes it easier for Australians to access information about what they can do and what assistance is available to help them make better environmental decisions. The site provides information on government initiatives and also provides a range of ancillary information to help Australians minimise their environmental footprint and save on energy bills. The site was launched in 2008 and funding to expand the website was announced as part of the Clean Energy Future Plan in 2011.

Similarly, Your Home is a guide to designing and building homes with lower energy and water use and greater overall sustainability, including a website (www.yourhome.gov.au) and a detailed technical manual. Your Home provides advice to householders and is also used in a range of technical training around Australia. A fifth version of Your Home with updated technical content reflecting new technologies, issues and practices will be released around the middle of 2013.

9.5.2 Specialised and technical information

The government and state and territory governments have developed specialised or technical information, tools and resources to meet the requirements of businesses and individuals working in the commercial, industrial or agricultural sectors in technical roles such as engineers, marine scientists, planners or natural resource managers.

The government, in conjunction with state and territory governments developed the Energy Efficiency Exchange (www.eex.gov.au), a website that aims to support the development and implementation of energy management and energy efficiency strategies by providing quality information from respected national and international sources in one location. The site is intended for use by medium to large Australian energy-using companies, defined as companies using more than 0.1 petajoules of energy per year (equivalent to 2,000 households). It seeks to complement other energy efficiency initiatives administered by Australian governments, such as the Energy Efficiency Opportunities Program and capacity-building activities under the National Strategy on Energy Efficiency (refer to Chapter 4 for more information on these policies and measures).

The government has also established the Carbon Farming Skills program, to provide land managers with access to credible, high quality advice and carbon services. The program was set up to fund the development of a new nationally accredited qualification for carbon service providers and accreditation of individuals and organisations providing services under the Carbon Farming Initiative (CFI). Complementing this program is the CFI Communications Program that provides farmers, land managers and their key influencers with credible, clear and consistent information on the CFI.

Through the Carbon Farming Futures (CFF) measure, the government is providing $286 million over six years towards the research, demonstration and extension of abatement practices that will allow land managers to integrate practices to improve soil carbon, reduce emissions from livestock and crops, and enhance sustainable agricultural practices. Under the CFF, the Filling the Research Gap program is providing $124 million over six years for research into emerging abatement technologies, strategies and innovative management practices that reduce greenhouse gas emissions from the land sector, diversify land sector income, sequester carbon and enhance sustainable agricultural practices. It also includes a national survey conducted by the ABS to identify common farming practices across different regions, which is being used to underpin the CFI additionality test and the development of offset methodologies.

The CFF builds on research undertaken through Australia's previous Climate Change Research Program, and targets current research gaps around abatement technologies and practices, including research priorities on reducing methane emissions, reducing nitrous oxide emissions, sequestering carbon and improving modelling capability.

Research outcomes will underpin the development of new abatement methodologies that land managers can use to participate in the CFI. Two funding rounds have been released to date, with 57 grants valued at $47 million in Round One and 31 grants valued at $30 million in Round Two.

Additionally, the CFF is providing $45 million over six years through the Extension and Outreach program. This program facilitates dissemination of information, support and an extension network to help farmers to participate in land sector emissions reduction activities and the CFI. Activities supported by the program will assist farmers, land managers and key influencers to reduce land sector greenhouse gas emissions, sequester carbon in the landscape and participate in the CFI. To achieve this, the program will fund extension providers who will operate within the existing extension networks; support the production of extension materials, case studies and decision support tools; establish a suite of additional delivery channels, including electronic media; and facilitate networking and dialogue amongst stakeholders. Under the first assessment phase, the program will invest in 24 projects valued at $21.3 million.

The Victorian Government has developed a range of information about climate variability, climate change and emissions for the agriculture industry. The Victorian Department of Environment and Primary Industries (DEPI) provide monthly climate updates which explain recent climate drivers in Victoria and Australia and forecast upcoming conditions. DEPI also produces a seasonal climate newsletter for broadacre industries and developed a series of animations called The Climatedogs to explain four key global climate processes to farmers. The Climatedogs was officially selected to screen at the Festival of Science Film in 2011.

9.6 International activities

The government is committed to assisting other countries – especially developing countries that are particularly vulnerable to climate change, to adapt to the unavoidable

impacts of climate change and to reduce their greenhouse gas emissions. Accordingly, the government actively participates in sharing its experiences and climate change policies with other countries.

9.6.1 Knowledge sharing and capacity building

Australia is committed to strengthening strategic adaptation planning capacity in the Pacific. The International Climate Change Adaptation Initiative (ICCAI) aims to increase understanding in partner countries of the impacts of climate change on their natural and socio-economic systems. The government is particularly committed to maintaining its close links with the Pacific. The Pacific–Australia Climate Change Science and Adaptation Planning (PACCSAP) program has been designed to assist communities across the Pacific to better understand and respond to climate change impacts, particularly in relation to infrastructure, coastal zone management and cross-sectoral planning.

The government also implemented the Pacific Adaptation Strategy Assistance Program under the ICCAI. The program is designed to strengthen the capacity of Pacific island countries and Timor-Leste to assess their vulnerabilities to climate change and develop adaptation strategies. It developed in close consultation with partner countries and regional organisations and included country-specific activities and a regional overview to describe regional trends and variability in climate change impacts, vulnerability and adaptive capacity.

The Pacific Climate Change Science Program (PCCSP), which was funded by the Australian Agency for International Development (AusAID), was managed by the former Department of Climate Change and Energy Efficiency (DCCEE). PCCSP was delivered by a partnership between the BoM and CSIRO during the period 2009- 2011, provided critical climate research and commenced important steps in capacity building in Pacific island countries.

The Asia Pacific (AP) Seminars, held annually since January 1991, serve as a useful regional vehicle to discuss major climate change issues from a technical point of view. The AP Seminars are a Japanese initiative structured around informative presentations and discussions between participants. Since 2004, Australia has partnered with Japan in the delivery of the seminars including; the 19th session held in Japan which focused on Monitoring, Reporting and Verification (MRV), the 20th session in Thailand on adaptation, the 21st session in Japan on technology development, and the 22nd session in Vietnam on MRV of mitigation and monitoring and evaluation of adaptation.

Recognising the complexity of UNFCCC process and the importance held by Small Island Developing States (SIDS) in reaching an ambitious agreement in 2015, the government announced a negotiator training initiative at the Pacific Islands Forum in August 2012. The program aims to improve the negotiator skills and knowledge for SIDS officials currently engaged in the UNFCCC negotiations. The program will also help build the capacity of junior officials expected to form the next generation of representatives at

future climate talks. This will be done through in-person training workshops, including simulated negotiation exercises, and tailored resources.

9.6.2 Research and scholarships

In December 2011, the then Minister for Climate Change and Energy Efficiency, the Hon Greg Combet MP, announced the release of a landmark new research report, Climate Change in the Pacific: Scientific Assessment and New Research as part of PCCSP. This peer-reviewed publication presents the most comprehensive scientific analysis to date of climate change in the Pacific region. The report is based on three years of research by the CSIRO and BoM. It details, for the first time, possible climate futures for the Cook Islands, Fiji, Kiribati, the Marshall Islands, the Federated States of Micronesia, Nauru, Niue, Papua New Guinea, Palau, Samoa, the Solomon Islands, Tuvalu, Tonga, Vanuatu and Timor-Leste. To ensure that information is accessible to Pacific island countries, country-specific information brochures were produced in English and 15 local languages. Minister Combet also launched a climate futures web tool that allows decision-makers and planners in partner countries to access specific information on climate risks for their local area.

The AusAid-CSIRO Research for Development Alliance is a strategic research partnership that brings together the research skills of CSIRO with AusAID's development expertise. AusAID has provided $12.8 million to support the Alliance from 2008 to 2013 for research projects on key themes including climate adaptation, water resources, sustainable cities and energy. Projects are being conducted in the Greater Mekong Region, Bangladesh, Vietnam and Indonesia.

One of the projects in Vietnam is refining climate models to improve weather forecasting and increase food production. AusAID has also established a new $10 million partnership with the Centre for International Forestry Research, which is a non-profit global research centre working on forest management in less-developed countries.

Australia Awards Scholarships are long term development awards administered by AusAID. They aim to contribute to the long term development needs of Australia's partner countries in line with bilateral and regional agreements. The scholarships provide opportunities for people from over 80 developing countries to undertake full time undergraduate or postgraduate study at participating Australian tertiary institutions. The study and research opportunities provided by Australia Awards Scholarships develop skills and knowledge of individuals to drive change and contribute to the development outcomes of their own country - including in climate change where that is an identified national priority.

9.6.3 Partnerships

The government values and continues to support activities under bilateral partnership agreements with key developed and developing countries including the United States, China and Indonesia.

Australia's International Forest Carbon Initiative aims to demonstrate that reducing emissions from deforestation and forest degradation in developing countries (REDD+) can be part of an equitable and effective future global agreement on climate change.

As co-chair of the REDD+ Partnership (with the Democratic Republic of the Congo), the then Department of Climate Change and Energy Efficiency increased private sector participation in the partnership. Australia also increased its contribution to the World Bank's Forest Carbon Partnership Facility, thereby increasing capacity to influence decisions and ensuring that a greater pool of resources are available to support REDD+ development.

Australia is co-Chair and Board member of the Green Climate Fund, which is a new international fund being established to help poor people adapt to the major development challenges posed by climate change and to contribute to global emissions reductions.

In December 2009, the government-level Australia-China Memorandum of Understanding (MoU) on climate change activities was extended until 2014. A new MoU between the then Department of Climate Change and Energy Efficiency (now the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education) and China's National Development and Reform Commission was also signed to enhance interagency collaboration. A number of workshops have since been conducted to enhance China's capacity to measure and report their greenhouse gas emissions.

The International Carbon Action Partnership is a forum to share experiences and knowledge and was established to assist in the development of a global carbon market.

In 2012-13, the Australian Government provided funding for an addition to the delivery of the partnership's primary capacity building initiative – the 2013 Summer School on Emission Trading for Emerging and Developing Countries.

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Abbreviations and Acronyms

Acronym	
AAD	Australian Antarctic Division
AADC	Australian Antarctic Data Centre
AAS	Australian Academy of Science
AAUs	assigned amount units
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
ACCESS	Australian Community Climate and Earth System Simulator
ACE CRC	Antarctic Climate and Ecosystems Cooperative Research Centre
ACCSP	Australian Climate Change Science Program
ACCU	Australian carbon credit unit
ACIAR	Australian Centre for International Agricultural Research
AEMO	Australian Energy Market Operator
AGEIS	Australian Greenhouse Emissions Information System
AIMS	Australian Institute of Marine Science
ALGA	Australian Local Government Association
ANAO	Australian National Audit Office
ANREU	Australian National Registry of Emissions Units
ANU	Australian National University
AODN	Australian Ocean Data Network
AP	Asia Pacific
APPEA	Australian Petroleum Production and Exploration Association
ARENA	Australian Renewable Energy Agency
ARI	Arthur Rylah Institute for Environmental Research
ASI	Australian Solar Institute
AusAID	Australian Agency for International Development

Acronym	
AVHRR	Advanced Very High Resolution Radiometer
Axis	Apache Axis1
AYCC	Australian Youth Climate Coalition
BEEC	Building Energy Efficiency Certificate
BREE	Bureau of Resources and Energy Economics
BoM	Bureau of Meteorology
C3E	Clean Energy Education and Empowerment
CAA	Climate Action Australia
CASPI	Climate Adaptation Science and Policy Initiative
CAWCR	Centre for Australian Weather and Climate Research
CBD	Commercial Building Disclosure
CC	Climate Change
CCF	Climate Change Fund
CCS	carbon capture and storage
CCUS	Carbon Capture, Use and Storage
CEEP	Community Energy Efficiency Program
CEF	Clean Energy Future
CEFC	Clean Energy Finance Corporation
CEM	Clean Energy Ministerial
CER	Clean Energy Regulator
CESC	Clean Energy Solutions Centre
CFI	Carbon Farming Initiative
CFF	Carbon Farming Futures
CFLs	compact fluorescent lamps
CGE	Computable General Equilibrium
CIE	Centre for International Economics
CIF	Climate Investment Funds
CIFOR	Centre for International Forestry Research
CMAs	Catchment Management Authorities
CMAS	Charities Maritime and Aviation Support Program
CMATSP	Coal Mining Abatement Technology Support Package
CMI	carbon market instruments

Acronym	
CMIP5	Coupled Model Intercomparison Project Phase 5
CO2CRC	Cooperative Research Centre for Greenhouse Gas Technologies
COAG	Council of Australian Governments
COBIT	Control Objectives for Information and related Technology
COD	chemical oxygen demand
COP	Conference of the parties to the UNFCCC
COSPPac	Climate and Oceans Support Program in the Pacific
CPM	Carbon Pricing Mechanism
CPRS	Carbon Pollution Reduction Scheme
CRC	Cooperative Research Centre
CRIS	Collaborative Research Infrastructure Scheme
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSLF	Carbon Sequestration Leadership Forum
DCCEE	Department of Climate Change and Energy Efficiency
DEEDI	QLD Department of Employment, Economic Development and Innovation
DES	Data Exchange Standards for Registry Systems under the Kyoto Protocol
DGR	deductible gift recipient
DIICCSRTE	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
DPI	The Victorian Department of Environment and Primary Industries
DOIC	Domestic Offsets Integrity Committee
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
E3	Equipment Energy Efficiency
EEGO	Energy Efficiency in Government Operations
EEO	Energy Efficiency Opportunities
EIF	Education Investment Fund
eMII	eMarine Information Infrastructure

Acronym	
EnDev	Energising Development partnership
ENSO	El Niño - Southern Oscillation
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ESAA	Energy Supply Association of Australia
ESI	Energy Savings Initiative
ESM	Energy Sector Model
ESS	Earth Smart Science
ETS	Emissions Trading Scheme
EU	European Union
EU ETS	European Union Emissions Trading Scheme
FCCC	Framework Convention on Climate Change
FCPF	Forest Carbon Partnership Facility
FCS	Forest Carbon Study
FIP	Forest Investment Program
FSM	Federated States of Micronesia
FullCAM	Full Carbon Accounting Model
GAW	Global Atmosphere Watch Programme
GCOS	Global Climate Observing System
GCP	Global Canopy Programme
GDP	gross domestic product
GEA	Global Energy Assessment
GEF	Global Environment Facility
GEMS	Greenhouse and Energy Minimum Standards
GFCS	The Global Framework for Climate Services
GGAP	Greenhouse Gas Abatement Program
GHG	greenhouse gas
GMI	Global Methane Initiative
GOOS	Global Ocean Observing System
GO-SHIP	Global Ocean Ship-Based Hydrographic Investigations Program
GPS	global positioning system
GSEP	Global Superior Energy Partnership

Acronym	
HCFC	Hydrochlorofluorocarbon
HEAT	Home Energy Advice Team
HESS	High Efficiency Systems Strategy
HESS	Home Energy Saver Scheme
HFCs	hydrofluorocarbons
HLCG	High Level Coordination Group
HVAC	Heating Ventilation and Air Conditioning
IAFCP	Indonesia-Australia Forest Carbon Partnership
ICAO	International Civil Aviation Organisation
ICCAI	International Climate Change Adaptation Initiative
ICCF	Indigenous Carbon Farming Fund
IEA	International Energy Agency
IEE	International Energy Efficiency
IFCI	International Forest Carbon Initiative
IGBP	International Geosphere-Biosphere Program
IIASA	International Institute for Applied Systems Analysis
IIS	Microsoft Internet Information Services 7
IMO	International Maritime Organisation
IMOS	Integrated Marine Observing System
INCAS	Indonesia National Carbon Accounting System
IOCI	Indian Ocean Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
IPEEC	International Partnership for Energy Efficiency Cooperation
IPGT	International Partnership for Geothermal Technology
IRENA	International Renewable Energy Agency
IRVA	Integrated Regional Vulnerability Assessment
ISGAN	International Smart Grid Action Network
ISO	International Standards Organisation
ITL	International transaction log
IUGG	International Union of Geodesy and Geophysics
JCG	Australia-China Joint Coordination Group on Clean Coal Technology

Acronym	
JCPAA	Joint Committee of Public Accounts and Audit
KFCP	Kalimantan Forests and Climate Partnership
KP	Kyoto Protocol
LCAL	Low Carbon Australia Limited
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
LECBP	Low Emissions Capacity Building Programme
LEDS	Low Emissions Development Strategies
LGEEP	Local Government Energy Efficiency Program
LNG	liquefied natural gas
LPG	Liquefied Petroleum Gas
LRET	Large-scale Renewable Energy Target
LULUCF	land use, land-use change and forestry
MARPOL	International Convention for the Prevention of Pollution from Ships
MDB	Multilateral Development Banks
MDBA	Murray-Darling Basin Authority
MODIS	Moderate Resolution Imaging Spectroradiometer
MPCCC	Multi-Party Climate Change Committee
MRP	Market Readiness Proposals
MRV	measurement, reporting and verification
MSI	Monash Sustainability Institute
NABERS	National Australian Built Environment Rating System
NAMAs	Nationally Appropriate Mitigation Actions
NAPAs	National Adaptation Programs of Action
NARCliM	NSW/ACT Regional Climate Model
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
NCCARF	National Climate Change Adaptation Research Facility
NCPP	National Climate Projections Program
NCRIS	National Collaborative Research Infrastructure Strategy

Acronym	
NEM	National Electricity Market
NERAG	National Emergency Risk Assessment Guidelines
NEXIS	National Exposure Information System
NFI	National Forest Inventory
NGERS	National Greenhouse and Energy Reporting System
NGGI	National Greenhouse Gas Inventory
NHMRC	National Health and Medical Research Council
NIWA	New Zealand National Institute of Water and Atmospheric Research
NLECI	National Low Emissions Coal Initiative
NMS's	National Meteorological Services
NMVOC	Non-methane volatile organic compounds
NPA-NDR	National Partnership Agreement on Natural Disaster Resilience
NPEI	National Plan for Environmental Information
NPSI	National Plan for School Improvement
NRM	Natural Resources Management
NRM Fund	Regional Natural Resource Management Planning for Climate Change Fund
NSEE	National Strategy on Energy Efficiency
NWI	National Water Initiative
ODA	Overseas Development Assistance
OECD	Organisation for Economic Co-operation and Development
OSCAR	Online System for Comprehensive Activity Reporting
PA	Partnership Assembly
PACCSAP	Pacific-Australia Climate Change Science and Adaptation Planning
PAGES	Past Global Changes
PALS	Pacific Appliance Labelling and Standards
PASAP	Pacific Adaptation Strategy Assistance Program
PCCSP	Pacific Climate Change Science Program
PDR	People's Democratic Republic
PFC	Perfluorocarbon

Acronym	
PICTs	Pacific Island Countries and Territories
PMR	Partnership for Market Readiness
PNG	Papua New Guinea
QA	Quality Assurance
QC	Quality Control
RAN/RAD GRK	Secretariat responsible for facilitating implementation of the National Action Plan to Reduce Greenhouse Gas Emissions in Indonesia
REBS	Renewable Energy Bonus Scheme
RECCAP	Regional Carbon Cycle Assessment and Processes
REDD	reduce emissions from deforestation and degradation
REDD+	Reducing emissions from deforestation and forest degradation in developing countries
REES	Residential Energy Efficiency Scheme
RET	Renewable Energy Target
RMI	Republic of the Marshall Islands
SCC	Select Council on Climate Change
SCF	Strategic Climate Fund
SE4ALL	United Nations Sustainable Energy for All
SEACI	South-East Australian Climate Initiative
SEAD	Super-efficient Equipment and Appliance Deployment
SIDS	Small Island Developing States
SGLP	Strong growth, low pollution: Modelling a carbon price
SGSC	Smart Grid, Smart City
SHARE	Supporting High-value Australian Renewable Energy
SKM-MMA	Sinclair Knight Merz McLennan Magasanik Associates
SLEEK	System for Land-based Emissions Estimation in Kenya
SOAP	Simple Object Access Protocol
SOOP	Ship of Opportunity Programme
SPC	Secretariat of the Pacific Community
SRES	Small-scale Renewable Energy Scheme

Acronym	
SREX	Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
SRI	United States - Australia Solar Energy Collaboration Strategic Research Initiative
SSL	Secure Socket Layer
STCs	Small-scale Technology Certificates
TAC	Technical Advisory Committee
TAFE	Technical and Further Education
TCCON	Total Column Carbon Observing Network
TERN	Terrestrial Ecosystem Research Network
UCC	University Climate Consortium
UNFCCC	United Nations Framework Convention on Climate Change
WALFA	West Arnhem Land Fire Abatement
WSDL	Web Service Definition Language
VET	vocational education and training
XBT	eXpendable BathyThermograph

Units	
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
Mt	million tonnes
NMVOCs	non-methane volatile organic compounds
N_2O	nitrous oxide
NO_x	oxides of nitrogen
PJ	petajoules
SF_6	sulphur hexafluoride
SO_2	sulphur dioxide

Glossary

Abatement refers to emissions reductions that would not have occurred the in the absence of a measure (e.g. carbon price abatement).

Abatement challenge the amount of abatement required from the carbon price and Carbon Farming Initiative to meet the 2020 target range

Adaptation an adjustment in natural or human social or economic systems in response to actual or expected climate change that moderates harm or exploits beneficial opportunities

Cap-and-trade scheme an emissions trading regime in which a limit (or cap) is placed on the total emissions allowable from the activities or sectors covered under the scheme. Tradeable emissions units are issued up to an amount equal to the cap

Carbon budget the total national emissions allowed under internationally agreed targets

Carbon capture and storage technology to capture and store greenhouse gas emissions from energy production or industrial processes. Captured greenhouse gases have the potential to be stored in a variety of geological sites

Carbon dioxide (CO_2) a naturally occurring gas; it is also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the earth's temperature

Carbon dioxide equivalent (CO_2-e) a standard measure that takes account of the different global warming potential of different greenhouse gases and expresses the cumulative effect in a common unit

Carbon market a trading system used by countries meet their national limits on emissions allowing participants buy or sell units of greenhouse-gas emissions. A carbon market may include a single emissions trading scheme or a series of linked emissions trading schemes applying across different jurisdictions

Carbon price emissions trading scheme plus effective carbon price on some transport fuels and synthetic greenhouse gases, as introduced under the Clean Energy Future Plan from 1 July 2012

Carbon sink natural or man-made systems that absorb and store carbon dioxide from the atmosphere, including trees, plants and the oceans

Climate models a numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties.

Covered sectors sectors that are covered by an emissions trading scheme and attract an obligation to surrender carbon pollution permits or eligible international units

Deforestation the conversion of forested land to an alternative, non-forest use

Domestic emissions Australia's emissions level before accounting for the purchase of international permits to help meet national emissions targets

El Niño - Southern Oscillation (ENSO) the oscillation between El Niño and La Niña conditions. El Niño refers to the extensive warming of the central and eastern tropical Pacific Ocean, which leads to a major shift in weather patterns across the Pacific. El Niño conditions are associated with drier conditions in eastern Australia. The La Niña phase is characterised by cooler than average sea surface temperatures in the central and eastern tropical Pacific Ocean. La Niña conditions are associated with higher than average winter, spring and early summer rainfall over much of Australia

Emissions the release of greenhouse gases into the atmosphere

Energy efficiency something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input

Energy security the uninterrupted availability of energy sources at an affordable price

Extreme weather event an event that is rare at a particular place and time of year. 'Rare' can be defined as being in the 10th or 90th percentile of the probability observed from past trends

Fast-start finance the collective pledge made by developed countries, during the 15th Conference of the Parties held in December 2009 in Copenhagen, to provide new and additional resources approaching USD 30 billion for the period 2010 - 2012, including forestry and investments, and balanced between mitigation and adaptation

Fixed-price period a period in an emissions trading scheme where the price of carbon units is fixed by the Government rather than determined by the market

Forest degradation a direct human-induced activity that leads to a long-term reduction in forest carbon stocks

Fugitive emissions greenhouse gas emissions that are released in connection with, or as a consequence of, the extraction, processing, storage or delivery of fossil fuel. Fugitive emissions do not include emissions released from the combustion of fuel for the production of useable heat or electricity

Geosequestration the deep geological storage of carbon dioxide from major industrial sources such as: fossil fuel-fired power stations, oil and natural gas processing, cement manufacture, iron and steel manufacture and the petrochemical industry

Greenhouse gases the atmospheric gases responsible for causing global warming and climate change. The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4),

nitrous oxide (N_20), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6)

Group of 20 (G20) brings together finance ministers and central bank governors from 19 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, the Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States of America plus the European Union, which is represented by the President of the European Council and by the Head of the European Central Bank

Indian Ocean Dipole (IOD) the see-sawing nature of sea-surface temperatures in the eastern and western Indian Ocean The IOD is a major contributor to the variability of rainfall over Australia, with a positive phase of the IOD associated with drier conditions in the Australian region, and a negative phase associated with enhanced rainfall.

Indirect emissions indirect emissions are emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand of goods and services), but which are physically produced by the activities of another organisation. Examples include electricity production, 'upstream' emissions generated in the production of goods purchased or processed by the entity and 'downstream' emissions associated with transporting and disposing of products sold by the entity

Ice core a cylinder of ice drilled out of a glacier or ice sheet. Ice cores provide an archive of past climatic and environmental changes.

Kyoto Protocol First Commitment period refers to the period in which developed countries (defined as Kyoto Protocol Parties that are listed in Annex I to the UNFCCC) are required to meet the first round of their emissions reduction obligations under the Kyoto Protocol. The Kyoto Protocol's first commitment period is from 2008 to 2012

Kyoto Protocol Second Commitment period refers to the period in which countries that have taken on a second round of commitments under the Kyoto Protocol are required to meet these commitments. Under amendments agreed at the 2012 UNFCCC Conference of the Parties the second commitment period is from 2013 to 2020

Kyoto Protocol an international treaty created under the UNFCCC in 1997. It entered into force in 2005. Among other things, the Kyoto Protocol sets binding targets for the reduction of greenhouse gas emissions by developed countries (defined as Kyoto Protocol Parties that are listed in Annex I to the UNFCCC). It includes individual emissions reduction targets for developed countries to be met within the first commitment period of 2008-2012 and the second commitment period of 2013-2020

Kyoto target Australia's Kyoto target is 108% of 1990 levels on average over the period 2008–12. Australia has put forward a target for the second commitment period (2013-2020) of 99.5% of 1990 levels on average

Kyoto units units issued under the Kyoto protocol, namely: assigned unit amounts, emissions reduction units, certified emissions reductions, and removal units

Land-use, land-use change and forestry (LULUCF) the umbrella term used in international climate change negotiations to refer to emissions and removals of greenhouse gases in the land sector. Emissions and removals from land-use are those that result from cropping and livestock production. Land-use change refers to the conversion of land to alternative uses, such as from forest to crop land or from grazing land to forest

Light detection and ranging (LiDAR) system a technology that allows precise estimates of terrain and tree height to be obtained from aircraft. It involves firing a laser pulse at a target and measuring the return energy as a function of time

Liable entities an entity that has an obligation under the emissions trading scheme

Measures refers to past, current or committed Australian, state or territory, or local government policy actions that reduce greenhouse gas emissions

Megadiverse the megadiverse countries are a group of countries that harbor the majority of the earth's species and are therefore considered extremely biodiverse. The World Conservation Monitoring Centre, an agency of the United Nations Environment Programme, has identified 17 megadiverse countries, most located in the tropics. Brazil, Indonesia, South Africa, Colombia and Australia harbour the most diversity

Mitigation a human intervention to reduce the sources of, or enhance the sinks for, greenhouse gases

Montreal Protocol the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted in 1987. It controls the consumption and production of chemicals that destroy stratospheric ozone, such as chlorofluorocarbons

National emissions Australia's emissions level after accounting for the purchase of international permits to help meet national emissions targets

National emissions trajectory broad guidance over the pathway of Australia's future national emissions

National Inventory Report an inventory of Australia's greenhouse gas emissions, prepared as part of Australia's National Greenhouse Accounts and used by the Australian Government to meet its international reporting obligations

Parts per million number of parts of a chemical found in one million parts of a particular gas, liquid, or solid

Paleoclimate climate during periods prior to the development of measuring instruments, including historic and geologic time, for which only proxy climate records (for example, tree rings, ice cores) are available

Projection a projection is a potential future evolution of a quantity or set of quantities, often computed with the aid of a model

Smart grid a smart grid is the application of information and communications technology to improve the efficiency and effectiveness of the generation, transmission and distribution, and usage of power

Stationary energy emissions Includes emissions from fuel consumption for electricity generation, fuels combusted in the manufacturing, construction and commercial sectors, and other sources such as domestic heating

Thermohaline circulation (THC) The large-scale circulation in the ocean that transforms low-density upper ocean waters to high-density intermediate and deep waters, and returns those waters back to the upper ocean. The THC is often referred to the 'conveyor belt' that transports heat, nutrients and oxygen around the world's oceans over a timescale of around 1000 years

Uncovered sectors sectors that are not covered by anemissions trading scheme

United Nations Framework Convention on Climate Change an international treaty, adopted in 1992, aimed at achieving the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system

With carbon price scenario corresponds to the UNFCCC 'with measures' scenario, includes impact of all existing policies and measures

With measures refers to the 'best estimate' of future emissions levels, adopting the most likely assumptions and modelling parameters. Corresponds to the "with carbon price" scenario

Without carbon price scenario refers to emissions that would occur in the absence of the carbon price and CFI. Includes a range of existing policies and measures such as the Renewable Energy Target (RET) and energy efficiency measures which were in place at 1 July 2012

ANNEX

Australia's Biennial Report 1

ANNEX
AUSTRALIA
Biennial Report 1

1. Introduction 1-2
2. Information on GHG emissions and trends 2-2
3. Quantified Economy-wide Emission Reduction Target (QEERT) 3-27
4. Progress in achievement of QEERT 4-37
5. Projections 5-47
6. Provision of financial, technological and capability-building support to developing country Parties 6-51
7. Other reporting elements 7-74

Biennial Report 1: Australia

1. Introduction

Australia is pleased to submit its first Biennial Report.

2. Information on GHG emissions and trends

Summary information on greenhouse gas emissions and trends

Since its Fifth National Communication on Climate Change (NC5), Australia has:

- more accurate and comprehensive emissions estimates following the adoption of new data, methods and source/sink categories;
- incorporated data collected under the National Greenhouse and Energy Reporting Act 2007 into the national inventory; and
- improved the national inventory system through strengthening of the planning and quality control systems.

In 2011, Australia's total greenhouse gas emissions – excluding the Land-Use, Land-Use Change and Forestry (LULUCF) sector – were 552 Million tonnes (Mt) carbon dioxide equivalent (CO_2 eq). Energy-related emissions dominate Australia's emissions profile: contributing 76 per cent of total emissions in 2011, while emissions associated with the agriculture sector are also a significant component (15 per cent) of the inventory. Emissions from the industrial processes (6 per cent) and waste (2 per cent) sectors are relatively minor. When LULUCF sector emissions and removals (-40 Mt CO_2-e) are included in the total, Australia's net greenhouse gas emissions fall to 512 Mt CO_2-e.

Australia's total greenhouse gas emissions (excluding the LULUCF sector) increased by 32 per cent between 1990 and 2011. When the LULUCF sector emissions and removals are included, Australia's net greenhouse gas emissions in 2011 decreased by 2 per cent compared with 1990 levels.

In 2011 carbon dioxide had the largest share of Australia's inventory (71 per cent), followed by methane (22 per cent) and nitrous oxide (5 per cent). Other greenhouse gases made up the remaining 2 per cent of Australia's inventory.

Summary information on Australia's national inventory arrangements, including changes since Australia's NC5, are detailed in Chapter 3 of Australia's 6th National Communications (NC6).

For more information see Chapter 3 of NC6 and Common Tabular Format (CTF) Table 1.

CTF Table 1 Greenhouse Gas Emissions (kt CO_2 eq)

Greenhouse Gas Emissions	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	kt CO_2 eq																							(%)
CO_2 emissions including net CO_2 from LULUCF	377 446	377 446	423 853	364 497	301 559	302 783	323 261	336 834	335 041	381 344	345 497	408 441	347 608	450 041	588 890	327 728	402 148	376 357	496 519	368 957	440 954	439 966	363 518	-4%
CO_2 emissions excluding net CO_2 from LULUCF	277 902	277 902	279 323	284 493	288 497	293 245	303 863	311 413	319 727	332 963	342 786	349 419	355 728	360 064	367 465	381 111	384 750	389 441	396 847	403 088	405 049	406 209	406 602	46%
CH_4 emissions including net CH_4 from LULUCF	120 901	120 901	122 777	120 029	116 415	114 466	115 195	114 778	117 601	118 118	115 891	118 350	121 578	119 400	122 572	115 924	116 850	117 022	120 725	118 270	115 345	114 068	114 171	-6%
CH_4 emissions excluding net CH_4 from LULUCF	116 127	116 127	116 190	115 477	113 318	110 317	112 187	111 355	114 510	114 499	113 207	115 635	117 639	114 625	111 551	112 868	112 864	113 509	114 639	115 357	112 361	110 552	112 569	-3%
N_2O emissions including net N_2O from LULUCF	20 401	20 401	20 794	20 383	20 538	21 162	21 949	23 110	23 907	24 873	25 338	26 900	28 465	28 370	29 520	27 387	27 508	27 364	27 571	27 122	26 374	26 353	26 199	28%
N_2O emissions excluding net N_2O from LULUCF	18 416	18 416	18 551	18 640	19 256	19 622	20 636	21 632	22 576	23 157	24 097	25 557	26 979	26 614	25 977	26 092	25 882	25 977	25 308	25 661	24 984	24 575	25 065	36%

HFCs	1 126	1 126	1 126	1 054	1 447	812	813	384	641	872	1 150	1 357	1 936	2 447	2 978	3 528	4 098	4 505	5 068	5 693	6 278	7 021	7 641	578%
PFCs	3 950	3 950	3 953	3 947	2 843	1 856	1 313	1 209	1 053	1 424	977	1 104	1 545	1 481	1 444	1 469	1 536	589	500	381	308	244	259	-93%
SF_6	221	221	240	259	278	296	317	283	260	234	206	200	206	212	216	218	191	181	170	158	143	145	149	-33%
Total (including LULUCF)	524 046	524 046	572 743	510 169	443 079	441 375	462 848	476 598	478 504	526 865	489 057	556 351	501 338	601 952	745 621	476 254	552 331	526 018	650 552	520 582	589 403	587 798	511 939	-2%
Total (excluding LULUCF)	417 742	417 742	419 383	423 869	425 638	426 149	439 128	446 276	458 768	473 149	482 422	493 272	504 033	505 443	509 630	525 285	529 321	534 201	542 531	550 339	549 123	548 744	552 286	32%

CTF Table 1 Greenhouse Gas Source and Sink Categories (kt CO_2 eq)

Greenhouse Gas Source and Sink Categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(kt CO_2 eq)																							(%)
1. Energy	289 155	289 155	291 013	297 033	300 338	301 852	313 573	320 868	331 791	345 418	352 020	361 191	367 835	371 277	377 830	392 159	398 269	402 480	411 975	419 011	422 276	421 556	422 040	46%
2. Industrial processes	24 670	24 670	23 948	24 587	24 387	24 590	24 362	24 262	24 393	25 570	25 972	25 816	26 838	27 430	28 560	29 895	29 098	29 283	30 916	31 324	29 709	32 067	33 313	35%
3. Solvent and other product use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture	86 507	86 507	87 046	85 033	83 797	83 150	84 643	85,918	87,528	87,738	89,895	92,219	95,132	92,414	89,815	90,169	89,080	89,822	86,714	86,676	83,860	81,633	84,143	-3%
5. Land use, land-use change forestry[b]	106 303	106 303	153 360	86 300	17 441	15 226	23 720	30 322	19 735	53 716	6 635	63 079	- 2 695	96 508	235 990	- 49 031	23 010	- 8 183	108 022	-29 757	40 280	39 053	- 40 348	-138%

6. Waste	17 411	17 411	17 376	17 216	17 117	16 555	16 550	15 228	15 057	14 422	14 535	14 046	14 228	14 323	13 426	13 062	12 874	12 616	12 926	13 328	13 278	13 489	12 791	-27%
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
Total (including LULUCF)	524 046	524 046	572 743	510 169	443 079	441 375	462 848	476 598	478 504	526 865	489 057	556 351	501 338	601 952	745 621	476 254	552 331	526 018	650 552	520 582	589 403	587 798	511 939	-2%

1 The common tabular format will be revised, in accordance with relevant decisions of the Conference of the Parties and, where applicable, with decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. *Notes:*

(1) Further detailed information could be found in the common reporting format tables of the Party's greenhouse gas inventory, namely "Emission trends (CO_2)", "Emission trends (CH_4)", "Emission trends (N_2O)" and "Emission trends (HFCs, PFCs and SF_6)", which is included in an annex to this biennial report; (2) 20XX is the latest reported inventory year; (3) 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviation: LULUCF = land use, land-use change and forestry.

[a]The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b]Includes net CO_2, CH4 and N_2O from LULUCF.

CTF Table 1 CO_2 Source and Sink Categories (kt)

Greenhouse Gas Source and Sink Categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	kt																							(%)
1. Energy																								
A. Fuel combustion (sectoral approach)	252 477	252 477	254 708	259 162	263 102	266 312	276 465	284 039	292 452	304 979	313 885	320 331	326 496	331 290	339 193	352 359	357 564	361 351	367 263	373 978	377 474	376 648	376 392	49%
1. Energy industries	142 437	142 437	145 682	149 028	150 802	151 686	157 514	162 192	168 840	181 304	188 614	191 571	198 830	200 230	207 075	215 367	218 755	223 434	226 127	228 797	235 783	231 810	228 980	61%
2. Manufacturing industries and construction	35 406	35 406	34 971	34 560	35 029	35 843	36 718	36 803	36 928	36 840	37 585	38 571	38 022	39 472	38 554	39 642	40 640	39 616	40 204	42 234	39 128	40 716	40 726	15%
3. Transport	60 663	60 663	60 017	61 115	62 340	63 872	66 500	68 799	70 117	70 136	70 856	72 789	71 386	72 979	74 356	78 112	78 429	78 893	81 045	82 871	82 486	83 612	85 625	41%
4. Other sectors	12 912	12 912	13 006	13 374	13 824	13 773	14 478	14 891	15 184	15 435	15 665	16 201	17 046	17 439	18 042	18 005	18 447	18 324	18 504	18 636	18 665	19 015	19 469	51%
5. Other	1 060	1 060	1 032	1 085	1 108	1 137	1 255	1 353	1 384	1 265	1 165	1 199	1 213	1 171	1 166	1 234	1 292	1 084	1 383	1 441	1 412	1 496	1 592	50%

B. Fugitive Emissions from fuels	7 105	7 105	6 854	7 154	7 031	6 755	6 927	6 630	6 558	6 770	7 032	7 805	8 308	7 846	7 002	6 695	6 738	6 873	7 318	7 298	7 766	8 220	7 652	8%
1. Solid fuels	1 122	1 122	1 106	1 234	1 130	1 067	1 054	1 160	1 266	1 250	1 055	1 077	1 137	1 144	1 003	953	1 180	1 093	1 161	1 039	1 208	1 181	1 422	27%
2. Oil and natural gas	5 982	5 982	5 747	5 920	5 901	5 689	5 873	5 470	5 292	5 520	5 976	6 729	7 171	6 702	5 999	5 743	5 558	5 779	6 157	6 259	6 558	7 039	6 231	4%
2. Industrial processes																								
A. Mineral products	5 583	5 583	5 246	5 060	5 289	6 090	5 920	6 005	6 076	6 478	6 561	6 354	6 362	6 415	6 553	6 515	6 605	6 796	7 113	7 022	6 536	6 433	6 556	17%
B. Chemical industry	1 009	1 009	1 020	1 077	1 147	1 184	1 353	1 365	1 350	1 508	1 506	1 659	1 922	1 959	2 318	2 569	2 725	3 417	3 918	3 443	3 180	3 559	3 354	232%
C. Metal production	11 572	11 572	11 336	11 879	11 763	12 737	12 980	13 171	13 121	13 058	13 630	13 097	12 466	12 377	12 219	12 779	10 923	10 816	11 057	11 154	9 902	11 087	12 357	7%
D. Other production	83	83	85	88	90	93	139	144	143	140	143	145	147	150	152	165	167	160	148	163	161	232	262	217%

E. Production of halocarbons and SF_6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Consumption of halocarbons and SF_6	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	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	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Agriculture																								
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	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	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	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	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field burning or agricultural residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land use land-use change and forestry [b]																								
A. Forest land	- 47 331	- 47 331	22 174	- 31 712	- 79 996	- 52 344	- 67 764	- 61 328	- 54 859	- 49 277	- 68 184	- 51 873	- 71 723	6 129	138 668	- 124 449	- 90 360	- 97 905	- 14 701	- 111 988	- 52 114	- 55 086	- 102 945	117%
B. Cropland	31 806	31 806	26 379	27 504	18 698	13 090	16 800	19 793	11 602	18 440	10 144	11 574	12 742	17 260	14 982	10 575	14 658	15 933	18 045	11 224	13 757	19 314	15 511	-51%
C. Grassland	119 947	119 947	100 251	88 481	78 722	53 380	75 153	70 904	62 462	83 677	64 724	103 944	54 740	70 464	72 127	65 086	97 629	73 183	100 536	71 324	77 763	73 054	47 805	-60%

D. Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	- 4 878	- 4 878	- 4 274	- 4 268	- 4 362	- 4 588	- 4 791	- 3 947	- 3 891	- 4 458	- 3 973	- 4 623	- 3 879	- 3 876	- 4 351	- 4 594	- 4 530	- 4 294	- 4 207	- 4 692	- 3 502	- 3 525	- 3 456	-29%
6. Waste																								
A. Solid waste disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Wastewater handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste incineration	73	73	73	74	74	74	80	58	28	28	29	28	28	28	28	28	28	29	29	29	30	30	30	-60%

D. 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
7. Other (as specified in the summary 1a in the latest submitted CRF)																								
Total CO_2 emissions including net CO_2 from LULUCF	377 446	377 446	423 853	364 497	301 559	302 783	323 261	336 834	335 041	381 344	345 497	408 441	347 608	450 041	588 890	327 728	402 148	376 357	496 519	368 957	440 954	439 966	363 518	-4%
Total CO_2 emissions excluding net CO_2 from LULUCF	277 902	277 902	279 323	284 493	288 497	293 245	303 863	311 413	319 727	332 963	342 786	349 419	355 728	360 064	367 465	381 111	384 750	389 441	396 847	403 088	405 049	406 209	406 602	46%
Memo items:																								
International bunkers																								
Aviation	4 339	4 339	4 513	4 789	5 192	5 343	5 849	6 302	6 530	7 222	7 257	7 320	7 782	6 684	5 915	7 102	8 209	8 309	9 264	9 178	9 379	10 244	10 319	138%
Marine	2 058	2 058	1 859	1 791	1 789	2 015	2 679	2 721	2 522	2 218	2 452	2 772	2 603	2 841	2 769	2 792	2 630	3 131	2 543	2 910	2 695	2 166	1 916	-7%

Multilateral operations																								
CO2 emissions from biomass	17 439	17 439	17 219	15 485	17 561	18 687	19 683	21 009	22 239	22 643	22 284	22 350	21 320	19 256	17 546	17 343	17 409	17 516	18 055	18 211	18 404	17 574	17 037	-2%

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Fill in net emissions/removals as reported in table Summary 1.A of the latest reported inventory year. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

CTF Table 1 CH4 Source and Sink Categories (kt)

Greenhouse Gas Source and Sink Categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported
	kt																							(%)
1. Energy																								
A. Fuel combustion (sectoral approach)	131	131	133	137	138	136	133	131	128	123	116	112	109	97	95	92	88	86	89	88	87	85	86	-35%
1. Energy industries	3	3	3	3	3	3	3	3	3	6	6	10	10	11	9	13	16	16	19	20	21	20	23	752%
2. Manufacturing industries and construction	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	-3%
3. Transport	28	28	28	29	30	31	32	32	33	32	31	30	28	28	27	27	24	23	22	20	19	19	18	-38%
4. Other sectors	98	98	101	104	104	101	97	93	90	83	77	70	69	56	58	51	46	46	47	46	45	44	44	-56%
5. Other	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.06	0.05	0.05	0.04	-7%

B. Fugitive Emissions from fuels	1 202	1 202	1 190	1 243	1 212	1 142	1 205	1 203	1 324	1 363	1 242	1 333	1 333	1 298	1 270	1 338	1 387	1 406	1 554	1 571	1 543	1 534	1 600	33%
1. Solid fuels	865	865	888	923	932	858	865	891	999	1 047	980	1 049	1 042	1 025	1 015	1 088	1 146	1 176	1 329	1 330	1 315	1 292	1 326	53%
2. Oil and natural gas	337	337	302	321	280	284	340	311	325	316	262	283	291	273	255	250	241	230	224	242	229	242	274	-19%
2. Industrial processes																								
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.6	0.6	0.5	0.5	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	32%
C. Metal production	2.8	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	2	3	2	-24%
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of halocarbons and SF6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Consumption of halocarbons and SF6	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	NA	NA	NA	NA	NA	NA	NA	NA	NA

3. Solvent and other product use																								
4. Agriculture																								
A. Enteric fermentation	3 044	3 044	3 049	2 987	2 920	2 850	2 826	2 815	2 835	2 833	2 864	2 878	2 897	2 834	2 836	2 849	2 863	2 814	2 724	2 672	2 600	2 604	2 610	-14%
B. Manure management	73	73	73	75	78	81	82	83	87	90	93	94	97	98	97	96	95	94	91	87	83	82	81	11%
C. Rice cultivation	23	23	25	26	29	29	31	34	34	35	32	35	35	28	19	11	16	13	9	2	2	8	16	-33%
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed burning of savannas	234	234	242	218	211	233	283	317	329	323	353	387	455	426	359	371	315	397	383	447	410	313	362	55%
F. Field burning or agricultural residues	9	9	9	9	10	10	10	11	12	13	13	13	14	11	12	11	13	11	10	9	10	12	14	48%
G. 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

5. Land use land-use change and forestry[b]																								
A. Forest land	66	66	168	95	41	85	56	74	58	88	35	37	84	134	443	54	65	56	190	66	79	111	30	-55%
B. Cropland	38	38	34	29	24	26	21	22	22	21	21	20	21	20	20	22	27	26	23	20	19	19	16	-58%
C. Grassland	123	123	111	93	82	87	66	67	67	63	72	72	83	74	62	69	98	85	77	53	44	38	30	-75%
D. Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste																								
A. Solid waste disposal	645	645	645	640	639	615	620	564	561	534	541	534	536	543	506	486	476	463	475	492	490	503	476	-26%
B. Wastewater handling	164	164	162	159	156	153	147	141	137	133	131	114	121	118	112	114	115	116	117	118	119	117	109	-33%
C. Waste incineration	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	890%

D. 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
7. Other (as specified in the summary 1a in the latest submitted CRF)																								
Total CH4 emissions including net CH4 from LULUCF	5 757	5 757	5 847	5 716	5 544	5 451	5 485	5 466	5 600	5 625	5 519	5 636	5 789	5 686	5 837	5 520	5 564	5 572	5 749	5 632	5 493	5 432	5 437	-6%
Total CH4 emissions excluding net CH4 from LULUCF	5 530	5 530	5 533	5 499	5 396	5 253	5 342	5 303	5 453	5 452	5 391	5 506	5 602	5 458	5 312	5 375	5 374	5 405	5 459	5 493	5 351	5 264	5 360	-3%
Memo items:																								
International bunkers																								
Aviation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral operations																								
CO2 emissions from biomass	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

CTF Table 1 N_2O Source and Sink Categories (kt)

Greenhouse Gas Source and Sink Categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	kt																							(%)
1. Energy																								
A. Fuel combustion (sectoral approach)	5	5	5	5	6	6	7	7	7	8	8	9	9	9	9	10	10	9	9	9	9	9	8	67%
1. Energy industries	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	42%
2. Manufacturing industries and construction	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	-4%
3. Transport	3	3	3	3	3	4	4	4	4	5	5	6	6	6	6	7	6	6	6	6	6	5	5	108%
4. Other sectors	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-18%
5. 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
B. Fugitive Emissions from fuels	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-21%
1. Solid fuels	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0005	0.0003	58583%

2. Oil and natural gas	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-21%
2. Industrial processes																								
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	3	3	3	4	5	5	5	5	5	6	5	6	7	7	8	8	9	9	9	10	10	11	9	157%
C. Metal production	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	-6%
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of halocarbons and SF_6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Consumption of halocarbons and SF_6	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and other product use																								
4. Agriculture																								
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	2	2	2	2	2	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5	195%

C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	43	43	44	43	43	43	44	46	47	48	50	52	54	53	52	52	52	50	48	46	46	47	48	12%
E. Prescribed burning of savannas	5	5	5	4	4	5	6	7	8	7	8	10	11	11	8	8	7	9	9	10	9	7	9	89%
F. Field burning or agricultural residues	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.4	0.4	31%
G. 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
5. Land use, land-use change and forestry[b]																								
A. Forest land	1	1	3	2	1	2	1	1	1	2	1	1	2	2	8	1	1	1	4	1	1	2	1	-55%
B. Cropland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-30%
C. Grassland	2	2	2	2	2	2	1	1	1	1	1	1	2	1	1	1	2	2	1	1	1	1	1	-75%
D. Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	2	2	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	2	2	1%
6. Waste																								
A. Solid waste disposal	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Wastewater handling	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22%
C. Waste incineration	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
D. Other	0.00	0.00	0.00	0.01	0.01	0.01	0.01	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	0.03	0.03	0.03	890%
7. Other (as specified in the summary 1a in the latest submitted CRF)																								
Total N_2O emissions including net N_2O from LULUCF	66	66	67	66	66	68	71	75	77	80	82	87	92	92	95	88	89	88	89	87	85	85	85	28%
Total N_2Oemissions excluding net N_2O from LULUCF	59	59	60	60	62	63	67	70	73	75	78	82	87	86	84	84	83	84	82	83	81	79	81	36%
Memo items:																								
International bunkers																								

Aviation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral operations																								
CO_2 emissions from biomass	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

CTF Table 1 Emissions of HFCs, PFCs, SF6 (kt CO_2 eq)

Greenhouse Gas Source and Sink Categories	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	kt																							(%)
Emissions of HFCs (kt CO2 eq)																								
HFC-23	1 126.3	1 126.3	1 126.3	1 053.9	1 446.6	811.7	718.8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-32	NO	NO	NO	NO	NO	0.0	3.1	13.0	24.1	34.8	48.7	63.2	99.3	134.9	171.5	208.1	244.6	279.3	334.7	403.3	470.0	551.7	617.8	NA
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-43-10mec	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-125	NO	NO	NO	NO	NO	0.0	12.6	51.9	95.1	134.7	185.9	227.4	339.3	441.9	550.7	654.0	765.9	853.2	980.7	1 113.9	1 255.1	1 404.9	1 554.1	NA
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-134a	NO	NO	NO	NO	NO	1	69	282	455	608	785	910	1 269	1 579	1 896	2 243	2 593	2 828	3 141	3 505	3 813	4 261	4 589	NA
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA

HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-143a	NO	NO	NO	NO	NO	0.0	9.0	37.0	67.5	95.1	130.6	156.1	228.1	291.4	359.8	422.8	494.4	543.9	611.5	671.1	740.6	803.0	881.0	NA
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
Unspecified mix of listed HFCs[d] (kt CO_2 eq)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
Emission of PFCs[c] (kt CO_2 eq)																								
CF_4	3 336.8	3 336.8	3 339.5	3 334.1	2 401.4	1 567.7	1 108.8	1 021.5	889.5	1 202.7	825.0	932.2	1 305.1	1 251.3	1 219.7	1 241.3	1 297.7	497.6	422.0	322.0	262.9	211.1	224.6	-93%
C_2F_6	613.4	613.4	613.8	612.9	441.4	288.2	203.8	187.8	163.5	221.1	151.6	171.4	239.9	230.0	224.2	228.2	238.5	91.5	77.6	59.2	45.0	32.6	34.7	-94%
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA

C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
$C\text{-}C_4F_8$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
Unspecified mix of listed PFCs[a](kt CO_2 eq)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
Emission of SF_6[c] (kt CO_2 eq)																								
SF_6	221.20	221.20	239.99	258.77	277.53	296.28	316.89	282.66	260.46	234.09	205.53	199.85	206.02	212.25	216.24	217.78	190.85	180.84	170.04	158.40	143.23	145.19	149.29	-33%

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] For the second and subsequent biennial reports, the global warming potential values need to be revised in accordance with decision 15/CP.17.

[c] Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.

[d] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories", HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

3. Quantified Economy-wide Emission Reduction Target (QEERT)

Australia's quantified economy-wide emission reduction target

The Australian Government has committed to a quantified economy-wide emission reduction target of 5 per cent on 2000 levels by 2020. Australia is prepared to adopt a more ambitious target of between 5 and 15 per cent or 25 per cent based on strict conditions relating to the extent of global action. Australia's 2020 target range are at Figure 1.

Figure 1 Australia's 2020 target conditions

Target at 2020	Conditions
NOTE: In the following '*advanced economies'* refers to Annex 1 parties to the UNFCCC and at least some other high/middle income economies; *'major developing economies'* refers to non-Annex 1 members of the Major Economies Forum.	
>5%	"The Government will not increase Australia's emission reduction target above 5 per cent until: • The level of global ambition becomes sufficiently clear, including both the specific targets of advanced economies and the verifiable emissions reduction action of China and India. • The credibility of those commitments and actions is established, for example, by way of a robust global agreement...., or commitment to verifiable domestic action on the part of major emitters including the United States, India and China, and • There is clarity on the assumptions for emissions accounting and access to markets."
15%	International agreement where *major developing economies* commit to substantially restrain emissions and *advanced economies* take on commitments comparable to Australia's. In practice this implies: • global action on track to stabilisation between 510-540ppm CO_2-e • advanced economy reductions in aggregate, in the range of 15 – 25% below 1990 levels • substantive measurable, reportable and verifiable commitments and actions by major developing economies, in the context of a strong international financing and technology cooperation framework, but which may not deliver significant

	emissions reductions until after 2020 • progress toward inclusion of forests (REDD) and the land sector, deeper and broader carbon markets, low carbon development pathways.
25% (up to 5 percentage points through Government purchase)	Comprehensive global action capable of stabilising CO_2-e concentrations at 450ppm CO_2-e or lower. This requires a clear pathway to achieving an early global peak in total emissions, with *major developing economies* slowing the growth and then reducing their emissions, *advanced economies* taking on reductions and commitments comparable to Australia, and access to the full range of international abatement opportunities through a broad and functioning international market in carbon credits. This would involve: • comprehensive coverage of gases, sources and sectors, with inclusion of forests (REDD) and the land sector (including soil carbon initiatives (e.g. bio char) if scientifically demonstrated) in the agreement • clear global trajectory, where the sum of all economies' commitments is consistent with 450ppm CO_2-e or lower, and with a nominated early deadline year for peak global emissions not later than 2020 • advanced economy reductions, in aggregate, of at least 25% below 1990 levels by 2020 • major developing economy commitments that slow emissions growth and then reduce their absolute level of emissions over time, with a collective reduction of at least 20% below business-as-usual by 2020 and a nomination of a peaking year for individual major developing economies • global action which mobilises greater financial resources, including from major developing economies, and results in fully functional global carbon markets.

The independent Climate Change Authority will make recommendations to the Government by 28 February 2014 on appropriate caps and targets for Australia to 2020.

Under the Kyoto Protocol second commitment period, Australia has committed to limit average annual emissions over the period 2013-2020 to 99.5 per cent of 1990 levels. Australia's Kyoto target (or Quantified Emission Limitation or Reduction Objective) is consistent with our commitment to reduce emissions by 5 per cent on 2000 levels by 2020.

Australia's Clean Energy Future legislation also contains a long term target to reduce Australia's carbon pollution by 80 per cent in 2050 compared with 2000.

Australia quantified economy-wide emission reduction target will be met through a comprehensive set of domestic emission reduction policies, including emissions trading

scheme and the Carbon Farming Initiative (CFI). The emissions trading scheme will set ‘emissions caps’ to ensure that Australia meets its 2020 and Kyoto Protocol targets.

Australia’s 2020 target and Kyoto Protocol target encompass all seven Kyoto gases and assume global warming potential values from the fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change. Australia’s targets also include emissions from forest management activities and net emissions from cropland management, grazing land management and revegetation activities (new Kyoto Protocol article 3.4 activities). The 2000 base figure includes net sequestration from afforestation/reforestation as well as net emissions from land use change for that year. Current estimates are that there has been no substantive change in emissions from the new Article 3.4 activities between 1990 and 2000 from these activities, so the 2000 base year, and hence the 2020 target, is not affected by the election of these activities.

Australia’s targets represent net emissions and include credible Kyoto-compliant units from emission reduction activities overseas as to be reflected in the Australian National Registry of Emissions Units. Under Australia’s emissions trading scheme there are quantitative and qualitative limits on international units that can be surrendered for liability under the scheme.

Further information is provided in CTF Tables 2 (a) - (f).

CTF Table 2 (a) Description of quantified economy-wide emission reduction target: base year[a]

Party AUSTRALIA		
Base year /base period	2000	
Emissions reduction target	% of base year 5 per cent unconditional. Up to 15 per cent or 25 per cent, both conditional on the extent of global action.	% of 1990 4 per cent unconditional. Up to 14 or 24 per cent.
Period for reaching target	2020	2020

[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.
[b]

CTF Table 2(b) Description of quantified economy-wide emission reduction target: gases and sectors covered[a1]

Gases covered	Base year for each gas (year):	
CO_2	2000	
CH_4	2000	
N_2O	2000	
HFCs	2000	
PFCs	2000	
SF_6	2000	
NF_3	2000	
Other gases		
Sectors Covered [b]	Energy	Yes
	Transport[c]	Yes
	Industrial processes[d]	Yes
	Agriculture	Yes
	LULUCF	Yes
	Waste	Yes

Abbreviations: LULUCF = land use, land-use change and forestry.
[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.
[b]More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.
[c]Transport is reported as a subsector of the energy sector.
[d]Industrial processes refer to the industrial processes and solvent and other product use sectors.

CTF Table 2(c) Description of quantified economy-wide emission reduction target: global warming potential values (GWP)[a]

Gases covered	GWP values[b]		
	Australia's 2020 target range was set based on the 100 year global warming potential values in the IPCC Second Assessment Report. Updated values will be adopted in the national inventory, due April 2015 consistent with the updated UNFCCC reporting guidelines agreed in Durban.		
	IPCC Second Assessment Report	IPCC Fourth Assessment Report	
CO_2	1	1	
CH_4	21	25	
N_2O	310	298	
HFCs	As per GWPs for the range of HFCs in IPCC's Second Assessment Report	As per GWPs for the range of HFCs in IPCC's Fourth Assessment Report	
PFCs	As per GWPs for the range of PFCs in IPCC's Second Assessment Report	As per GWPs for the range of PFCs in IPCC's Fourth Assessment Report	
SF_6	23,900	22,800	
NF_3	-	17,200	

Abbreviations: GWP = global warming potential

[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b]Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

[c]Specify.

CTF Table 2(d) – Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector[a]

Role of LULUCF	LULUCF in base year level and target Contribution of LULUCF is calculated using	Included Activity-based approach

Abbreviation: LULUCF = land use, land-use change and forestry.
[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

CTF Table 2(e)I Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention[a]

		Possible scale of contributions (*estimated kt CO_2 eq*)
	CERs	
	ERUs	
	AAUs[b]	All available mechanisms will be used to meet target.
	Carry-over units[c]	100,000 (across all unit types)
	Other mechanism units under the Convention (specify)[d]	

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.
[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.
[b]AAUs issued to or purchased by a Party.
[c]Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision XX /CMP.8.
[d]As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17.

CTF Table 2(e)II Description of quantified economy-wide emission reduction target: other market-based mechanisms[a]

		Possible scale of contributions (*estimated kt CO_2 eq*) No carbon credits from any other market-based mechanisms will be counted as contributing to meeting Australia's target.

[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

CTF Table 2(f) Description of quantified economy-wide emission reduction target: any other information[a,b]

The Department of Industry, Innovation, Climate Change, Science Research and Tertiary Education (DIICCSRTE) releases official projections of Australia's greenhouse gas emissions annually. The latest release was in October 2012. Since the release of the 2012 Australia's Emissions Projections, at the 2012 Doha Climate Change Conference, Australia signalled its intention to join the Kyoto Protocol second commitment period, agreeing to limit average annual emissions over the eight year period from 2013 to 2020 to 99.5 per cent of the 1990 level. This is referred to as Australia's quantified emission limitation or reduction objective (QELRO). This commitment is consistent with Australia's existing unconditional pledge to reduce emissions to 5 per cent below 2000 levels by 2020. In May 2013, Australia also announced its decision to further broaden coverage of the land sector to include net emissions from cropland management, grazing land management and revegetation activities within its second commitment period target. These changes will be incorporated in the 2013 Australia's Emissions projections expected to be released in late 2013.

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[a]Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.
[b]This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

4. Progress in achievement of QEERT

Mitigation action and progress towards Australia's QEERT

Australia has established an emissions trading scheme to enable it to meet its national emission reduction targets. The legislation underpinning the emissions trading scheme requires liable entities to acquire and surrender enough emissions units to meet their liabilities – or else pay a shortfall charge. An additional penalty applies if the shortfall charge remains unpaid. The emissions trading scheme is supported by the National Greenhouse and Energy Reporting Scheme (NGERS), which provides the framework for measuring, reporting and verifying liable emissions.

The Clean Energy Regulator, which administers the emissions trading scheme and NGERS, has a range of legislated monitoring and enforcement powers to minimise non-compliance. These include:

- Engaging liable entities through consultation, education and support.
- Monitoring liable entities through independent audits and inspections, through exercising information-gathering powers and through analysing the information that it has obtained.
- Enforcing legislated obligations through administrative remedies (such as accepting enforceable undertakings, issuing infringement notices or pursuing court orders requiring the relinquishment of emissions units) or by pursuing (in more serious cases) civil or criminal proceedings.

Further information on mitigation actions and their effects is provided in CTF Table 3; further detail on these policies and measures can also be found in NC6 Chapter 4.

Further information on progress towards meeting Australia's target can be found in NC6 Chapter 5, page 4.

Domestic institutional arrangements relating to Australia's QEERT

The following information relating to "changes in … domestic institutional arrangements, including institutional, legal, administrative, and procedural arrangements used for domestic compliance, monitoring, reporting, archiving of information and evaluation of the progress towards its economy-wide emission reduction target" is contained in the NC6:

- The passage of the Clean Energy Act 2011, including its:

– objects to give effect to Australia's international obligations addressing climate change under the UNFCCC; to support the development of an effective global response to climate change; to take action directed towards meetings Australia's long-term target of reducing net emissions to 80 per cent below 2000 levels by 2050 (see NC6 Chapter 4).
– provisions relating to default pollution caps for sectors covered by Australia's emissions trading scheme, which will ensure Australia achieves its 2020 quantified economy-wide emission reduction target and Kyoto target (see NC6 Chapter 4).

- provisions relating to the enforcement and monitoring powers of the Clean Energy Regulator to administer the emissions trading scheme (see NC6 Chapter 4).

- provisions relating to the regular, expert, independent and public by the Climate Change Authority that relate to Australia's emission reduction targets, appropriate emissions caps under the emissions trading scheme, and the extent of any non-compliance with the emissions trading scheme (see NC6 Chapter 4).

- The Clean Energy Act 2011 can be accessed at: http://www.comlaw.gov.au/Details/C2011A00131

– Changes to the National Greenhouse and Energy Reporting System auditing arrangements that require third party assurance of emissions reports by Corporations representing around 95 per cent of Australia's emissions (see NC6 Chapter 4).

– Changes to the Carbon Farming Initiative, which reflect changes to the national accounting arrangements identified above (see NC6 Chapter 4).

CTF Table 3 Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action[a]	Sector(s) affected[b]	GHG (s) affected	Objective and/or activity affected	Type of instrument[c]	Status on implementation[d]	Brief description[e]	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative) in kt CO_2 eq[1]
Carbon Price*	Energy Transport Industrial processes Waste	Carbon dioxide Methane Nitrous oxide Perfluorocarbons	National Carbon Price including an Emissions Trading Scheme from 2015-16	Regulatory Economic International	Implemented		2012	Administered by the Clean Energy Regulator	2015 57,600 2020 148,300
Carbon Farming Initiative*	Waste LULUCF Agriculture	Carbon dioxide Methane Nitrous oxide	A baseline and credit scheme that allows farmers and landholders who take steps to reduce carbon pollution to generate carbon credits. Credits can be traded into the emissions trading scheme.	Fiscal Voluntary	Implemented		2011	Australian Government with private participants	2015 7,000 2020 7,200
Queensland and New South Wales Land Clearing	LULUCF	Carbon dioxide	The legislation reduces land-use change emissions from clearing of native vegetation	Regulatory	Implemented		1997	New South Wales and Queensland Government	2015 19,600 2020

Name of mitigation action[a]	Sector(s) affected[b]	GHG (s) affected	Objective and/or activity affected	Type of instrument[c]	Status on implementation[d]	Brief description[e]	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative) in kt CO_2 eq[1]
Legislation*			in New South Wales and Queensland.						18,400
Greenhouse Gas Abatement Scheme*	Energy Industrial processes Waste LULUCF	Carbon dioxide	Requires liable entities (electricity retailers and large electricity users who choose to participate) to meet mandatory annual targets for reducing or offsetting greenhouse gas emissions from the production of electricity that they supply or use.	Regulatory	Completed		2003	New South Wales Government	2015 1,000 2020 1,000

Name of mitigation action[a]	Sector(s) affected[b]	GHG (s) affected	Objective and/or activity affected	Type of instrument[c]	Status on implementation[d]	Brief description[e]	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative) in kt CO_2 eq[1]
Western Australia Smart Travel*	Transport	Carbon dioxide Methane Nitrous oxide	A program that provided communities, workplaces and the local government with the information, tools and resources needed to reduce their impact on the environment.	Voluntary	Implemented		1996	Western Australia Government	2015 500 2020 400
Greenhouse Friendly*	Energy Transport Waste LULUCF	Carbon dioxide Methane Nitrous oxide	Designed to help meet the challenge of climate change by certifying carbon-neutral products and services and approving abatement credits for sale on the voluntary market.	Voluntary	Completed		2001	Australian Government program with private industry participants	2015 400 2020 300

[1] These estimates incorporate policies and measures in place at October 2012. These estimates do not include the Australian Government's decision to join the Kyoto Protocol second commitment period and the decision to broaden coverage of the land sector to include net emissions form cropland management, grazing land management and revegetation activities.

Note: The two final columns specify the year identified by the Party for estimating impacts (based on the status of the measure and whether an ex post or ex ante estimation is available).
Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry.
[a]Parties should use an asterisk (*) to indicate that a mitigation action is included in the 'with measures' projection.
[b]To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors, cross-cutting, as appropriate.
[c]To the extent possible, the following types of instrument should be used: economic, fiscal, voluntary agreement, regulatory, information, education, research, other.
[d]To the extent possible, the following descriptive terms should be used to report on the status of implementation: implemented, adopted, planned.
[e]Additional information may be provided on the cost of the mitigation actions and the relevant timescale.
[f]Optional year or years deemed relevant by the Party.

Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use changes and forestry activities

Information is provided in CTF Tables 4, 4(a) II and 4(b).

CTF Table 4 - Reporting on progress[a, b]

Year[c]	Total emissions excluding LULUCF (kt CO_2 eq)	Contribution from LULUCF[d] (kt CO_2 eq)	Quantity of units from market based mechanisms under the Convention (number of units and kt CO_2 eq)	Quantity of units from market based mechanisms (number of units and kt CO_2 eq)
Base year/base period				
2000	493 272	71 320	-	-
2010	548 744	19 972	-	-
2011	552 286	10 854	-	-

CTF Table 4(a)II Progress in achievement of the quantified economy-wide emission reduction target – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol[a,b, c]

Greenhouse Gas Source and Sink Activities	Base year[d]	Net emissions/removals[c]					Accounting parameters[h]	Accounting quantity[i]
		2008	2009	2010	2011	Total[g]		
	(kt CO_2 eq)							
A. Article 3, paragraph 3 activities	71 320.36							
A.1. Afforestation and reforestation								-96 037.04
A1.1. Units of land not harvested since the beginning of the commitment period[j]		-22 439.47	-21 559.26	-25 280.80	-26 719.67	-95 999.19		-95 999.19
A.1.2. Units of land harvested since the beginning of the commitment period[j]		1.12	5.84	-14.53	-30.29	-37.85		-37.85
A.2 Deforestation		56 621.08	48 692.03	45 267.63	37 603.97	188 184.72		188 184.72
B. Article 3 paragraph 4 activities								
B.1. Forest management (if elected)		NA	NA	NA	NA	NA		NA
3.3 offset[k]							92 147.67	NA
Forest management cap[l]							0.00	NA
B.2. Cropland management (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0.00
B.3. Grazing land management (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0.00
B.4. Revegetation (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0.00

[1]A.1.1. Units of land not harvested since the beginning of the commitment period.

[2]A.1.2. Units of land harvested since the beginning of the commitment period.

Note: 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

[c] Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

[d] Net emissions and removals in reference year (2000)

[e] All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

[f] Additional columns for relevant years should be added, if applicable.

[g] Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

h The values in the cells “3.3 offset” and “Forest management cap” are absolute values.

The accounting quantity is the total quantity of units to be added to or subtracted from a Party’s assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

[j] In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

[k] In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[l] In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

CTF Table 4(b) Reporting on progress[a, b, c+]

Kyoto Protocol units[d] (kt CO_2 eq)										Other units[d,e] (kt CO_2 eq)			
AAUs		ERUs		CERs		tCERs		lCERs		Units from market-based mechanisms under the Convention		Units from other market-based mechanisms	
2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quantity of units													
		2011								2012			
Total		**0**								**0**			

Note – Australia understands surrender as distinct from holding. Surrender is when an entity or Party retires a unit for compliance purposes. No units have been surrendered as of the date of submission of this report.

5. Projections

Australia's Emissions Projections 2012 shows that the emissions trading scheme, the CFI and Australia's existing suite of policy measures including the Renewable Energy Target and energy efficiency measures are projected to limit Australia's net emissions to 537 Mt CO_2-e in 2020, consistent with Australia's unconditional commitment to reduce emissions by 5 per cent below 2000 levels in 2020[1].

They also show that Australia remains on track to meet its Kyoto protocol first commitment period target of limiting emissions to 108 per cent from 1990 levels (estimated outcome to be 105 per cent of 1990 levels).

The emissions trading scheme and CFI are projected to drive at least 155 Mt CO_2-e of abatement in 2020. This amount of abatement means Australia's net emissions are projected to be 22 per cent below where they would otherwise be without the newly introduced emissions trading scheme and CFI.

There have been no substantive changes to the modelling framework that Australia uses for projections since NC5. Information on these methodologies can be found in Chapter 5 of NC6.

[1] This publication can be found at: http://climatechange.gov.au/sites/climatechange/files/files/climate-change/projections/aep-summary.pdf - see particularly Table 1 on page 10.

CTF Table 5 Summary of key variables and assumptions used in the projections analysis[a]

	Historical						Projected						
Key underlying assumptions[1]	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2025**	**2030**
Australia's population growth (per cent)			1.20	1.33	1.72	1.46	1.49	1.49	1.48	1.47	1.43	1.34	1.22
Australia's population (millions)			19.15	20.39	22.34	22.67	23.01	23.35	23.69	24.04	25.83	27.66	29.46
Real carbon price (2010 $, AUD$/t CO2-e)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.0	21.5	22.1	29.4	39.4	52.6
Gross domestic product - Level (2010 $ billion)					1285	1312	1366	1414	1456	1499	1720	1954	2213
Real gross national income per person (2010 $ '000)					55.8	58.1	59.5	60.4	61.1	61.7	64.8	67.2	69.7
Real wage (index: 2010=100)					100.0	106.7	108.8	111.4	112.4	114.3	120.2	124.8	127.5
Terms of trade (index: 2010=100)	68.0	60.0	62.3	77.1	100.0	119.8	119.2	115.6	113.7	112.0	104.0	96.0	88.3
Emission intensity of electricity generation (t CO2-e/MWh)						0.848	0.833	0.819	0.806	0.790	0.723	0.685	0.610
Average wholesale electricity prices ($ per MWh)						42	43	63	64	66	67	87	110
Domestic Australian gas prices ($/GJ)													
National Electricity Market (NEM) gas prices						4.8	4.8	4.8	4.9	5.0	6.0	7.5	9.2
Non-NEM gas prices						6.2	6.2	6.2	6.0	5.5	6.3	7.9	9.8
Private per person consumption - level ('000 2010 AUD$)					31.5	31.9	32.5	33.1	33.6	34.0	36.8	38.7	40.2

[1] These emissions projections (released in October 2012) rely on assumptions used by the Australian Treasury in their 2011 modelling exercise *Strong growth, low pollution: Modelling a carbon price*

CTF Table 6a Information on updated greenhouse gas projections under a 'with measures' scenario[a]

	GHG emission and removals (kt CO_2 eq)							GHG emission projections (kt CO_2 eq)	
	Base year	1990	1995	2000	2005	2010	2011	2020	2030
Sector[d,e]									
Energy	250 568	195 100	213 304	250 568	279 458	293 731	290 166	317 877	302 595
Transport	75 113	62 100	68 356	75 113	80 697	83 198	85 475	92 390	88 458
Industry/industrial processes	26 237	24 100	24 376	26 237	29 509	31 698	32 871	30 612	32 604
Agriculture	92 179	86 800	84 596	92 179	89 024	79 486	80 962	90 967	100 426
Forestry/LULUCF	35 375	100 639	31 115	35 375	44 670	15 794	16 906	18 763	ne
Waste management /waste	14 364	18 800	16 584	14 364	13 251	14 076	13 957	9 812	7 382
Other (fugitive)	35 809	29 200	32 258	35 809	35 820	40 501	42 246	53 116	57 732
Total	***529 644***	***516 739***	***470 590***	***529 644***	***572 429***	***558 485***	***562 582***	***613 535***	***589 198***
Gas									
CO_2 emissions including net CO_2 from LULUCF	379 210	361 747	330 153	379 210	419 611	414 946	416 083	452 767	ne
CO_2 emissions excluding net CO_2 from LULUCF	349 737	277 900	304 229	349 737	382 394	401 787	401 997	437 134	422 130
CH_4 emissions including net CH_4 from LULUCF	120 072	126 391	115 836	120 072	118 403	112 450	114 724	125 351	ne
CH_4 emissions excluding net CH_4 from LULUCF	115 928	114 600	112 191	115 928	113 170	110 600	112 743	123 153	129 414
N_2O emissions including net N_2O from LULUCF	27 280	23 001	22 145	27 280	28 120	24 041	24 229	27 773	ne
N_2O emissions excluding net N_2O from LULUCF	25 522	18 000	20 599	25 522	25 900	23 256	23 389	26 841	30 414
HFCs	1 976	1 100	1 143	1 976	4 758	6 804	7 302	7 461	7 133
PFCs	1 104	4 000	1 313	1 104	1 536	244	245	184	106

SF_6	2	500	-	2	-	-	-	-	-
Other (specify e.g. NF_3)	-	-	-	-	-	-	-	-	-
Total with LULUCF[f]	**529 644**	**516 739**	**470 590**	**529 644**	**572 429**	**558 485**	**562 582**	**613 535**	**ne**
Total without LULUCF	**494 269**	**416 100**	**439 475**	**494 269**	**527 759**	**542 691**	**545 676**	**594 772**	**589 198**

These estimates incorporate policies and measures in place at October 2012. These estimates do not include the Australian Government's decision to join the Kyoto Protocol second commitment period and the decision to broaden coverage of the land sector to include net emissions form cropland management, grazing land management and revegetation activities. These changes will be incorporated in the 2013 Australia's Emissions Projections and have not been incorporated into the emissions estimates in this table.

Estimates of the overall impacts on Australia's emissions reductions targets have been published in a fact sheet that is available on the DIICCSTRTE website – *The Impact of the Kyoto Protocol accounting changes on Australia's quantified emission limitation or reduction objective (QELRO) and targets* (DIICCSRTE 2013). http://climatechange.gov.au/international/negotiations/history-negotiations/kyoto-protocol/impact-kyoto-accounting-changes-qelro-and-targets

Projections have been developed for the energy sector (stationary energy, transport and fugitive emissions sectors), and the agriculture, industrial processes, waste, and land use, land-use change and forestry sectors.

Historical emissions data for 2011 from the Update of Australia's National Greenhouse Gas Inventory, December Quarter 2011 (Department of Climate Change and Energy Efficiency (DCCEE), 2012) was used as the base year for the 2012 projections for most sectors.

In the agriculture, waste and forestry sectors, a base year of 2010 was used, with data sourced from the 2010 National Greenhouse Gas Inventory (DCCEE 2012).

Since the release of the 2010 National Greenhouse Gas Inventory and Australia's National Greenhouse Gas Inventory, December Quarter 2011, the Australian Government has submitted to the UNFCCC its final Australian National Greenhouse Accounts, National Inventory report 2011 (DIICCSRTE, 2013).

These changes will be incorporated in the 2013 Australia's Emissions Projections and have not been incorporated into the emissions estimates in this table.

Note: There are no estimates for LULUCF emissions for 2030.

[1] Figures provided here are for stationary energy.

6. Provision of financial, technological and capability-building support to developing country Parties

Australia provides a range of financial, technological and capacity-building support to developing country Parties to build their capacity to reduce carbon emissions and to take action to adapt to the effects of climate change, as outlined in CTF Tables 7, 8, and 9, and elaborated in Chapter 7 of NC6.

Table 7 gives a summary of public financial support over the reporting period (covering two Australian financial years from 2010-11 to 2011-12). Table 7(a) provides information on public financial support through multilateral channels (NC6 Chapter 7). Table 7(b) provides information on public financial support through bilateral, regional and other channels (NC6 Chapter 7).

The reporting period covers two years (FY 2010/11 and 2011/12) of Australia's three year fast-start finance commitment.

Australia's climate finance for this two-year period was:

- Balanced between mitigation and adaptation measures;
- Provided as grants and is fully budgeted; and
- Prioritised toward countries most vulnerable to climate change, with around one third of funding expected to benefit Small Island Developing States (SIDS) and around one quarter of Least Developed Countries (LDCs).

This funding was new and additional because it was drawn from the growing aid program and did not divert funds from existing development priorities or programs.

For the purposes of this report, "provided" means funds have been transferred from the Australian Government to a recipient (including multilateral organisations). Funds reported as "climate-specific" were those provided for in dedicated federal budget measures.

Funds are reported in AUD millions. Currency exchange for the information provided in CTF Table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office.

In addition to CTF Tables 7, 7(a) and 7(b), further information on financial support provided by Australia can be found in NC6 Chapter 7.

CTF Table 7 Provision of public financial support summary 2010-11

Allocated channels	Domestic currency					USD[b]				
	Core/ General[c] (AUD$ million)	Climate –specific[d] (AUD$ million)				Core/ General[c]	Climate –specific[d]			
		Mitigation	Adaptation	Cross Cutting	Other[f]		Mitigation	Adaptation	Cross Cutting	Other[f]
Total contributions through multilateral channels: Multilateral climate change funds[g]	22.50	7.43	-	-	0.16	22.86	7.55	-	-	0.16
Other multilateral climate change funds[h]	1.25	51.25	2.45		0.75	1.27	52.06	2.49	-	0.76
Multilateral financial institutions, including regional development banks	298.60	1.25	-	-	-	303.35	1.27	-	-	-
Specialised United National bodies	19.00	-	-	0.87	-	19.3	-	-	0.88	-
Contributions through bilateral, regional and other channels	-	7.90	71.42	16.92	-	-	8.03	72.55	17.19	-
Total	**341.35**	**67.83**	**73.87**	**17.79**	**0.91**	**346.78**	**68.91**	**75.04**	**18.07**	**0.92**

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office

Abbreviation: USD = United States dollars.
[a]Parties should fill in a separate table for each year, namely 20XX-3 and 20XX-2, where 20XX is the reporting year.
[b]Parties should provide an explanation on methodology used for currency exchange for the information provided in table 7, 7(a) and 7(b) in the box below.
[c]This refers to support to multilateral institutions that Parties cannot specify as climate-specific.
[d]Parties should explain in their biennial reports how they define funds as being climate-specific.
[e]This refers to funding for activities which are cross-cutting across mitigation and adaptation.
[f]Please specify.
[g]Multilateral climate change funds listed in paragraph 17(a) of the "UNFCCC biennial reporting guidelines for developed country Parties" in decision 2/CP.17.
[h]Other multilateral climate change funds as referred in paragraph 17(b) of the "UNFCCC biennial reporting guidelines for developed country Parties" in decision 2/CP.17.

Each Party shall provide an indication of what new and additional financial resources they have provided, and clarify how they have determined that such resources are new and additional. Please provide this information in relation to table 7(a) and table 7(b).

Documentation box:
New and additional: funding is drawn from the growing aid program and does not divert funds from existing development priorities or programs.

CTF Table 7 Provision of public financial support summary 2011-12

Allocated channels	Domestic currency					USD[b]				
	Core/ General[c] (AUD$ million)	Climate –specific[d] (AUD$ million)				Core/ General[c]	Climate –specific[d]			
		Mitigation	Adaptation	Cross Cutting	Other[f]		Mitigation	Adaptation	Cross Cutting	Other[f]
Total contributions through multilateral channels: Multilateral climate change funds[g]	22.60	7.46	15.00	0.50	0.61	24.03	7.93	-	-	0.65
Other multilateral climate change funds[h]	2.67	32.63	-	5.00	0.93	2.84	34.69	-	5.32	0.99
Multilateral financial institutions, including regional development banks	266.20	2.67	-	-	-	283.02	2.84	-	-	-
Specialised United National bodies	24.50	-	-	0.84	-	26.05	-	-	0.89	-
Contributions through bilateral, regional and other channels	-	1.00	30.53	107.13		-	1.06	32.46	113.9	-
Total	**315.97**	**43.76**	**45.53**	**113.47**	**1.54**	**335.94**	**46.52**	**32.46**	**120.11**	**1.64**

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office.

Abbreviation: USD = United States dollars.
[a]Parties should fill in a separate table for each year, namely 20XX-3 and 20XX-2, where 20XX is the reporting year.
[b]Parties should provide an explanation on methodology used for currency exchange for the information provided in table 7, 7(a) and 7(b) in the box below.
[c]This refers to support to multilateral institutions that Parties cannot specify as climate-specific.
[d]Parties should explain in their biennial reports how they define funds as being climate-specific.
[e]This refers to funding for activities which are cross-cutting across mitigation and adaptation.
[f]Please specify.
[g]Multilateral climate change funds listed in paragraph 17(a) of the "UNFCCC biennial reporting guidelines for developed country Parties" in decision 2/CP.17.
[h]Other multilateral climate change funds as referred in paragraph 17(b) of the "UNFCCC biennial reporting guidelines for developed country Parties" in decision 2/CP.17.

Each Party shall provide an indication of what new and additional financial resources they have provided, and clarify how they have determined that such resources are new and additional. Please provide this information in relation to table 7(a) and table 7(b).

Documentation box:
New and additional: funding is drawn from the growing aid program and does not divert funds from existing development priorities or programs.

CTF Table 7a Provision of public financial support: multilateral 2010-11 and 2011-12

Multilateral Organisation	2010-11				2011-12				Status	Source	Financial Instrument	Type of support	Sector
	Core		CC Specific		Core		CC Specific						
	AUD	USD	AUD	USD	AUD	USD	AUD	USD					
Global Environment Facility	22.50	22.86	7.43	7.54	22.60	24.03	7.46	7.93	Provided	ODA	Grant	Mitigation	Cross-cutting
Least Developed Countries Fund	0.00	0.00	0.00	0.00	0.00	0.00	15.00	15.95	Provided	ODA	Grant	Adaptation	Cross-cutting
Special Climate Change Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Adaptation Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Green Climate Fund	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.53	Provided	ODA	Grant	Cross-cutting	Cross-cutting
UNFCCC Trust Fund Supplementary Activities	0.00	0.00	0.16	0.16	0.00	0.00	0.61	0.65	Provided	ODA	Grant	Other	N/A
Other													
Global Green Growth Institute	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.32	Provided	ODA	Grant	Cross-cutting	Cross-cutting
UNFCCC – Core	0.00	0.00	0.51	0.52	0.00	0.00	0.71	0.75	Provided	ODA	Grant	Other	N/A
Kyoto Protocol	0.00	0.00	0.24	0.24	0.00	0.00	0.22	0.23	Provided	ODA	Grant	Other	N/A
UNFCCC Trust Fund for Participation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Provided	ODA	Grant	Other	N/A
Subtotal	**22.50**	**22.86**	**8.34**	**8.47**	**22.60**	**24.03**	**29.50**	**31.36**					
Multilateral Financial Institutions including regional development banks													
World Bank	228.40	232.03	N/A	N/A	185.30	197.01	N/A	N/A	Provided	ODA	Grant	Other	Not applicable
Partnership for Market Readiness	0.00	0.00	0.00	0.00	0.00	0.00	10.00	10.63	Provided	ODA	Grant	Mitigation	Forestry
Forest Carbon Partnership Facility	0.00	0.00	0.00	0.00	0.00	0.00	11.93	12.68	Provided	ODA	Grant	Mitigation	Forestry
Energy Sector Management Assistance Program	1.25	1.27	0.75	0.76	2.67	2.84	1.60	1.70	Provided	ODA	Grant	Mitigation	Energy
Climate Investment Fund—Clean Technology Fund	0.00	0.00	25.00	25.40	0.00	0.00	0.00	0.00	Provided	ODA	Grant	Mitigation	Energy
Climate Investment Fund—Scaling-Up Renewable Energy Program	0.00	0.00	0.00	0.00	0.00	0.00	9.10	9.68	Provided	ODA	Grant	Mitigation	Energy

Climate Investment Fund—Pilot Program on Climate Resilience	0.00	0.00	2.45	2.49	0.00	0.00	0.00	0.00	Provided	ODA	Grant	Adaptation	Cross-cutting
Climate Investment Fund—Forest Investment Program	0.00	0.00	25.50	25.91	0.00	0.00	0.00	0.00	Provided	ODA	Grant	Mitigation	Forestry
International Finance Corporation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
African Development Bank	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Asian Development Bank	70.20	71.32	N/A	N/A	80.90	86.01	N/A	N/A	Provided	ODA	Grant	Other	Not applicable
Clean Energy Financing Partnership Facility	0.00	0.00	1.25	1.27	0.00	0.00	2.67	2.84	Provided	ODA	Grant	Mitigation	Energy
European Bank for Reconstruction and Development	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Inter-American Development Bank	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Other													
Subtotal	**299.85**	**304.62**	**54.95**	**55.82**	**268.87**	**285.86**	**35.30**	**37.53**					
Specialised United Nations bodies													
United Nations Development Programme	17.90	18.18	N/A	N/A	23.30	24.77	N/A	N/A	Provided	ODA	Grant	Other	Not applicable
United Nations Environment Programme	1.10	1.12	N/A	N/A	1.20	1.28	N/A	N/A	Provided	ODA	Grant	Other	Not applicable
Other													
Inter-Governmental Panel on Climate Change	0.00	0.00	0.87	0.88	0.00	0.00	0.84	0.89	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	**19.00**	**19.30**	**0.87**	**0.88**	**24.50**	**26.05**	**0.84**	**0.89**					
Total	**341.35**	**346.78**	**64.16**	**65.18**	**315.97**	**335.94**	**65.64**	**69.79**					

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office.

Documentation box:
New and additional: funding is drawn from the growing aid program and does not divert funds from existing development priorities or programs.

CTF Table 7b Provision of public financial support: bilateral and other 2010-11

Recipient Country/region	Total Amount Climate Specific		Status	Funding Source	Financial Instrument	Type of Support	Sector
	AUD	USD					
Asia-Pacific Regional	2.40	2.44	Provided	ODA	Grant	Mitigation	Forestry
Pacific Regional	39.58	40.21	Provided	ODA	Grant	Adaptation	Cross-cutting
Fiji	0.72	0.73	Provided	ODA	Grant	Adaptation	Cross-cutting
FSM, Palau, RMI	0.83	0.84					Cross-cutting
Kiribati	4.96	5.03	Provided	ODA	Grant	Adaptation	Cross-cutting
Nauru	0.50	0.51					Water and Sanitation
Niue & Tokelau	1.00	1.02					Cross-cutting
PNG	1.81	1.84	Provided	ODA	Grant	Mitigation	Cross-cutting
Samoa	0.69	0.70	Provided	ODA	Grant	Adaptation	Agriculture
Solomon Islands	3.99	4.05					Transport
Tonga	2.01	2.04					Cross-cutting
Tuvalu	1.00	1.02	Provided	ODA	Grant	Adaptation	Cross-cutting
Vanuatu	0.00	0.00	Provided	ODA	Grant	Adaptation	
Cook Islands	0.50	0.51					Cross-cutting
East Asia Regional	4.36	4.43	Provided	ODA	Grant	Adaptation	Cross-cutting
Timor Leste	0.48	0.49	Provided	ODA	Grant	Adaptation	Cross-cutting
Indonesia	10.75	10.92	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Vietnam	0.00	0.00	Provided	ODA	Grant	Adaptation	
Philippines	0.00	0.00					
Laos PDR	4.00	4.06					Energy
South Asia Regional	4.00	4.06	Provided	ODA	Grant	Adaptation	Water and Sanitation
Bangladesh	1.00	1.02	Provided	ODA	Grant	Adaptation	Cross-cutting
Maldives	0.00	0.00					
Sri Lanka	0.17	0.17	Provided	ODA	Grant	Adaptation	Cross-cutting
Caribbean and other SIDS	10.00	10.16	Provided	ODA	Grant	Adaptation	Cross-cutting
East Africa Regional	0.00	0.00					
Southern Africa Regional	0.00	0.00					
West Africa Regional	0.00	0.00					

Global Unspecified	1.50	1.52	Provided	ODA	Grant	Mitigation	Forestry
Total	**96.25**	**97.77**					

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office.

Documentation box:
New and additional: funding is drawn from the growing aid program and does not divert funds from existing development priorities or programs.

CTF Table 7b Provision of public financial support: bilateral and other 2011-12

Recipient Country/region	Total Amount Climate Specific		Status	Funding Source	Financial Instrument	Type of Support	Sector
	AUD	USD					
Asia-Pacific Regional	0.00	0.00	Provided	ODA	Grant	Mitigation	
Pacific Regional	28.76	30.58	Provided	ODA	Grant	Adaptation	Cross-cutting
Fiji	0.00	0.00	Provided	ODA	Grant	Adaptation	
FSM, Palau, RMI	1.40	1.49					Cross-cutting
Kiribati	2.85	3.03	Provided	ODA	Grant	Adaptation	Water and Sanitation
Nauru	0.50	0.53					Water and Sanitation
Niue & Tokelau	0.42	0.45					Other
PNG	1.73	1.85	Provided	ODA	Grant	Mitigation	Cross-cutting
Samoa	1.70	1.80	Provided	ODA	Grant	Adaptation	Cross-cutting
Solomon Islands	1.99	2.12					Transport
Tonga	0.00	0.00					
Tuvalu	0.80	0.85	Provided	ODA	Grant	Adaptation	Water and Sanitation
Vanuatu	1.00	1.06	Provided	ODA	Grant	Adaptation	Transport
Cook Islands	0.00	0.00					
East Asia Regional	9.80	10.42	Provided	ODA	Grant	Adaptation	Cross-cutting
Timor Leste	1.40	1.49	Provided	ODA	Grant	Adaptation	Cross-cutting
Indonesia	4.47	4.76	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Vietnam	17.10	18.18	Provided	ODA	Grant	Adaptation	Cross-cutting
Philippines	0.27	0.28					Cross-cutting
Laos PDR	1.00	1.06					Energy
South Asia Regional	7.38	7.85	Provided	ODA	Grant	Adaptation	Water and Sanitation
Bangladesh	7.00	7.44	Provided	ODA	Grant	Adaptation	Cross-cutting
Maldives	0.50	0.53					Cross-cutting
Sri Lanka	0.00	0.00	Provided	ODA	Grant	Adaptation	
Caribbean and other SIDS	5.20	5.53	Provided	ODA	Grant	Adaptation	Cross-cutting
East Africa Regional	2.60	2.76					Agriculture

Southern Africa Regional	5.00	5.32					Cross-cutting
West Africa Regional	2.90	3.08					Agriculture
Global Unspecified	32.87	34.95	Provided	ODA	Grant	Mitigation	Cross-cutting
Total	**138.64**	**147.41**					

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on annual average conversion rates as published by the Australian Taxation Office.

Documentation box:
New and additional: funding is drawn from the growing aid program and does not divert funds from existing development priorities or programs.

National approach to tracking and reporting provision of support

Australia's climate change finance is tracked by AusAID using its Aidworks aid initiative tracking system, which is the principal management tool for the implementation of Australia's development assistance program. Aidworks integrates program management and delivery with the enabling capabilities associated with financial, procurement, agreement, quality and performance management. Australia's climate change activities, like its other development assistance activities, are subject to mandatory quality and performance reporting requirements.

In this Biennial Report Australia is reporting on aid activities where the principal purpose is climate change. During the reporting period, Australia's climate finance came from distinct budget measures that were tracked, monitored and reported on. Australia will provide a breakdown of activities as part of its final fast-start reporting.

Meeting developing country needs

To ensure that the resources provided effectively address the needs of non-Annex I Parties in addressing climate change mitigation and adaptation, Australia supports a country-driven approach to aid delivery. Climate finance investments are more sustainable and effective when owned and driven by partner governments. Where investments address national priorities or involve a high level of engagement and decision-making by national governments, the effectiveness and uptake of a program can be increased. Throughout the fast-start period, Australia has looked for opportunities to increase national ownership of projects, by addressing country needs, working with government partners and using partner country processes and systems to deliver climate finance projects.

Private finance

Australia recognises the key role that climate finance from all sources will play in scaling-up and supporting mitigation and adaptation actions. Effective delivery of public climate finance requires supportive policy and institutional frameworks that will help ensure the success of individual projects and catalyse private investment.

Appropriate policies, regulation and governance create conducive enabling environments to support climate-compatible development. Public finance can contribute to strengthening elements of national administration in recipient countries, including the broader institutional architecture and the public financial system. It can also help to remove barriers to investment and improve the risk-reward calculation to make projects more attractive to private investors.

Climate finance is well placed to continue to support developing countries in improving their enabling environments, including policy frameworks, to drive low carbon and climate-resilient growth. For example:

- supporting regulatory and institutional reforms that cut "red tape" and encourage competition and innovation;

- supporting institutional capacity-building;
- investing in catalytic infrastructure, including information and communications technology;
- facilitating dialogue between the public and private sectors; and
- providing private sector financiers with advice to give them a better understanding of the risks in conflict-affected and fragile economies

Through the recently established OECD Research Collaborative on Tracking Private Climate Finance, Australia is partnering with a range of developed countries and international organisations to identify, test, and propose methodologies to track and attribute mobilised private finance flows to climate-relevant projects in developing countries. The outcomes of this research project could assist Australia and other developed countries to track and attribute private finance flows mobilized by their public investments in the future.

Technology transfer

Australia is actively participating in a range of international technology-based partnerships and programs aimed at strengthening information networks, training and resource tools, and practical collaboration on climate change actions.

Information on measures to support technology transfer and access can be found in CTF Table 8 and NC6 Chapter 7.

Building capacity

Countries face a range of challenges in responding to climate change. This often includes a lack of in-country expertise and capacity to implement desired reforms or effectively absorb large climate finance flows. It is important for donors to assist developing countries where needed to establish institutional and technical capacity to enable them to take action and incorporate climate change into long-term development planning. By investing in programs that build in-country capacity, developing countries are empowered to take control of their climate change agendas, while increasing the long-term sustainability of individual projects.

Information on capacity-building measures can be found in CTF Table 9 and NC6 Chapter 7.

CTF Table 8 Provision of Technology Development and Transfer Support

Recipient country and or region	Targeted area	Measures and activities related to technology transfer	Sector[c]	Source of the funding for technology transfer	Activities undertaken by	Status	Additional information[d]
	Mitigation Adaptation Mitigation and adaption		Energy Transport Industry Agriculture Water and sanitation Other	Private Public Private and Public	Private Public Private and Public	Implemented Planned	
Focus on non-Annex I and Clean Energy Ministerial (CEM) members	Mitigation	Australia funds the renewable energy components of the **Clean Energy Solutions Centre (CESC),** an online portal of clean energy policy information and tools including: • remote expert assistance, • online training, and • peer-to-peer	Renewable Energy Energy Efficiency Clean Transport Energy Access	Public	Private and Public	Implemented	The CEM was launched in 2010 to bring together ministers from major economies with key institutional and corporate stakeholders to collaborate on policies and programs that accelerate the deployment of clean energy technologies. The CESC is one of thirteen CEM initiatives, of which

		learning.	Infrastructure				Australia is a member of seven.
Focus on non-Annex I and Clean Energy Ministerial (CEM) members	Mitigation	Since 2012, the Clean Energy Ministerial **Carbon Capture, Use and Storage (CCUS)** Action Group has focused on three work streams aimed at analysing the financial and commercial risks of CCS demonstration, identifying and enabling support for CCS in developing countries, and supporting CCS in industrial applications.	Energy	Public	Private and Public	Implemented and continuing	Australia co-leads the Carbon Capture, Use and Storage (CCUS) Action Group; it was established in 2010. It brings together governments, institutions and industry to facilitate political leadership and provide recommendations to the CEM on concrete, near-term actions to accelerate CCS deployment.
China	Mitigation	Under the **Australia-China Joint Coordination Group on Clean Coal Technology (JCG),** Australia works closely with China's National Energy Administration on a range of collaborative activities, including:	Energy (CCS)	Public	Private and Public	Implemented and continuing	The JCG was established in 2007 to facilitate mutually beneficial cooperation on low-emissions coal technology. It is funded by an Australian Government commitment of $20 million.

		• Provision of AUD12 million to support a feasibility study for a post-combustion capture (PCC) project; • Six collaborative research projects, completed in 2012; • Establishment of the Australia-China JCG Partnership Fund to support joint research seminars, workshops and researcher exchanges; • Establishment of a Post Combustion Capture (PCC) Technology Advancement project, to help advance PCC technology under the flue gas conditions prevalent in Chinese coal fired power stations; and • The China-					

		Australia Geological Storage of CO2 Project aims to promote capacity building, training opportunities, and the sharing of expertise on the geological storage of CO2.					
Annex I and non-Annex I	Mitigation	Over the reporting period Australia contributed significant resources to the **Global Carbon Capture and Storage Institute**. The Institute's capacity development activities focus on developing countries, helping to build an 'enabling environment' for CCS by addressing barriers and building in-country expertise, in recognition that 70 per cent of CCS deployment will need to occur in non-OECD	Energy (CCS)	Public	Private and Public	Continuing	Tailored capacity development programs have been developed or updated by the Institute for Malaysia, Mexico, India and South Africa, in consultation with key industry and government stakeholders. Key initiatives include: • introduction of an elective CCS subject into university courses in Malaysia. • a CCS scoping study and capacity assessment for India, in partnership with The Energy Research Institute (TERI);

		countries to achieve global emission reduction targets.					and • the development of a CCS strategy for Indonesia, in collaboration with the ADB • The signing of a MOU with China's National Development and Reform Commission (NDRC) regarding cooperation on CCS, including through research, development and demonstration projects; and developing industrial and academic networks.
Annex I and non-Annex I		Australia is an active member of the **Global Methane Initiative** (GMI) which encourages the recovery and use of methane by focusing on the five main methane emission sources: agriculture, coal mines, municipal solid waste, oil and gas systems, and					The GMI addresses methane abatement as well as commercial use of fugitive emissions, and targeting additional emission sources such as wastewater.

		wastewater. GMI projects are accelerating the deployment of methane emission-reducing technologies and practices, stimulating economic growth and energy security in Partner countries, especially those with high energy growth forecasts and helping to build capacity in the area of methane abatement.					
non-Annex I		Australia is supporting the work of the **International Renewable Energy Agency (IRENA)** by contributing to its Global Renewable Energy Atlas and Renewable Energy Roadmap, as well as a range of other products and resources IRENA is developing to support developing	Renewable Energy	Public	Private and Public	Ongoing	IRENA is a treaty-level inter-governmental organisation of more than 150 sovereign member states, and aims to work with member countries and other international organisations to accelerate the development and deployment of renewable energy. The Australian Government ratified the Statute of IRENA on 5 January 2011 and from its inception has served as a

		countries develop their own renewable energy resources and industries.					member of the IRENA Council. Since 2010 Australia has been assisting IRENA with its engagement with Pacific Island countries, most notably providing assistance to IRENA with the first Pacific Island Renewable Energy Experts Meeting in Sydney. Most recently IRENA assumed the role of leading renewable energy efforts against the United Nations Sustainable Energy for All (SE4ALL) Initiative.
non Annex-I		Throughout the reporting period Australia has been a member of the IEA's **Climate Technology Initiative.** Member countries undertake a broad range of cooperative activities in partnership with developing and transition countries and other international bodies to accelerate development and	Clean Energy	Private and Public	Private and Public	Ongoing	Australia supports the initiative's role in creating enabling environments, which includes addressing market barriers to private sector investment and deployment of technology. Activities are designed to be consistent with the UNFCCC technology transfer objectives.

		diffusion of climate-friendly and environmentally sound technologies and practices. Australia supports the initiative's role in creating enabling environments, which includes addressing market barriers to private sector investment and deployment of technology. Activities are designed to be consistent with the UNFCCC technology transfer objectives.					

[a]To be reported to the extent possible.
[b]The tables should include measures and activities since the last national communication or biennial report.
[c]Parties may report sectoral disaggregation, as appropriate.
[d]Additional information may include, for example, funding for technology development and transfer provided, a short description of the measure or activity and co-financing arrangements.

CTF Table 9 Provision of capacity-building support[a]

Recipient country/region	Targeted area	Programme or project title	Description of programme or project[b,c]
Developing country partners	**Mitigation**	**The World Bank Partnership for Market Readiness (PMR)**	Australia has contributed $12.5 million (including FY 2012/13) to the PMR, shared its expertise in developing and implementing its national emissions trading scheme and domestic offset mechanism (the Carbon Farming Initiative) and hosted a PMR Partnership Assembly.
Developing country partners	**Mitigation**	**Low Emissions Capacity Building Programme (LECB)**	Australia is supporting 25 countries through the LECB to strengthen their institutional and technical capacity to plan and undertake mitigation actions, through the formulation of LEDS and NAMAs. The programme is also assisting countries to establish the national greenhouse gas inventory and MRV systems required to underpin mitigation actions.
Various REDD+ partner countries, including Indonesia, Papua New Guinea (with the United Nations Food and Agricultural Organization), Vietnam and Fiji	**Mitigation**	**The International Forest Carbon Initiative (IFCI)**	The $273 million International Forest Carbon Initiative (IFCI) is Australia's key contribution to global action on reducing emissions from deforestation and forest degradation in developing countries (REDD+). The IFCI is helping developing countries build capacity to participate in a future REDD+ mechanism, and to support the inclusion of REDD+ in the 2020 new agreement that will be applicable to all countries. As part of the IFCI, a research partnership in Indonesia is delivering policy and technical research on REDD+; the Asia Pacific Forestry Skills and Capacity Building Program is helping to improve forest governance, law enforcement and regulatory frameworks; and the Energising Development partnership is

			developing sustainable markets for improved cooking technologies in developing countries.
Various REDD+ partner countries	**Mitigation**	**Forest Carbon Partnership Facility (FCPF)**	Through the IFCI, Australia supports the Forest Carbon Partnership Facility (FCPF), a global partnership of governments, businesses, civil society, and indigenous peoples established to provide financial and technical assistance to countries seeking to build their capacity to effectively implement REDD+.
Various REDD+ partner countries	**Mitigation**	**Forest Investment Program (FIP)**	The Forest Investment Program (FIP), which utilises grants and near-zero interest credits to complement large-scale investments and leverage additional resources for REDD+, including through the private sector.
Indonesia	**Mitigation**	**The Indonesia-Australia Forest Carbon Partnership (IAFCP)**	Commenced in 2008, the IAFCP builds on long-term practical cooperation between Australia and Indonesia on REDD+ to support strategic policy dialogue on climate change; development of Indonesia's National Carbon Accounting System; and implementation of an incentive-based REDD+ demonstration activity in Central Kalimantan.
Asia-Pacific	**Adaptation**	**Research for Development Alliance**	The CSIRO-AusAID Research for Development Alliance aims to tackle important development challenges in the Asia-Pacific through improved knowledge of climate, water and energy systems. The Alliance builds partner capacity to inform development decisions that will improve both resilience and environmental management.
Pacific	**Adaptation**	**Pacific Australia Climate Change Science and**	Through the Pacific Australia Climate Change Science and Adaptation Planning (PACCSAP) Program, Australia is

		Adaptation Planning Program (PACCSAP)	supporting new country-specific research in the Pacific on climate change. Work has also begun on helping Pacific countries apply climate change projections to planning adaptation measures.
Pacific countries	**Adaptation**	**Climate and Oceans Support Program**	Australia's Climate and Oceans Support Program in the Pacific is supporting Pacific meteorological services to use climate science to support planning in various sectors including agriculture, water security and health.
Pacific nations including: Cook Islands, Federated States of Micronesia, Fiji, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.	**Adaptation**	**Pacific Adaptation to Climate Change Project**	The United Nations Development Program's Pacific Adaptation to Climate Change project helps build the capacity of participating countries to adapt to climate change in the food security, water and coastal management sectors.
Vietnam, Timor-Leste, the Philippines, Papua New Guinea, Solomon Islands, Vanuatu, Kiribati, Republic of Marshall Islands, Tonga and Fiji.	**Adaptation**	**Climate Change Action Grants scheme**	Australia's Community-based Climate Change Action Grants scheme is a new program supporting non-government organisations to work with local communities to build their capacity and resilience to climate change, focussing on disaster risk reduction, food and water security, agricultural productivity and ecosystem-based adaptation.
Vietnam	**Adaptation**	**Vietnam Climate Change and Coastal Ecosystems Program**	Australia has partnered with Germany and the Government of Vietnam to help communities in the Kien Giang province to adapt to climate change and improve the management of coastal environments.

Pacific	**Adaptation**	**Pacific Adaptation Strategy Assistance Program (PASAP)**	The PASAP produced regional climate change research to provide country specific climate projections in the region and has been well received by Pacific countries, their development partners and the international community.

[a]To be reported to the extent possible.
[b]Each Party included in Annex II to the Convention shall provide information, to the extent possible, on how it has provided capacity-building support that responds to the existing and emerging capacity-building needs identified by Parties not included in Annex I to the Convention in the areas of mitigation, adaptation and technology development and transfer.
[c]Additional information may be provided on, for example, the measure or activity and co-financing arrangements.

7. Other reporting elements

Emissions measurement, reporting, and verification and emissions projections

Australia has comprehensive arrangements for national emissions inventory and emissions projections reporting (see NC6 Chapter 3 and Chapter 5).

Australia's national greenhouse accounts (see NC6 Chapter 3) and emissions projections reporting (see NC6 Chapter 5) enable the tracking of emissions at the national, state and territory levels and across different industry sectors. The accounts provide comprehensive, comparable and transparent information to underpin assessments of progress towards national emission reduction commitments. The accounts comprise the following key publications and systems:

- Quarterly Update of Australia's national greenhouse gas inventory, which provides estimates of emissions at the national level for the latest quarter;
- Australia's National Inventory Report submitted annually to the UNFCCC and reviewed by international experts under both the UNFCCC and the Kyoto Protocol;
- Australia's National Inventory by Economic Sector, which reports emissions annually by Australia-New Zealand Standard Industry Classifications (ANZSIC);
- State and Territory greenhouse gas inventories, which provides nationally consistent data for Australia's eight states and territories;
- Accessibility to Australian data is enhanced through a searchable database of emissions published on the department's website, the Australian Greenhouse Emissions Information System (AGEIS);
- Company emissions data are published under Australia's National Greenhouse and Energy Reporting System (NGERS), in place since 2008, used by Australian Corporations to report their emissions at a facility level, and which also provides the basis for companies to meet their obligations under Australia's emissions trading scheme; and
- Australia's Emissions Projections, published annually, include projections of national and sectoral emissions under different policy scenarios, and an assessment of the abatement required to meet Australia's emission reduction targets.

Australia's self-assessment of emissions reduction compliance

Clean Energy Regulator

The Clean Energy Regulator is responsible for administering the emissions trading scheme and the Renewable Energy Target. The Regulator has robust powers to ensure the integrity of the scheme and the Australian National Registry of Emissions Units.

Climate Change Authority

The Government has established the independent Climate Change Authority to report to Parliament on a range of matters that relate to Australia's emission reduction targets.

The Authority will conduct broad inquiries to evaluate Australia's progress and inform its recommendations on Australia's emissions reduction goals. The Authority recognises climate science as a foundational issue which informs the basis of its Reviews.

The *Clean Energy Act 2011* specifies that the Authority conduct a Caps and Targets Review. The first review will be completed by 28 February 2014, and each subsequent review must be completed annually thereafter.