

A photograph of three cockatoos perched on a tree branch. The cockatoo in the center has a bright red crest, while the two on either side have grey crests. They are surrounded by green foliage and sunlight filtering through the leaves.

**AUSTRALIA'S
7TH NATIONAL
COMMUNICATION
ON CLIMATE CHANGE**

A REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

DECEMBER 2017

Acknowledgement of traditional owners and country

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

Produced by the Department of the Environment and Energy

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Many Australian Government programs are ongoing. The information in this publication was correct at the time of its publication in December 2017.



JOINT MINISTERIAL FOREWORD

Over the last four years, the international community has taken steps forward in global action on climate change. Australia is proud to be one of more than 165 countries to ratify the Paris Agreement. We have set a credible and responsible 2030 target to reduce emissions by 26 to 28 per cent below 2005 levels.

We take our international commitments seriously. The Australian Government has implemented a mix of economy-wide policies and measures to reduce emissions, drive investment in clean energy and improve energy productivity. Together these policies are delivering great results and have us on track to exceed our 2020 emissions reduction target.

The Australian Government is also working on new policies to help drive Australia's trajectory towards lower emissions. We have integrated our climate and energy policies. We are acting on expert advice to implement a National Energy Guarantee for the electricity sector to combine reliable energy supply and emissions reductions. For the transport sector, we are consulting on measures to improve fuel efficiency standards for light vehicles, strengthen noxious emissions standards and improve fuel quality. We are fast-tracking the phase-down of harmful hydrofluorocarbons, commencing action a year ahead of global commitments and starting 25 per cent below the Montreal Protocol's limits.

Understanding how our climate is changing and its potential impacts is critical to shaping our policy response. All levels of government have enhanced efforts to manage climate risks and adapt to a changing climate. The Australian Government has a *National Climate Resilience and Adaptation Strategy*. Most state, territory and local governments now have adaptation plans or strategies in place.

Our research infrastructure is world-class and our researchers are making valuable contributions to global climate science. Research into the tropical oceans climate processes has provided insights to Australian climate variability and their causes. This will allow Australian researchers to model future climate changes with greater accuracy, assisting government and industry decision making. Australia is also contributing valuable insights from research and systematic observations in the Southern Ocean and Antarctica.

Australia is delivering on our commitment to provide \$1 billion of climate finance over five years to support developing countries to build resilience and reduce emissions. This includes a commitment of \$200 million to the Green Climate Fund and \$300 million support for the Pacific region. We are integrating climate change across our aid program with a focus on supporting effective climate action in our region and on mobilising public and private sector investment for the transition to a low emissions, climate resilient global economy.

Australia is proud to present its Seventh National Communication which 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. We will continue to evolve our policy responses and review our progress towards targets, in accordance with Australia's commitments under the UNFCCC and Paris Agreement.



The Hon Julie Bishop MP
Minister for Foreign Affairs



The Hon Josh Frydenberg MP
Minister for the Environment and Energy

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ABBREVIATIONS AND ACRONYMS

ACRONYMS

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ACCESS	Australian Community Climate and Earth System Simulator
ACE CRC	Antarctic Climate and Ecosystems Cooperative Research Centre
ACCU	Australian carbon credit unit
AEMO	Australian Energy Market Operator
AGEIS	Australian Greenhouse Emissions Information System
ANAO	Australian National Audit Office
ANREU	Australian National Registry of Emissions Units
ARENA	Australian Renewable Energy Agency
BoM	Bureau of Meteorology
CAWCR	Centre for Australian Weather and Climate Research
CCS	carbon capture and storage
CEFC	Clean Energy Finance Corporation
CEM	Clean Energy Ministerial
CER	Clean Energy Regulator
CESC	Clean Energy Solutions Centre
COAG	Council of Australian Governments
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ERAC	Emissions Reduction Assurance Committee
ENSO	El Niño - Southern Oscillation
ERF	Emissions Reduction Fund
ESM	Energy Sector Model
FullCAM	Full Carbon Accounting Model
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility
GEMS	Greenhouse and Energy Minimum Standards
GHG	greenhouse gas
HFCs	hydrofluorocarbons
IMO	International Maritime Organization
IMOS	Integrated Marine Observing System
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
JCG	Australia-China Joint Coordination Group on Clean Coal Technology
LNG	liquefied natural gas

LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
MRV	measurement, reporting and verification
NARClIM	NSW/ACT Regional Climate Model
NCRIS	National Collaborative Research Infrastructure Strategy
NEM	National Electricity Market
NGER	National Greenhouse and Energy Reporting
NIR	National Inventory Report
NRM	Natural Resources Management
NURG	National Inventory Users Reference Group
ODA	Overseas Development Assistance
OECD	Organisation for Economic Co-operation and Development
PACCSAP	Pacific-Australia Climate Change Science and Adaptation Planning
PAGES	Past Global Changes
PALS	Pacific Appliance Labelling and Standards
PFC	perfluorocarbon
PICTs	Pacific Island Countries and Territories
PV	photovoltaic
QA	quality assurance
QC	quality control
REDD+	Reducing emissions from deforestation and forest degradation in developing countries
RET	Renewable Energy Target
SRES	Small-scale Renewable Energy Scheme
UNFCCC	United Nations Framework Convention on Climate Change
VET	Vocational Education and Training

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 ₂ O	nitrous oxide
NO _x	oxides of nitrogen
SF ₆	sulphur hexafluoride
SO ₂	sulphur dioxide
tCO ₂ -e	tonnes of carbon dioxide equivalent

GLOSSARY

Abatement	Emissions reductions as a result of an action. For example the adoption of a policy or measure.
Adaptation	An adjustment in natural or human social or economic systems in response to actual or expected climate change. The adjustment aims to reduce the harmful impacts or seek beneficial opportunities of climate change.
Australian Community Climate and Earth System Simulator (ACCESS)	A weather and climate modelling system. It provides short term and seasonal forecasts and climate projections. Developed in Australia by the Bureau of Meteorology, CSIRO and universities it builds on other forecast models including the United Kingdom Met Office Unified Model.
Air source heat pump	An energy efficient heating and cooling system which transfers heat from outside to inside a building, or vice versa.
Australian carbon credit units (ACCUs)	Units issued by the Clean Energy Regulator representing one tonne of carbon dioxide equivalent (tCO ₂ -e) stored or avoided by Emissions Reduction Fund projects.
Basal melting	Basal melting of ice shelves is a natural process where heat from ocean water melts the underside of the ice shelf.
Black system event	Extreme events that disrupt the electricity system and result in a significant part of the electricity grid suffering a total shutdown.
Broadacre cropping	Used in Australia to describe farms or industries engaged in the production of grains, oilseeds and other crops (especially wheat, barley, peas, sorghum, maize, hemp, safflower and sunflower) on a large scale.
Carbon capture and storage	A 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 (CO₂)	A naturally occurring gas and 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 responsible for increasing the earth's temperature.
Carbon dioxide equivalent (CO₂-e)	A standard measure to take account of the different global warming potential of different greenhouse gases and expresses the cumulative effect in a common unit.
Carbon Neutral	Reducing emissions where possible and then investing in carbon offset projects to achieve zero overall emissions.
Carbon sink	Natural or man-made systems that absorb and store carbon dioxide from the atmosphere, including trees, plants and the oceans.
Carryover	Surplus emission units 'carried over' from a prior Kyoto Protocol commitment period and used in the next period.
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.

Climate change risks	The physical risks from the changing climate and the transition risks associated with developments that may (or may not) occur in the process of adjusting towards a lower-carbon economy.
COAG (Council of Australian Governments)	The peak intergovernmental decision-making forum in Australia including the Australian Government's Prime Minister, state and territory governments' First Ministers and the President of the Australian Local Government Association.
COAG Energy Council	The ministerial forum for the Commonwealth of Australia, states and territories of Australia and New Zealand, to work together in the pursuit of national energy reforms.
Competitive metering	Supports a competitive market for the rollout of smart meters enabling a more efficient delivery of services. It gives consumers access to new products better tailored to their energy use. Smart meters use software based components allowing consumers to control their energy use and respond to high and low demand in the market. For example programming appliances to operate during low demand periods to save on energy costs.
Cost-reflective electricity pricing	Better reflects the true cost of supplying electricity to different customer groups. It helps to manage peak electricity demand issues by providing price signals to consumers to shift their energy use away from peak periods, use distributed energy resources efficiently and access demand management services.
Distributed electricity generation	Technologies such as co-generation, solar PV and batteries are deployed in a dispersed way throughout the electricity network. They can be used to offset centralised grid demand, provide generation to the market and other services to support reliability or system security.
Deforestation	Lands where there has been direct human-induced conversion of forested land to an alternative, non-forest use since 1 January 1990.
Demand management	The modification of consumer demand for energy through various methods such as load reduction, load shifting or use of onsite generation, particularly during extreme peak electricity demand or emergencies.
Dispatchable generation	A source of electricity (e.g. a power plant) which can adjust their output supplied to the electrical grid on demand.
Domestic / national emissions	Greenhouse gas emissions and removals, resulting from human (anthropogenic) activities in Australia and external territories.
Downscaling	The process by which coarser resolution global climate model outputs are translated into finer resolution climate information to better account for regional climatic influences, such as local topography.
Dynamic	A process or system characterised by change, activity or progress.
El Niño and La Niña conditions	El Niño refers to the extensive warming of the surface 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.

Emissions intensity	The total emissions divided by the total energy content of the fuels or the total energy used in a sector. The overall emissions intensity of coal used in Australia, for example, is determined by the quantity and emission factors for each of the many types and grades of coal used.
Emissions per capita	The total emissions divided by the total population, expressed as an amount of carbon dioxide equivalent emissions per person.
Energy efficiency	Something is more energy efficient if it delivers more services/output for the same energy input, or the same services/output for less energy input.
Energy security	The uninterrupted availability of energy sources at an affordable price.
Enteric fermentation	The process in animals by which gases, including methane, are produced as a by-product of microbial fermentation associated with digestion of feed.
Extreme weather event	A weather 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.
Forest degradation	A direct human-induced activity that leads to a long-term reduction in forest carbon stocks.
Forest Fire Danger Index	Used to forecast the influence of weather on fire behaviour in forests. The index is related to the chances of a fire starting, its rate of spread, its intensity, and its difficulty of suppression, according to various combinations of air temperature, relative humidity, wind speed and both the long and short-term drought effects.
Fugitive emissions	Generally deliberate but not fully controlled emissions typically result from leaks, including from pump seals, pipe flanges and valve stems. Fugitive emissions also include methane emitted from coal mine seams. During petroleum storage tank filling, venting loss of vapour is a fugitive emission.
Greenhouse gases	Gases that contribute to global warming, including carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF ₆) and nitrogen trifluoride (NF ₃). In addition, the photochemically important gases—non methane volatile organic compounds (NMVOCs), oxides of nitrogen (NO _x) and carbon monoxide (CO)—are also considered. NMVOC, NO _x and CO are not direct greenhouse gases. However, they contribute indirectly to the greenhouse effect by influencing the rate at which ozone and other greenhouse gases are produced and destroyed in the atmosphere.
Hydrofluorocarbons (HFCs)	Used as substitutes for ozone depleting substances such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs).
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.
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.

Intergovernmental Panel on Climate Change (IPCC)	The international body responsible for assessing the state of knowledge about climate change. The IPCC increases international awareness of climate change science and provides guidance to the international community on issues related to climate change response.
Kyoto Protocol	The protocol to the convention on climate change was developed through the UNFCCC negotiating process in Kyoto, Japan, in 1997. It sets binding greenhouse gas emissions targets for UNFCCC developed country Parties that ratify the agreement. The first commitment period of the KP ran from 2008–2012. In 2012 Parties to the Kyoto Protocol agreed to the Doha Amendment, establishing a second commitment period to run from 2013–2020.
Kyoto 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 greenhouse gas inventory sector covering emissions and removals from land and forests caused by human activities. This sector does not include emissions from the Agriculture sector, such as emissions from livestock or fertilisers applied to croplands.
Light detection and ranging (LiDAR) system	A technology allowing 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.
Measures	Past, current or committed Australian, state or territory, or local government policy actions to reduce greenhouse gas emissions.
Mitigation	A human intervention to reduce the sources of, or enhance the sinks for, greenhouse gases.
Montreal Protocol	The 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 Electricity Market (NEM)	The wholesale market through which generators sell electricity in eastern and southern Australia. The main customers are energy retailers, which bundle electricity with network services for sale to residential, commercial and industrial energy users.
National / domestic emissions	Greenhouse gas emissions and removals, resulting from human (anthropogenic) activities in Australia and external territories.
National Inventory Report	An inventory of Australia’s national greenhouse gas emission estimates, prepared as part of Australia’s National Greenhouse Accounts and used by the Australian Government to meet its international reporting obligations. Reports are compiled and submitted annually under the rules for reporting applicable to the UNFCCC and under the Kyoto Protocol.
Paleoclimate	The 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 and ice cores) are available.
Projection	A potential future evolution of a quantity or set of quantities, often computed with the aid of a model.
Smart grid	The application of information, communications and control technology to improve the efficiency and effectiveness of electricity networks.

Solar photovoltaic (PV)	Solar cells that convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the PV effect.
Statutory authority	A body created by Australian Government legislation that is a separate legal entity from the Commonwealth (Australian Government) and which has the power to hold money on its own account.
United Nations Framework Convention on Climate Change (UNFCCC)	An international environmental treaty which entered into force in 1994. Parties to the convention have agreed to work towards achieving the ultimate aim of stabilising 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.



1. EXECUTIVE SUMMARY

This report details Australia's progress towards meeting its commitments under the United Nations Framework Convention on Climate Change (UNFCCC). It addresses recommendations made by the UNFCCC Expert Review Team's assessment of Australia's Sixth National Communication including: greater detail on sectoral policies to reduce emissions, information on the roles and responsibilities of Australia's government departments and institutions, and detailed information on the Emissions Reduction Fund. The third Biennial Report, at Annex A, provides information on Australia's greenhouse gas emissions and trends, projections against our 2020 target, and our financial assistance provided to developing country Parties to the Convention.

Australia is committed to effective global action to address climate change.

Australia has ratified the Paris Agreement alongside more than 165 other countries. The Australian Government has set an ambitious target to reduce emissions by 26 to 28 per cent on 2005 levels by 2030. This is equivalent to halving per capita emissions or reducing the energy intensity of Australia's economy by two-thirds.

Australia has implemented a comprehensive set of policies to reduce greenhouse gas emissions across the economy, increase energy efficiency and fast track development and uptake of clean energy. In 2017, the Australian Government reviewed these policies to ensure they remain effective in achieving Australia's 2030 target and Paris Agreement commitments.

Following the sixth auction in December 2017, the \$2.5 billion Emissions Reduction Fund contracted more than 191 million tonnes of abatement with more than \$265 million remaining to purchase further emissions reductions.

Household use of solar energy has surged under the Renewable Energy Target. Australia has one of the highest number of solar panels on roofs per capita in the world, representing 17 per cent of Australian households.

Measures under the National Energy Productivity Plan are delivering cost savings and emissions reductions. For example the Equipment Energy Efficiency program applies standards and efficiency labels to equipment such as air conditioners, commercial refrigerated display cabinets and refrigerators, delivering an estimated \$7 billion in economic benefits and reducing emissions by 45 Mt CO₂-e (cumulative to 2030).

The National Carbon Offset Standard is supporting voluntary action to manage greenhouse gas emissions and achieve carbon neutrality.

New policies and measures are being developed. Australia is transforming its energy system to deliver affordable and reliable energy to Australians while also meeting our international commitments. A public policy priority for Australia is integrating climate and energy policies to ensure affordable and reliable power while reducing emissions. The Australian Government is working with the Energy Security Board and the Council of Australian Governments Energy Council to implement a National Energy Guarantee. The Guarantee will require electricity retailers to use a mix of energy sources to provide a reliable energy supply and reduce emissions. This approach was recommended by experts.

A Ministerial Forum of Australian, state and territory governments is developing policies to reduce emissions from Australia's motor vehicles. In 2015 the transport sector produced approximately 18 per cent of Australia's emissions, most of these were from cars and light commercial vehicles.

The Australian Government has reviewed its climate change policies to ensure they remain effective in achieving the 2030 emissions reduction target.

Australia's efforts are having a positive effect. Australia's high per capita emissions are declining, as reported in the National Greenhouse Accounts. This decline is, in large part, the result of government policies, an overall decline in land clearing, and structural changes in Australia's economy including a move away from manufacturing and heavy industrial activities for export.

Australia is on track to overachieve its 2020 emissions reduction target of five per cent below 2000 levels by 294 Mt CO₂-e. This is despite a projected increase in emissions over the period to 2020, primarily driven by the development of liquefied natural gas facilities.

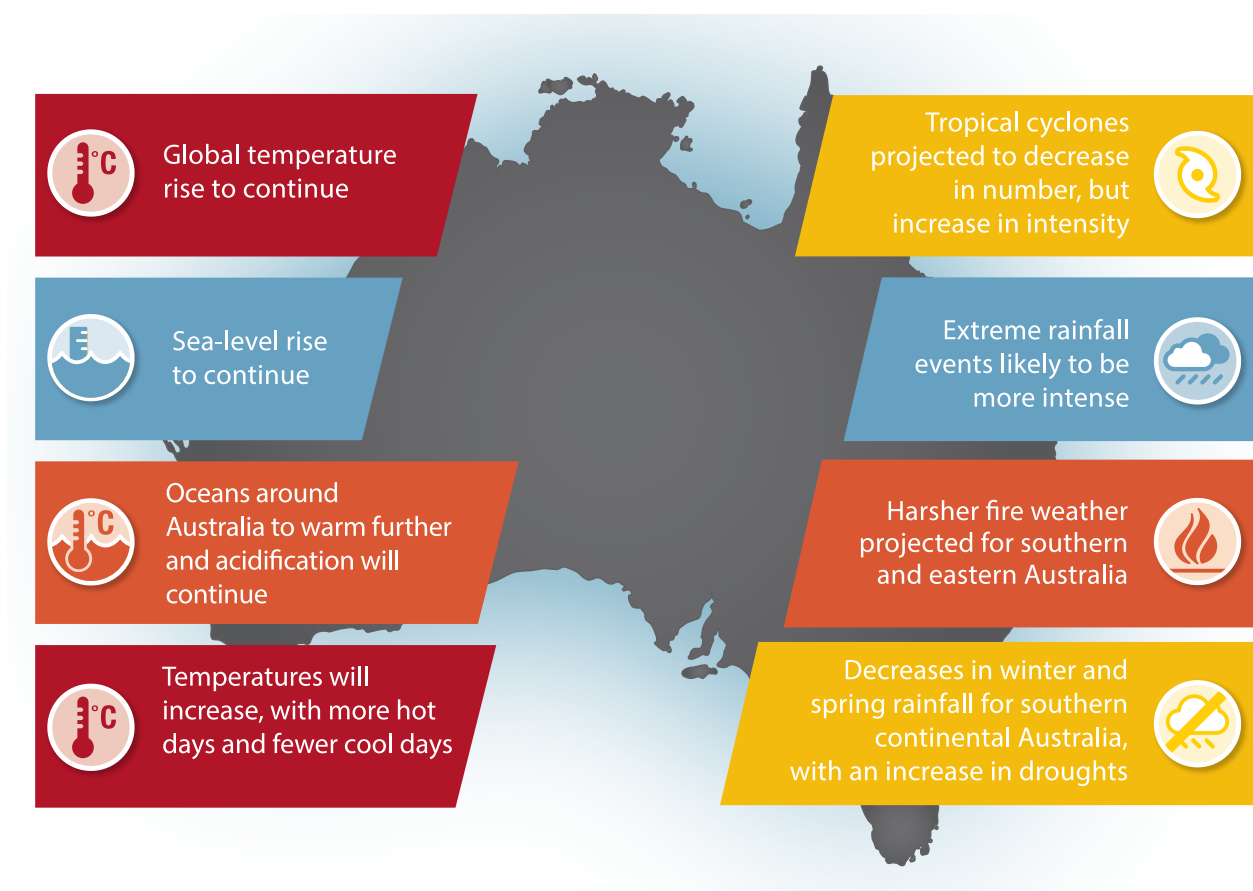
The Australian climate has changed. We have experienced higher temperatures, increased frequency and intensity of extreme heat events, and an increase in high fire risk weather conditions and drought conditions since the middle of the 20th Century. These changes in climate are expected to continue (see Figure 1.1).

Australian governments have enhanced their efforts to adapt to these changes. Australia continues to invest in climate change projections, research into impacts and adaptation, and climate change risk and vulnerability assessments.

In 2015, the Australian Government released a national strategy which communicates how Australia is managing climate risks and outlines the vision for a climate-resilient future.

Most state and territory and local governments now have adaptation plans or strategies in place and are managing climate risks across a range of sectors and in government decision making.

Figure 1.1: General trajectories of the changing climate, available from the State of the Climate 2016



Source: Bureau of Meteorology and CSIRO

Australia continues to build its knowledge of how the climate is changing and how we can manage its impacts. The Commonwealth Scientific and Industrial Research Organisation and the Bureau of Meteorology play important roles in monitoring, analysing and communicating observed changes in Australia's climate. In 2015, together they released the most comprehensive set of climate change projections ever developed for Australia. This information is critical for governments and business to understand how a change in climate will impact the industries, infrastructure and assets in their region and plan for these impacts.

Australia continues to be a leader in research in the Southern Ocean and the Antarctic and play an important role in systematic observation. Research findings and observations contribute to global advancement and understanding of climate science. For example, Cape Grim Baseline Air Pollution Station, on Tasmania's west coast, is one of the three premier Baseline Air Pollution Stations in the World. Air samples collected at Cape Grim since the mid-1970s show changes in greenhouse gas levels and other air pollutants over time.

Australia is contributing to regional and international action on climate change. Australia provides support for developing countries to address climate change through finance, capacity building and technology transfer. Increasingly Australia's official development assistance is invested in climate change mitigation, adaptation, resilience-building and humanitarian relief.

Australia is committed to doing its part to meet the 2010 UNFCCC Conference of Parties collective goal of mobilising US\$100 billion a year in climate finance for developing countries by 2020. At the Conference of the Parties in Paris, Australia's Prime Minister (the Hon Malcolm Turnbull MP) pledged \$1 billion over five years to build climate resilience and reduce emissions. This includes a commitment of \$200 million to the Green Climate Fund (2014 to 2018) and \$300 million to address climate change in Pacific Island Countries.

Australia has been a founding member of international collaborations. The International Partnership for Blue Carbon brings together governments, non-government organisations and research institutions to enhance the protection and restoration of coastal blue carbon ecosystems for climate action. In 2016, Australia and France launched a new Plan of Action for the International Coral Reef Initiative focused on the impacts of climate change on coral reefs and efforts that can be taken to build reef resilience.

Australia is ensuring governments at all levels, business, industry and the community are empowered to take positive action and support climate change efforts into the future.

Over the past four years, the Australian Government has created data sets and resources to help decision makers and communities understand and respond to the impacts of a change in climate in Australia. These include the [State of the Climate 2016](#) and [State of the Environment](#) reports, [CoastAdapt](#), and the [Your Home](#) and [Your Energy Savings](#) websites.

State and territory governments are promoting public awareness and helping address climate change. Pledges, action plans and government programs, coupled with information, training and networking opportunities are helping to mobilise local level action on climate change.

Non-government organisations, including industry peak bodies, are leveraging industry specific expertise and networks to provide tailored support for climate change adaptation in the building, engineering and investment sectors.

Sustainability is embedded in a nation-wide curriculum for Australian schools with subjects on climate change and the impacts of greenhouse gas emissions. This will ensure young Australians develop the knowledge, skills, values and world views to contribute to more sustainable patterns of living.



2. AUSTRALIA'S NATIONAL CIRCUMSTANCES

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Key developments

Australia's per capita emissions have been declining over the past two decades while the population and economy have grown.

Australia's national circumstances shape its response to climate change. Australia's vast size, diverse landscapes, predisposition to climate variability, resource based economy and small but growing population living mostly in coastal regions pose challenges and opportunities to managing the impacts of climate change.

Australia is one of the world's largest energy producers, generating almost three times the volume of national consumption and exporting excess production. Australia has a large agricultural sector, producing food for domestic consumption as well as export.

Australia's large resource and agricultural production, and dependence on long-haul transport have led to relatively high, but declining, per capita emissions compared to other developed countries. In 2015, per capita emissions were 22 tonnes of carbon dioxide equivalent (CO₂-e) per person (including *land use, land-use change and forestry*). This represents a 35 per cent per capita emissions decline from 1990 levels. These declines are, in large part, a result of government policies, an overall decline in land clearing emissions, and structural changes in Australia's economy including a move away from manufacturing and other heavy industrial activities.

Australia is transforming its electricity market, from a 20th century electricity grid dominated by large scale, fossil fuel-fired generators to a 21st century grid with increasing penetration of renewables, storage and demand management technologies. A public policy priority for Australia is integrating climate and energy policies to enable the electricity market to successfully transition while reducing emissions. The National Energy Guarantee, announced in October 2017, will deliver more affordable and reliable electricity while meeting Australia's international commitments to emissions reduction.

This chapter describes Australia's national circumstances, including: government structure, demography, economic performance, industry profiles, settlement and transport characteristics, and climate features.

2.1 AUSTRALIA – GEOGRAPHY, DEMOGRAPHY AND GOVERNMENT

Australia is the sixth largest country in the world, with a land area of 7.7 million square kilometres. Australia's marine jurisdiction is the third largest in the world, with an exclusive economic zone covering 10 million square kilometres. Australia is the driest inhabited continent; 70 per cent of it is either arid (average rainfall of 250 mm or less) or semi-arid (average rainfall of between 250 and 350 mm) land.

Australia's population is 24 million people. Most people live in urban areas along the eastern and western coastal regions. Over 85 per cent of Australians live within 50 kilometres of the coastline, and two in three Australians live in a capital city.

Population growth is a strong driver of emissions growth, and an important element of Australia's national circumstances. Over the past 10 years, Australia's population has increased by 18 per cent, or approximately 3.8 million people, compared to an Organisation for Economic Co-operation and Development (OECD) average of around 7 per cent. All Australian states and territories experienced population growth between 2015 and 2016, including through immigration.

Australia's population is expected to continue to grow and reach around 30 million by 2030. Australia's population is aging with the median age increasing from 34 years in 1995 to 37 years in 2015, and is expected to continue that trend.

Australia has a federal system of government with three levels: federal (the Australian Government), state and territory (Queensland, New South Wales, South Australia, Tasmania, Victoria, Western Australia, the Australian Capital Territory and the Northern Territory) and local. Local government bodies are created by state and territory law. There are 546 local governing bodies across the country.

Australia's written constitution sets out the responsibilities of the Australian Government, including foreign affairs and trade, defence and immigration. States and territories are responsible for matters not assigned to the Australian Government, such as health and education, though in practice the two levels of government cooperate in many areas.

The Council of Australian Governments (COAG) is the peak intergovernmental forum in Australia. COAG members are the Prime Minister, state Premiers, territory First Ministers and the President of the Australian Local Government Association. COAG manages matters of national significance or matters requiring co-ordinated action by all Australian governments.

COAG is supported by a number of ministerial councils that provide a forum for intergovernmental collaboration and decision making on specific policy areas. They develop policy reforms and advice for COAG consideration, and oversee the delivery and review of reforms agreed by COAG. There are eight COAG councils, with the Energy Council bearing primary responsibility for energy policy, including carbon policy.

Since the Sixth National Communication, the Meeting of Environment Ministers replaced the COAG Standing Council on Environment and Water. These meetings provide a forum to discuss strategic issues including climate change, and agree on cross-government actions to improve Australia's environment.

In 2016 the Australian Government combined energy and climate change policy responsibility under a single agency, the Department of the Environment and Energy, to better integrate energy and climate policy. The Department of the Environment and Energy works closely with the Department of Foreign Affairs and Trade, Australia's lead agency responsible for international negotiations under the United Nations Framework Convention on Climate Change.

Since the Sixth National Communication the national inventory functions moved from the former Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education to the Department of the Environment and Energy.

2.2 ECONOMY

Australia is an open economy, highly integrated with the global economy.

Australia's economy has grown for over 25 consecutive years. Between 1996 and 2015 Australia's average annual economic growth was 3.4 per cent compared to an OECD average of 2.2 per cent. For the 2015–16 financial year, Australia's real GDP grew by 2.6 per cent, and real GDP per capita was approximately \$69,421, an increase of 1.37 per cent from the previous year. Australia's strong, continuous economic growth has boosted living standards and household consumption.

In this integrated global market, Australia has specialised in areas where it enjoys a comparative trade advantage. This includes resources and energy, which account for around 60 per cent of Australia's exports by value, and agriculture, which accounts for around 15 per cent of exports by value. Australia's economy benefits significantly from tourism, which generates jobs, investment and growth in communities throughout Australia. Australia has competitive advantages in tourism through proximity to Asia, appealing natural assets, a safe geopolitical environment and low cost airfares.

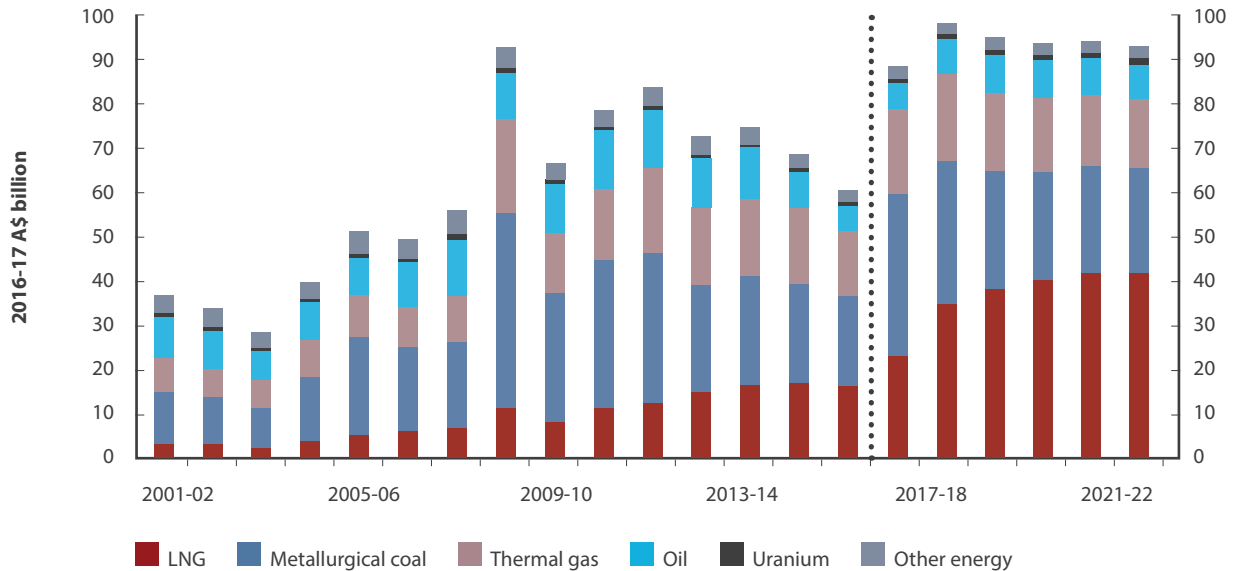
2.3 ENERGY

Australia is one of the world's largest energy producers. In 2015–16 two thirds of Australia's energy production was exported.

Australia's energy production is dominated by coal (Figure 2.1), which in 2014–15 accounted for approximately 74 per cent of energy production. This is followed by natural gas (20 per cent), oil (4 per cent) and renewables (2 per cent). The proportion of renewable energy production is growing due to measures such as the Renewable Energy Target (see Chapter 4), which aims to increase renewable energy to about 23.5 per cent of Australia's electricity generation by 2020. Apart from oil, Australia's energy resources are expected to last for many more decades, even with increasing production.

In 2014–15, Australia’s net exports were equal to around two thirds domestic energy production. In 2014–15 energy exports were valued at \$67 billion, 39 per cent of total commodity exports. Over the next two years, Liquefied Natural Gas (LNG) is forecast to add \$14 billion to Australia’s resources and energy exports.

Figure 2.1: Australia’s energy commodity exports



Source: ABS (2017) International Trade in Goods and Services, 5368.0; Department of Innovation and Science (2017)

2.3.1 Energy sources

2.3.1.1 Coal

Australia holds the world’s fifth-largest black and brown coal reserves, with around 10 per cent of the world’s economically recoverable black coal and 24 per cent of the world’s economically recoverable brown coal. At the end of 2015, Australia’s black coal reserves was estimated at 68 billion tonnes and brown coal at 77 billion tonnes.

Australia is the world’s largest exporter of metallurgical (coking) coal, and the second largest exporter of thermal coal. Coal is Australia’s second-largest export behind iron ore, valued at around \$55 billion in 2016–17. In 2016–17, Australia exported 182.5 million tonnes of metallurgical coal and 202 million tonnes of thermal coal.

In the context of continuing global demand for coal, the Australian Government is investing in research on low-emissions technologies, including carbon capture and storage and high efficiency low emissions coal (further detail is provided in Chapter 4).

2.3.1.2 Oil

Australia has limited resources of crude oil, and most known remaining oil resources are condensate and naturally occurring liquefied petroleum gas (LPG) associated with large offshore gas fields.

Australia holds around 0.2 per cent of world crude oil reserves. In 2015–16 crude oil exports fell by 8 per cent to 514 petajoules (14 billion litres).

The proportion of LPG reserves to current production is estimated at around 16 years. For crude oil it is estimated at seven to 10 years, and for condensate it is estimated at 25 years. The ratio for oil has remained around this level since the 1980s due to new discoveries and existing resources becoming more economical.

2.3.1.3 Natural gas

Australia holds approximately two per cent of the world's economically recoverable conventional gas reserves. At current production rates reserves will last Australia 51 years.

Australia has major reserves of unconventional gas, mainly coal seam gas. In 2015–16 coal seam gas production increased to 955 petajoules and accounted for 28 per cent of natural gas production.

Australia may have significant resources of shale and tight gas, although estimates are uncertain.

Since the Sixth National Communication, Australia has developed an east coast gas export market, with three plants at Gladstone in Queensland built to turn coal seam gas into LNG for export. Around half of Australia's gas was produced for the domestic market in 2014–15, with the other half exported as LNG. LNG exports increased by 4 per cent in 2015–16 to 2,025 petajoules, as new export capacity on the east coast expanded. LNG exports are projected to increase from \$17 billion in 2015–16 to \$42 billion in 2021–22, an average annual increase of 16 per cent.

2.3.1.4 Uranium

Australia has the world's largest economically recoverable uranium (1,287 Kt) as at January 2016, representing around one-third of global resources. At current rates of production, Australia's uranium resources will last a further 210 years. All production of uranium is exported under stringent conditions to ensure it is used for peaceful purposes only.

2.3.1.5 Renewable energy

Australia's renewable energy consumption is dominated by biomass including wood, wood waste and bagasse (55 per cent) and hydroelectricity (15 per cent) in 2015–16. Energy consumption from biomass comes from households burning wood for heat, and heat produced in the process of sugar production. The remainder comes from wind, solar and other forms of bioenergy. Australia has an abundance of renewable energy sources, and there is potential for future development in large-scale solar energy, onshore wind energy and marine energy.

With the support of the Renewable Energy Target, there is strong investment in emerging renewable energy technologies in Australia. The Clean Energy Council expects at least 42 large-scale renewable energy projects to be under construction or completed in 2017, delivering over \$8.5 billion in investment and more than 4385 MW of new renewable capacity. Wind and solar power, in particular, have grown strongly in recent years. The share of renewable electricity generation grew to 16 per cent of Australia's total electricity generation in 2016.

2.3.2 Domestic energy consumption

Australia's primary energy consumption is dominated by fossil fuels.

In 2015–16, oil, including LPG and refined products, accounted for the largest share of Australian energy consumption at 37 per cent. This is followed by coal at 32 per cent. After five years in a row of decline, coal consumption rose by 2.5 per cent in 2015–16, underpinned by increased black coal use in electricity generation. Natural gas accounted for 25 per cent of energy consumption while renewable energy sources accounted for the remaining six per cent of total energy consumption. In response to forecast shortfalls for the domestic market in 2018–19, the Australian Government signed an agreement with three major LNG exporters to offer sufficient gas to the domestic market. In 2017, the Australian Government implemented the Australian Domestic Gas Security Mechanism to ensure a sufficient supply of natural gas to meet the forecast needs of Australian consumers. The 2017–18 Federal Budget also provided around \$90 million to expand and accelerate ongoing gas market reforms aimed at promoting transparency and liquidity in the market. Australia does not consume any nuclear energy.

The electricity supply sector is the largest (net) consumer of energy accounting for 29 per cent in 2015–16. This is followed by transport (27 per cent) and manufacturing (18 per cent). These sectors are followed by the mining, residential and commercial services sectors.

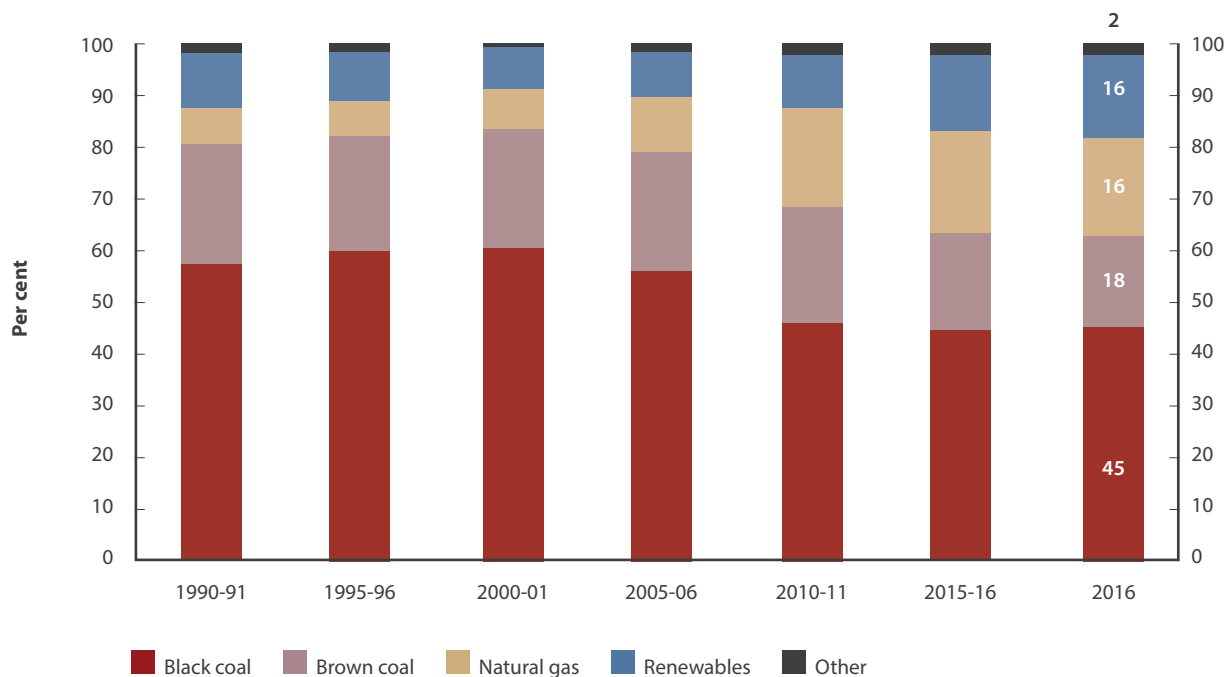
Australia’s energy consumption rose by 2.3 per cent in 2015–16 to 6,066 petajoules, its highest ever level. Growth in energy consumption has generally remained below the rate of economic growth over the past three decades. This can mainly be attributed to a shift in the economy towards less energy intensive sectors such as services and improvements in energy efficiency.

2.3.3 Electricity

Like many other developed countries, Australia is transitioning its electricity market due to rapid technological change, the increasing penetration of renewable energy, a more distributed generation system, withdrawal of coal fired generation, and changing consumer demand. A focus in Australia’s public policy and business investment decision making is how best to manage this transition.

In 2016, total electricity generation in Australia was 258 terawatt hours. Coal remained the biggest fuel source for electricity generation at 63 per cent. Natural gas fired generation accounted for 18 per cent of electricity generation, renewable energy for 16 per cent (42 per cent hydroelectricity, 31 per cent wind, 18 per cent solar photovoltaic and nine per cent bioenergy), and oil fired generation for two per cent (see Figure 2.2). Generation from renewables is expected to rise up to 2020 as the Renewable Energy Target drives new investments.

Figure 2.2: Australian electricity generation, by energy source



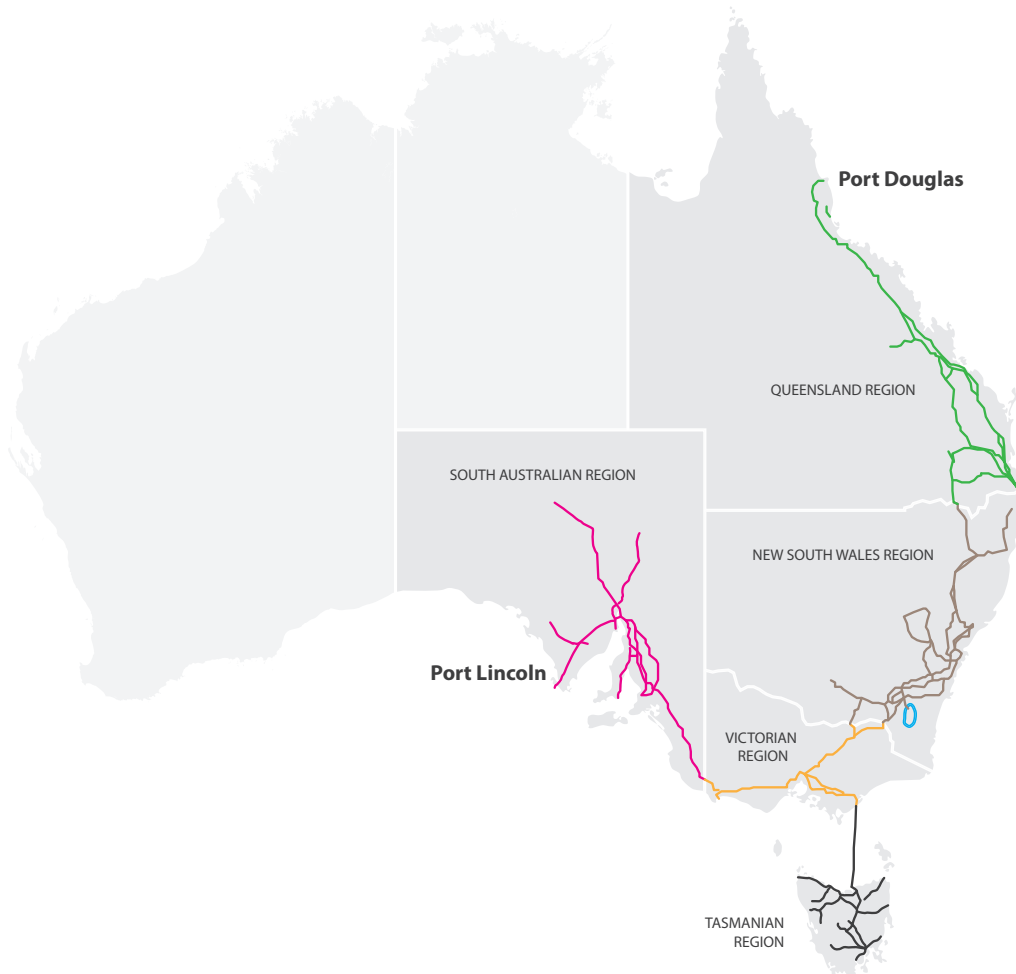
Source: Australian Energy Statistics, Table O1. Australian electricity generation, by fuel type, physical units, [Australian Energy Update 2017](#)

2.3.4 Energy market structure

The Australian electricity market is made up of three separate large-scale systems: the National Electricity Market (NEM), the Western Australian Market, and the Northern Territory Market. These markets are distinct from one another due to their geographical separation and the high costs of transporting electricity over long distances. The most westerly point of the NEM is about 2000 kilometres from Perth in Western Australia (see Figure 2.3).

In each market, electricity is created by generators and this electricity is sent out via transmission networks to electricity distributors and large-scale end users, such as large industrial facilities. Electricity distributors then distribute electricity to end users, including residential, commercial and industrial. Electricity retailers buy electricity in wholesale markets and sell it to end users, packaged to include the costs of generation, transmission and distribution, and the retail services.

Figure 2.3: Map of Australia's National Electricity Market
 Note: Western Australia and the Northern Territory have separate systems



Source: Independent Review into the Future Security of the National Electricity Market, Blueprint for the Future June 2017

2.3.4.1 National Electricity Market

The NEM refers to both the wholesale market in which electricity is traded, and the physical interconnected electricity grid of the eastern states. The grid extends from Port Douglas in Queensland, through New South Wales, the Australian Capital Territory, Victoria and Tasmania, and across to Port Lincoln in South Australia (see Figure 2.3). It is connected by six major transmission interconnectors between states and territories, and approximately 804,000 kilometres of transmission and distribution lines.

The Australian Energy Market Operator (AEMO) is responsible for the operation of the NEM. AEMO schedules electricity to be dispatched from specific generators to create a gross energy pool, which is then sent out to meet demand.

The Australian Government announced the National Energy Guarantee in October 2017. The National Energy Guarantee will deliver more affordable and reliable electricity while meeting Australia’s international commitments to emissions reduction. The Government will work with the independent Energy Security Board and with the states and territories through the Council of Australian Governments Energy Council to implement the National Energy Guarantee. Formed out of the Independent Review into the Future Security of the National Electricity Market (the Finkel Review), the Energy Security Board comprises an independent chair and deputy chair along with the expert heads of the Australian Energy Market Commission, the Australian Energy Regulator and the AEMO. (see Chapter 4 for more details).

2.4 INDUSTRY

2.4.1 Services

The Australian economy, like most developed economies, is services based. The dominance of the services sector reflects ongoing structural change, leading to a greater percentage of employment and output in services, and a lower proportion coming from agriculture and manufacturing.

The services sector accounted for 61 per cent of GDP in 2015–16. The largest services industry in terms of value was financial and insurance services with \$146.2 billion in revenue in 2015–16. Health care and social services employed the most people at around 1.5 million workers. Services also play an increasingly important role in Australia's international trade. In 2015–16, education-related travel services (\$19.9 billion) were the biggest service exports. Annual growth in international education in 2015–16 was 9.4 per cent.

2.4.2 Construction

The construction industry is the second largest contributor to Australia's economy, accounting for approximately eight per cent of GDP. The construction industry's share of employment and output has been growing since the 1990s, reflecting strong demand for mining related construction during the mining investment boom, and more recently the expansion in residential building activity.

2.4.3 Mining

The Australian mining sector contributed 6.9 per cent of GDP in 2015–16 and has a strong comparative advantage in a number of mineral exports. As a result, the mining sector is larger in Australia than most developed economies.

Mining output is growing at 6.2 per cent, the fastest of all industry sectors. The high growth is a result of moving to a production phase following extensive capital investments peaking in 2013. The low employment growth of one per cent in 2015–16 reflects the transition from mining investment to production. Even though commodity prices have been lower, mining sector revenues continue to be higher than ten years ago because volumes are higher. Resource and energy exports are forecast to reach a record \$205 billion in 2016–17. Key commodity exports include iron ore, metallurgical and thermal coal.

Australia's LNG industry has become an important part of the mining sector. It is estimated in the next two to five years Australia will become the largest LNG exporter in the world.

2.4.4 Manufacturing

Manufacturing's share of output and employment has been declining in Australia since the 1960s, like all developed countries, as technology has replaced labour. Globalisation has accelerated this decline. In 2015–16 manufacturing contributed six per cent to GDP.

Australia has relatively high labour and energy costs, making it difficult to compete with emerging economies in labour and energy-intensive manufacturing.

Knowledge-intensive manufacturing sub sectors using highly-skilled and educated labour such as non-metallic mineral products have grown by 8.5 per cent over the last two years. The share of Australian advanced manufacturing exports in meeting global demand has seen an upward trend from the late 1990s. This suggests Australia is gaining a competitive edge in advanced manufacturing, particularly in parts and components specialisation. Greater links to global production networks contributed to growth in these sub sectors.

The food and beverages, pharmaceuticals and building materials sub sectors are growing. Demand for these products are driven by growth in home building in Australia's capital cities (especially in Sydney and Melbourne), increased demand for Australian goods from Asia, and the lower Australian dollar.

2.5 TRANSPORT

Australia is one of the world's most urbanised countries with almost 90 per cent of people living in cities. Population density outside cities is low. The road system accounts for 79 per cent of passenger travel and is among the largest in the world (874,000 kilometres). The rail system is also one of the largest in the world, but the non-urban component (95 per cent) is mainly a freight network. Rail accounts for four per cent of passenger travel, while air accounts for 17 per cent.

Transport energy use in petajoules is increasing at around one per cent each year. Transport emissions are increasing at around the same rate.

2.5.1 Passenger transport

Reflecting the long distances between population centres and strong population growth, Australia's passenger vehicle fleet consumes a relatively large amount of fuel by international standards. In 2016 the average rate of fuel consumption of passenger vehicles was 10.6 litres per 100 kilometres.

Aggregate fuel demand is increasing. In the 12 months ending 30 June 2016, passenger vehicles consumed an estimated 18,606 million litres of fuel, of which 82.6 per cent was petrol. Diesel powered vehicles constitute approximately 22 per cent of the national vehicle fleet.

Private road vehicles account for around 86 per cent of total passenger kilometres. Of the average 18.2 million vehicles registered in Australia during the year ending 30 June 2016, approximately 13.7 million (75.4 per cent) were registered as passenger vehicles.

Public transport remains important in cities, especially for travel into central business districts; performing around 10 per cent of total passenger kilometres within Australia's capital cities.

2.5.2 Domestic freight transport

As a large, relatively isolated country, Australia relies on domestic freight to access international markets for export and import of goods, and to support more efficient internal markets. With a growing population and increasing demand for Australian resources and produce, particularly from Asian markets, Australia's domestic freight task is expected to grow by 26 per cent by 2026.

On an average day, around five million tonnes of domestic freight is moved in Australia. Road transport accounts for around 30 per cent of the domestic freight task (in tonne-kilometres performed) and rail accounts for around 55 per cent. Trucks are increasingly responsible for non bulk commodity haulage with rail falling steadily as a proportion. By contrast, rail dominates bulk commodity haulage.

Intrastate movements of bulk commodities from their area of production to the seaport or processing location account for a large proportion of rail freight. 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. Almost all growth in rail haulage has taken place in mining haulage in northwest Australia. Road haulage is important in long distance freight transport on the north south corridor linking cities along the eastern seaboard.

2.6 AGRICULTURE

Australia's agriculture industries use about 50 per cent of Australia's total land, farming the higher rainfall coastal regions to the drier inland. In 2014-2015, the estimated area of farms was 384.6 million hectares of land, owned or operated by 123,000 agricultural businesses in Australia. Around 82 per cent or 316.7 million hectares of agricultural land was used for grazing, and 31.4 million hectares, or four per cent were used for growing crops.

Agricultural production is export oriented producing more than is required for domestic consumption. In 2015-16, the gross value of Australia's agricultural production was \$56 billion, while the total value of agricultural and food exports totalled \$44.7 billion. Australia's agricultural industries produce a range of crops, horticulture commodities and livestock, from grains, sugar, cotton, fruit, vegetables, nuts and wine grapes to dairy and beef cattle, sheep, lambs and pigs.

Agriculture's share of output and employment saw a rise in 2017 after years of steady decline since the 1960s. The latest National Accounts, the Australian Bureau of Statistics estimates of Australia's economic activity, indicate agricultural output is growing. In the March quarter 2017 it rose by 14.7 per cent compared to 10.4 per cent recorded in the September quarter 2016. Employment growth was also strong at 2.8 per cent.

2.7 FORESTRY

In 2014 Australia had 132 million hectares of forest, covering approximately 17 per cent of the continent. Of this, approximately 130 million hectares are native forests and two million hectares are plantation forests. The annual area of native forests harvested in Australia approximately halved over the decade to 2014, while production of wood from industrial plantations increased. Following a peak in 2007, the rate of new plantations established declined steadily to 2014. These trends reflect a structural transition in the forest production industry in Australia as existing plantations mature and displace production from native forests.

A major trend in forest management in Australia over the decade to 2014 has been declining native forest harvesting and increasing plantation harvesting. The clearance of forest land for grazing and cropping is a major contributor to greenhouse gas emissions. Net emissions from this activity are reported in Australia's greenhouse gas inventory under the *land use, land-use change and forestry* sector. Over the period from 2005 to 2014, the total forest area cleared annually has declined by nearly half, with the area of primary forest cleared reduced by around three quarters.

Wildfires are the largest cause of year to year variability in emissions from Australian forests. Over the period 2003 to 2014, the average annual wildfire burn in temperate forests was less than 0.5 Million hectares (Mha). In peak years, wildfire burn areas were 2.6 Mha in 2003, 1.7 Mha in 2007 and 1.1 Mha in 2014. There has been an increase in extreme fire weather and a longer fire season across large parts of Australia since the 1970s due to climate change. In early 2016, multiple fires in Tasmania's Wilderness World Heritage Area burnt more than 100,000 hectares of land.

2.8 BUILDING STOCK AND URBAN STRUCTURE

Australia has experienced low density urban development as a result of high abundance of land and widespread car availability. The majority of Australians live in houses. In 2016, standalone houses accounted for the largest proportion of Australian homes (73 per cent), with semi-detached, row housing, town houses, flats and apartments accounting for 26 per cent.

Out of the 10 million dwellings in Australia in 2016, the vast majority were private dwellings (8.9 million). More than two thirds of these households (69 per cent) had one family living in them, down from three quarters in 1991. The average number of people living in each household was 2.6 people.

2.9 WASTE

In 2014–15, Australia generated about 64 million tonnes (Mt) of waste, an increase of 12 per cent from 2006–07. Population growth was a major contributor to the increase in waste production. Per capita waste production in 2014–15 was 2.7 tonnes. Approximately 58 per cent of total waste production was recycled or recovered for embodied energy, an increase of 30 per cent from 2006–07. The total 2014–15 waste disposed was about 27 Mt.

Waste policies and programs have been established at all levels of governments in Australia. Policy and legislative responsibility for waste rests primarily with the states and territories, and policy at this level has the greatest influence on waste management.

In 2015 waste accounted for two per cent of Australia's national inventory of greenhouse gas emissions. Between 1990 and 2014, emissions from the waste sector declined by more than one third. There has been a significant decline in waste methane from landfill due to uptake of technology that captures methane gas.

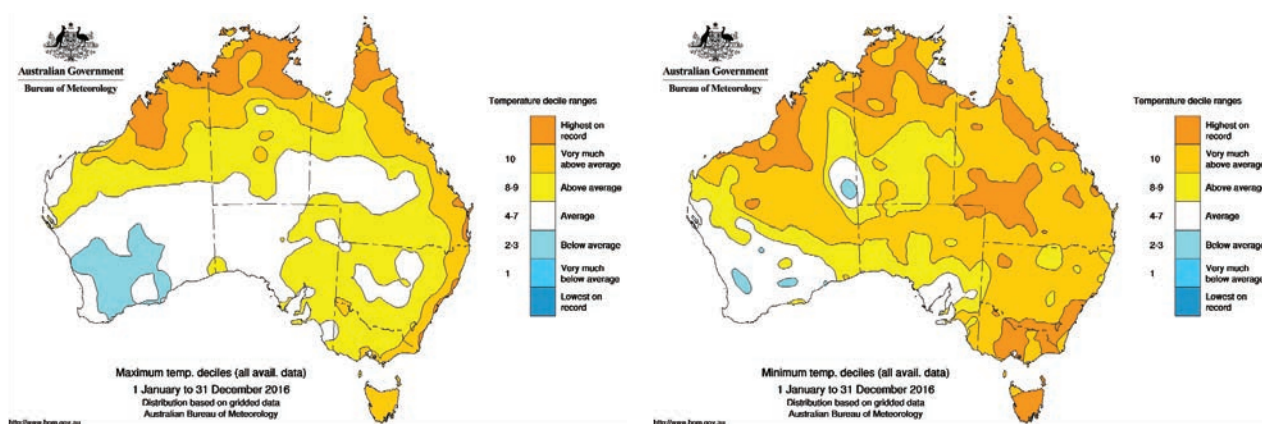
2.10 CLIMATE

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, with considerable rainfall and temperature variability both across the country and from year to year.

2.10.1 Temperature

Australia has a wide range of daily temperatures. On 28 February 2016 summer temperatures ranged from minimums of 5.7 degree Celsius (°C) in New South Wales to 30.8°C in Queensland, and to maximums of 8°C in Tasmania and 45.6°C in Queensland (see Figure 2.4).

Figure 2.4: Australia's maximum and minimum temperatures for 2016



Source: Australian Bureau of Meteorology, Issued 5 December 2017

The annual average temperature in Australia has increased by 1°C since 1910, with most warming occurring since 1950. Australia's top five warmest years on record included each of the last four years—2013, 2014, 2015 and 2016. Each decade since the 1950s has been warmer than the preceding decade.

2016 was Australia's fourth-warmest year on record. The warmth around the north and east coasts of Australia brought a record warm year for several of Australia's major cities. Darwin and Sydney had their warmest years on record for both minimum and maximum temperature, while Hobart had its warmest nights on record and warmest annual mean temperature. For Brisbane, the annual mean temperature was the warmest on record.

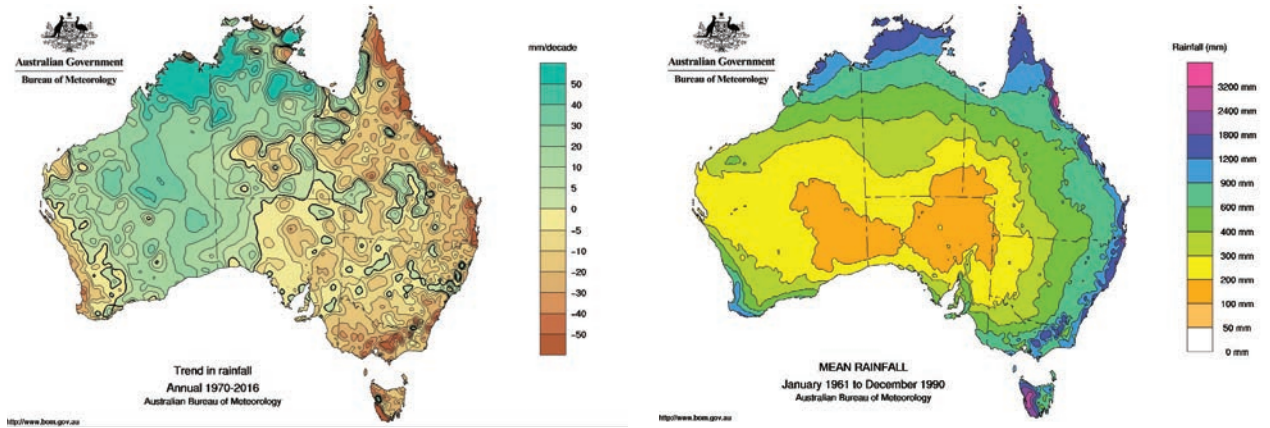
2.10.2 Rainfall

Australian rainfall varies greatly from one year to the next and from one decade to the next. For example there is a large variation around the mean rainfall in the Murray Darling Basin from 50 per cent in the Murrumbidgee catchment to 300 per cent in the Barwon Darling River system. Rainfall variation is strongly influenced by phenomena such as El Niño and La Niña. Despite large natural variability, underlying longer-term trends are evident in some regions.

Since the 1970s there has been significant drying across southern Australia, especially across the cool April to October growing season (see Figure 2.5). For the southeast of the continent, rainfall for the period 1996 to 2015 has decreased by around 11 per cent since national rainfall records began in 1900. This period encompasses the Millennium Drought, which saw low annual rainfall totals across the region from 1997 to 2010. The drying trend is particularly strong between May and July over southwest Western Australia, with rainfall since 1970 around 19 per cent less than the long term average. Since 1996, this decline from the long term average has increased to around 25 per cent.

In northern Australia, most rain falls between October and April associated with the summer monsoon, with large year-to-year variability. Monsoonal lows, widespread thunderstorms and tropical cyclones often bring heavy rainfall. Since the 1970s, there has been increased rainfall across northern Australia.

Figure 2.5: Trend in total rainfall across Australia, 1970-2016 (mm); Average rainfall Annual



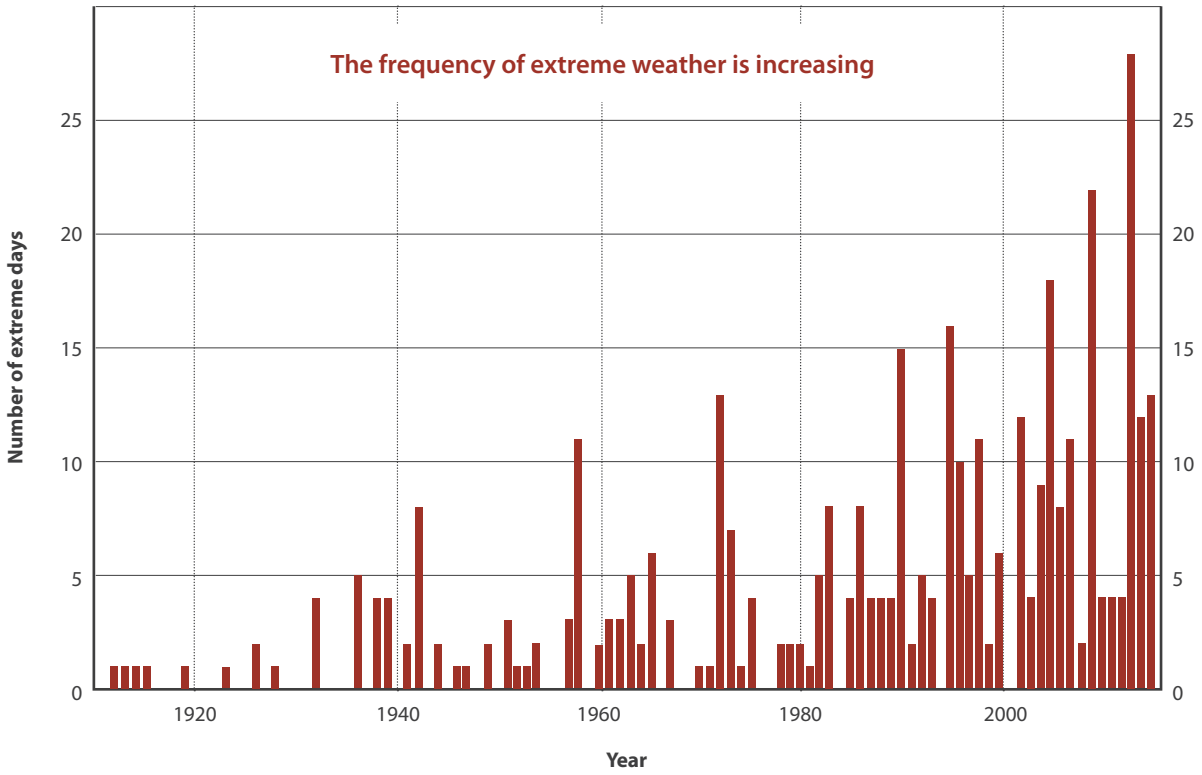
Source: Australian Bureau of Meteorology, Issued 5 December 2017

2.10.3 Extreme events

Australia experiences a range of extreme weather events, including droughts, floods, tropical cyclones, storms, heatwaves and bushfires. Long-term records show Australia is experiencing changes in both frequency and intensity of extreme weather events. The most obvious change has been an increase in the occurrence of record-breaking heat. In 2014, during October to November Australia recorded daytime temperatures of 2.47°C above the 1961 to 1990 mean. Extreme temperature events across large areas of the continent are also increasing in frequency (see Figure 2.6).

The increasing frequency of extreme heat events is leading to longer fire seasons and more extreme fire events.

Figure 2.6: Frequency of extreme heat events 1910-2015



Source: Bureau of Meteorology, [State of the Climate 2016](#), page 7

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3. NATIONAL GREENHOUSE GAS INVENTORY

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In accordance with National Communication reporting rules, unless otherwise stated, the greenhouse gas data in this report are consistent with Australia's *National Inventory Report 2015* (NIR 2017), submitted under the UNFCCC and its Kyoto Protocol in May 2017. In addition to the National Inventory Report, Australia publishes a range of supporting emissions estimates to provide further information on Australia's emissions on a regional and industry basis. Together, these products constitute the Australian National Greenhouse Accounts (see Box 3.1).

Key developments

In 2016, Australia's emissions per capita (22.1 t CO₂-e per person) and the emissions intensity of its economy (0.32 kg CO₂-e per dollar of real GDP) were at their lowest levels since 1990. Over the period 1990 to 2015, on a UNFCCC accounting basis, energy-related emissions (stationary energy, transport and fugitives emissions from fuels) dominated Australia's emissions profile. The *energy* sector experienced the greatest increase in emissions, followed by emissions from the *industrial processes and product use* sector. The *land use, land-use change and forestry (LULUCF)* sector experienced the greatest decline in emissions over 1990 to 2015, with emissions from *waste and agriculture* also falling.

Australia is committed to the continuous improvement of its national greenhouse gas inventory. Emissions estimates are prepared using best available data and an integrated inventory system. Estimates are subject to extensive and mature quality assurance and control processes to ensure they meet the UNFCCC quality criteria of transparency, time series consistency, accuracy, completeness and comparability.

Since the Sixth National Communication and second Biennial Report, Australia has developed a range of measures to improve its national greenhouse gas inventory system and emissions estimates – these measures include the adoption of new data and methods, new source/sink categories and strengthening of quality assurance and control processes.

3.1 OVERVIEW OF NATIONAL EMISSIONS

Australia's total greenhouse gas emissions including the *LULUCF* sector decreased by 9.3 per cent between 1990 and 2015 under the UNFCCC accounting framework. Australia's net greenhouse gas emissions in 2015, excluding *LULUCF* sector emissions and removals, increased by 27 per cent compared with 1990 levels.

Box 3.1 Australia's National Greenhouse Accounts

The National Inventory is captured in a suite of publically available products called the Australian National Greenhouse Accounts. Together they provide comprehensive, transparent information to government, the private sector and the general public on Australia's greenhouse gas emissions from 1990 onwards.

The National Inventory Report is the cornerstone of the Accounts. It enables Australia to meet its annual international reporting obligations and provides the basis for assessing Australia's compliance with its international emission reduction commitments. It is prepared in accordance with relevant UNFCCC and Kyoto Protocol decisions and Intergovernmental Panel on Climate Change (IPCC) guidance for emissions estimation.

In addition to the National Inventory Report, the Accounts include:

- Quarterly Updates of Australia's National Greenhouse Gas Inventory, which provide timely information on emission trends on a quarterly basis
- an overview of the State and Territory Greenhouse Gas Inventories, published annually
- the National Inventory by Economic Sector, which comprises emissions estimates by economic sector (rather than by IPCC sectors, as in this report), published annually

- the Australian Greenhouse Emissions Information System (AGEIS). Integral to the preparation of the inventory, AGEIS is an online database providing detailed greenhouse gas emissions data from the Accounts. Data is available at the national and state level and by economic sector, and can be queried through a dynamic interface and search function
- the Full Carbon Accounting Model (FullCAM). Like AGEIS, FullCAM is a key information technology asset in the inventory's preparation, focused on land sector reporting. It has a public web interface.

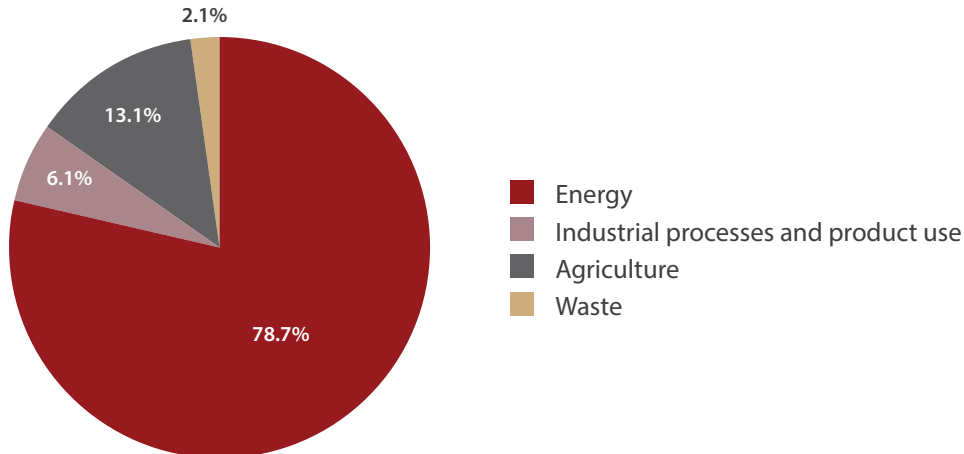
The Accounts are available on the Department of the Environment and Energy's website: <http://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/tracking-emissions>

3.1.1 Emission profile

In 2015, Australia's total greenhouse gas emissions including the *LULUCF* sector were 525.6 million tonnes (Mt) carbon dioxide equivalent (CO₂-e) under the UNFCCC accounting framework. Australia's net greenhouse gas emissions excluding *LULUCF* were 533.3 Mt CO₂-e in 2015.

Energy-related emissions (stationary energy, transport and fugitive emissions from fuels) dominate Australia's emissions profile, contributing 78.7 per cent of total emissions in 2015 excluding *LULUCF*, while the *agriculture* sector contributes 13.1 per cent. Emissions from the *industrial processes and product use* (6.1 per cent) and *waste* (2.1 per cent) sectors are relatively minor. *LULUCF* sector emissions and removals were a net sink of -7.7 M CO₂-e in 2015.

Figure 3.1: Australia's emissions profile 2015^(a)



Source: Australian Department of the Environment and Energy

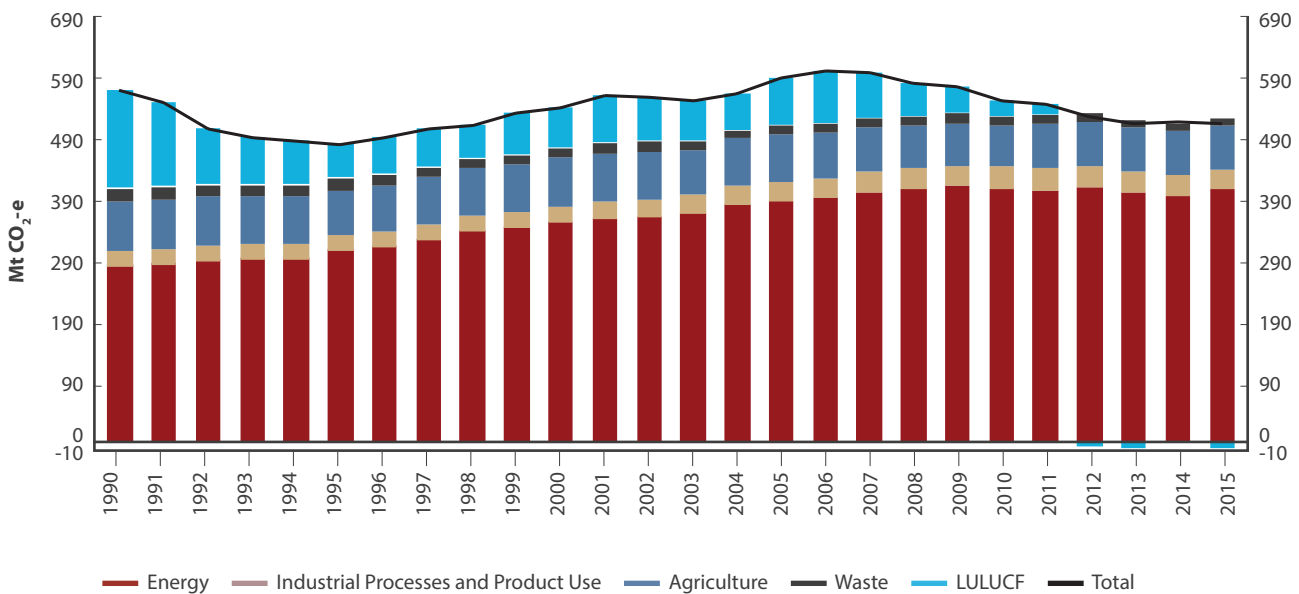
(a) The *LULUCF* sector was a net sink of -7.7 Mt CO₂-e in 2015

Table 3.1: Australia's Net Greenhouse Gas Emissions by Sector (UNFCCC Inventory)

Sector and Subsector	Emissions Mt CO ₂ -e			Per cent change
	1990	2014	2015	1990–2015
1. Energy (combustion + fugitive)	293.9	408.6	419.6	42.7%
• Stationary energy	195.4	274.9	279.8	43.2%
• Transport	61.4	93.0	95.2	55.1%
• Fugitive emissions from fuel	37.1	40.7	44.5	19.9%
2. Industrial processes and product use	26.1	32.4	32.3	24.0%
3. Agriculture	80.2	72.8	70.0	-12.7%
4. Land use, land use change and forestry (LULUCF)	159.5	1.0	-7.7	-104.8%
5. Waste	19.7	12.0	11.4	-42.2%
Total net emissions (including LULUCF)^(a)	579.3	526.8	525.6	-9.3%

(a) The LULUCF sector was a net sink of -7.7 Mt CO₂-e in 2015

Figure 3.2: Australia's net greenhouse gas emissions by sector, 1990-2015 (UNFCCC Inventory)



Source: Australian Department of the Environment and Energy

As shown in Table 3.1 and Figure 3.2, the largest increase in emissions over 1990 to 2015 was from *energy* (42.7 per cent increase, 84.4 Mt CO₂-e), which comprises stationary energy for example from fossil fuel combustion for electricity generation (43.2 per cent increase, 84.0 Mt CO₂-e), transport (55.1 per cent increase, 33.8 Mt CO₂-e), and fugitive emissions from fuels (19.9 per cent increase, 7.4 Mt CO₂-e). *Industrial processes and product use emissions* increased by 24 per cent, or 6.2 Mt CO₂-e. Emissions declined in *agriculture* (12.7 per cent decrease, -10.2 Mt CO₂-e), *waste* (42.2 per cent decrease, -8.3 Mt CO₂-e) and *LULUCF* (104.8 per cent decrease, -167.2 Mt CO₂-e).

The principal drivers of these emission trends are:

- **Energy:** The largest sectoral increase in greenhouse gas emissions over the 1990 to 2015 period, of 84.4 Mt CO₂-e (42.7 per cent), occurred in the *stationary energy* sector, driven in part by increasing population, household incomes and export increases from the resource sector. Within the *stationary energy* sector, *electricity generation* emissions have fallen from a peak in 2009 due to a combination of lower electricity demand and changes in the fuel mix used to generate electricity. The main drivers for the increase in *transport* emissions are continuing growth in the number of passenger vehicles, along with an increase in diesel consumption in heavy vehicles. *Fugitive emissions* have increased largely due to increased production from open cut coal mines and increased gas production.
- **Industrial processes and product use:** The increase in emissions since 1990 is primarily driven by the growth in emissions associated with hydrofluorocarbons (HFCs) and chemical industries.
- **Agriculture:** The decrease in emissions since 1990 is primarily associated with a decline in sheep numbers. Offsetting these decreases has been an increase in cattle numbers. Overall, net *agriculture* emissions declined 12.7 per cent.
- **Waste:** The net emissions from *waste* have decreased as increases associated with growing populations and industrial production have been offset by increased methane recovery.
- **LULUCF:** The decreasing trend in emissions from *LULUCF* since 1990 has been mainly driven by the decline in emissions from land clearing (forest land converted to cropland and grassland).

See the Common Tabular Format (CTF) Tables 1.1-1.5 in the Annex A for details of Australia's emissions by sector.

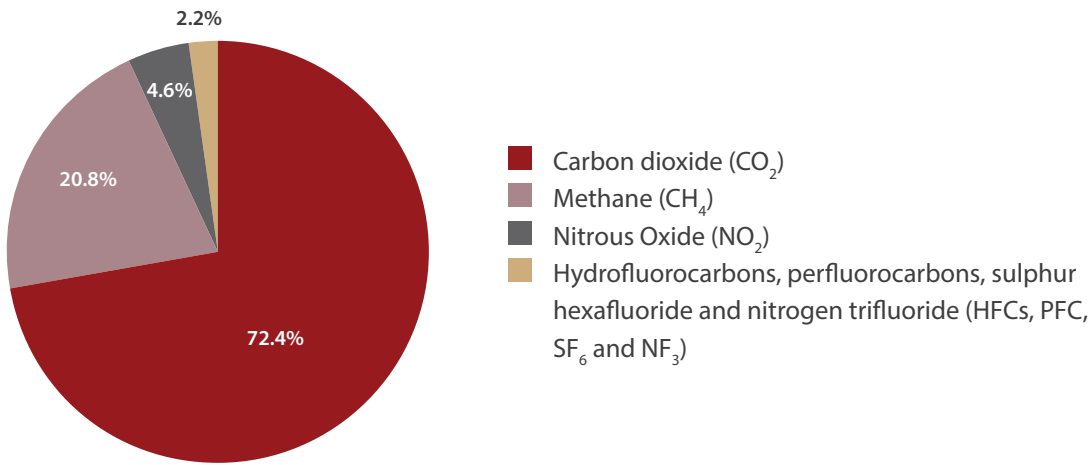
3.2 EMISSIONS BY GREENHOUSE GAS TYPE

In 2015, carbon dioxide accounted for 72.4 per cent of Australia's total emissions (including *LULUCF*), followed by methane (20.8 per cent) and nitrous oxide (4.5 per cent) (Table 3.2 and Figure 3.3). Other greenhouse gases made up the remaining 2.2 per cent of Australia's inventory.

Table 3.2: Australia's net greenhouse gas emissions by gas type (UNFCCC Inventory)

Greenhouse gas	1990		2015		Change
	Mt CO ₂ -e	per cent of total	Mt CO ₂ -e	per cent of total	Mt CO ₂ -e
Carbon dioxide (CO ₂)	418.5	72.2	380.3	72.4	-38.2
Methane (CH ₄)	132.7	22.9	109.6	20.8	-23.1
Nitrous oxide (N ₂ O)	21.9	3.8	23.9	4.5	2.0
Hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride (HFCs, PFC, SF ₆ and NF ₃)	6.2	1.1	11.8	2.2	5.5
Total CO₂-e emissions	579.3	100%	525.6	100%	-53.8

Figure 3.3: Australia's net greenhouse gas emissions by gas type 2015 (UNFCCC Inventory)



Source: Australian Department of the Environment and Energy

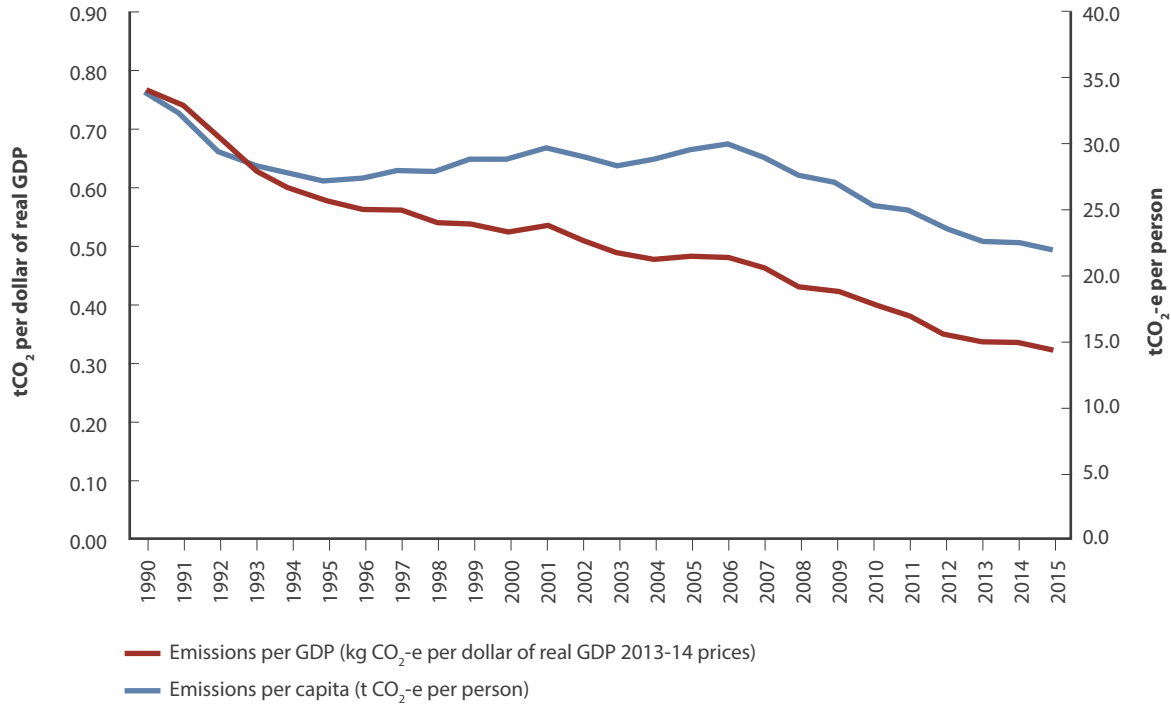
3.2.1 Australia's emissions per capita and emissions intensity

Australia's emissions per capita have declined over the last twenty years (Figure 3.4). These declines have resulted from specific emissions management actions across sectors, the large decline in *LULUCF* emissions over the period, and structural changes in the economy.

Australia's population grew strongly between 1990 and 2016, from 17.1 million in 1990 to around 24.1 million in 2016 (growth of 41.4 per cent). Emissions per capita in 2015 were 22.1 t CO₂-e per person, compared to 33.9 t CO₂-e in 1990, representing a 34.9 per cent decline.

Australia's real GDP also grew over this period, from \$756 billion in 1990 to over \$1,617 billion in 2015 (growth of 113.8 per cent). For the 2015 national inventory total (including emissions from *LULUCF*) emissions intensity was 0.33 kg CO₂-e per dollar of real GDP, compared to 0.77 kg CO₂-e per dollar of real GDP in 1990, representing a 57.6 per cent decline (Figure 3.4).

Figure 3.4: Australia’s emissions per capita and emissions intensity, 1990-2015



Source: Australian Department of the Environment and Energy

3.3 NATIONAL INVENTORY SYSTEMS

In accordance with the guidelines for national systems (decision 19/CMP.1 annex paragraph 12(a) and decision 3/CMP.11), the Australian Department of the Environment and Energy is responsible for all aspects of the National Inventory compilation. This includes activity data coordination, emission estimation, quality control, improvement planning, preparation of reports, and submission of reports to the UNFCCC on behalf of the Australian Government, defined under Administrative Arrangements Orders.

Since the Sixth National Communication, the Australian Government enacted changes to the makeup of Australian Government departments. These changes included shifting the national inventory functions from the former Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education to the Department of the Environment and Energy.

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

Assistant Secretary
 National Inventory Systems and International Reporting Branch
 Department of the Environment and Energy
 Australian Government
 GPO Box 787
 Canberra ACT 2601
 AUSTRALIA

nationalgreenhouseaccounts@environment.gov.au

3.3.1 Coverage

Australia's inventory covers sources of greenhouse gas emissions, and removals by sinks, resulting from human (anthropogenic) activities, grouped under the five sectors identified by the IPCC:

- *energy* (including stationary energy, transport and fugitive emissions from fuels)
- *industrial processes and product use*
- *agriculture*
- *land use, land use change and forestry (LULUCF)*
- *waste*

The inventory covers the major greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃). Indirect greenhouse gases covered in ancillary fashion for reporting under the UNFCCC are: carbon monoxide (CO), oxides of nitrogen (NOX), and non methane volatile organic compounds (NMVOCs). Sulphur dioxide (SO₂), an aerosol precursor, is included because emissions of this gas influence global warming.

Geographical coverage of the Australian inventory includes the six states (Queensland, New South Wales, South Australia, Tasmania, Victoria and Western Australia), mainland territories (Australian Capital Territory, Jervis Bay Territory and Northern Territory), associated coastal islands, and external territories (Ashmore and Cartier Islands, Christmas Island, Cocos Islands, Coral Sea Islands, Heard and McDonald Islands and Norfolk Island). Australia's Antarctic Program operations in the Antarctic are covered.

3.3.2 Data sources

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

3.3.2.1 The National Greenhouse and Energy Reporting System

Australia's mandatory national reporting system for companies is among the most comprehensive data collection systems for national greenhouse gas inventories in the world.

The legislative framework for this system was established through the *National Greenhouse and Energy Reporting Act 2007* (NGER). The NGER system supports Australia's international inventory reporting obligations and incorporates robust measurement, reporting and verification arrangements to provide confidence in the quality of collected data.

Energy, industrial processes and product use and *waste* sector emissions estimates are informed by data collected under the NGER system. Reporting is mandatory for all facilities with emissions above 25,000 tonnes CO₂-e per year or energy consumed or produced above a certain limit. Every major company in Australia must estimate and report relevant activity data, ensuring consistency in data collection for these sectors.

The Australian Department of the Environment and Energy has policy and legislative oversight of the NGER system and responsibility for tracking progress against Australia's emissions reduction target. The Clean Energy Regulator (CER) manages the process of input data collection from companies, data verification/auditing and the dissemination of this data to government agencies. The CER's Emissions and Energy Reporting System is used for the collection of the data. Annual reports have been submitted by companies under the NGER system for Australian financial years since 2008-09.

The rules for the estimation of activity data, Emission Factors and emissions by companies are well defined and set out in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Commonwealth) (the Determination).

The National Greenhouse Accounts Framework estimation methodologies, used by the Australian, state and territory governments, industry, company and facility level inventories, ensure consistency. These estimation methodologies are consistent with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006 guidelines). Integration and consistency of the estimation methods and data is critical for ensuring 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 Australian Greenhouse Emissions Information System (AGEIS) (see section 3.3.4 of this chapter).

Since the Sixth National Communication, key amendments to the Determination have included:

- updated Global Warming Potentials adopted by the Parties to the UNFCCC and its Kyoto Protocol, and in line with the mandatory application of the IPCC 2006 guidelines
- updates in response to the repeal of Australia's *Clean Energy Act* (2011)
- provision of new methods for reporting *fugitive emissions* associated with carbon capture and storage.

As part of Australia's commitment to continuously improve its national inventory the Determination is reviewed annually by the Department of the Environment and Energy. The reviews seek to ensure the NGER system aligns with Australia's international reporting obligations, and to identify options to improve the consistency, cost effectiveness and accuracy of the methods available to estimate emissions. Proposed amendments to the Determination are subject to public consultation.

The NGER Act and its subordinate legislation are available at: www.cleanenergyregulator.gov.au

3.3.2.2 Other data sources

Where possible, NGER system data sources are used for the *energy, industrial processes and product use* and *waste* sectors, supplemented by national data sources, as required. Other data collection is well integrated with the objectives of other programs, with a reliance on data collected and published by Australia's principal economic statistics agencies; the Australian Bureau of Statistics (ABS) and the Department of Industry, Innovation and Science. These organisations have collected *energy* statistics for over 40 years and use 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 the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), is the major source of activity data for the *agriculture* sector.

The Department of the Environment and Energy employs consultants to process satellite imagery used to determine land cover change for the *LULUCF* sector. Satellite imagery is sourced from Geosciences Australia (Australia's principal satellite ground station and data processing facility). Data to support estimates of HFCs are sourced from compulsory reporting by importers under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 2003*. Solid waste disposal data are sourced within the Department of the Environment and Energy. Disposal data are collected annually as part of the National Waste Reporting initiative.

3.3.3 Estimation methods

The Australian methodology for estimating greenhouse gas emissions and sinks uses country-specific and IPCC methodologies and emission factors consistent with the IPCC 2006 guidelines and the *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol* (IPCC 2014 revised methods).

In general, Australia's national inventory uses a mix of tier two and tier three estimation methods incorporating:

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

The additional complexity in the methodology allows emissions to be estimated more accurately. The full description of the methodologies used by Australia in emissions estimation is provided in the most recent [NIR](#).

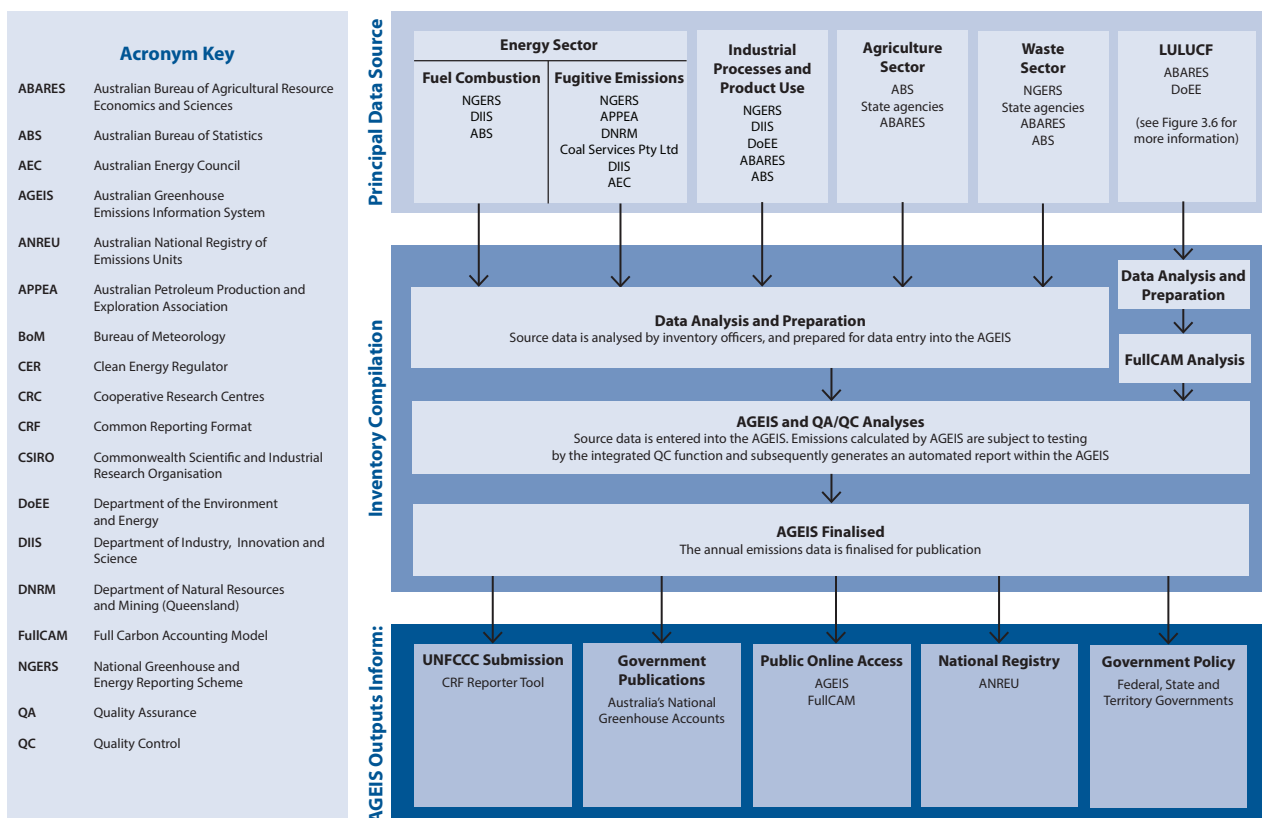
3.3.4 Supporting Inventory Systems

Estimation of emissions is conducted utilising two key Information Technology assets: AGEIS, and, for the *LULUCF* sector, FullCAM (Figure 3.5 and 3.6).

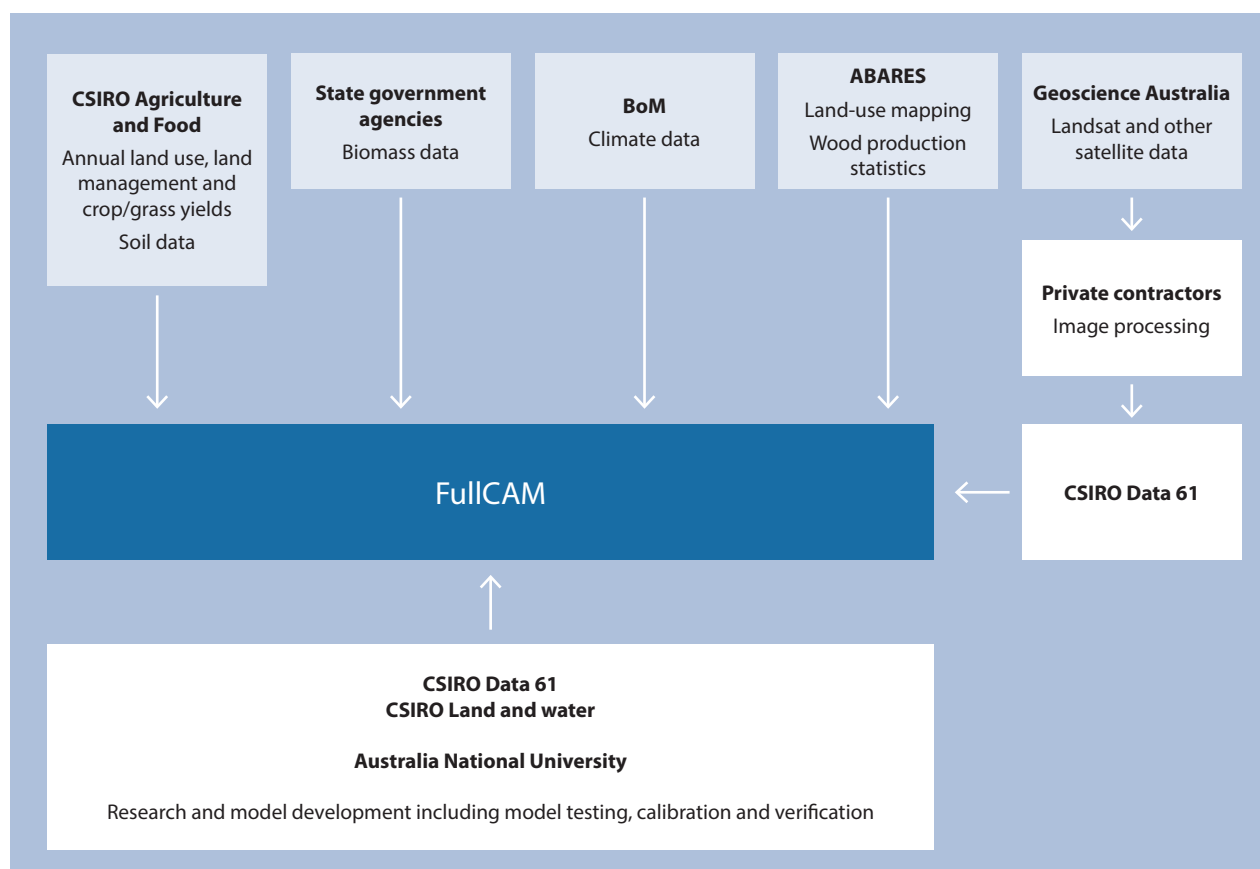
AGEIS was introduced to the inventory production process in 2005. It has been designed to meet the requirements for national inventory systems and is an integral part of the inventory preparation and publishing processes. The AGEIS software incorporates the emissions estimation methods used for the national inventory. In addition, it fully integrates quality control procedures and centralises emissions estimation, inventory compilation and reporting, and data storage activities. The AGEIS supports high transparency levels for Australia's National Greenhouse Accounts, with emissions data publicly accessible through a dynamic web interface. The AGEIS is continuing to be expanded and refined. Recent investment includes integration and automation of quality control systems and the automatic population of data reported through the updated Common Reporting Format Reporter software.

While the AGEIS is used for final preparation of Australia's National Greenhouse Accounts, FullCAM prepares estimates of emissions and removals from the *LULUCF* sector and Kyoto Protocol *LULUCF* activities. FullCAM has been substantially redeveloped to improve its capability to model ecosystems. This was achieved by applying techniques described in the IPCC 2014 revised methods and the addition of updated national datasets. To date, the modelling capability has been completed for conversion of forests to other land uses (e.g. cropping and grazing), conversion of lands to forest, croplands remaining croplands, cropland management, and the grassland component of grasslands remaining grasslands and grazing land management.

Figure 3.5: Department of the Environment and Energy Inventory asset structures and relationships



Source: Australian Department of the Environment and Energy

Figure 3.6: FullCAM institutional arrangements

Source: Australian Department of the Environment and Energy

The Department of the Environment and Energy staff and external consultants have extensive experience in inventory preparation. The Department of the Environment and Energy aims to maximise the number of staff trained as UNFCCC reviewers to participate in UNFCCC Expert Review processes. All senior technical staff are qualified reviewers and have been accepted onto the UNFCCC Roster of Experts. Where particular technical expertise is not available within the Department of the Environment and Energy, expert consultants are engaged to undertake analysis and review work in accordance with the principles of the Australian Government's procurement guidelines.

3.3.4.1 Process for national consideration and approval of the inventory

Australia's draft National Inventory Report is considered by the National Greenhouse Gas Inventory Committee, which comprises representatives of the Australian, state and territory governments. Key domestic users of national inventory data are engaged in the formal review arrangements through the National Inventory Users Reference Group (NURG). This group includes Australia's premier science organisation, academics, sectoral experts, and industry representatives. The NURG meets once or twice per year.

The National Greenhouse Gas Inventory Committee and the NURG are the principal mechanisms for formal external review of the Report prior to its release. The release of each year's inventory and submission to the UNFCCC is approved by the Deputy Secretary of the Department of the Environment and Energy.

3.3.5 Quality assurance and quality control

Australia's national inventory is subject to mature and extensive quality assurance (QA) and quality control (QC) processes. These measures conform to IPCC Guidelines and Supplementary Methodologies.

QA/QC processes for Australia's national inventory systems are outlined in the *National Inventory Systems: Quality Assurance-Quality Control Plan* and summarised in Australia's NIR 2017. These processes contribute to the production of accurate inventories. Uncertainties are reduced to the extent practicable, and estimates are transparent, documented, consistent over time, complete and internationally comparable.

Australia's key QC controls have been systematically built into the operation of AGEIS. Auditable checks are undertaken to reduce the risks of errors associated with activity data input, missing data, recalculations and the time series consistency of generated emission estimates. Input data and implied emission factors are checked for recalculations and time series consistency prior to submission using AGEIS and the Common Reporting Format reporter tool.

Systems have been established to monitor the outcomes of QA/QC risk mitigation strategies and control measures, principally managed through the AGEIS. Each year, evaluation of data collected under the monitoring systems is undertaken and documented in the *National Inventory Systems: Evaluation of Outcomes*. Following consideration of this document, improvements to the inventory are made through the *National Inventory Systems: Inventory Improvement Plan*.

Since the Sixth National Communication and second Biennial Report, additional QA/QC activities and procedures have been implemented as identified in Australia's NIR 2017. These include:

- new functionalities introduced into the AGEIS to achieve efficiencies in the QC process, mitigate the risk of transcription errors during QC activity checks, and centralise all QC activities for review and archiving.
- review of Agriculture, Cropland and Grassland methods undertaken by the FullCAM and agriculture inventory expert advisory panel in 2015.
- review of Forest Management by an international expert (S. Federici) from the UNFCCC reviewer roster in 2015.
- improvements in the QC programs within FullCAM.
- review of deforestation and treatment of natural disturbances under UNFCCC accounting by an international expert (S. Federici) from the UNFCCC reviewer roster in 2016.
- performance audit to assess the effectiveness of the preparation and reporting of Australia's greenhouse gas emissions estimates in the National Inventory Report 2014 (revised) by the Australian National Audit Office (ANAO, see Annex A, section 7.1) from August 2016 to April 2017.
- review and update of key parameters used by FullCAM in modelling carbon fluxes in forests (by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) experts K. Paul and S. Roxburgh) in 2017.

3.3.6 Recalculation of previously submitted inventory data

Inventory estimates are periodically recalculated. This occurs for a number of reasons including updated UNFCCC reporting guidelines, revisions in key external data sources and revisions to data due to refinements in the estimate methodology or the inclusion of additional sources. To ensure the accuracy of the estimates, and to maintain consistency of the time series, recalculation of past emissions estimates are undertaken for all previous years. These recalculations are conducted in accordance with the IPCC 2006 guidelines.

Since the Sixth National Communication and second Biennial Report, Australia has:

- compiled more accurate and comprehensive emissions estimates following the refinement of existing and adoption of new data, methods and source/sink categories.
 - in particular, Australia has implemented two significant recalculations; in the *LULUCF* sector, and in the *oil and gas fugitives* sector. The adoption of advanced methods, estimation and calibration techniques have greatly increased the level of confidence in the sectors' emissions estimates.
- improved the national inventory system through strengthening of QA/QC systems, based on the ANAO performance audit of the national inventory.

- the audit concluded Australia has appropriate procedures for data processing, emissions calculations and reporting. See Annex A, section 7.1 for further details.
- made updates for consistency with the revised UNFCCC reporting guidelines including the adoption of the IPCC 2006 guidelines.
- updated global warming potentials used to convert emissions into carbon dioxide equivalents to reflect the revised UNFCCC reporting guidelines.
- applied higher tier data collected under the *National Greenhouse and Energy Reporting Act (2007)* into the national inventory and the latest science on emission processes in the *agriculture* sector.
- improved the national inventory system through strengthening of the planning and quality control systems.

The inventory has progressively incorporated more facility specific data obtained under the National Greenhouse and Energy Reporting System. Recalculations flowing from the change are identified and incorporated in Australia's National Inventory Reports. Detailed descriptions of any recalculations are included each year in those reports.

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 Kyoto 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 on 19 December 2008. Since this date, the ANREU has been subject to annual independent assessments under Article 8 of the Kyoto Protocol. Each assessment found it continues to perform the functions, and adhere to the technical standards, adopted under the Kyoto Protocol. As at the date of this Report, the ANREU was not the subject of any recommendations arising from the Article 8 review process. Australia's independent assessment reports are available on the [UNFCCC website](#).

Organisations or individuals wanting 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' as amended by decision 3/CMP.11 and 4/CMP.11, provides the basis for the rules underpinning the operation of the ANREU. In addition, the Australian Government passed the *Australian National Registry of Emissions Unit Act 2011* and the *Australian National Registry of Emissions Unit Regulations 2011* (ANREU Regulations), which covers the management and operation of the ANREU.

The ANREU is administered by the CER, a statutory agency of the Government. The ANREU is available at: <https://nationalregistry.cleanenergyregulator.gov.au/>.

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

Publicly available information includes:

- 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 for cancellation or retirement accounts
- account representative details for each account.

Personal information of Account Authorised Representatives is confidential and is not published, in accordance with decision 13/CMP.1 paragraph 44 as amended by decision 3/CMP.11 and Regulation 50 of the ANREU Regulations.

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

3.4.1 Name and contact information for the Australian National Registry

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3.4.2 Database structure and capacity of the Australian National Registry

For a description of the database structure and capacity of the ANREU, see Volume 3, Annex 7 of Australia's NIR 2017. Recent changes to the ANREU are set out in Volume 3, Chapter 14, of the NIR 2017.

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4. POLICIES AND MEASURES

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Key developments

Since the Sixth National Communication, Australia has implemented a comprehensive suite of policies to reduce greenhouse gas emissions across the economy, transition the electricity sector to low emissions, increase energy efficiency and fast track development and uptake of clean energy.

Policies in operation include the Emissions Reduction Fund (ERF) and its Safeguard Mechanism, the Renewable Energy Target and the National Energy Productivity Plan. Funding through the Australian Renewable Energy Agency and the Clean Energy Finance Corporation supports clean energy innovation across the spectrum of research and development, demonstration and deployment.

Voluntary action to manage greenhouse gas emissions and achieve carbon neutrality is guided by the National Carbon Offset Standard.

Work is underway on additional policies to reduce emissions in the electricity and transport sectors and to meet international commitments of the Montreal Protocol.

At the state and territory level, governments have developed climate change strategies incorporating renewables, energy efficiency and waste management.

Together these policies and measures are working to limit Australia's emissions. The official projections from December 2016 show Australia is on track to beat its 2020 target by 294 Mt CO₂-e. This includes Australia's overachievement from the Kyoto Protocol first commitment period (2008–2012) target of 128 Mt CO₂-e.

Emissions Reduction Fund and Safeguard Mechanism

Under the ERF, Australian businesses, landholders and others can earn carbon credits from projects which reduce or avoid greenhouse gas emissions. The ERF has expanded the opportunities offered to the land sector under the former Carbon Farming Initiative and extended opportunities to the whole economy.

The Australian Government has allocated \$2.5 billion to purchase emissions reductions through the ERF. After the sixth auction in December 2017, the Clean Energy Regulator has contracted to purchase more than 191 million tonnes, helping to meet Australia's emissions reduction targets. More than \$265 million remains to purchase more emissions reductions.

The Safeguard Mechanism puts emission limits on Australia's largest emitters, covering around half of Australia's emissions. It ensures emission reductions purchased by the Australian Government through the ERF are not offset by increases in emissions above business-as-usual levels elsewhere in the economy. The Safeguard Mechanism commenced on 1 July 2016.

National Energy Productivity Plan

In 2015, the Council of Australian Governments Energy Council (COAG) (representing the Australian, state, and territory governments) released a National Energy Productivity Plan to accelerate a 40 per cent improvement in Australia's energy productivity by 2030.

Clean Energy Support

In 2015, the Australian Parliament amended the Renewable Energy Target scheme which will see at least 23.5 per cent of Australia's electricity come from renewable sources by 2020. In 2016, three separate funds were established for the Clean Energy Finance Corporation to invest in clean energy projects targeting cities and the built environment, the Great Barrier Reef and emerging technologies.

Electricity Sector

In 2015, the Australian Government transferred the Australian Renewable Energy Agency and the Clean Energy Finance Corporation to the Environment portfolio. In 2016 the energy and environment portfolios were merged to form the Department of the Environment and Energy.

In October 2016, the COAG commissioned an independent review into the future security of the National Energy Market. The review delivered a national blueprint to reduce emissions while delivering secure, reliable and affordable electricity.

On 17 October 2017 the Australian Government announced it will accept the recommendation of the Energy Security Board for a new National Energy Guarantee. The Guarantee replaces the 50th recommendation of the independent review into the future security of the National Energy Market. It will deliver more affordable and reliable electricity while meeting Australia's international commitments to emissions reduction. The Guarantee requires electricity retailers to contract with or directly invest in energy resources to supply an amount of dispatchable energy while also meeting a specified emissions level for the electricity they buy. The Government will work together with the Energy Security Board and the COAG Energy Council to implement the National Energy Guarantee.

Transport Sector

A Ministerial Forum from the Australian, state and territory governments is developing policies to reduce emissions from Australia's motor vehicles. In 2015 the transport sector produced approximately 18 per cent of Australia's emissions, most of these are from cars and light commercial vehicles.

Hydrofluorocarbons

In June 2017, the Australian Government passed legislation to phase-down hydrofluorocarbon (HFC) imports from 1 January 2018. The import phase-down will reduce HFC emissions by reducing the amount of hydrofluorocarbons (HFCs) in the economy. The HFC phase-down will be complemented by other measures to reduce HFC emissions including action to improve equipment maintenance to reduce HFC leaks and improve energy performance.

On-going Commitment to Policy Review

On 9 November 2016, Australia ratified the Paris Agreement and set a 2030 target to reduce emissions by 26 to 28 per cent below 2005 levels. This will see emissions per capita halved and the emissions intensity of the economy fall by approximately two-thirds.

The Australian Government regularly reviews its climate change policies. In 2017, these policies were reviewed to ensure they remain effective in achieving Australia's 2030 target and Paris Agreement commitments. Stakeholders were consulted extensively on the opportunities and challenges of reducing emissions on a sector-by-sector basis. The Australian Government will continue to review and refine its climate change policies to ensure they remain effective in achieving Australia's 2030 targets and Paris Agreement commitments.

By 2020, the Australian Government will develop a whole-of-economy emissions reduction strategy for 2050.

4.1 POLICY-MAKING PROCESS

In Australia, all levels of government develop and implement climate change policies and measures.

At the national level, the Australian Department of the Environment and Energy develops and implements a national response to climate change. The main legislated policy measures to reduce emissions are the Emissions Reduction Fund (ERF), the Safeguard Mechanism, the Renewable Energy Target and the Equipment Energy Efficiency Program.

State and territory governments have developed climate change policies for their region. Policies at this level include land use controls, waste recovery, energy efficiency and renewable energy programs. Most state and territory governments and several local councils have renewable energy targets and emission reduction goals in place.

The Australian, state and territory governments maintain direct links between their departmental counterparts to share knowledge, resolve policy issues and collaborate on industry and community engagement. Ministerial discussions on climate change occur regularly through two forums: the COAG Energy Council and the Meeting of Environment Ministers.

The Council of Australian Government Energy Council

As noted in Chapter 2, the COAG Energy Council was formed in 2013, and supersedes the previous iterations of the council (Ministerial Council on Energy and Standing Council on Energy and Resources) which have existed since 2001. The COAG Energy Council is responsible for developing and implementing an integrated and coherent approach to national energy and mineral resources policy. The Council's work brings together energy and emissions reductions policies in a number of areas:

- ensuring electricity markets are adaptable to a range of future scenarios including a higher share of renewables and more distributed electricity generation
- working with the Council's Senior Committee of Officials to advise how emissions reduction policies affect the electricity sector, to gain a better understanding of potential impacts and facilitate integration of climate and energy policies
- progressing the National Energy Productivity Plan (NEPP) to reduce electricity bills, improve policy coordination between jurisdictions, increase the efficiency across Australia's energy system and reduce emissions.

Meeting of Environment Ministers

The Meeting of Environment Ministers comprises the Australian Minister for the Environment and Energy and the Environment Minister from each Australian state and territory. In April 2014, Environment Ministers agreed they would meet as needed with a focus on streamlining multi-jurisdictional environmental work. These meetings provide a forum to discuss strategic issues, including climate change, and agree cross-government actions to improve Australia's environment.

A combined environment and energy portfolio

In July 2016, the Australian Government merged the energy and environment portfolios to form the Department of the Environment and Energy to better integrate climate and energy policies. The Department designs and implements Australian Government policies and programs to protect and conserve the environment, water and heritage, promote climate action, and provide secure, reliable and affordable energy.

Publicly accessible information

The Australian Government makes publications accessible to the public through various websites: e.g.

- <https://www.australia.gov.au/about-government/publications>
- <https://www.nla.gov.au/librariesaustralia/recent-australian-government-publications-govrap>
- <http://www.environment.gov.au/about-us/publications>

These websites include legislative arrangements and enforcement and administrative procedures, established pursuant to the implementation of the Kyoto Protocol.

4.1.1 Monitoring and evaluation

The Administrative Arrangements Order sets out policy responsibilities for Australian Government Departments. Under this Order the Australian Department of the Environment and Energy is responsible for climate and energy matters and all related legislation.

Australia's policies and measures are developed based on expert advice and continuous consultation with industry and the community. Policies are implemented within strict governance frameworks and often by independent bodies such as the Clean Energy Regulator. As reported in the Sixth National Communication, the Clean Energy Regulator is an independent statutory authority established on 2 April 2012 under the *Clean Energy Act 2011*. It is responsible for administering schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions. This includes the ERF, the Safeguard Mechanism and the Renewable Energy Target.

Independent bodies may be established to manage financing of projects under a policy. The Australian Government established the Australian Renewable Energy Agency to accelerate Australia's shift to an affordable and reliable renewable energy future. The Clean Energy Finance Corporation co-invests with the private sector to increase the flow of funds into renewable energy, energy efficiency and low-emissions technologies.

Policies are regularly reviewed to ensure they remain effective.

The Australian Government's Department of Finance runs an Assurance Review process. Australian Government Assurance Reviews are designed to strengthen governance and assurance practices and play an important role in assisting government agencies to successfully deliver major programs and projects. They are short, intensive reviews conducted by independent reviewers sourced from both the public and private sector. The ERF is subject to this process. In July to August 2017, an Assurance Review of the ERF focussed on the implementation and its performance against its stated objectives. The ERF received an overall rating of 'green'. This means the scheme has been effectively implemented and is on track to deliver its objectives of lowest-cost emissions reductions, genuine abatement and streamlined administration.

Public consultation is integral to Australia's policy-making processes. Advice is sought through the release of discussion papers or draft legislation for public comment or through face-to-face consultation. The ERF was designed with industry and public input. Feedback was sought throughout the process, comments were invited on the initial design through the public release of a Green Paper. Final positions on the design, implementation and ongoing development of the ERF were presented in a White Paper for public comment. Regular engagement is facilitated through a dedicated climate change policy outreach and engagement team in the Department of the Environment and Energy.

4.1.2 Independent and special policy reviews

Independent review of legislation

The Climate Change Authority (the Authority), created on 1 July 2012, is an independent statutory agency established by the *Climate Change Authority Act 2011* (CCA Act). The Authority is required to conduct periodic reviews of:

- the *Carbon Credits (Carbon Farming Initiative) Act 2011* (Commonwealth) and associated instruments. This incorporates the ERF. The second review of the Act is due for completion by 31 December 2017.
- the *National Greenhouse and Energy Reporting Act 2007* and associated instruments. The first review of the Act is due to be completed by 31 December 2018.

Reviews are undertaken on other matters as requested by the Minister responsible for climate change or the Australian Parliament. The Authority also conducts and commissions its own independent research and analysis. The Authority has completed the following reviews since the Sixth National Communication:

- Towards the Next Generation: Delivering Affordable, Secure and Lower Emissions Power, a joint report with the Australian Energy Market Commission, 2017
- Special Review into Australia's policies and future targets for reducing greenhouse gas emissions, in the context of its international commitments and actions of other countries. The Special Review is made up of the following reports:
 - Report One: Draft and Final Report on Australia's future emissions reduction targets, 2015
 - Report Two: Australia's climate policy options, 2015

- Report Three: Towards a climate policy toolkit: Special Review on Australia's climate goals and policy, 2016. Further research is being conducted into ways to reduce greenhouse gas emissions on the land while enhancing the natural environment and improving on-farm profitability.
- Research report on [Policy options for Australia's electricity supply sector](#), 2016.

In 2014, the Authority conducted periodic policy reviews of the Renewable Energy Target, and the former Carbon Farming Initiative, and reviewed Australia's greenhouse gas emissions reduction goals and progress toward meeting them.

For more information on the outcome of reviews conducted by the Authority, see the Reviews and Publications sections of the Climate Change Authority website at: <http://climatechangeauthority.gov.au>.

Independent Review into the Future Security of the National Electricity Market

As noted in Chapter 2, Australia is facing a transition in its electricity market due to rapid technological change, the increasing penetration of renewable energy, a more distributed generation system, withdrawal of coal-fired generation, and changing consumer demand.

Following a black system event that left South Australia without power in 2016, the COAG Energy Council commissioned the Independent Review into the Future Security of the National Electricity Market, chaired by Australia's Chief Scientist, Dr Alan Finkel AO. The final report was released in June 2017.

Consultation for the Review occurred in two-stages. The first stage focused on information gathering, collecting as much knowledge as possible on the state of the National Electricity Market. The second stage focused on extensive stakeholder consultations, including both individual and roundtable meetings with the Chair and other Panel members.

Stakeholder views were fundamental to forming the [Preliminary Report](#), publicly presented as an Issues Paper. The Preliminary Report sought input through a public submission process, which received over 390 submissions. Approximately 450 people across the energy industry, including market participants, technology experts, consumer and business representatives, and the public attended meetings in various capital cities, providing the Panel with a wide breadth of views.

The Final Report, [Blueprint for the Future: Independent Review into the Future Security of the National Electricity Market](#) suggests, with policy certainty and fast action, Australia can benefit from a secure and reliable energy future. The report made 50 recommendations focussing on four key outcomes for the National Electricity Market: increased security, future reliability, rewarding consumers, and lower emissions. These outcomes will be underpinned by the three pillars of an orderly transition, better system planning and stronger governance.

Some of the recommendations to ensure the optimal functioning of Australia's electricity system into the future include:

- strengthening obligations and reliability through Security Obligations for new generators. These obligations would require new generators to ensure they can supply electricity when needed for the duration and capacity determined for each National Electricity Market (NEM) region
- a requirement for electricity generators to provide three years' notice of their intention to close, to facilitate an orderly transition
- rewarding consumers for demand management and the power they generate through distributed energy resources like rooftop solar photovoltaic (PV) to help reduce consumers' electricity bills
- improving approaches for data collection, analysis and sharing across the energy sector.

4.1.3 Australia's review of climate change policies

When announcing Australia's 2030 target, the Australian Government committed to review its climate change policies. The aim of the review was to ensure Australia's policies remain effective in achieving Australia's 2030 target and Paris Agreement commitments. The review looked at the opportunities and challenges of reducing emissions on a sector by sector basis, taking into consideration the different circumstances and characteristics of

each sector. The review considered recommendations from the Independent Review into the Future Security of the National Electricity Market.

The [Terms of reference](#) for the review were released by the Minister for the Environment and Energy on 5 December 2016.

The Australian Department of the Environment and Energy consulted widely with businesses across all sectors of the economy and with the community. This included the release of a [discussion paper](#) on 24 March 2017, which generated [357 public submissions](#) (105 from individuals and 252 from organisations). Senior Executives of the Department of the Environment and Energy met with more than 270 stakeholders and the Minister for the Environment and Energy hosted two roundtables, attended by representatives of 42 business, community, environmental and Indigenous organisations. The final report [[hyperlink to report when available](#)] details the review findings.

4.1.4 Australia's voluntary national review

The Australian Government is undertaking a voluntary national review on Australia's progress towards the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. The review will assess how Australia is integrating the Sustainable Development Goals into domestic and international policies. It will help Australia understand its achievements and areas requiring further domestic action. This review will be finalised in July 2018.

4.2 POLICIES AND MEASURES AT THE NATIONAL LEVEL

The Australian Government has a comprehensive suite of policies to reduce greenhouse gas emissions across the economy, transition the electricity sector to low emissions, increase energy efficiency and fast track development and uptake of clean energy.

Policies in operation include the Emissions Reduction Fund (ERF) and its Safeguard Mechanism, the Renewable Energy Target and the National Energy Productivity Plan. Funding through the Australian Renewable Energy Agency and the Clean Energy Finance Corporation supports clean energy innovation across the spectrum of research and development, demonstration and deployment.

Voluntary action to manage greenhouse gas emissions and achieve carbon neutrality is supported by the National Carbon Offset Standard.

Work is underway on additional policies to reduce emissions in the electricity and transport sectors through a National Energy Guarantee and the Ministerial Forum on Vehicle Emissions; and to meet international commitments of the Montreal Protocol to phase-down hydrofluorocarbons.

These policies are having a positive effect. Together they are reducing Australia's emissions. The latest official emissions projections show Australia is on track to beat its 2020 target by 294 Mt CO₂-e. This includes Australia's over-achievement against the Kyoto Protocol first commitment period of 128 Mt CO₂-e. See Table 4.1 for details of the effects of Australia's mitigation policies aimed at limiting and reducing greenhouse gas emissions. Further detail of Australia's emissions projections is provided in Chapter 5.

4.2.1 Cross-sector policies and measures

Reducing Greenhouse Gas Emissions across the economy

Emissions Reduction Fund






The ERF is made up of three interrelated elements:




- **crediting** emissions reductions
- **purchasing** emissions reductions
- **safeguarding** emissions reductions.

Crediting

The ERF allows businesses, community organisations, local councils, farmers and others to receive carbon credits by undertaking approved emissions reduction activities. Methods define which activities are eligible to earn carbon credits, and how emissions reductions are to be measured, verified and reported. Participants receive one Australian carbon credit unit for every tonne of emissions they reduce or avoid. Eligible activities include improving energy efficiency, fuel switching, capturing methane from landfills and storing carbon in forests and soils. Over 700 emissions reduction projects are registered under the ERF. Figure 4.1 gives examples of eligible activities, shows the number of registered projects and the number of projects contracted to deliver emissions reductions to the Australian Government.

Figure 4.1: Emissions Reduction Fund Projects

Project type	Registered projects	Contracted projects	Contracted emissions reductions (Mt CO ₂ -e)	Examples of eligible project activities
 Energy efficiency	53	11	4.7	<ul style="list-style-type: none"> Reducing commercial and industrial energy use by installing high efficiency appliances like refrigeration and fans, or energy efficient street lights. Boosting energy efficiency in small energy users such as households.
 Vegetation	380	238	124	<ul style="list-style-type: none"> Protecting native forests by reducing land clearing. Planting trees to grow carbon stocks. Regenerating native forest on previously cleared land.
 Savanna burning	72	51	13.8	<ul style="list-style-type: none"> Managing bushfires in Australia's savannas to avoid high intensity fires.
 Agriculture	47	21	17.8	<ul style="list-style-type: none"> Reducing emissions from beef cattle and milking cows through dietary supplements or efficient herd management. Capturing and destroying the methane from effluent waste at piggeries. Building soil carbon through changed farming practices such as crop stubble retention.
 Industrial fugitives	15	12	5.6	<ul style="list-style-type: none"> Capturing and destroying waste methane from coal mines. Reducing fugitive emissions from oil and gas operations. Reducing emissions at Australia's highest emitting facilities.

Project type	Registered projects	Contracted projects	Contracted emissions reductions (Mt CO ₂ -e)	Examples of eligible project activities
 Waste	137	102	24.5	<ul style="list-style-type: none"> Reducing the amount of waste in landfill, through composting, resource recovery, or separating organic household waste using dedicated council bins. Capturing methane from landfills and producing electricity. Treating wastewater at places such as sewerage plants or abattoirs.
 Transport	7	3	1.2	<ul style="list-style-type: none"> Reducing emissions from air, land and sea transport through new technologies and more efficient practices.
 Total ¹	711 projects registered	438 projects contracted	191.7 Mt CO ₂ -e contracted	<ul style="list-style-type: none"> The full list of eligible activities is available here: www.environment.gov.au/climate-change/emissions-reduction-fund/methods

Source: Clean Energy Regulator and Australian Department of the Environment and Energy, December 2017

Purchasing

The Australian Government has allocated \$2.5 billion to purchase carbon credits through the ERF, using a competitive process of reverse auctions or other processes that represent value for money and comply with legislated purchasing principles. All Government purchases are made by the Clean Energy Regulator. Participants register a project and bid to enter into contracts of up to 10 years duration with the Government. If a project does not earn sufficient credits to meet the contractual obligations, the project proponent may need to ‘make good’ by buying carbon credits from someone else. Participants may also sell carbon credits achieved under the ERF privately such as, to entities wanting to offset their emissions.

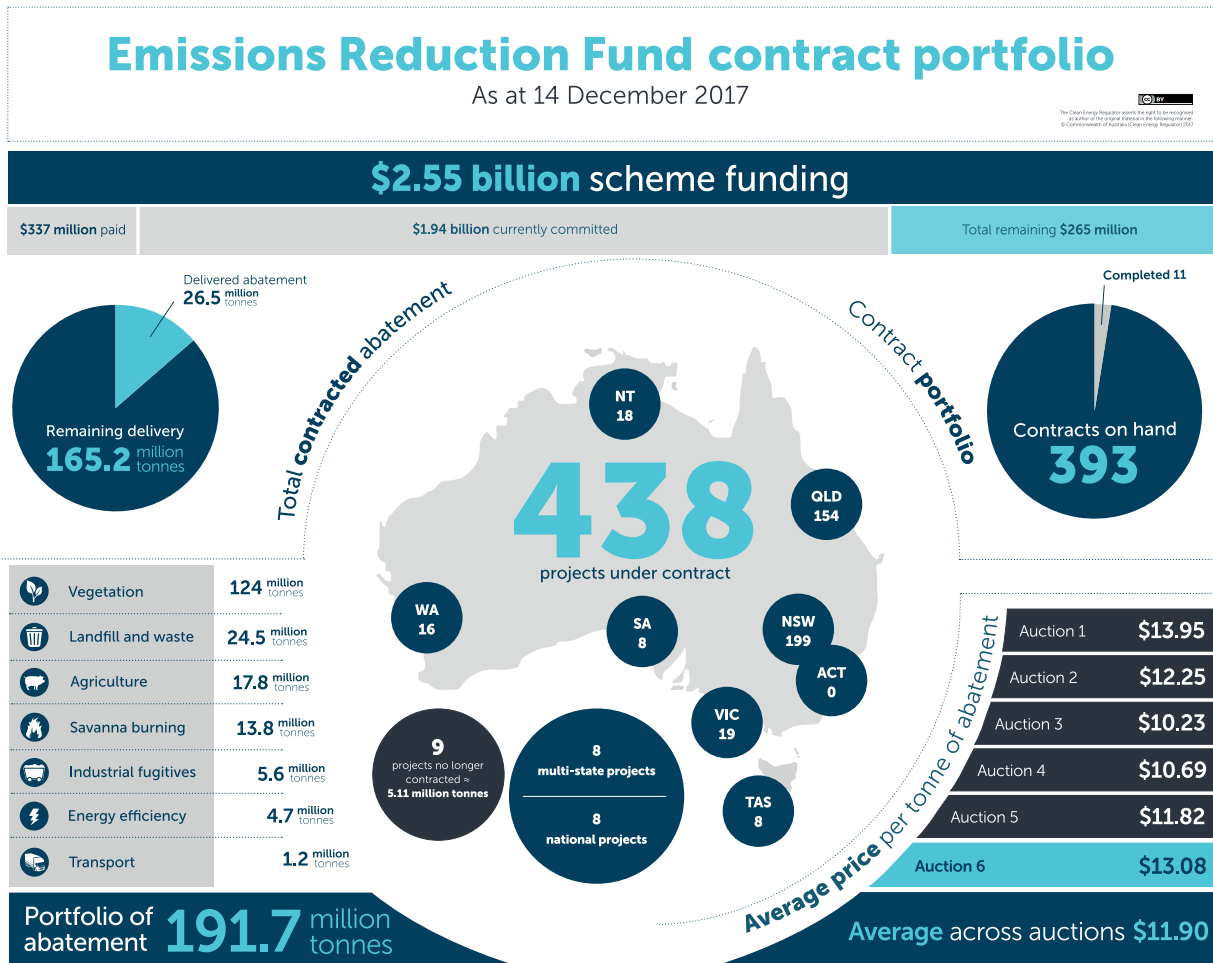
From the first six ERF auctions, the Clean Energy Regulator has contracted more than 191 million tonnes of emissions reductions from 438 projects at an average price of \$11.90. This represents the largest emissions reduction commitment by the private sector in Australia. After six auctions, more than \$265 million remains to purchase further emissions reductions. Projections indicate the ERF is expected to deliver more than 80 million tonnes of abatement by 2020.¹

Many ERF projects have abatement profiles extending beyond 2020 and will contribute 242 million tonnes to Australia’s 2030 emissions reduction target.

Figure 4.2 sets out the sectoral breakdown of activity in the ERF, including contracted abatement, by method, following the sixth auction in December 2017.

1. This does not take into account results from the sixth ERF Auction which were not available at the time of finalising this estimate.

Figure 4.2: Combined results for all Emissions Reduction Fund auctions



Source: <http://www.cleanenergyregulator.gov.au/ERF/Auctions-results>.

As well as reducing emissions, ERF projects provide important co-benefits including income and employment for rural and Indigenous communities and improved biodiversity. Revenue from projects is being reinvested to improve farms and help Indigenous Australians to continue working and living on their land.

The Australian, state and territory governments have separate legislation and measures to conserve biodiversity and sustainably manage natural resources ([Environment Protection and Biodiversity Conservation Act 1999](#)). This includes the [Native Vegetation Framework](#) and natural resource management plans implemented at the regional level.

The full results of the auctions, application process, registered projects, and credits issued are available on the [Clean Energy Regulator website](#).

Case study: North East Arnhem Land Fire Abatement Project

The North East Arnhem Land Fire Abatement ERF project in the Northern Territory is contributing to Australia's emissions reduction targets and providing invaluable environmental, social, cultural and economic benefits.

Operated by the Yirralka Rangers in north east Arnhem Land, the project is undertaking early dry season fire management to avoid high intensity wildfires later in the season. This reduces greenhouse gas emissions and protects the natural and cultural assets of the Laynhapuy Indigenous Protected Area.

In 2016, the Yirralka Rangers traversed 10,000 km of remote country by vehicle and 4,200 km by helicopter to undertake ground and aerial burning. Their hard work resulted in a productive year, earning more than 110,000 Australian carbon credit units through the ERF.

The project successfully bid into the Clean Energy Regulator's fourth reverse auction in November 2016, where they contracted 100,000 tonnes of abatement, allowing the project to sell their Australian carbon credit units to the Australian Government over coming years. Private investors and corporations can also purchase Australian carbon credit units from projects like the North East Arnhem Land Fire Abatement project to voluntarily offset their carbon emissions and support environmental, cultural and social co-benefits.



Yirralka Rangers Fuel Reduction Burning, Laynhapuy Indigenous Protected Area: Copyright: Yirralka Rangers / Laynhapuy Homelands Aboriginal Corporation

Caring for country is not just about plants and animals, it is also about songlines and sacred sites within the country. Under Yolngu law we must protect these places. Ranger djama (work) is good because it gives us more ways to fulfil our obligation to look after country while continuing to live on our ancestral lands. Living on the homelands is the vision of our old people.

Mungurrapin Maymuru, Yirralka Rangers Cultural Manager.

The North East Arnhem Land Fire Abatement project is the fifth fire project to be registered in Arnhem Land by Arnhem Land Fire Abatement (ALFA) NT Pty Ltd—a company owned exclusively by Aboriginal people with custodial responsibility for those parts of Arnhem Land under active bushfire management. The five ERF fire projects they support cover almost 80,000 km²—an area larger than Tasmania—and have been issued with over 1.8 million Australian carbon credit units to date.

ALFA NT Pty Ltd emphasises the high value of co-benefits generated by Indigenous fire projects, including Indigenous employment, supporting Aboriginal people to return and remain on their country, biodiversity protection, transfer of knowledge to younger generations, maintaining Aboriginal languages, and higher standards of mental and physical health.

The Yirralka Rangers and the Laynhapuy Indigenous Protected Area are supported by the Australian Government's Indigenous Protected Area and Working on Country—Indigenous Ranger programs. These programs maintain and enhance the biodiversity of the land and sea, protect cultural sites, develop alternative sources of income and build the Yolngu people's skills and capacity to undertake activities like those covered by the ERF. The role of the Yirralka Rangers goes beyond the physical to the nurturing of spiritual components—essential to the Yolngu people's relationship with their land.

Ensuring integrity of the Emissions Reduction Fund

To be eligible to receive Australian carbon credit units under the ERF, emissions reduction activities must be genuine and additional, going beyond business as usual. This is achieved by specifying eligible emissions reduction activities in legislative instruments known as 'methods'. Methods also define how the emissions reductions are to be measured, verified, reported and monitored. Methods can only be made if the independent Emissions Reduction Assurance Committee (ERAC) confirm they comply with legislated 'Offsets Integrity Standards' (see Figure 4.3). Methods are reviewed at least every four years to ensure they continue to meet these standards. Additionally, the Minister for the Environment and Energy is required by legislation to consider whether any adverse environmental, economic or social impacts are likely to arise from the activities covered by the method.

The Department of the Environment and Energy works with industry, research organisations, technical experts, and other Australian Government agencies to develop robust methods, underpinned by research and supported by industry. Methods are available for activities across all sectors in the economy, including reducing emissions from agriculture and transport, combustion of coal mine waste gas, improving the energy efficiency of commercial buildings and industrial facilities, flaring landfill gas, reforestation and revegetating land, and managing savanna burning. The availability of methods offering a wide range of eligible activities across the economy has been essential to the ERF's achievements.

The Clean Energy Regulator is responsible for administering the ERF. This includes registering projects, accrediting project auditors, issuing carbon credits, running auctions and managing contracts for delivery of emissions reductions. The Regulator ensures participants comply with the legislated requirements of the ERF including that projects are new, not required by law and are not funded by other listed government programs.

Table 4.2 lists all methods.

Emissions Reduction Assurance Committee

The ERAC replaced the Domestic Offsets Integrity Committee established under the former Carbon Farming Initiative. The ERAC is an independent, expert committee which assesses ERF methods against the Offsets Integrity Standards specified in legislation. The ERAC advises the Minister for the Environment and Energy on whether proposed new activities or variations to existing activities meet these standards. The Minister for the Environment and Energy cannot make or vary a method without the ERAC having first determined that it meets the legislated Offsets Integrity Standards.

The ERAC considers advice from the Clean Energy Regulator, an independent statutory agency, on implementation of proposed methods.

The ERAC release draft methods for public consultation before providing their advice to the Minister. The consultation period for draft methods or variations of existing methods is 28 days, unless the ERAC determines a shorter period (no less than 14 days) is appropriate. The ERAC monitors and reviews the effectiveness of methods over time and advises the Minister whether or not the method should continue to apply.

Figure 4.3: Offsets Integrity Standards

The ERF is enacted through the <i>Carbon Credits (Carbon Farming Initiative) Act 2011</i> , the Carbon Credits (Carbon Farming Initiative) Regulations 2011 and the Carbon Credits (Carbon Farming Initiative) Rule 2015. The Act sets out offsets integrity standards for methods. Draft ERF Methods are assessed against the following criteria:	
Additional	Abatement is unlikely to occur in the ordinary course of events
Measureable and verifiable	Abatement can be measured and verified
Eligible	Emissions reductions credited must be able to be counted towards Australia's emissions reduction targets
Evidence based	Methods must be supported by clear and convincing evidence
Material	Project abatement and related significant emissions should be accounted for
Conservative	Estimates, assumptions and projections used in the methodology determination should be conservative

Safeguard Mechanism

The Safeguard Mechanism is designed to ensure emissions reductions purchased by the Australian Government through the ERF are not offset by significant increases in emissions above business-as-usual levels elsewhere in the economy. The Safeguard Mechanism does this by placing emission limits (or baselines) on Australia's largest emitters. It covers around 140 businesses that have facilities with annual direct emissions of more than 100,000 tCO₂-e. The Safeguard Mechanism applies to around half of Australia's emissions, including the manufacturing, mining, oil and gas, transport, and electricity sectors. Facilities covered by the Safeguard Mechanism are required to reduce emissions or purchase carbon credits (namely abatement credited under the ERF) to ensure net emissions remain below the baseline.

For existing facilities, baselines are set at business-as-usual levels, that is, the highest level of reported emissions over the five years ending in 2013-14. Baselines can be adjusted under certain circumstances, for example to accommodate significant expansions, business growth where emissions intensity is continuously improving, and natural variability in resource grades at mining, oil and gas facilities. For new investments operational after 2020, baselines will be set with reference to best practice emissions intensity, rather than historical emissions.

The Clean Energy Regulator administers the [Safeguard Mechanism](#) and makes baselines consistent with the enabling legislation, the *National Greenhouse and Energy Reporting Act 2007*.

Voluntary Action

National Carbon Offset Standard and the Carbon Neutral Program

The Australian Government is supporting businesses to take voluntary action to reduce and offset emissions through the National Carbon Offset Standard (the Standard).

The Standard sets out how to measure, reduce, offset, report and audit greenhouse gas emissions, and how to achieve carbon neutral certification. Carbon neutral means reducing emissions where possible and then investing in carbon offset projects to achieve zero overall emissions.

The Standard is available in a range of categories, organisations, products and services, buildings, precincts and events.

Some of Australia's best known organisations are part of a group of leading enterprises certified as carbon neutral. It is already possible to fly carbon neutral, buy carbon neutral food and wine, and source carbon neutral business products. These businesses are investing in carbon offset projects that deliver additional environmental or social outcomes such as improved water quality, increased biodiversity and Indigenous employment.

For certified businesses, the Carbon Neutral Certification Trade Mark is available for use. It provides a legitimate stamp of approval that an organisation has met all the requirements of the Standard and provides further opportunities to demonstrate climate commitments to stakeholders and customers.

For more information on the National Carbon Offset Standard and the Carbon Neutral Program see the Department of Environment and Energy website: <http://www.environment.gov.au/climate-change/carbon-neutral>.

4.2.2 Transport sector

Ministerial Forum on Vehicle Emissions

The Australian Government established a Ministerial Forum to coordinate a whole-of-government approach to addressing emissions from motor vehicles. The Forum is consulting on three measures: fuel efficiency standards for light vehicles, strengthening noxious emissions standards, and improving fuel quality. A fuel efficiency standard could save money for households and businesses while reducing greenhouse gas emissions. The Forum is looking at other measures to increase uptake of low emission vehicles.

Green Vehicle Guide

[The Green Vehicle Guide](#) provides information to car purchases about the performance of their vehicle choice and the Australian Government provides exemptions from some vehicle taxes for highly efficient vehicles.

Australian Engagement on International Transport Emissions

Australia is working with other countries to reduce emissions from international aviation and shipping through the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). These sectors' 'bunker fuels' are not counted in countries' emissions inventories or targets under the Paris Agreement or the Kyoto Protocol. Emissions from international aviation accounts for around 1.3 per cent of global emissions and international shipping around 2.2 per cent. Reducing international aviation and shipping emissions requires a commitment 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 reduce emissions. In 2013, ICAO reached agreement to offset growth in emissions from 2020. ICAO agreed to implement a range of measures to meet this target, including a market-based measure. The Australian Government supported ICAO to adopt the market-based Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Australia and 71 other countries have volunteered to participate in the CORSIA from its commencement in 2021.

The Australian international aviation industry, including Qantas and Virgin Australia, support the CORSIA. The CORSIA is intended to help achieve carbon neutral growth in international aviation by requiring airlines to purchase offsets if industry emissions increase above 2020 levels. All operators flying international flights (above capacity and emissions thresholds) have to measure and report on their emissions from 2019. Offsetting obligations will be calculated by applying the international aviation sector's growth rate to an operator's emissions from flights between participating countries.

International shipping emissions

The Australian Government supports negotiations within the IMO to develop a strategy to reduce greenhouse gas (GHG) emissions from international shipping. In October 2016, the IMO Marine Environment Protection Committee agreed to develop a comprehensive strategy to reduce GHG emissions from international shipping. The IMO intends to adopt an initial strategy (to outline inter alia level of ambition and candidate measures to reduce emissions) in April 2018 and a revised strategy (to include implementation schedules) in early 2023. Work on the strategy builds on the IMO's significant work on climate change mitigation. Regulations on energy efficiency for ships, including an Energy Efficiency Design Index and Ship Energy Efficiency Management Plan, entered into force in January 2013.

A mandatory data collection system was adopted in October 2016, which requires all ships of 5,000 gross tonnage and above on international voyages to collect and report consumption data for each type of fuel oil used. The data collection system is the first step in the IMO's three-step process of analysing collected data to provide the basis for an objective and inclusive policy debate. This will inform decisions on further measures needed to enhance energy efficiency and address GHG emissions from international shipping.

Australia continues to support the IMO in the development of these important initiatives and is taking all necessary steps to ensure the regulations are implemented and enforced domestically. Australia wants to ensure that the GHG emissions reduction strategy strikes the right balance between reducing GHG emissions from ships and maintaining the sector's unique role in supporting global trade.

4.2.4 Industrial processes and product use

Hydrofluorocarbons

In June 2016, the Australian Government announced a phase-down of hydrofluorocarbon (HFC) imports. Legislation was passed in June 2017 and Australia's phase-down will start on 1 January 2018. The import phase-down will reduce HFC emissions by reducing the amount of HFCs in the economy. The HFC phase-down will be complemented by other measures to reduce HFC emissions including action to improve equipment maintenance to reduce HFC leaks and improve energy performance.

Australia's HFC phase-down is ahead of the global phase-down under the *Montreal Protocol on Substances that Deplete the Ozone Layer*. It commences one year early. Australia's HFC limits start 25 per cent below the Montreal Protocol's limits and Australia has more frequent reduction steps. Australia will use 25 per cent less HFCs than that permitted under the Montreal Protocol over the period from 2018 to 2036. The HFC phase-down under the Montreal Protocol will see developed nations reduce HFC production and imports by 85 per cent compared to current levels by 2036. All developing countries will take on phase-down obligations.

ENERGY SECTOR

Transitioning the Electricity Sector

Renewable Energy Target

The Australian Government supports the uptake of renewable energy through the Renewable Energy Target. The scheme is expected to generate at least 23.5 per cent of Australia's electricity from renewable sources by 2020.

The Renewable Energy Target is helping transform Australia's electricity generation mix to cleaner and more diverse sources. It supports growth and employment in the renewable energy sector by providing a financial incentive for investment in new renewable energy projects.

The Renewable Energy Target has two components:

- the Large-scale Renewable Energy Target of 33,000 GWh by 2020 encourages investment in large scale projects
- the Small-scale Renewable Energy Scheme helps home-owners and small businesses to install eligible small-scale renewable energy systems and solar hot water systems.

Large-scale Renewable Energy Target

Eligible large-scale renewable energy generators, like solar and wind farms, hydro-electric and biomass power stations, can create certificates under the Large-scale Renewable Energy Target. Electricity retailers are legally obligated to buy and surrender a certain amount of certificates to the Clean Energy Regulator each year. This operates as a subsidy to renewable energy generators.

In August 2017, more than 70 per cent of the estimated capacity required to reach the target had been accredited.

Small-scale Renewable Energy Scheme

The Small-scale Renewable Energy Scheme assists homeowners and small businesses with upfront costs of installing small-scale (less than 100 kilowatt capacity) wind, hydro and solar panel systems. This scheme has assisted Australian households to install more than 1.8 million solar PV systems and one million solar water heater systems.

In August 2017, Australia hit a milestone of 6000 megawatt capacity across 2.8 million small-scale installations of renewable energy systems such as solar PV systems, solar water heaters and air source heat pumps. That is enough to power 1.8 million homes.

Case study: Rooftop revolution

Fly over almost any Australian suburb today and multiple rooftop solar panels can be seen to glint in the sun. This reflects the steady increase in small-scale rooftop solar panel installations under the Renewable Energy Target.

In August 2017 the number of small-scale solar panel installations on Australian household roofs passed 1.8 million, with a capacity of six gigawatts—enough to power more than 1.8 million homes or every home in Sydney. This highlights the role of everyday Australians in generating renewable energy and managing their electricity expenses.

Businesses are also realising the benefits of going solar. Installations under the higher end of the Small scale Renewable Energy Scheme include a bakery, dairy farm, abattoir, hardware store, insurance company, schools, bowling club, manufacturing business, retail business and a community club for ex-servicemen and women.

The Hornsby Retired Services League Club in North Sydney installed a 100 kilowatt system in April 2014.

We had been investigating solar energy for a number of years to complement our existing environmental and sustainability measures and to reduce increasing energy costs, said Hornsby RSL Club Assistant CEO, Steve Rigney. The electricity generated by the 100 kilowatt solar system is consumed entirely by the Club—creating considerable savings per annum off our total energy bill. It's well worth it.

The average size of installations has been increasing, from two kilowatts in 2010 to 5.6 kilowatts in 2016. The number of higher kilowatt capacity systems also increased in 2016, with 1,887 installations between 30 and 100 kilowatts, compared with 874 in 2013.

From residential to industrial and commercial, rooftops around the country are evidence of Australians' growing use of solar.

National Energy Guarantee

On 17 October 2017 the Australian Government announced it will accept the recommendation of the Energy Security Board for a new National Energy Guarantee. The Guarantee will deliver more affordable and reliable electricity while meeting Australia's international commitments to emissions reduction. The Guarantee requires electricity retailers to contract with or directly invest in energy resources to supply an amount of dispatchable energy while also meeting a specified emissions level for the electricity they buy. The Government is working with the Energy Security Board and the states and territories through the COAG Energy Council to implement the National Energy Guarantee.

How it works

The Guarantee will require energy retailers and some large energy users to ensure that the electricity they contract for or purchase meets both a reliability and an emissions target.

Ultimately, each individual retailer will determine how they meet the requirements under the Guarantee.

Retailers can do this within their existing portfolio of generators, by investing in new generation assets, or by contracting directly with generators, storage or demand response services that:

- the system maintains a minimum amount of dispatchable capacity to meet customer and system reliability needs
- the emissions associated with electricity purchased in the market are aligned with Australia's emissions reduction commitments under the Paris Agreement.

The independent Energy Security Board says the Guarantee will result in lower emissions and a more reliable and affordable energy system for Australian consumers.

Setting the emissions target and review process

The Australian Government will determine a 2030 emissions target for the National Electricity Market based on Australia's international commitments. This will be translated into the annual level of the emissions guarantee for individual retailers, with the future trajectory of the emissions guarantee announced in advance.

The Guarantee would set out the process through which future targets can be set in response to the Paris Agreement's five-yearly process to pledge further emissions reduction commitments. To provide investor certainty, market participants would be given sufficient notice about any changes to the level of the emissions guarantee in future years.

4.2.5 Increasing Energy Efficiency

National Energy Productivity Plan

The National Energy Productivity Plan (NEPP) aims to accelerate a 40 per cent improvement in Australia's energy productivity by 2030. It consolidates national, state and territory government and industry measures to provide a national framework and an initial economy-wide work plan.

The NEPP aims to boost competitiveness and growth, help families and businesses manage their energy costs and reduce emissions. This is being done through a package of 34 measures which support:

- smarter energy choices (by providing more efficient incentives, empowering consumers and promoting business action)
- better energy services (by driving greater innovation, more competitive and modern markets and updating consumer protections and standards).

Key achievements of the NEPP include:

- Tighter energy standards for equipment: the [Equipment Energy Efficiency \(E3\) program](#) delivers a single, integrated program on energy efficiency standards and energy labelling for equipment and appliances. To accelerate the impact of the E3 program, new proposed standards have been consulted on for air conditioners, commercial refrigerated display cabinets, industrial fans, swimming pool pumps, lighting, refrigerators and freezers. These measures will deliver an estimated \$7 billion in economic benefits and reduce emissions by 45 MtCO₂-e (cumulative to 2030).
- Expansion of the Commercial Building Disclosure program: requires most sellers and lessors of large office spaces to provide energy efficiency information to prospective buyers and tenants. From 1 July 2017 the mandatory disclosure threshold for buildings size was lowered from 2,000 square metres to 1,000 square metres. This will lead to an estimated \$50 million in new energy savings, and about 3.5 MtCO₂-e reduction, calculated on a five year program duration, between the years of 2015 and 2019.
- Improved energy efficiency of residential buildings: targeted industry training and tools are being delivered to improve compliance with the energy performance requirements of the Australian National Construction Code, and ensure residential buildings are built to need less energy for heating and cooling.
- Robust energy use data: the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is creating an Energy Use Data Model to understand Australians' energy consumption and influencing factors such as a change in climate, exponential growth in use of solar electricity, and increasing energy efficiency.

Further improvements to the NEPP are underway. These include consideration of opportunities to improve energy productivity in the Australian Government's operations and the introduction of cost-reflective electricity pricing and competitive metering. The COAG Energy Council has committed \$8 million in its 2016–17 budget to support collaborative work on a number of measures. NEPP measures include:

- Funding of \$160,000 over 2017–18 for Victoria to develop a pilot of the Victorian Residential Efficiency Scorecard's assessment tool, which measures the energy efficiency of existing homes. This will allow jurisdictions across Australia to test the Scorecard's assessment tool.
- Implementation of the Australian Government's Smart Cities Plan, including the \$100 million a year

Sustainable Cities Investment Fund. The aim is to accelerate the deployment of clean energy, renewable energy and energy efficiency technology in cities. This will be partially driven through negotiation of initial [City Deals](#).

- The Townsville City Deal, Australia's first, was signed on 9 December 2016. The Launceston City Deal was signed on 20 April 2017. The Australian Government and NSW Government will work together with local governments across Sydney's West and South-West Districts towards a landmark Western Sydney City Deal—the first in New South Wales.

4.2.6 Fast-tracking Clean Energy Innovation

The Australian Government supports clean energy innovation across the spectrum of research and development, demonstration and deployment. Research and development grants are provided by the Australian Renewable Energy Agency (ARENA), the Australian Research Council and the CSIRO. Seed funding for emerging technology is provided by the Clean Energy Innovation Fund which is part of the Clean Energy Finance Corporation (CEFC) and is operated in consultation with ARENA. Projects near commercial deployment can access debt and equity from the CEFC.

Australian Renewable Energy Agency

The Australian Renewable Energy Agency is a statutory authority established by the *Australian Renewable Energy Agency Act 2011*, which commenced operations on 1 July 2012. ARENA provides research, development and deployment grant funding to improve the affordability and increase the supply of renewable energy in Australia. As at 30 June 2017, ARENA had committed approximately \$1 billion to over 317 projects. This has been matched by approximately \$2.5 billion in co-funding, making the total over \$3.5 billion. These funds have supported projects spanning the commercialisation pathway, from research and development to demonstration and near-commercial deployment projects.

ARENA has \$800 million to 2022 to support renewable energy projects. The Australian Government's priorities for ARENA include:

- at least double the funding allocated to research and development, consistent with Australia's Mission Innovation target.
- funding research and development of technologies supporting electricity system security and reliability (such as storage).

ARENA draws on independent expert advice (such as the Independent Review into the Future Security of the National Electricity Market and CSIRO Low Emissions Technology Roadmap) and works collaboratively with other agencies supporting clean energy innovation.

ARENA Project Snapshot: Driving innovation in large-scale solar

In September 2016, the Australian Government through ARENA, allocated \$92 million in new funding for large-scale solar projects. Twelve new solar projects—six in Queensland, five in New South Wales and one in Western Australia—will deliver more than 480 megawatts of new solar capacity. The projects will triple the amount of energy produced by large-scale solar projects in Australia and provide enough energy to power 150,000 average Australian homes. Due to be commissioned by the end of 2018, together they will generate 1100 GWh annually. This equates to approximately seven per cent of the new capacity required to meet Australia's 2020 Renewable Energy Target as at 1 September 2016.

ARENA Project Snapshot: Snowy Hydro 2.0

The Australian Government through ARENA is contributing \$8 million to a feasibility study into Snowy 2.0, a pumped hydro project with the potential to provide storage for large scale, reliable renewable energy.

It would increase the generation capacity of the existing Snowy Mountains Scheme by up to 50 per cent, making up to 2000 megawatts available to the National Electricity Market.

It will also boast enough capacity to provide 350,000 MW/h of power over a week, enough to meet peak demand continuously for 500,000 homes.

This energy storage capacity could then be used to ease pressure at times of high demand and provide rapid-response back-up to fill unexpected gaps in electricity supply.

The site being considered for Snowy 2.0 involves linking the existing Tantangara and Talbingo reservoirs, which are separated by a height differential of 700m. Both are already part of Australia's existing Snowy Mountains Scheme.

Clean Energy Finance Corporation

The [Clean Energy Finance Corporation \(CEFC\)](#) is a statutory authority established by the *Clean Energy Finance Corporation Act 2012*, which commenced operations on 1 July 2013. The CEFC's mission is to increase the flow of finance into Australia's clean energy sector. The CEFC uses debt and equity funding to promote investment in clean energy technologies. The CEFC does this through direct investments which attract private sector finance, as well as making indirect investments through its strategic co-financing partners. Projects near commercial deployment can access debt and equity from the CEFC at close to market rates.

As at 30 September 2017, and since 2013, the CEFC has made cumulative investment commitments of \$5 billion to projects with a total value of \$14 billion. These projects will reduce emissions from energy and industrial processes, and include investments in solar energy and energy storage. The CEFC invests commercially to increase the flow of funds into renewable energy, energy efficiency and low emissions technologies.

Each dollar of CEFC investment commitments in 2016–2017 was matched by more than \$2 from the private sector. The CEFC's investment portfolio is expected to generate a return above the Government's costs of funds. In 2016, the Australian Government agreed to create three new funds within the CEFC:

- The Clean Energy Innovation Fund (see below).
- [The Sustainable Cities Investment Program](#): The Program supports the national Smart Cities Agenda by investing in energy efficiency, renewable energy and low emissions technology projects that improve Australian cities.
- [Reef Funding Program](#): The Program provides up to \$1 billion over 10 years for clean energy projects benefiting the health of the Great Barrier Reef. The Reef Funding Program will contribute to the implementation of the [Reef 2050 Plan](#), the overarching framework for protecting and managing the Great Barrier Reef.

The CEFC also works through banks and other financial institutions to offer financial products to encourage businesses to make sustainable purchasing choices for energy efficient equipment, fuel efficient, electric and hybrid vehicles, and to implement small scale behind-the-meter renewable energy projects.

Clean Energy Innovation Fund

The Australian Government established the \$200 million [Clean Energy Innovation Fund](#) in July 2016 to support early stage and emerging clean energy technologies. The Clean Energy Innovation Fund is co-managed by the CEFC and ARENA. The Fund draws on ARENA's experience in the renewable energy sector, and its technical expertise in assessing these projects. This complements the CEFC's financial investment expertise.

Final approval is provided by the CEFC Board, which is responsible for all investment commitments made under the *Clean Energy Finance Corporation Act 2012*.

As at 30 September 2017, \$43 million in CEFC finance for total projects worth \$121 million has been invested in seven projects under the Clean Energy Innovation Fund. Investments include:

- \$2 million to clean-tech company, Wattwatchers to expand production of its award-winning measurement technology that helps better manage energy use and costs. Wattwatchers clamp-on internet device, advanced control analytics and cloud-hosted management interface provide real time data showing where and when energy is being consumed. The multi-channel auditor device can be used to inform customers of energy usage and identify energy waste or poor performance.

- \$5 million to Victoria-based manufacturer SEA Electric to ramp up its conversion of medium-duty trucks and commercial vans to electric vehicles. The technology can be applied to businesses performing express freight, general delivery, and waste collection duties around Australia.
- \$5 million to GreenSync, an innovative Melbourne-based company aiming to bring smart technology solutions to the energy grid of the future, as part of an \$11.5 million Series B capital raising (the post development stage).
- \$10 million to the \$50 million capital raising of Carbon Revolution, a Geelong-based company producing one-piece light-weight carbon fibre car wheels help reduce energy consumption and carbon emissions from lighter vehicles.

Case study: Thinxtra scales up network to support Internet of Things technologies

Australian company Thinxtra is deploying the world-leading Sigfox Low Powered Wide Area Network (LPWAN) technology to provide a low-cost operating framework for Internet of Things Technologies to cut energy use.

While a range of devices already on the market can be connected to existing internet services, Thinxtra's LPWAN technology requires far less power and provides much longer battery life for devices that only require the transmission of small amounts of data and intermittent internet connectivity.

More than 150 local businesses have already partnered with Thinxtra to leverage its network technology to create operational efficiencies in a wide range of industries, such as:

- smart water meter service companies that enable large water users to detect leaks
- smart farming service providers with waterproof data communicators that integrate with software and sensors to provide daily data on soil, weather and other environmental monitoring
- smart logistics solution providers with cold chain monitoring trackers to increase traceability of food and reduce wastage.

The company is on track to have a network covering 95 per cent of the Australian population by the end of 2017 and aims to be the low power wide area network of choice for Internet of Things.

Thinxtra's Internet of Things network provides the lowest device-to-cloud connectivity, at the lowest level of energy consumption and is complementary to Bluetooth, RFID, 2G, 3G, 4G and Wi-Fi technologies. The Thinxtra network is an extension of the global Sigfox network, based on antennae and base station infrastructure that is independent of existing telecommunications networks.

The CEFC has committed up to \$10 million to assist the expansion of Thinxtra, through the Clean Energy Innovation Fund, as part of a \$20 million Series B capital raising.

CSIRO Low Emissions Technology Roadmap

The Australian Government released a [Low Emissions Technology Roadmap](#) in June 2017. The Roadmap was developed by the CSIRO, and highlights opportunities to grow Australia's clean technology sector, fast track emissions reductions and be part of future global supply chains.

The roadmap considered the scope for new technology to reduce greenhouse gas emissions from the energy sector (including electricity generation, heat production, direct combustion, transport, electricity and fuel consumption and fugitive emissions from coal mines, coal seam gas operations and gas pipelines).

It considered the possible mix of energy technologies to make a greater contribution to meeting Australia's 2030 emissions reduction target (and longer term emissions reduction goals) at least cost. Priority was given to technologies where Australia can become a major part of a global supply chain.

The roadmap explored the potential economic opportunities for Australian industry through deployment of relevant technologies or by participating in growing low emission fuel and technology supply chains.

The roadmap considered four options or 'pathways' to decarbonisation of the energy sector, which in 2016 accounted for 79 per cent of Australia's emissions.

The report found:

- Australia is endowed with energy-rich resources and is well positioned to benefit from innovation in low-emission technologies.
- Energy productivity will remain important in reducing energy costs and emission levels throughout the transition.
- While the technology pathways are comparable in terms of cost, they carry different levels of commercial, technical, social, and stakeholder risks.
- Given those risks, a technology neutral approach is recommended to support the lowest-cost solutions to emerge.

Mission Innovation

Australia was a founding member of Mission Innovation—a global initiative to increase public investment in clean energy research and development (R&D) as part of global efforts to accelerate innovation breakthroughs in clean energy technologies. Along with 21 other member countries plus the European Union, the Australian Government has pledged to double public expenditure on clean energy R&D from 2015 levels by 2020.

In joining the global Mission Innovation initiative, Australia pledged to double early stage government clean energy R&D expenditure to at least \$216 million by 2020, equivalent to approximately US\$170 million. The scope of Australia's pledge encompasses the areas of renewable energy, energy storage, fuel cells and smart grids, energy efficiency, nuclear energy, and carbon capture and storage.

Mission Innovation government expenditure is expected to encourage substantial private investment in new technology. For example, through the Breakthrough Energy Coalition, Bill Gates has committed US\$1 billion and garnered support from 27 other billionaires across ten countries to direct capital to clean energy projects in participating countries.

Australia is taking a keen interest in four of the seven Innovation Challenges established under Mission Innovation: in smart grids, carbon capture and storage, converting sunlight, and affordable heating and cooling of buildings. Australia has research expertise in all seven Innovation Challenges, and the Australian Government will be working to support participation in the challenges across the Australian research community.

ARENA will play a key role in delivering Australia's Mission Innovation commitment, both by providing funding for clean energy R&D, and by supporting participation in the Innovation Challenges. The Australian Department of the Environment and Energy will work with the Australian Research Council and the CSIRO to encourage more funding proposals from the clean energy R&D community. These agencies will develop strategic work programs for R&D aimed at enhancing global collaboration and increasing the chances of breakthrough technologies coming to fruition.

For more information on Australia's Mission Innovation pledge see: <http://mission-innovation.net/participating-countries/australia/>.

Carbon Capture and Storage

The Australian Government and private sector are supporting carbon capture and storage (CCS) research, development and demonstration activities, including:

- Chevron's **Gorgon project** (Western Australia), Australia's first commercial-scale CCS project, expected to commence capturing carbon dioxide from its natural gas field in 2018. Each year three to four million tonnes of carbon dioxide will be injected into undersea storage, reducing emissions from the facility by 40 per cent.

- The **CarbonNet Project** (CarbonNet) is investigating the potential for a commercial scale CCS network in the Gippsland region of Victoria. The network could integrate multiple carbon dioxide capture projects in the Latrobe Valley, transporting carbon dioxide via a common-use pipeline and injecting it deep beneath the Gippsland Basin to be securely stored within suitable geological formations. If proved viable, CarbonNet could enable innovative new industries in Gippsland securing jobs, boosting skills and attracting investment while strengthening Victoria's energy security.
- The **Cooperative Research Centre for Greenhouse Gas Technologies Otway research facility** is Australia's first demonstration of the deep geological storage of carbon dioxide. The project provides technical information on the injection, storage and monitoring of carbon. This information will influence national policy and industry while providing assurance to the community. The facility demonstrates that carbon capture and storage is safe, cost-effective and meets the expectations of government and the community.
- The **CCS Research Development and Demonstration Fund** provides funding for carbon capture and storage projects with a particular focus on transport and storage. It supports the Australian Government's commitment to reduce the technical and commercial barriers to the deployment of large-scale CCS projects.
- The Australian Government contributed funding and support for an industry-led **Roadmap for Carbon Capture and Storage for Australia**. The Roadmap was released in February 2017 and highlights CCS is an essential component of Australia's energy mix, to ensure energy security and affordability while meeting future emissions reductions targets at low cost. It is required in the power sector and will also play a vital role in decarbonising industrial processes, such as cement and steel production.
- The **National Geosequestration Laboratory** delivers innovative research solutions to support Australia's carbon storage, energy and resources industries. For example, it is the lead research partner for the South West Hub CCS project in Western Australia.
- The Australian Government has introduced to Parliament proposed changes to the *Clean Energy Finance Corporation Act 2012* to allow the **Clean Energy Finance Corporation** to invest in CCS.

Solar communities

The Solar Communities program provides \$5 million in funding for community groups to install rooftop solar panels, solar hot water and solar-connected battery systems. It will support local responses to climate change and deliver lower electricity costs for community organisations.

Funding for the program is targeted to specific regions and commenced in the first half of 2017.

The [Food Rescue Charities Program](#) provides a further \$1.2 million to support four charities to invest in solar, batteries and energy efficient refrigeration systems. The program directs practical investment to help food rescuers reduce their energy costs by switching to renewable energy, increasing their capacity to rescue and store more food and reducing greenhouse gas emissions by reducing the amount of food ending up in landfill.

Concentrated Solar Thermal

The Australian Government has committed up to \$110 million for an equity investment, if required, to secure the delivery of a solar thermal project in Port Augusta, South Australia. This investment will diversify energy generation and storage technologies and create new employment opportunities.

4.3 POLICIES AND MEASURES AT THE STATE, TERRITORY AND LOCAL LEVELS

4.3.1 Policies and measures of state and territory governments

State and territory governments have built on existing policies since the Sixth National Communication and introduced new policies and targets, continuing to support mitigation efforts.

- Energy efficiency obligation schemes ('white certificate' schemes) are currently operating in the Australian Capital Territory, New South Wales, South Australia and Victoria.
- Unregulated, market-based feed-in tariffs for small-scale renewables are operating in the Australian Capital Territory, New South Wales, Queensland and Tasmania. Regulated feed-in tariffs are operating in regional Queensland, Victoria and Western Australia. In South Australia, there are both regulated and unregulated feed-in tariffs operating depending on the customer group.
- The Australian Capital Territory, South Australia and Victoria have a legislated renewable energy target, while Queensland and Northern Territory have committed to aspirational renewable energy targets.
- Legislated long-term emissions reduction goals have been set in the Australian Capital Territory, Tasmania, South Australia and Victoria. Aspirational long-term emissions reduction goals have been set in New South Wales, Queensland and Tasmania.

Most state and territory governments have developed or are developing climate change policies and measures within the auspices of an overarching climate change strategy. Many are operating in parallel with similar Australian Government climate change policies.

The Australian Capital Territory

In 2010 the Australian Capital Territory (ACT) Government released the [*Climate Change and Greenhouse Gas Reduction Act 2010*](#) (the Act). The Act promotes the development of policies and practices to address climate change, set targets to reduce greenhouse gas emissions, and to provide for monitoring and reporting in relation to these targets. The ACT has committed to the following targets, which have been re-enforced by the ACT's 9th Parliamentary Agreement to the Legislative Assembly:

- a legislated target of 100 per cent renewable energy (electricity) by 2020
- a legislated emissions reduction target of 40 per cent below 1990 levels by 2020
- carbon neutral government operations by 2020
- a legislated emissions reduction target of 80 per cent below 1990 levels by 2050
- a legislated target of net zero¹ greenhouse gas emissions by 2050, at the latest.

The ACT Government released their second [*Climate Change Strategy and Action Plan \(AP2\)*](#) in 2012. AP2 outlines how the ACT will achieve its 2020 targets and provides a framework for achieving long-term targets out to 2050.

Other strategies have been released to support the ACT's commitment to reducing emissions:

- The [*Renewable Energy Industry Development Strategy*](#) will accelerate the development of an export-oriented, renewable energy industry in the ACT.
- The [*ACT Planning Strategy*](#) establishes how the territory will develop into the future to meet the aspirations of the people and the environmental, social and economic challenges of the 21st century.
- The [*ACT Waste Management Strategy 2011-2025*](#) outlines the direction for the management of waste in the ACT to achieve a carbon neutral waste sector.
- [*Transport for Canberra*](#) establishes the framework for Canberra's transport planning to 2030 to achieve mode share targets and to reduce transport emissions.
- The [*Carbon Neutral ACT Government Framework*](#) aims to coordinate a whole of government approach to achieving carbon neutrality in central operations and services, in a cost-effective manner, by 2020.

A number of policies and programs continue to operate or have been introduced since 2012, including the ACT's large-scale solar auction and the Energy Efficiency Improvement Scheme. Both are mechanisms for achieving the ACT Government's greenhouse gas reduction targets.

1. Net zero emissions refers to achieving a balance between emissions from human activities and removing emissions from the atmosphere through 'sinks' such as forests and coastal and marine ecosystems.

New South Wales

In 2016 the New South Wales (NSW) Government released the [NSW Climate Change Policy Framework](#), outlining its long-term objectives to achieve net zero emissions by 2050 and to make NSW more resilient to a changing climate.

A number of policies and programs in NSW targeting energy efficiency and renewable energy have been continuing to operate and have been introduced since 2012.

- In 2017, the NSW Government announced \$112.5 million of funding towards energy efficiency and other programs to help households and small businesses save energy and money as part of a wider energy bill relief package.
- The [NSW Energy Savings Scheme](#), enhanced in 2015 and 2017, could save households and businesses up to \$8.2 billion on their energy bills during the life of the scheme.
- The [NSW Energy Efficiency Action Plan](#) and a range of other programs drive improvements in energy efficiency. This plan has actions to improve energy savings through the NSW Energy Savings Scheme and targeted assistance to help vulnerable households save energy.
- The [NSW Renewable Energy Action Plan](#) and Renewable Energy Advocate attracts investment, grows renewable energy expertise and builds community support for renewable energy.
- The [Government Resource Efficiency Policy](#) reduces energy use and improves energy efficiency in government operations.
- Minimum energy savings targets for all new homes built in the state under its [Building Sustainability Index \(BASIX\)](#) policy were increased in July 2017. These will save over 350,000 households around \$1.1 billion on energy bills from 2017 to 2035.
- The [Waste Less, Recycle More](#) initiative was extended from 1 July 2017 until 2021. The initiative includes grants programs for local government, business, industry and the community.
- The NSW Office of Environment and Heritage, on behalf of Australian, state and territory governments, manages the National Built Environment Rating System. This system measures the environmental performance of Australian buildings, tenancies and homes.

Northern Territory

The Northern Territory Government has committed to adopt a target of 50 per cent renewable energy by 2030. This commitment includes commissioning advice from an independent panel of experts to inform a [Roadmap to Renewables](#) report to provide the Northern Territory Government with advice, options and recommendations on how best to achieve the target. The Northern Territory Government is expected to finalise an implementation plan by mid-2018.

The [Solar Energy Transformation Program](#) aims to transform the delivery of electricity in remote off-grid communities throughout the Northern Territory. The program is integrating solar panels via a control system into existing diesel power stations to create solar/diesel hybrid power stations in remote Aboriginal communities in the Northern Territory.

Queensland

In 2017, the Queensland Government released its [Queensland Climate Change Response](#). This outlines the Government's commitments and actions to transition to a low carbon, clean growth economy and adapt to the impacts of a changing climate. The [Queensland Climate Transition Strategy](#) includes three climate commitments to support Queensland's transition to a low carbon economy:

- a 50 per cent renewable energy target by 2030
- a net zero emissions target by 2050
- an interim emissions reduction target of at least 30 per cent below 2005 levels by 2030.

The [Powering Queensland Plan](#), released in 2017, sets out the Queensland Government's strategy to guide the state through the short-term and long-term challenges facing Australia's energy markets. The \$1.16 billion plan aims to deliver stable energy prices, ensure long-term security of electricity supply, transition to a cleaner energy sector, and create new investment and jobs. The plan confirms the Queensland Government's commitment to a 50 per cent renewable energy target by 2030. Objectives under the Plan include improving large-scale renewable project facilitation, planning and network connections, and establishing a Queensland Energy Security Taskforce to develop an energy security plan and a demand management and energy efficiency strategy for the state.

[Queensland's Electric Vehicle Strategy](#), released in 2017, prepares Queensland for a transition to electric vehicles (EVs). EVs and renewable energy will be crucial in the effort to reduce Queensland's greenhouse gas emissions over the next decade.

The [Queensland Waste Avoidance and Resource Productivity Strategy \(2014–2024\)](#) outlines the opportunities and challenges ahead for Queensland to improve its waste avoidance and recovery performance.

South Australia

Since Australia's Sixth National Communication, the South Australian Government released [South Australia's Climate Change Strategy 2015–2050—Towards a low carbon economy and South Australia's Waste Strategy 2015-2020](#). Both plans introduced new targets for South Australia including:

- net zero emissions by 2050
- achieving \$10 billion in low carbon investment by 2025 ([Low Carbon Investment Plan for South Australia](#))
- generating 50 per cent of electricity from renewable sources by 2025
- improving energy efficiency of government buildings by 30 per cent on 2001 levels by 2020
- Adelaide to be the world's first carbon neutral city
- reducing municipal solid waste to landfill by 70 per cent by 2020
- reducing commercial and industrial waste to landfill by 80 per cent by 2020
- reducing construction and demolition waste to landfill by 90 per cent by 2020.

In 2017, the South Australian Government released '[Our Energy Plan](#)', which seeks to ensure more of the State's power is sourced, generated and controlled in South Australia, while increasing security, boosting competition and placing downward pressure on electricity prices. This plan includes the world's largest Lithium-ion battery, a Renewable Technology Fund and a 150 megawatt solar thermal power plant to meet the State Government's energy needs.

Tasmania

The Tasmanian Government is amending the *Climate Change (State Action) Act 2008* to include the proposal to legislate for a target of net zero emissions for Tasmania by 2050.

In June 2017, the Tasmanian Government released [Climate Action 21: Tasmania's Climate Change Action Plan 2017–2021](#) (Climate Action 21) which sets out the Tasmanian Government's agenda for action on climate change through to 2021.

In August 2017, the Tasmanian Government committed to making Tasmania renewable energy self-sufficient by 2022. This includes a target of an additional 1,000 gigawatt hours of additional renewable energy generation.

The [Tasmanian Energy Strategy – Restoring Tasmania's Energy Advantage](#) sets a framework for investigating the increased use of renewable energy sources such as wind and biofuels. The [Tasmanian Energy Security Taskforce](#) delivered its final report in August 2017 with recommendations for further renewable energy development in Tasmania.

The Tasmanian Government has a range of policies and measures to reduce emissions including:

- the \$20 million Tasmanian Energy Efficiency Loan Scheme which provides interest free finance for the purchase of energy efficient products
- an Electric Vehicle Working Group has been established to develop a coordinated approach to electric vehicle uptake in Tasmania
- the Smarter Fleets Program, which improves vehicle fleet efficiencies.

Victoria

The *Climate Change Act 2017* (the Act) provides Victoria with the legislative foundation to manage climate risks and transition to net zero emissions. The Act sits alongside other Victorian Government climate and energy initiatives including [Victoria's Climate Change Framework](#), [Victoria's Climate Change Adaptation Plan 2017-2020](#) and [Victoria's Renewable Energy Action Plan](#). The Act:

- establishes a long-term emissions reduction target of net zero by 2050 and requires five yearly interim targets to keep Victoria on track to meet this target
- introduces a new set of policy objectives and an updated set of guiding principles to embed climate change in government decision making
- requires the Victorian Government to develop a Climate Change Strategy every five years, setting out how Victoria will meet its targets and adapt to the impacts of climate change (from 2020)
- requires Adaptation Action Plans (from 2021)
- establishes a pledging model to reduce emissions from the Government's own operations and from across the economy (from 2020)
- establishes a system of periodic reporting to provide transparency, accountability and ensure the community remains informed.

A budget of \$25.4 million has been allocated over the next four years to meet commitments under the Act.

The Victorian Government is implementing initiatives in the energy sector to improve energy efficiency and energy productivity:

- The [Renewable Energy Action Plan](#) sets a long-term renewable energy policy agenda and pathway to meet Victoria's renewable energy targets of 25 per cent by 2020 and 40 per cent by 2025. The Victorian Government has allocated \$146 million to deliver the plan.
- The forthcoming [Energy Efficiency and Productivity Strategy](#) builds on Victoria's commitment to improving energy efficiency and productivity as articulated in the 2015 Energy Efficiency and Productivity Statement – Saving Energy, Growing Jobs.
- The [Greener Government Buildings program](#) commenced in 2009 and was reinstated in 2016 with over \$53 million in investment planned. This program will continue saving energy and emissions in existing government buildings and infrastructure.

Western Australia

The Western Australian Government has the following strategies and programs in place to reduce emissions:

- The [Low Emissions Energy Development \(LEED\) Fund](#) provided over \$17 million to innovative technology projects at the commercial demonstration, commercialisation, and local adaptation stages between 2008 and 2016.
- A commitment of \$19.5 million to renewable energy projects in Albany including the deployment of wave energy technology, development of common user infrastructure to facilitate connection of wave energy to the State's electricity grid, and the establishment of a Wave Energy Centre of Excellence.

- A number of trials and pilot programs exploring the feasibility of standalone solar and battery storage power systems and utility-scale battery systems in isolated parts of the electricity grid.
- The [Renewable Energy Buyback scheme](#), a regulated feed-in tariff for eligible residential customers, non-profit organisations, and educational institutions.
- The [Western Australian Waste Strategy: Creating the Right Environment](#) includes landfill diversion targets for improving rates of waste reuse and recycling and reducing the volume of waste disposed of to landfill—the strategy includes a target for reducing municipal solid waste to landfill in the metropolitan region by 65 per cent by 2020.
- The [METRONET](#) project will expand Perth's rail connectivity of Perth's suburbs and support transport efficiency across the metropolitan area.

4.3.2 Policies and measures of local governments

Local governments in Australia play a valuable role in helping Australia meet its emissions reduction targets.

The Australian Local Governments Association represents 562 councils across Australia² and engages extensively on climate change related matters, including representation at the Meeting of Environment Ministers.

Through the [Cities Power Partnership](#), local councils will undertake to improve transport systems and expand renewable energy and energy efficiency, and will work together to share their knowledge and achievements.

Several local councils in Australia have pledged to achieve zero emissions or 100 per cent renewable energy between 2020 and 2050.³

4.4 POLICIES AND MEASURES NO LONGER IN PLACE

The Sixth National Communication detailed policies and measures under the Clean Energy Future Package. In July 2014 the *Clean Energy Legislation (Carbon Tax Repeal) Bill 2014* took effect. The Australian Government subsequently introduced several critical new initiatives including the Emissions Reduction Fund, new legislation to phase-down hydrofluorocarbons, the National Energy Productivity Plan and the Safeguard Mechanism. The Government also merged the energy and environment portfolios to better integrate climate and energy policies. A number of measures previously announced did not proceed as these were replaced by measures with similar objectives or were unlikely to deliver value for money.

Policies and measures no longer in place by June 2017 include:

- Biodiversity Fund
- Carbon Farming Futures
- Carbon Tax
- Charities Maritime and Aviation Support Program
- Clean Technology Program
- Coal Sector Assistance Package
- Community Energy Efficiency Program
- Destruction Incentives Program
- Energy Efficiency Information Grants Program
- Energy Efficiency Opportunities Program

2. <http://alga.asn.au/site/misc/alga/downloads/publications/ALGA%20Election%20Document%202016.pdf?Menu=50,587>

3. <http://bze.org.au/zero-carbon-communities/>

- Energy Security Fund Smart Grid, Smart City
- Heating ventilation and air conditioning high efficiency systems strategy
- Home Energy Saver Scheme
- Indigenous Carbon Farming Fund
- The Industrial Energy Efficiency Data Analysis Project
- Jobs and Competitiveness Program
- Local Government Energy Efficiency Program
- Low Income Energy Efficiency Program
- Regional Natural Resource Management Planning for Climate Change Fund
- Remote Indigenous Energy Program
- Steel Transformation Plan

Table 4.1: Policies and measures aimed at limiting and reducing greenhouse gas emissions

(Note: this list is not exhaustive)

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Emissions Reduction Fund*	Transport, agriculture, LULUCF, waste, energy efficiency, mining oil & gas, industrial facilities	CO ₂ , CH ₄ , N ₂ O	To help reduce Australia's emissions through the generation of carbon credits from projects which avoid greenhouse gas emissions or sequester carbon.	Government Contracts	Implemented	The ERF purchases low cost abatement in the form of ACCU's generated by eligible activities under a method which has met offset integrity standards.	Initiated 2011. Revised 24 Nov 2014	Carbon Credits (Carbon Farming Initiative) Act 2011, administered by the Clean Energy Regulator	21,825 ^a
Safeguard Mechanism*	Industrial, mining, oil & gas, transport, waste, energy	CO ₂ , CH ₄ , N ₂ O	To ensure that emissions reductions purchased by the Australian Government are not offset by significant increases in emissions above business-as-usual levels elsewhere in the economy.	Regulatory	Implemented	The Safeguard Mechanism places emissions limits (baselines) on facilities which emit > 100,000 t CO ₂ -e per year. Facilities covered by the Safeguard Mechanism are required to reduce emissions or purchase carbon credits to ensure net emissions remain below the baseline.	1 July 2016	National Greenhouse and Energy Reporting Act 2007, and National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015, administered by the Clean Energy Regulator	Not estimated. The mitigation impact would be calculated as the difference between emissions above the baseline and the safeguard baseline.
Large-scale Renewable Energy Target (RET)*	Energy	CO ₂ , CH ₄ , N ₂ O	To reduce emissions of greenhouse gases in the electricity sector by encouraging the additional generation of electricity from renewable sources.	Regulatory	Implemented	The Large-scale RET of 33,000 GWh by 2020 encourages investment in large-scale renewable energy projects.	1 April 2001	Renewable Energy (Electricity) Act 2000, administered by the Clean Energy Regulator	19,838

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ e)
Small-scale Renewable Energy Scheme (SRES)	Energy, energy efficiency	CO ₂ , CH ₄ , N ₂ O	To reduce emissions of greenhouse gases in the electricity sector by encouraging the additional generation of electricity from renewable sources.	Regulatory	Implemented	The SRES helps home-owners and small businesses to install eligible small-scale renewable energy systems and solar hot water systems.	1 April 2001	Renewable Energy (Electricity) Act 2000, administered by the Clean Energy Regulator	Not estimated. Solar PV generation in Australia is projected to be around 10,000 GWh in 2020. This can be attributed to the SRES as well as other various state/territory policies including state feed-in tariffs, the individual mitigation impact of which has not been separately quantified.
National Energy Productivity Plan (NEPP)*	Buildings, government operations, renewable energy, gas, National Electricity Market, transport, SMEs, Industrial.	CO ₂ , CH ₄ , N ₂ O	To deliver the Commonwealth's commitment to improve Australia's energy productivity by 40% between 2015 and 2030.	Fiscal, regulatory, voluntary, information and research instruments.	1) Commercial Buildings Disclosure program expansion – implemented. (2) Introduction of a Clean Energy Innovation Fund and its commitment to expand the role of ARENA – Implemented. 3) New prioritisation plan to accelerate the impact of the successful Equipment Energy Efficiency program, with new proposed standards released on air conditioners and refrigerated cabinets – Implemented.	The NEPP covers 34 economy-wide measures across most sectors supporting smarter energy choices and better energy services.	2015	CEFC, ARENA, Department of the Environment and Energy, Department of Infrastructure and Regional Development, COAG Energy Council, all Australian states and territories	Existing Commercial Building Disclosure: 381; Existing E3 program: 6,227 Note: the NEPP was not included in the 2016 emissions projections, as design of the full package of NEPP measures had not been finalised.

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Ministerial Forum on Vehicle Emissions	Light vehicles	CO ₂	To improve the fuel efficiency of new light vehicles sold in Australia	Regulatory	Planned	The policy would set a fleet-wide fuel efficiency target to reduce emissions emitted by light vehicles.	Subject to government decision and legislation	Department of Infrastructure and Regional Development	Not estimated, as final design and implementation is subject to government decision.
Hydrofluorocarbon (HFC) management	Industrial - Refrigeration and air conditioning	HFC	To reduce HFC imports (and thus emissions) to 15% of baseline	Legislation	Adopted	The policy will reduce HFC imports by 85% by 2036 from a baseline of 8000 kt CO ₂ -e	2018	Department of the Environment and Energy	Zero, the impact of this measure is estimated to be after 2020. This measure was not included in the 2016 projections as it had not yet been legislated.
HFC management	Industrial - refrigeration and air conditioning	SGGs including HFCs	To reduce leakage of SGGs and increase energy efficiency	Education	Planned	The policy is intended to change behaviour by providing information about benefits of leak testing and servicing of installed equipment.	2018	Department of the Environment and Energy	Not estimated as final design and implementation is subject to government decision.
Australian Renewable Energy Agency (ARENA)	Energy, including energy-related transport and industrial process emissions.	GHGs	To improve the competitiveness of renewable energy technologies, and increase the supply of renewable energy in Australia.	Research funding; information.	Implemented	ARENA is a statutory authority providing research, development, demonstration and deployment grant funding to improve the affordability and increase the supply of renewable energy in Australia.	2012	Department of the Environment and Energy	ARENA's activities are an enabler for greenhouse gas emissions reduction. Improving the competitiveness of renewable energy provides the option to scale up renewable energy generation at lower cost, bringing down the cost of emissions reductions.

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Clean Energy Finance Corporation (CEFC)	Energy sector primarily, and through energy efficiency, support across the economy, including built environment, transport, manufacturing and agribusiness	GHGs	To reduce emissions from energy and industrial processes, and include investments in solar energy and energy storage.	Economic	Implemented	CEFC is a statutory authority that uses debt and equity funding to promote investment in clean energy technologies, namely renewable energy technologies, energy efficiency technologies and low emissions technologies and their supply chains	2013	Department of the Environment and Energy; Clean Energy Finance Corporation	The CEFC's current commitments will contribute funding to projects, that once fully constructed and operational, are estimated to achieve annual abatement of 9 million tonnes CO ₂ -e in 2020. Note the CEFC does not claim that this abatement occurs independent of complementary policy such as the RET.

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
- g This does not take into account results from the sixth ERF Auction which were not available at the time of finalising this estimate.

Table 4.2: Available methods in operation under the Emissions Reduction Fund

Sector	No.	Method
Agriculture	1	Beef cattle herd management Projects reduce methane emissions from beef cattle. Improved breeding and feeding practices lower the average age of the herd and produce higher weight gain relative to age.
	2	Reducing greenhouse gas emissions in beef cattle through feeding nitrate containing supplements Projects reduce methane emissions from beef cattle by providing a nitrate supplement to cattle. Urea is often used as a feed supplement to increase the amount of protein in the diet of cattle. When some or all of the urea is replaced by nitrate supplements, the cattle produce less methane emissions as they digest their food.
	3	Reducing greenhouse gas emissions in milking cows through feeding dietary additives Projects reduce emissions from dairy cows by adding oil supplements to cattle feed. Increasing the fat content of a milking cow's diet reduces the emissions that result from the digestion process.
	4	Destruction of methane generated from dairy manure in covered anaerobic ponds Projects reduce emissions from dairy manure by covering effluent ponds and either using the captured methane to generate electricity or burning it off using a flare.
	5	Destruction of methane from piggeries using engineered biodigesters Projects reduce emissions from piggery manure by capturing and combusting methane in engineered biodigesters. The methane can be used to generate electricity or burnt off using a flare. Engineered biodigesters are specifically designed for this purpose.
	6	Destruction of methane generated from manure in piggeries Projects reduce emissions from piggery manure by covering effluent lagoons and either using the captured biogas (methane) to generate electricity or burning it off using a flare.
	7	Fertiliser use efficiency in irrigated cotton Projects reduce emissions by improving the efficiency of synthetic fertiliser use in irrigated cotton. This involves undertaking activities that produce a greater yield of cotton per tonne of fertiliser used.
	8	Savanna fire management Projects reduce emissions from savanna fires in Northern Australia by undertaking early dry season burns which reduce the incidence and extent of larger, higher intensity fires in the late dry season.
Electricity	9	Aggregated small energy users Projects reduce the energy use of large groups of households or small businesses by rolling out energy saving technologies (e.g. low energy lightbulbs and appliances) and implementing behaviour change programs.
	10	Commercial and public lighting Projects reduce energy use by replacing existing commercial, industrial and public lighting (including street lighting) with high efficiency lighting and/or lighting controls.
	11	Commercial building energy efficiency Projects reduce energy used by offices, shopping centres or hotels by replacing heating and air-conditioning systems with more efficient models, installing energy efficient LED lighting, and upgrading glazing and insulation.
	12	High efficiency commercial appliances Projects reduce energy use by installing high efficiency air conditioners, close control air conditioners, liquid chilling packages or refrigerated display cabinets in commercial or industrial buildings.
	13	Industrial electricity and fuel efficiency Projects improve the energy efficiency of commercial or industrial equipment by upgrading equipment such as industrial boilers and pumping systems and converting equipment to operate on lower emissions fuel (e.g., switching from diesel to gas). The method is best suited to large projects as it requires statistical approaches to calculate emissions reductions.
	14	Refrigeration and ventilation fans Projects reduce energy use by installing highly efficient fans, for example in refrigerated display cabinets, freezer cabinets, cold storage warehouses and ventilation systems in commercial or industrial buildings.
Stationary Energy	15	Facilities Projects reduce emissions by improving the level of emissions per unit of output at a facility (also referred to as emissions intensity). This method is designed for use by facilities that emit more than 25,000 tonnes of carbon dioxide equivalent per annum and report under the National Greenhouse and Energy Reporting scheme.

Sector	No.	Method
Fugitives	16	<p>Coal mine waste gas</p> <p>Projects reduce fugitive emissions of methane from underground coal mines by combustion or in a flameless oxidation device. When methane is combusted it produces energy and carbon dioxide exhaust gas. Emissions are reduced because of the high global warming potential of methane.</p> <p>When coal mine waste gas is oxidised in an electricity production device, the project has the additional abatement effect of displacing electricity produced by other generators on the electricity network. Projects may be credited both for methane destruction and for electricity displacement.</p>
	17	<p>Oil and gas fugitives</p> <p>Projects reduce fugitive emissions from oil and gas facilities, and pipelines through the installation of gas capture equipment. The equipment re-routes fugitive emissions of methane to a new or existing flare device for combustion. When methane is combusted it produces energy and carbon dioxide exhaust gas. Emissions are reduced because of the high global warming potential of methane.</p>
Transport	18	<p>Aviation</p> <p>Projects reduce fuel-related emissions from airlines through activities such as upgrading existing planes, improving operational practices and switching to biofuels.</p>
	19	<p>Land and sea transport</p> <p>Projects reduce fuel-related emissions from road, rail and sea transport through activities such as replacing or modifying existing vehicles, changing fuel sources, or improving operational practices.</p>
Vegetation Management	20	<p>Avoided deforestation</p> <p>Projects avoid emissions by not clearing an area of native forest where a permit to clear was granted prior to July 2010. Projects also store carbon (sequestration) in the trees as they grow. All projects under this method are based in western New South Wales.</p>
	21	<p>Avoided clearing of native regrowth</p> <p>Projects avoid emissions by not clearing existing native forests in areas that have a history of land clearing. Projects also store carbon in the trees as they grow.</p>
	22	<p>Human-induced regeneration of a permanent even-aged native forest 1.1</p> <p>Projects store carbon by assisting regeneration of native forest on land where forest cover has been suppressed for at least ten years. Assisted regeneration can include cessation of tree clearing, controlling feral animals and/or weed species, and managing livestock grazing. Projects under this method are concentrated in western New South Wales and south-west Queensland.</p>
	23	<p>Native forest from managed regrowth</p> <p>Projects store carbon by regenerating native forest on land that has been cleared for agricultural use. Regeneration occurs by ceasing clearing and stopping any other activities that have been suppressing or destroying regeneration.</p>
	24	<p>Reforestation and afforestation</p> <p>Projects store carbon (sequestration) by permanently planting a new forest (afforestation) or re-establishing a depleted forest (reforestation) on land previously used for grazing or cropping.</p> <p>This method differs from environmental planting methods in two ways: carbon is estimated through tree measurement rather than modelling; and any species may be planted (other than declared weeds).</p>
	25	<p>Reforestation by environmental or Mallee plantings</p> <p>Projects store carbon (sequestration) by permanently planting native species to achieve forest cover. Differs from afforestation/reforestation in that carbon is estimated through modelling (FullCAM) rather than measurement, and only native species may be planted.</p>
	26	<p>Measurement based methods for new farm forestry plantations</p> <p>Projects store carbon (sequestration) through establishing small scale harvestable forests on land that has previously been used for grazing or cropping.</p>
	27	<p>Designated Verified Carbon Standard projects</p> <p>These projects protect native forests on private land by ceasing harvesting of wood products. Projects store carbon (sequestration) through ceasing harvesting of native forest on private land. This method only applies to offsets projects that were previously validated under the international Verified Carbon Standard.</p>
	28	<p>Sequestering carbon in soils in grazing systems</p> <p>Projects store carbon (sequestration) in the soil through changed land management in grazing systems. This method uses direct measurement (sampling) of changes in soil carbon due to activities that include converting cropland to permanent pasture, rejuvenating pastures, or changing grazing patterns.</p>

Sector	No.	Method
Vegetation Management	29	<p>Estimating sequestration of carbon in soil using default values</p> <p>Projects store carbon in the soil through changed land management. This method uses default values of increased soil carbon derived using FullCAM modelling. Abatement by increasing inputs of carbon to the soil or reducing the loss of soil carbon is achieved by permanently converting land from annual cropping to pasture, retaining crop residue that was previously removed through burning or baling in field or increasing biomass yields through inputs such as fertiliser, lime and water.</p>
	30	<p>Plantation Forestry</p> <p>The plantation forestry method applies to projects that sequester carbon in plantation forests established for commercial harvesting of wood products. Projects may establish new plantation forests, convert short-rotation plantations to long-rotations, or maintain existing plantations established under another method.</p>
Waste and Wastewater	31	<p>Alternative waste treatment</p> <p>Projects avoid the emissions that would occur in a landfill. Alternative waste treatment is a way of processing mixed waste to remove organic material. The organic material is then processed through composting or other low emissions waste treatment options.</p>
	32	<p>Landfill gas</p> <p>Projects reduce emissions by capturing and combusting methane generated in a landfill. Methane may be combusted in a device such as a flare, boiler or electricity generator. Methane has a global warming potential 25 times higher than carbon dioxide; when combusted it produces energy and carbon dioxide exhaust gas. Overall emissions are reduced because of the high global warming potential of methane.</p>
	33	<p>Source separated organic waste</p> <p>Projects avoid emissions that would occur in a landfill by sorting organic waste at the source and placing it in a separate bin; such as a bin specifically for food waste. The separated organic waste is then processed through composting or other low emissions waste treatment options.</p>
	34	<p>Wastewater treatment</p> <p>Projects reduce the amount of methane released into the atmosphere by changing the way domestic, commercial or industrial wastewater is treated. Activities could include covering an open lagoon to capture (then combust) gas, or building an engineered biodigester to capture and combust methane from wastewater. This method could apply to meat, poultry and paper industries or treatment of domestic wastewater (sewerage).</p>

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5. PROJECTIONS

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Key developments

Current emissions projections show Australia continues to make progress in reducing emissions.

As outlined in Australia's emissions projections 2017, Australia is expected to surpass the emissions reductions required to meet its **2020 target (5 per cent below 2000 levels)** by 166 Mt CO₂-e. If Australia's carryover of 128 Mt CO₂-e from the first commitment period of the Kyoto Protocol is included, the overachievement is 294 Mt CO₂-e.

It is estimated to meet **Australia's 2030 target (26-28 per cent below 2005 levels)**, 868-934 Mt CO₂-e of cumulative emissions reductions are needed between 2021 and 2030.

The estimates do not yet take account of a number of policies including the National Energy Guarantee or the Australian Government's consideration of vehicle efficiency standards.

This chapter presents Australia's greenhouse gas emissions projections. The estimates of greenhouse gas emissions from 1990 to 2015 in this chapter are consistent with Australia's 2015 National Inventory Report (DoEE 2017a). Projections of greenhouse gas emissions from 2016 to 2030 are consistent with Australia's Emissions Projections 2017 (DoEE 2017).

The following sections outline Australia's approach to emissions projections, projection results and sectoral trends.

5.1 AUSTRALIA'S APPROACH TO EMISSIONS PROJECTIONS

Australia's emissions projections are prepared by gas and by sector. Emissions by gas are expressed in terms of carbon dioxide equivalent (CO₂-e) using the 100 year global warming potentials contained in the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report. Sectors reported are: *energy (subdivided into electricity, direct combustion¹, transport, and fugitive emissions); industrial processes and product use; agriculture; waste; and land use, land use change and forestry.*

The emissions projections are estimated on a United Nations Framework Convention on Climate Change (UNFCCC) accounting basis consistent with Australia's accounting for the 2030 targets. Reporting years for all sectors are reported for financial years as key data sources are published on this basis. For instance, '2030' refers to financial year 2029–30.

The projections are prepared on the basis of current implemented and adopted policies and measures as of December 2017. This includes taking account of the Australian Government's Large-scale Renewable Energy Target of 33,000 GWh by 2020, abatement from the Emissions Reductions Fund, implemented initiatives under the National Energy Productivity Plan, the ARENA, the CEFC and the legislated phase-down of hydrofluorocarbons (HFCs).

The projections do not take account of policies and initiatives undergoing development or policies announced since December 2017. These include:

- the National Energy Guarantee
- measures to improve the fuel efficiency of Australia's vehicle fleet being progressed by the Australian Government's Ministerial Forum on Vehicle Emissions
- proposed state government renewable energy targets
- the work of the COAG Energy Council.

1. Direct combustion sector is defined as stationary energy, excluding electricity.

5.2 SUMMARY OF AUSTRALIA'S EMISSIONS PROJECTIONS

Australia assesses progress against its 2020 target, of five per cent below 2000 levels, using an emissions budget approach. A trajectory to achieve the emissions budget is calculated by taking a linear decrease from 2010 to 2020, beginning from the Kyoto Protocol first commitment period target level and finishing at five per cent below 2000 level emissions in 2020. Australia's progress is assessed as the difference in cumulative emissions between projected emissions and the target trajectory over the second commitment period of the Kyoto Protocol, 2013 to 2020. For further information refer to chapters 3 and 4 of the Biennial Report Annex.

Australia's Emissions Projections 2017 reported Australia is on track to over-achieve its 2020 target by 166 Mt CO₂-e without carryover, or 294 Mt CO₂-e if carryover is included. Current estimates show that Australia is expected to over-achieve on its 2020 target without the use of units from market-based mechanisms, that is, the use of units is supplemental to domestic action. While, Australia reserves its right to use units from market-based mechanisms, Australia is focused on domestic action to meet its target. Further details of possible contributions from market based mechanisms are contained in the Biennial Report Annex, CTF tables 2(e), 2(e)II and 2(f).

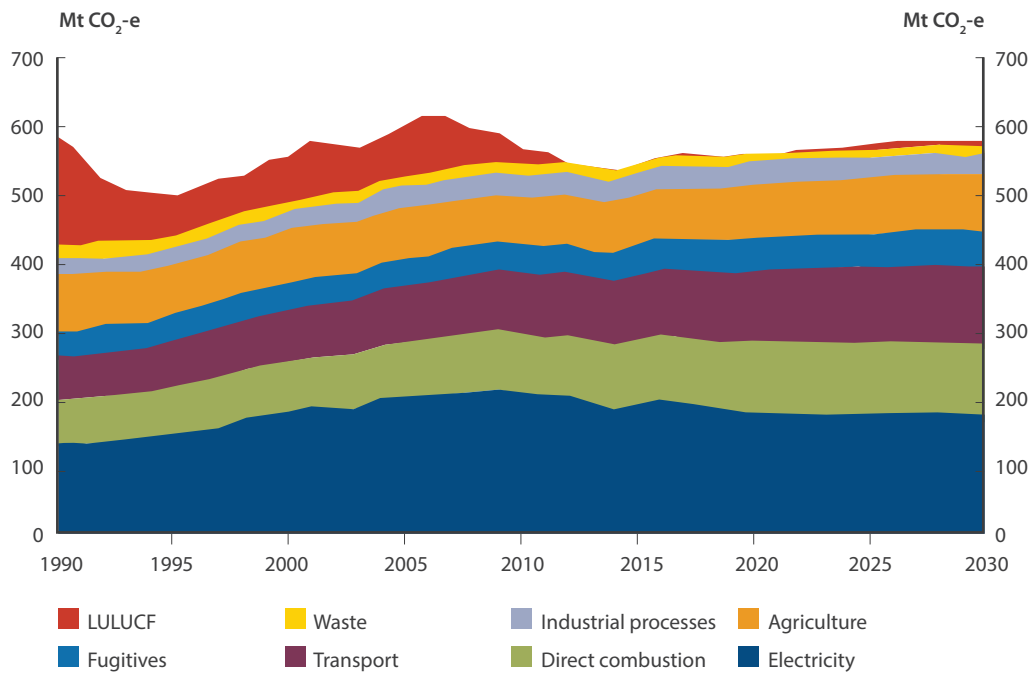
Australia's emissions are projected to grow by 25 Mt CO₂-e between 2015 and 2020. This is primarily driven by the development of liquefied natural gas (LNG) facilities, over the period to 2020. Increased emissions from LNG are largely offset by falling emissions in the electricity sector as a result of flat electricity demand, a decline in the emissions intensity of generation due to the Renewable Energy Target (RET) and the announced closures of coal power stations. Emissions in 2020 are projected to be 551 Mt CO₂-e.

Australia assesses progress against its 2030 target, of 26 to 28 per cent below 2005 levels, using an emissions budget approach. Australia currently considers its 2030 emissions budget as a ten year commitment from 2021 to 2030.

Australia's Emissions Projections 2017 reported Australia would require emission reductions between 868 Mt CO₂-e (26 per cent reduction) and 934 Mt CO₂-e (28 per cent reduction) over the period 2021 to 2030 to meet Australia's 2030 target.

Australia's emissions are projected to grow by 19 Mt CO₂-e between 2020 and 2030. This growth is largely in the transport sector, led by increased heavy vehicles activity for freight, and the agriculture sector, driven by increased stocking numbers. Emissions in other sectors are projected to stabilise or grow slowly after 2020. Electricity emissions are expected to be flat as demand growth is offset by the effect of policies and initiatives under the National Energy Productivity Plan. Long-term emissions from industrial processes and product use are expected to be lower following the legislated phase-down of HFCs from 2018.

Figure 5.1: Domestic emissions by sector, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

Table 5.1: Summary of emissions projections by sector and gas

Sector	Historical – GHG emissions and removals (Mt CO ₂ -e)						Projected – GHG emission projections (Mt CO ₂ -e)		
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Electricity	130	143	175	197	205	189	175	173	173
Direct combustion	66	71	75	82	84	91	105	103	103
Transport	61	68	74	82	89	95	101	108	112
Fugitives	37	37	40	39	42	45	51	51	53
Industrial process and product use	26	25	27	32	35	32	34	34	32
Agriculture	80	73	79	76	66	70	75	79	82
Waste	20	19	15	14	15	11	10	10	10
Land use, land use change and forestry	160	55	66	76	25	-8	-1	6	4
Gas									
CO ₂ emissions including net CO ₂ from LULUCF	418	345	399	446	415	380	396	405	406
CO ₂ emissions excluding net CO ₂ from LULUCF	278	305	350	386	407	402	411	414	416
CH ₄ emissions including net CH ₄ from LULUCF	133	121	124	118	112	110	118	122	127
CH ₄ emissions excluding net CH ₄ from LULUCF	120	111	113	108	102	101	109	113	118
N ₂ O emissions including net N ₂ O from LULUCF	22	22	25	26	27	24	24	25	26
N ₂ O emissions excluding net N ₂ O from LULUCF	15	16	19	21	19	18	19	20	21

	Historical – GHG emissions and removals (Mt CO ₂ -e)						Projected – GHG emission projections (Mt CO ₂ -e)		
	1990	1995	2000	2005	2010	2015	2020	2025	2030
HFCs	1	1	2	5	8	11	12	12	12
PFCs	5	2	1	2	0	0	0	0	0
SF ₆	0	0	0	0	0	0	0	0	0
NF ₃	-	-	-	-	-	-	-	-	-
Total with LULUCF	579	491	551	597	562	526	551	564	570
Total without LULUCF	420	435	485	521	537	533	552	559	566

Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.3 TOTAL EFFECT OF POLICIES AND MEASURES

Australia has estimated the total effect of policy and measures using a bottom-up approach in line with the Reporting Guidelines on National Communications. Emissions and removals from 1990 to 2015 are based on National Greenhouse Gas Inventory estimates, while values for 2016 and later are based on projections. Priority has been given to policies and measures, or combinations of policies and measures, with the most impact on greenhouse gas emissions and removals, and are able to have their abatement reported accurately.

Australia's emissions projections ('with measures') incorporates the impact of all of Australia's implemented and adopted policies and measures up to December 2017. This includes additional policies Australia has announced since the Sixth National Communication to help meet its energy and emissions targets. Details of these policies and measures are presented in Chapter 4.

The table below shows the quantified effect of Australia's implemented and adopted policies and measures. These policies and measures are delivering abatement, modifying long-term trends in anthropogenic greenhouse gas emissions.

Table 5.2: Total abatement estimate as at December 2017, Mt CO₂-e

	2015	2020	2025	2030
National emissions ('with measures')	526	551	564	570
Abatement from policies and measures (Mt CO ₂ -e)	12	48	53	54
Abatement by gas (Mt CO ₂ -e)				
CO ₂	12	41	44	44
CH ₄	0	8	7	5
N ₂ O	0	0	0	0
HFCs	0	0	2	5
PFCs	0	0	0	0
SF ₆	0	0	0	0

Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

The abatement estimate includes the following implemented and adopted policies and measures:

- the Emissions Reduction Fund (including the safeguard mechanism), initiated in 2011 and revised in 2014
- various Commonwealth and state government energy efficiency programs both regulatory and voluntary
- the Renewable Energy Target, implemented in 2001
- ozone and hydrofluorocarbon measures, to be implemented in 2018.

5.3.1 Assumptions and uncertainties

Australia's policies and measures have been established for many years and have often undertaken some form of evolution since their inception. This process has created a mix of policies shared across industries and government jurisdictions.

Interlinkages between measures make it difficult to assess abatement for some individual policies and measures and determine how greenhouse gas emissions would have evolved in the absence of any policies or measures. It can also be difficult to disentangle the impact of particular policies from a range of prevailing economic factors. For example, there is a degree of complexity in attempting to estimate the mitigation effect of the Australian Government's Small-scale Renewable Energy Scheme (SRES). The scheme creates a financial incentive for the installation of small scale renewable energy systems, like solar photovoltaic systems. Over the period this scheme has been in place, state and territory feed-in tariffs, other renewable energy programs, increases in electricity prices and the falling costs of solar PV, have seen growth in solar PV installation beyond what could be attributed to the SRES alone.

It is difficult to model 'without policy' scenarios to determine the impact of measures, as the assumptions used may not have a high degree of confidence or consensus. Consequently, a 'without measures' scenario has not been calculated for Australia.

5.3.2 Kaya identity analysis

A Kaya identity analysis was conducted in an effort to show trends in important drivers of Australia's emissions and set up a method to calculate the total effect of policies and measures in future National Communications. The Kaya equation, shown below, expresses CO₂ emissions as the product of four factors: population; GDP per capita; energy intensity of the economy and the emissions intensity of energy.

$$CO_2 = P \times \frac{GDP}{P} \times \frac{Ec}{GDP} \times \frac{CO_2}{Ec}$$

Where:

CO₂ is Australia's CO₂ emissions

P is Australia's population

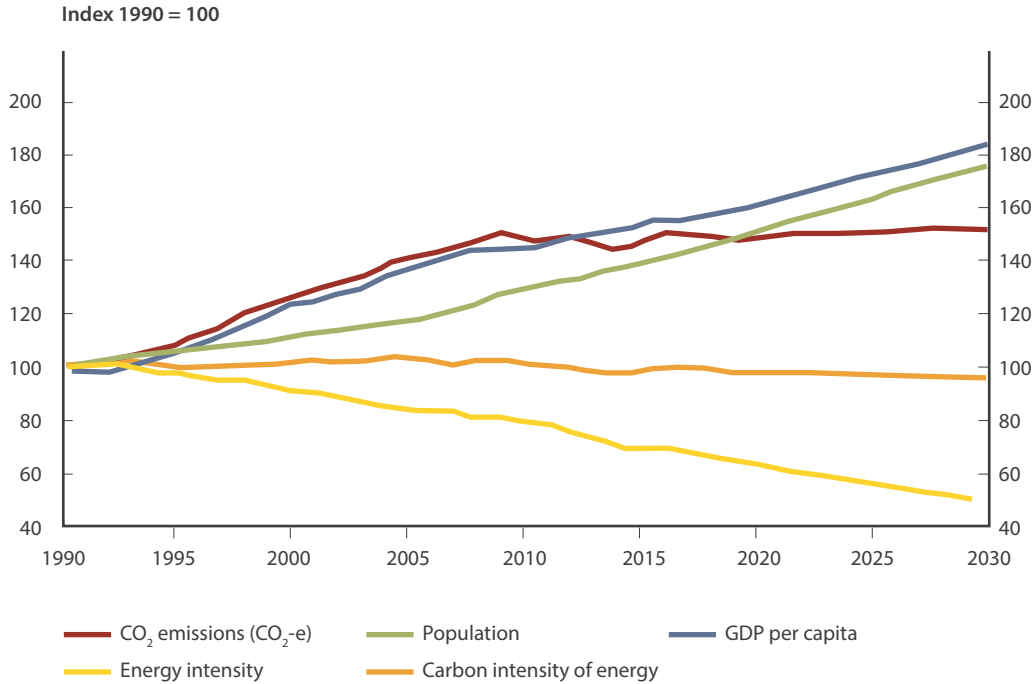
GDP is Australia's gross domestic product

Ec is Australia's energy consumption

Trends in these factors provide insight into how Australia's national circumstances have impacted on CO₂ emissions since 1990. It should be noted each factor is not necessarily independent of each other and movement in a single factor will not automatically result in a corresponding change in CO₂ emissions.

The Kaya identity analysis (Figure 5.2) demonstrates the projected growth in Australia’s population and GDP out to 2030 is strong, especially compared to other Organisation for Economic Co-operation and Development (OECD) countries. This includes expected growth in the services sector and the share of GDP Australia derives from emissions intensive mining and agricultural industries. Despite these challenges, both energy intensity and emissions intensity of energy reduce in Australia over the time series.

Figure 5.2: Growth in CO₂ energy sector emissions and underlying drivers, 1990-2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

Australia will consider using this analysis as a reference base for future National Communications. Future Kaya identity analyses could be compared to this analysis to monitor improvements in the projected energy intensity of the economy and emissions intensity of energy. The differences presented by these factors between the new analysis and the reference analysis provide Australia with a possible method to calculate and assign appropriate changes to additional policies and measures.

5.4 EMISSIONS PROJECTION BY SECTOR

This section sets out the emissions projection results, key trends and drivers for each reported sector. Further information on sectoral results can be found in Australia’s Emissions Projections 2017.

5.4.1 Projections of the energy sector (electricity)

Electricity emissions are the result of fuel combustion for the production of electricity, both on-grid and off-grid. *Electricity* represents the largest share of emissions in the National Greenhouse Gas Inventory.

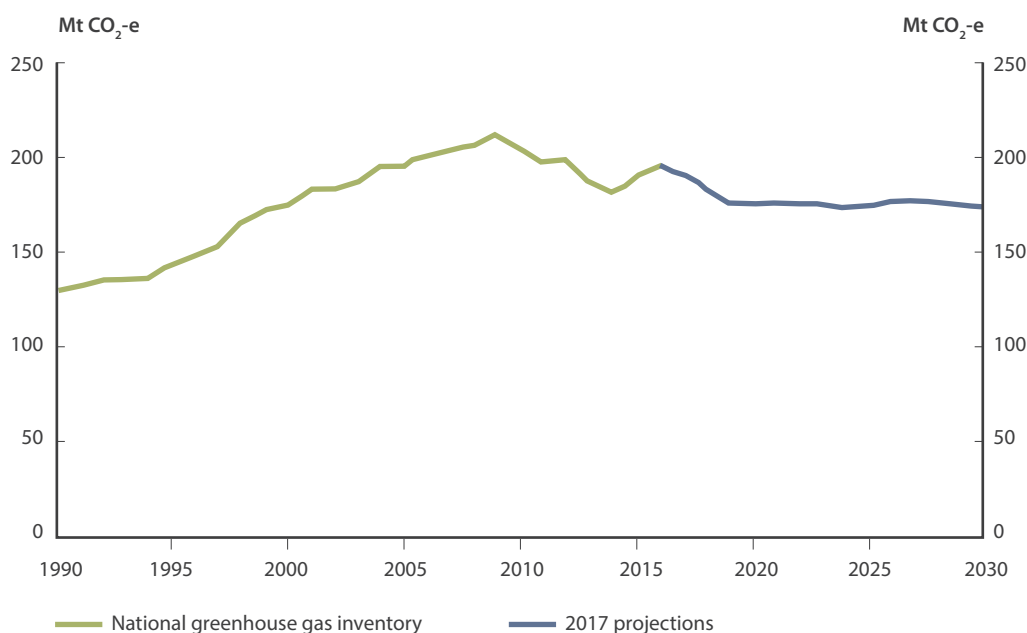
Emissions to 2020

Electricity emissions are projected to be 175 Mt CO₂-e in 2020, a decrease of 8 per cent below 2017 levels. This is in part due to the announced closures of Hazelwood power station and units at the Muja power station. Increases in renewable generation to meet the RET also drive emissions down to 2020.

Emissions to 2030

Emissions are projected to be 173 Mt CO₂-e in 2030, a decrease of 1 per cent below 2020 levels. While electricity demand is expected to grow by 1.2 per cent a year, much of the increase in demand is met by increased gas and renewable generation, particularly strong growth in solar generation. Liddell power station is assumed to close in the projections in 2022 as announced.

Figure 5.3: Electricity emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.4.1.1 Methodology and assumptions

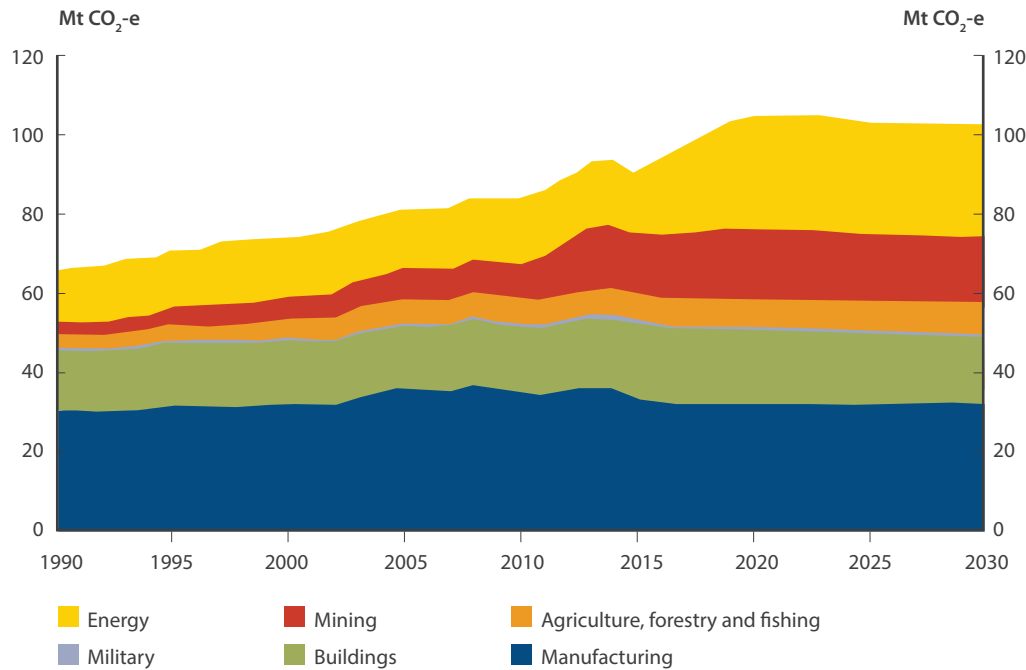
The *electricity* emissions projections have been prepared based on modelling and research commissioned by the Department of the Environment and Energy and undertaken by Jacobs Australia in 2017 (Jacobs Australia forthcoming). Jacobs Australia used electricity market simulation models as well as other sub-models to prepare the electricity emissions projections. The modelling simulates the electricity market across Australia taking into account the bidding behaviours of energy market incumbents, potential new entrants as well as technology costs and assumptions around the uptake of embedded generation.

The Department of the Environment and Energy has sourced data from the Australia Energy Market Operator (AEMO 2017; AEMO 2017a) and the National Greenhouse and Energy Reporting scheme to inform electricity demand projections for each of the major electricity grids and large off-grid users. The electricity demand projections take into account reduced demand from various energy efficiency programs.

5.4.2 Projections of the energy sector (direct combustion)

Emissions from *direct combustion* are from the burning of fuels for energy used directly, in the form of heat, steam or pressure (excluding for electricity generation and transport). Emissions from *direct combustion* are estimated for six subsectors: energy, mining, manufacturing, buildings, primary industries and military (Figure 5.4). Fuel combusted in mobile equipment in mining, manufacturing, construction, agriculture, forestry and fishing is also included in *direct combustion*.

Figure 5.4: Direct combustion emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

Emissions to 2020

Direct combustion emissions are projected to be 105 Mt CO₂-e in 2020, an increase of 8 per cent above 2017 levels. The largest growing sector in the short term is natural gas combusted at LNG plants, where production is projected to increase by nearly 200 per cent from 2015 to 2020. The mining subsector also grows due to an expected increase in coal, iron ore, gold and copper production to meet a projected increase in export demand for these commodities.

Emissions to 2030

Direct combustion emissions are projected to be 103 Mt CO₂-e in 2030, a decrease of 2 per cent below 2020 levels. Manufacturing is projected to continue to be the biggest contributor to sector emissions, however emissions are not projected to grow to 2030. Emissions from buildings are expected to fall over the projections period due to improvements in energy efficiency of new buildings and appliances as well as fuel switching from gas to electric appliances. Emissions from the agriculture, forestry and fishing sector are projected to grow steadily over the projections period due to a projected increase in diesel use in the agriculture sector.

5.4.3.1 Methodology and assumptions

The *direct combustion* emission projections are prepared using a bottom-up modelling approach whereby production estimates and emissions intensities are used to generate a projection for each subsector.

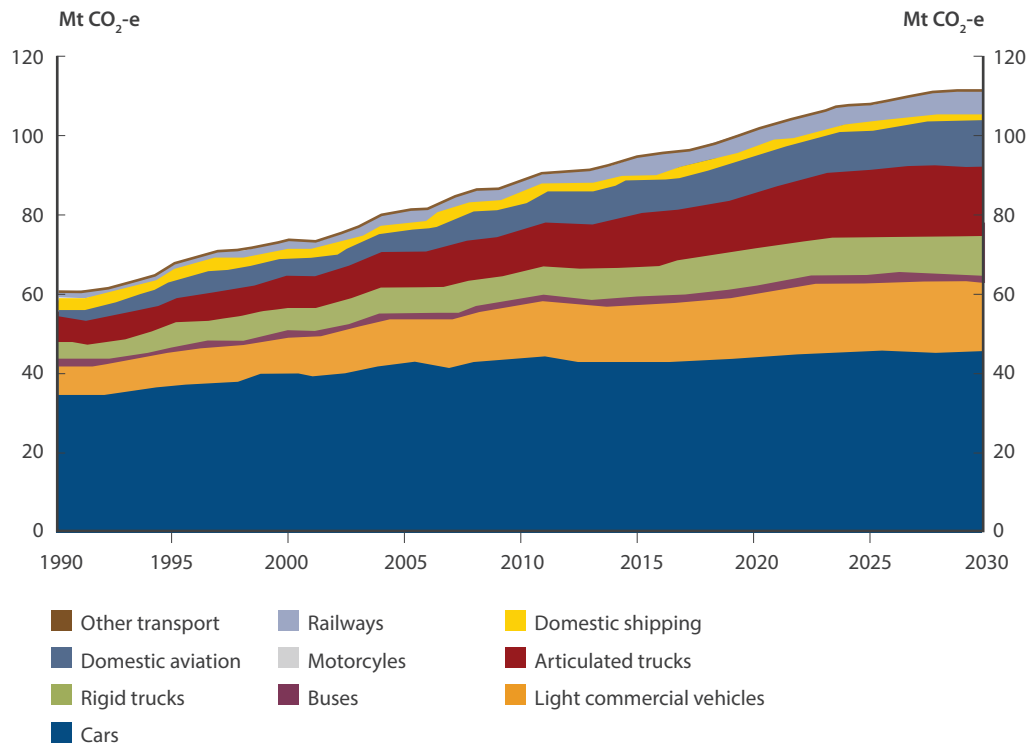
Coal and LNG production is estimated at a facility level for the fugitive sector emissions projections and is used to inform the direct combustion emissions. The emissions intensities of production are sourced from the National Greenhouse Gas Inventory data and historical trends are analysed to inform the modelling. Production estimates are collected from, and informed by, a range of sources, including from the National Greenhouse and Energy Reporting scheme and the Office of the Chief Economist (OCE 2016; OCE 2017; OCE 2017a). Third party activity information is also used including AME Group’s industry analysis and IBIS world industry reports. Production

estimates used for this sector are consistent with those used in other sectors. Emissions from the residential and commercial subsectors are based on the 2016 ClimateWorks Australia report on Gas-Electricity Substitution Projections to 2050.

5.4.4 Projections of the energy sector (transport)

The *transport* sector consists of emissions from the combustion of fuels for transportation. This includes road, domestic aviation, rail, domestic shipping, off-road recreational vehicle activity and gas pipeline transport. Road transport includes cars, light commercial vehicles, motorcycles, rigid trucks, articulated trucks and buses. Emissions from electricity used in electric vehicles and rail are accounted for under the electricity sector.

Figure 5.5: Transport emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

Emissions to 2020

Transport emissions are projected to be 101 Mt CO₂-e in 2020, an increase of 5 per cent above 2017 levels. Emissions are projected to steadily increase out to 2030 as transport activity grows due to population and economic growth. Cars and light commercial vehicles are projected to continue as the largest source of transport emissions.

Emissions to 2030

Transport emissions are projected to be 112 Mt CO₂-e in 2030, an increase of 10 per cent above 2020 levels. From 2025 onwards, cars and light commercial vehicles' share of transport emissions is projected to fall due to improvements in vehicle efficiency, larger uptake of electric vehicles and growth in other sub-sector emissions such as heavy duty vehicles (articulated trucks, rigid trucks and buses). By 2025, the price of electric vehicles is expected to decline, reaching parity with traditional internal combustion engines vehicles. Electric vehicles are projected to comprise 15 per cent of new vehicle sales by 2030. This equates to about 4 per cent of the vehicle fleet in 2030. Steady growth in heavy vehicle emissions is projected in line with projected growth in GDP, rising

demand for consumer goods resulting in an increased volume for freight carried, and limited uptake of low emissions fuels, such as biofuels.

Emissions from the non-road sector are projected to grow out to 2030, with most of the growth occurring in the domestic aviation sector. Growth in this sector is expected to remain strong due to increasing demand for air travel over other forms of medium-to-long distance travel. Emissions from rail transport are expected to grow slowly over the projections period in line with increases in iron ore production in Australia. Emissions from domestic shipping and pipeline transport are projected to remain flat throughout the projections period.

5.4.4.1 Methodology and assumptions

The Department of the Environment and Energy commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and ABMARC to undertake the modelling of *transport* emissions for the 2016 projections (Reedman and Graham 2016) (ABMARC 2016). For the 2017 projections, the modelling was updated to account for the changes in the National Greenhouse Gas Inventory.

The transport activity data, provided by the Bureau of Infrastructure, Transport and Regional Economics, was input into CSIRO's Energy Sector Model (ESM), an economic partial equilibrium model. ESM is a bottom-up model implemented as a linear program optimisation. The model has a robust economic decision-making framework. The framework incorporates: the cost of alternative fuels and vehicles; and detailed characterisation of fuel and vehicle technical performance (including fuel efficiencies and emission factors by transport mode, vehicle type, engine type and age).

Technological development and vehicle efficiency improvement trends were provided by ABMARC in consultation with the Department of Infrastructure and Regional Development. The oil price projections are informed by the Office of the Chief Economist (OCE 2016) and the United States Energy Information Administration (EIA 2016).

5.4.5 Projections of the energy sector (fugitive emissions)

Fugitive emissions are released during the extraction, processing and delivery of fossil fuels. *Fugitive* emissions do not include emissions from fuel combusted to generate electricity, operate mining plant and equipment, or transport fossil fuels by road, rail or sea.

Emissions to 2020

Fugitive emissions are projected to be 51 Mt CO₂-e in 2020, an increase of 5 per cent above 2017 levels.

Fugitive emissions from oil and gas are projected to increase from 22 Mt CO₂-e in 2017 to 24 Mt CO₂-e in 2020. Emissions from LNG production are projected to increase as the remaining LNG plants under construction come online and ramp up to full production. The Wheatstone project (WA) commenced production in October 2017 while the Ichthys project (NT) and Prelude Floating LNG project (WA) are expected to commence production during the 2018 calendar year. Emissions growth from LNG is projected to be partially offset by decreasing emissions from the Gorgon LNG project (WA) after the commencement of carbon capture and storage prior to 2020.

Fugitive emissions from coal mines are projected to increase from 26 Mt CO₂-e in 2017 to 28 Mt CO₂-e in 2020. Coal production is projected to increase due to strengthening coal prices and a return to higher production levels after Cyclone Debbie impacted coal production in 2017.

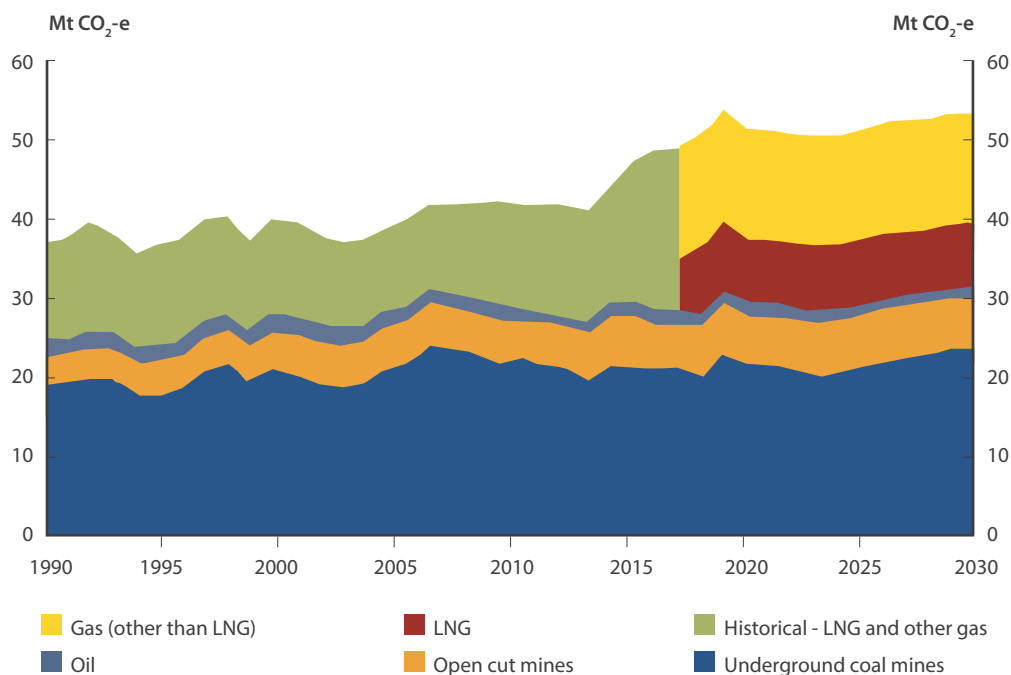
Emissions to 2030

Fugitive emissions growth is projected to slow over the period to 2030 to be 53 Mt CO₂-e, an increase of 4 per cent above 2020 levels.

Fugitive emissions from oil and gas are projected to fall by 2 per cent to 23 Mt CO₂-e in 2030.

Fugitive emissions from coal mining are projected to increase by 9 per cent to 30 Mt CO₂-e in 2030 as coal production is projected to increase by 5 per cent. Fugitive coal emissions will be sensitive to changes in the global energy mix. The increase in coal emissions is partially offset by a projected decline in emissions associated with Australian oil production over the period to 2030.

Figure 5.6: Fugitive emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.4.5.1 Methodology and assumptions

Fugitive emissions from coal and LNG production are prepared using bottom-up models based on facility specific estimates of production and the emissions intensity for each mine or LNG facility. Facility specific emission intensity estimates are sourced from the National Greenhouse and Energy Reporting scheme, National Greenhouse Gas Inventory data, environmental impact statements or expert advice. Coal production is estimated based on estimates from the Office of the Chief Economist (OCE 2017, OCE 2017a) and AME Group. For black coal, total production from new mines are scaled back so that total production is consistent with estimates from the International Energy Agency's *World Energy Outlook 2017* (IEA 2017).

Fugitive emissions from oil and domestic gas consumption are based on historical National Greenhouse Gas Inventory intensities and projections of activity data. The data is sourced from the Office of the Chief Economist (OCE 2017; OCE 2017a) and the Australian Energy Market Operator (AEMO 2016; AEMO 2016a; Lewis Grey Advisory 2016).

5.4.6 Projections of the industrial processes and product use sector

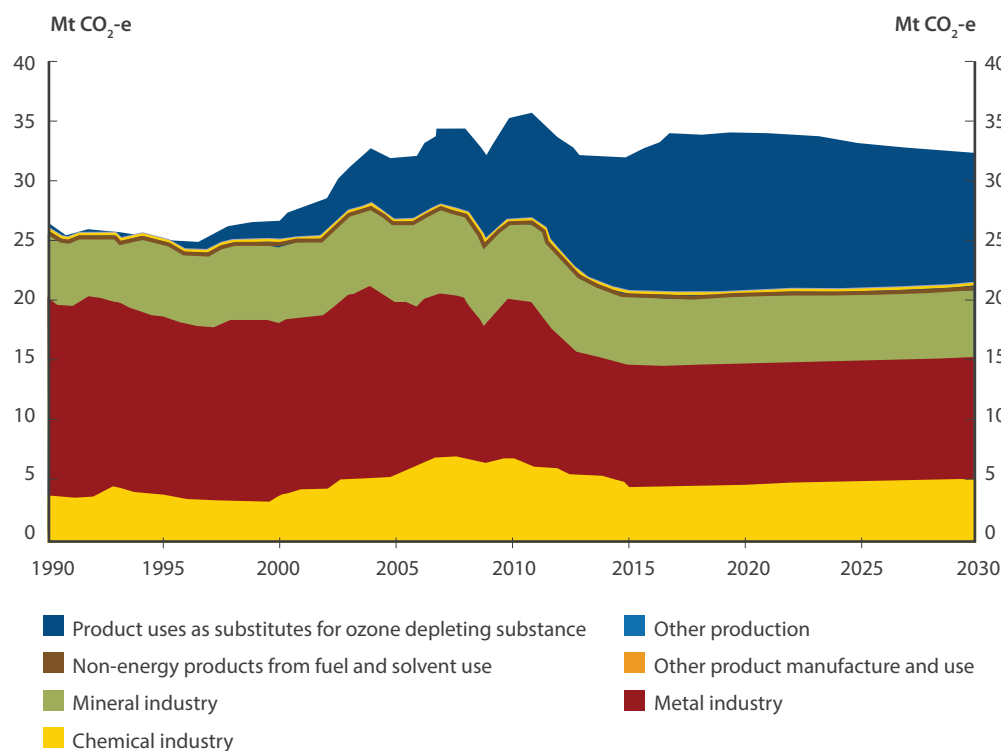
The *industrial processes and product use* sector includes emissions from non-energy related production processes, such as metals and chemical production.

Emissions to 2020

Industrial processes and product use emissions are projected to be unchanged at 34 Mt CO₂-e between 2017 and 2020.

Emissions to 2030

Industrial processes and product use emissions are projected to be 32 Mt CO₂-e in 2030, a decrease of 5 per cent below 2020 levels. The legislated phase-down of HFCs is the primary driver of the decline. The phase-down will reduce the amount of bulk HFC gas permitted to be imported into Australia from 2018.

Figure 5.7: Industrial processes and product use emissions, 1990 to 2030

Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.4.6.1 Methodology and assumptions

Emissions from *industrial processes and product use* are prepared using bottom-up modelling approaches. Commodity production projections are estimated at the industry level and where appropriate, align with estimates prepared for the *direct combustion* sector. Production estimates are collected from, and informed by, a range of sources, including the Office of the Chief Economist (OCE 2017; OCE 2017a), AME Group, IBISWorld, as well as desktop research conducted internally.

Emissions projections for the product uses as substitutes for ozone depleting substances and other product manufacture and use subsectors, are estimated by extrapolating models used in the preparation of the National Greenhouse Gas Inventory.

5.4.7 Projections of the agriculture sector

The *agriculture sector* includes emissions from enteric fermentation (the digestive process of some animals including cattle and sheep), manure management, rice cultivation, agricultural soils and field burning of agricultural residues. It does not include emissions from electricity use or fuel combustion from operating equipment, which are included in the electricity and direct combustion sectors.

Emissions to 2020

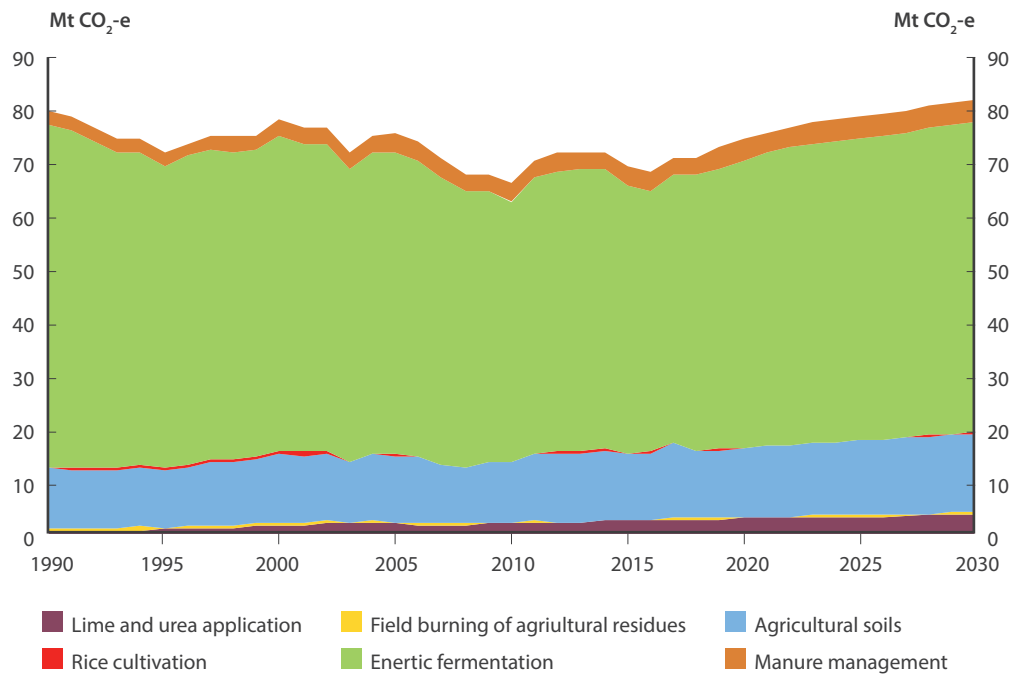
Agriculture emissions are projected to increase to be 75 Mt CO₂-e in 2020, an increase of 5 per cent above 2017 levels.

Emissions to 2030

Agriculture emissions are projected to be 82 Mt CO₂-e in 2030, an increase of 10 per cent above 2020 levels, underpinned by rising food demand and an assumed return to average seasonal conditions. This is a change from recent historical trends which saw periods of low rainfall, which reduced agricultural activity and therefore emissions.

Beef cattle is projected to continue to be the biggest contributor to sectoral emissions, followed by sheep and dairy cattle. Most emissions come from enteric fermentation from livestock, so fluctuations in these animal numbers has a major effect on emissions in this sector. While the majority of beef cattle will continue to be fed by grazing on pasture, the projections have factored in an increase in grain fed beef cattle in feedlots due to these cattle being less susceptible to drought. Grain fed cattle are more emissions intensive, due to increased energy intake and increased concentration of manure in feedlots.

Figure 5.8: Agricultural emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.4.7.1 Methodology and assumptions

Agriculture emissions projections are prepared bottom-up, using productivity forecasts from the Australian Bureau of Agricultural and Resource Economics and Sciences to 2021 (ABARES 2017; ABARES 2017a). After 2021, activity growth rates are based on a combination of the OECD FAO agricultural outlook (OECD/FAO 2017) and CSIRO's Australian National Outlook 1 (2015). Emissions are calculated as the product of agricultural activity and the relevant emissions factor, and converted to carbon dioxide equivalent. Emissions factors are sourced from the National Greenhouse Gas Inventory, and are assumed to be constant over the projections period.

5.4.8 Projections of the waste sector

The *waste* sector covers emissions from the disposal of organic materials to landfill and wastewater emissions from domestic, commercial and industrial sources. Emissions are predominantly methane generated from anaerobic decomposition of organic matter.

Emissions to 2020

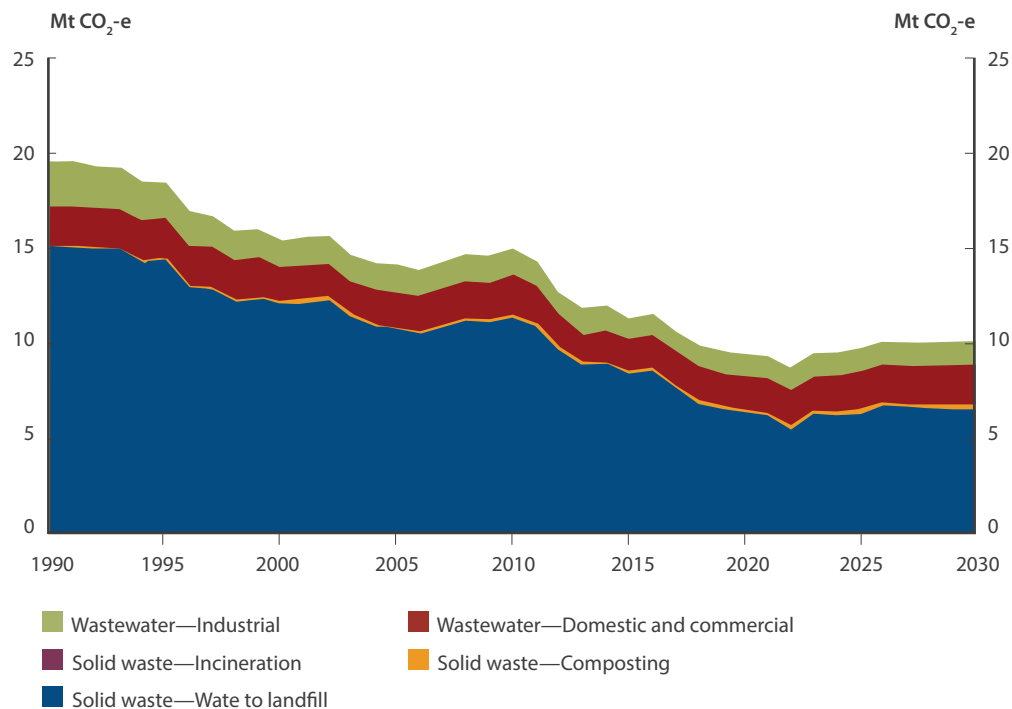
Emissions in the *waste* sector are projected to be 10 Mt CO₂-e in 2020, a decrease of 11 per cent below 2017 levels. The decrease in *waste* sector emissions is predominately the result of the increase in recycling and methane capture rates over the period. This includes projects funded under the ERF for methane capture and combustion and projects to avoid methane by reducing the amount of waste in landfill.

Emissions to 2030

Emissions are projected to be 10 Mt CO₂-e in 2030, broadly unchanged compared to 2020 levels.

Emissions in the *waste* sector dip in 2022, reflecting the projected peak in ERF contracted abatement. Post 2022, waste emissions are projected to gradually increase as population and industry production impacts begin to outpace growth in ERF abatement and methane capture rates.

Figure 5.9: Waste emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

5.4.8.1 Methodology and assumptions

Emissions from *waste* are prepared by the Department of the Environment and Energy with modelling for three subsectors: solid waste, domestic and commercial wastewater, and industrial wastewater. The projections calculate emissions based on population forecasts in line with the latest Australian Government estimates. The rates of waste generation, diversion, methane capture and proportion of wastewater anaerobically treated are from consultants, Hyder Consulting (Hyder 2014).

The projections of wastewater activity are based on the assumption that the organic content of wastewater, the proportion of wastewater that is treated anaerobically, and the proportion of the population serviced by a sewer will remain at the levels estimated for 2012², over the projections period.

Over the period 2016 to 2025, per capita waste generation is assumed to grow at the same average rate of increase observed between 2008 and 2011 of 1.7 per cent per year. Growth in waste generation is assumed to peak in 2025 as the impact of state and national waste policies, recycling and increased waste conscious products converges with expected population growth. Waste generation is capped at 2025 levels from 2025 to 2030.

2. The department's estimate of these parameters come from the Australian National Greenhouse Accounts: National Inventory Report 2012 (DoE 2014), which was used by Hyder Consulting (Hyder 2014)

5.4.9 Projections of the land use, land-use change and forestry sector

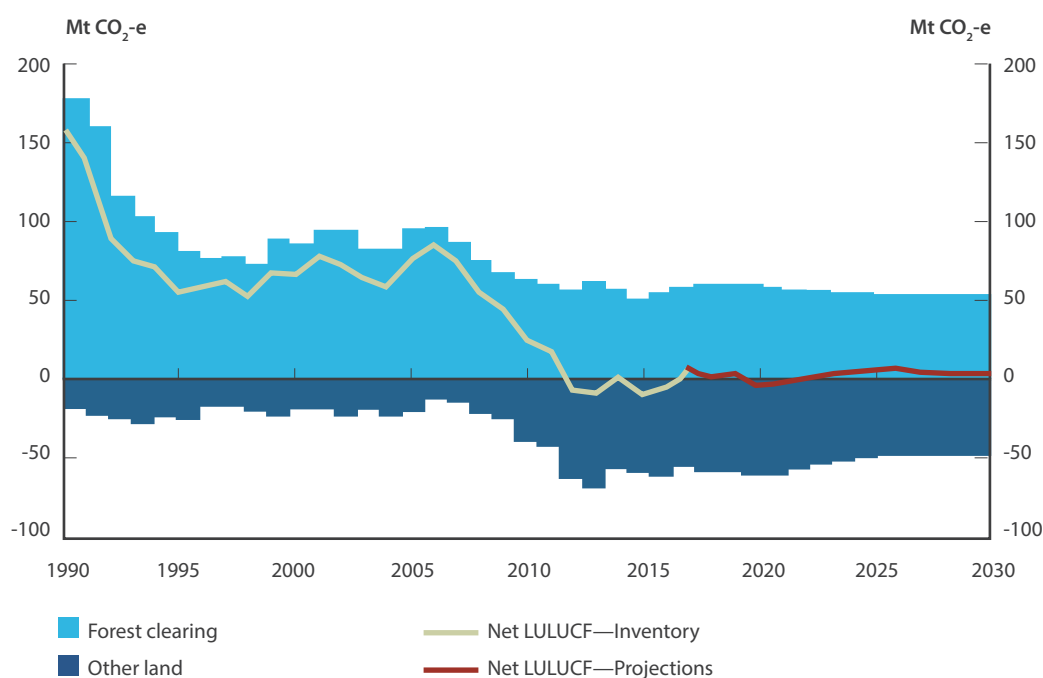
Unlike other sectors, management actions in the land use, land use change and forestry (LULUCF) sector can generate both sources of greenhouse gas emissions and sinks that remove or sequester carbon dioxide from the atmosphere. Net emissions from management actions are heavily influenced by biological processes, so can be complex and challenging to estimate.

The LULUCF sector projections are based on the UNFCCC inventory structure as described in Australia's National Inventory Report 2015 (DoEE 2017a). The major categories used include:

- **forest land**, including *forest land remaining forest and land converted to forest* (e.g. harvest and regeneration of native forests and establishment and harvest of plantations) and includes sinks from regrowing forest on previously cleared land
- **forest clearing** (emissions from the UNFCCC land-use classification of *forest converted to other land uses*, includes direct clearing-related emissions and delayed emissions from previous clearing) but excluding sinks from regrowing forests on previously cleared lands
- **cropland** (i.e. woody horticulture and changes in soil carbon under herbaceous crops)
- **grasslands** (e.g. changes in soil carbon through pastoral activities, fire management in savanna rangelands and changes in shrubby vegetation extent on grasslands) and
- **wetlands and settlements** (changes in shrubby vegetation extent on wetlands and within settlements, as well as aquaculture activities, and mangrove and tidal marsh conversions not already reported in *forest land or forest conversions*).

Figure 5.10 shows net LULUCF emissions are expected to remain broadly stable, generally as a small net source of emissions, across the period to 2030. The most influential source of emissions, forest clearing (grey), has been separated from the other land sector categories (grouped together as dark blue). The latter group covers the establishment and ongoing management of forests and grazing land with a minor contribution from cropland. Together, this group represents a significant carbon sink across the projections period.

Figure 5.10: Land use, land-use change and forestry emissions, 1990 to 2030



Source: Department of the Environment and Energy 2017; Department of the Environment and Energy analysis

Emissions to 2020

During the period to 2020, net emissions from the LULUCF sector are expected to decrease slightly to become a small net sink in 2020. A short-term rise in land clearing emissions to support additional grazing land is offset by higher carbon sinks from forests and plantations as post-harvest regrowth exceeds harvesting losses.

Emissions to 2030

From 2021 to 2030, net emissions are projected to increase initially, before stabilising around 2025. This reflects two countervailing factors. Firstly, emissions from land clearing follow a declining trend, assuming a relatively stable clearing rate and a high proportion of clearing activity of young, less biomass-intensive, regrowth forest. Secondly, net emissions from other land categories are projected to rise. This mainly reflects continuing high rates of timber harvest from forest plantations and low rates of new plantation establishment (ABARES Outlook scenarios for Australia's forestry sector (ABARES 2015)), as well as a gradual return to long-term average emissions from changes in shrubby and other woody vegetation extent and soil carbon under grazing and crop lands.

5.4.9.1 Methodology and assumptions

The Full Carbon Accounting Model (FullCAM) provides the modelling framework for estimating land sector emissions in the national inventory and the emissions projections. FullCAM models the exchange of carbon between the terrestrial biological system and the atmosphere in a full/closed cycle mass balance model which includes all biomass, litter/debris and soil pools. The model uses data on climate, soils and management practices, as well as land use changes observed from satellite imagery to produce estimates of emissions and removals across the Australian landscape. For more information, a detailed description of the model is provided in Australia's National Inventory Report (DoEE 2017a) Appendix 6.B.

Key assumptions include:

- The forecast land clearing rates on forest lands converted to croplands and grasslands are assumed to return to historical levels before following the relationship between land clearing activity and the farmers' terms of trade, as described in Australia's National Inventory Report (DoEE 2017a) (Appendix 6.A.6 and 6.H).
- For projections of net emissions from forest lands, log harvest forecasts were adopted from the 'business as usual' scenario published in the *Outlook Scenarios for Australia's Forestry Sector: Key Drivers and Opportunities* (ABARES 2015). The projections utilised the FullCAM modelling framework to estimate emissions, in conjunction with the harvested wood products model as described in section 2.1 of *Australian Land Use, Land Use-Change and Forestry emissions projections to 2035* (DoE 2015).

The projections include abatement from vegetation, soil carbon and savanna burning projects under the ERF by storing carbon on the land and by reducing methane and nitrous oxide released by fire.

For cropland and grassland emissions projections, management practices are assumed to remain unchanged over the projection period, and emissions to gradually return to long-run average conditions

5.5 PROJECTIONS OF INTERNATIONAL BUNKER FUELS EMISSIONS

Emissions from international bunker fuels result from fuel combusted for international aviation and international marine transport. These emissions are excluded from the national inventory total, by international agreement. Emissions from international bunker fuels were 13.6 Mt CO₂-e in 2015. Emissions are projected to be 15.3 Mt CO₂-e in 2020, an increase of 13 per cent above 2015 levels. Emissions are projected to be 19.6 Mt CO₂-e in 2030, an increase of 45 per cent above 2015 levels.

The majority of growth in emissions is driven by the international aviation sector, accounting for 11.8 Mt CO₂-e in 2015 or 87 per cent of international bunker fuels emissions. Emissions are projected to rise steadily out to 2030 in line with the historical trends, at an average of 2.7 per cent a year. Emissions are projected to be 13.5 Mt CO₂-e in 2020 and 17.7 Mt CO₂-e in 2030.

Emissions from the marine bunkers sector have declined in recent years, accounting for 1.7 Mt CO₂-e in 2015.

Emissions are projected to increase slightly in line with world demand for Australia's resources and commodities. Emissions are projected to grow to 1.8 Mt CO₂-e in 2020 and 2.0 Mt CO₂-e in 2030.

Emissions from international bunker fuels incorporate historical emissions data from *Australia's National Inventory Report 2015* (DoEE 2017a) from 1990 to 2015. Emissions were projected to 2030 based on the historical compound annual growth rate from 2010 to 2015 for international aviation and international marine emissions.

5.6 AUSTRALIA'S METHODOLOGY

The projections are developed using a combination of top-down and bottom-up modelling prepared by the Department of the Environment and Energy analysts and external consultants. The Department draws on public data sources by government agencies and other bodies to inform estimates of production/activity or growth at the sectoral or subsectoral level. These estimates, with relevant emission factors, are then used to calculate emissions for sectors.

5.6.1 Data sources

The key data sources include:

- historical emissions data from the National Inventory Report 2015 (DoEE 2017a), released in June 2017, and *Quarterly Update of Australia's National Greenhouse Gas Inventory*³ (DoEE 2017b),
- macroeconomic assumptions of gross domestic product and exchange rates consistent with the Australian Government's 2017–18 Budget (2017),
- population growth from the Australian Bureau of Statistics (ABS 2013); and
- commodity forecasts and activity levels informed by a number of publications and data from government agencies and other bodies, including:
 - the Australian Bureau of Agricultural and Resource Economics and Sciences
 - the Department of Industry, Innovation and Science
 - the Bureau of Infrastructure, Transport and Regional Economics
 - the Australian Energy Market Operator
 - announcements by business of investment intentions.

The Department applies consistent assumptions across all sectors of these projections.

Further detail of data sources can be found in *Australia's Emissions Projections 2017* (DoEE 2017).

Data on underlying assumptions can be found at CTF Table 5 in Annex A, Australia's third Biennial Report.

5.6.2 Summary of sectoral models

Table 5.3 summarises the models used for calculating emissions for each sector.

Table 5.3: Summary of sectoral models

Sector	Model (type, purpose)
Electricity	A simulation model developed by consultants, Jacobs Australia. The simulation model emulates the dispatch mechanism of the electricity market using a multi-area probabilistic dispatch algorithm that determines dispatch of plant within each year and optimal choice of new plant over the modelling period.
Direct Combustion	Purpose built, bottom-up models estimating emissions based on estimates of production at the subsectoral level.
Transport	Economic partial equilibrium model called the Energy Sector Model (ESM) developed by CSIRO and the Australian Bureau of Agriculture and Resource Economics (ABARE) in 2006. The model has been used for a large number of government and industry projection modelling projects. The transport sector modelling is conducted using a combination of least cost economic modelling, subject to biophysical and other constraints.

3. June Quarter 2017

Sector	Model (type, purpose)
Fugitives	Purpose built, bottom-up models estimating emissions based on facility level estimates of coal and LNG production. Sub-sectoral models based on national indicators for oil and other fugitive emissions from natural gas.
Industrial processes and product use	Purpose built, bottom-up models estimating emissions based on estimates of production at the subsectoral/facility level.
Agriculture	Purpose built, bottom-up model estimating emissions based on agricultural production at the subsectoral level.
Waste	Purpose built top down model with waste emissions calculated by subsector, driven by population and historical rates and trends of waste generation and diversion.
Land use, land use change and forestry	The Full Carbon Accounting Model (FullCAM) is the model used to construct and project Australia's national greenhouse gas emissions for the land sector. FullCAM deals with biological and management processes which affect carbon pools and the transfers between pools in forest and agricultural systems.

5.6.3 Strengths and weaknesses of the projections methodology

Preparing the projections involve making judgements about the growth path of future emissions. Australia recognises there can be considerable difficulty and uncertainty associated with making estimates about the future. Australia attempts to reduce some of this difficulty in its approach to projections. Australia's modelling methodology has both strengths and weaknesses.

Australia's modelling methodology strengths:

- The initial starting point for the projections are the latest estimates of historical emissions from the National Greenhouse Gas Inventory.
- The projections are updated annually as part of assessing progress of Australia's achievement of its international emissions reduction targets.
- The approach to preparing projections, the methodologies and data sources used are reviewed annually as part of ongoing assessments to determine the appropriateness of current approaches and determine any improvements that can be made.
- The projections use data from publicly available information and estimates by government agencies, international sources and consultants. Macroeconomic parameters informing the projections are consistent with forecasts from authoritative national sources including the Australian Government Departments of the Treasury and the Australia Bureau of Statistics.
- Methodologies, assumptions and results for each sector are subject to review by a technical working group made up of government agencies and other experts. Projection results are also subject to extensive internal quality assurance and quality checking. The projections results and process can also be subject to an independent external audit, as has occurred recently over 2016 and 2017 by the Australian National Audit Office.
- For Australian Government policies and measures, estimates of abatement are modelled collaboratively by policy analysts with projection analysts/modellers.

Australia's modelling methodology weaknesses:

- For some sectors, historical trends and relationships are assumed to continue to apply in the future. This may not be accurate due to structural or technological changes. A combination of quantitative and qualitative analysis is used to inform adjustments to projections to account for such changes.
- The projections do not take into account the physical impact of climate change on the environment in a consistent manner across sectors. This can be particularly difficult for sectors like agriculture, where changes to climate and seasonal conditions are difficult to forecast and can have a significant impact on emission results.
- Future economic or production/activity estimates, used in the projections, are inherently uncertain.

5.7 CHANGES SINCE AUSTRALIA'S SIXTH NATIONAL COMMUNICATION AND SECOND BIENNIAL REPORT

Australia's Sixth National Communication projected total emissions in the with-measures scenario in 2020 to be 614 Mt CO₂-e. This represented an 18 per cent increase in emissions between 1990 and 2020 using the UNFCCC accounting method.

Australia's 2015 second Biennial Report projected total emissions in 2020 to be 593 Mt CO₂-e. Australia was expected to be within its 2020 emissions budget by 28 Mt CO₂-e, inclusive of carryover from the first Kyoto Protocol commitment period.

Since the Sixth National Communication and second Biennial Report, there have been updates to inventory estimates, sectoral data and the impact of policies and measures, reflected in changes to 2020 projections across submissions (Table 5.4).

Table 5.4: Comparative sectoral breakdown of projections for 2020 under a 'with measures' scenario, UNFCCC accounting.

	Stationary energy ^a	Transport	Fugitives	IPPU	Agriculture	Waste	LULUCF	Total Emissions
6 th National Communication	318	92	53	31	91	10	19	614
2 nd Biennial Report	300	103	46	34	80	10	21	593
7 th National Communication	280	101	51	34	75	10	-1	551

a Stationary energy includes emissions from the electricity and direct combustion sectors.

Emissions projections for the Sixth National Communication were produced using a mix of computable general equilibrium and partial equilibrium models and sector-specific models. The use of these models was largely to inform design of an economy wide emissions reduction mechanism.

Projections for Australia's second Biennial Report were produced through a combination of top down and bottom up sectoral models, prepared by the (then) Department of the Environment analysts and external consultants. Projections were prepared to 2020.

Since the second Biennial Report, there have been some minor improvements to sectoral models and additions to data sources used in the projections. The preparation of the emissions projections underwent a performance audit by the Australian National Audit Office (ANAO) in 2017. The audit found the arrangements for preparing, calculating and reporting on Australia's greenhouse gas emission projections were largely effective. The ANAO noted the utility and transparency of projections could be improved by expanding on the information published in the projections (ANAO 2017).

For the Seventh National Communication, the projections have been produced through a combination of top down and bottom up sectoral models. Projections are prepared by Department of the Environment and Energy analysts with assistance from external consultants. The projections are prepared to 2030 using estimates of activity/production or activity growth based on publicly available data or data obtained from consultants. This data, with relevant and the most up to date emission factors, are used to calculate emissions.

Further information on the assumptions and methodology for sectors can be found in Australia's Emissions Projections 2017 Report.

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Eucalypt regrowth after Black Saturday bushfires, Strathewen Victoria, June 2009

Photographer: Robert Kerton, CSIRO

6. CLIMATE CHANGE VULNERABILITY AND ADAPTATION

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Key developments

Since the Sixth National Communication on Climate Change in 2013, Australian governments have continued to build their understanding of and ability to respond to the changing climate.

Australia continues to invest in climate change projections, research into impacts and adaptation, and climate change risk and vulnerability assessments. This improves understanding of the challenges faced by Australia from a changing climate. For example, in 2015 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology released the most comprehensive set of climate change projections ever developed for Australia as a whole. These projections are available on the website, [Climate Change in Australia](#).

Some state and territory governments have invested in downscaled (higher resolution) climate change projections, regional or sector specific impacts research or risk assessments. These investments are helping jurisdictions understand their localised climate risks, enabling adaptation decision making including in catchment scale water management and land-use planning. For example, the New South Wales and Australian Capital Territory Governments have jointly invested in regional climate change projections to provide high quality, high resolution data for their jurisdictions.

Over the same period, Australian governments have enhanced efforts to manage climate change risks. In 2015, the Australian Government released the [National Climate Resilience and Adaptation Strategy](#). The strategy articulates how Australia is managing climate risks and outlines the vision for a climate resilient future. It contains a set of principles to guide effective adaptation and considers areas for future review, consultation and action.

Most state, territory and local governments now have adaptation plans or strategies in place and are managing their climate risks across a range of sectors and in government decision making. For example, the South Australian Government has regional adaptation plans in place for each of its 12 government regions. The Queensland, South Australian, Tasmanian and Victorian governments all revised or implemented their state adaptation plans or strategies in 2017.

6.1 CLIMATE CHANGE ADAPTATION IN AUSTRALIA

Climate change adaptation in Australia is underpinned by a series of agreements made between the Australian, state and territory governments through the Council of Australian Governments (COAG). These agreements set priority areas for adaptation action and clarify roles and responsibilities for adaptation. These agreements are reflected in this chapter's reporting of adaptation activity.

As reported in the Sixth National Communication, the COAG agreed on a [National Climate Change Adaptation Framework](#) in 2007. The framework established priorities for adaptation action and initiated a range of activities to build resilience and adapt to climate change impacts. It articulated measures to enhance national climate change science and adaptation research capacity and institutions.

In 2012, the Select Council on Climate Change, comprising ministers from the Australian Government and all state and territory governments, agreed on roles and responsibilities for climate change adaptation in Australia.

The Australian Government provides the public with access to national climate science to help Australians understand the potential impacts from a changing climate. For example the website [Climate Change in Australia](#) provides comprehensive regional level data that projects future climate. This effort is often leveraged by state and territory governments to provide more detailed information focussed on the particular needs of their populations. The Australian Government is putting businesses and communities in a better place to manage their climate change risks by providing guidance and information on best adaptation practice. For example [CoastAdapt](#) is an online support tool for decision makers in managing climate risks in Australia's coastal zone.

The Australian Government manages climate change impacts to its assets, investments and infrastructure; and works to deliver seamless critical government services. For example, as one of the largest landholders in Australia,

the Department of Defence's [Environmental Strategy 2016-2036](#) includes a priority to manage current and future risks to its estate associated with natural hazards and climate change.

State, territory and local governments play a major role in direct adaptation action. They are responsible for service delivery including emergency management and health services, land use planning and management of assets and infrastructure in Australia. State and territory governments ensure appropriate regulatory and market frameworks (for example, infrastructure and state planning) are in place and deliver adaptation responses within their jurisdiction. State and territory governments provide regional climate science and adaptation information tailored for their decision-making context.

Local governments manage climate change risks to the services, assets and infrastructure they control. There are 537 local government bodies in Australia accountable to a diverse range of metropolitan, regional, rural and Indigenous communities. State and territory governments are responsible for local governments, so local government roles and responsibilities differ from state to state. Generally, local government responsibilities include:

- planning and development approval
- administration of facilities such as regional airports, ports and marinas
- infrastructure, building and property services, such as local roads and bridges, waste collection and management, and building inspections, licencing and enforcements
- recreation facilities, such as parks, swimming pools and sports fields
- community services, such as child care, aged care and community and welfare services
- health services, such as water and food inspection
- coordination of local emergency management responses.

Most local governments across Australia have undertaken climate change risk assessments and/or developed initial adaptation plans. Many plans are being revisited, due to the evolving quality of climate data and tools available. Most local government adaptation plans are driven by state and territory governments. Some local governments have undertaken these plans in advance of their state or territory government.

The [National Climate Change Adaptation Framework](#) and agreed roles and responsibilities continue to guide adaptation action by Australian governments, as is reflected in this chapter. The climate impacts outlined in section 6.2 of this chapter reports observed and projected impacts on the priorities for adaptation action. Reporting on adaptation responses, including policies, risk assessments and monitoring and evaluation frameworks, is structured by Australian, and state and territory governments. Due to practicality of reporting, the adaptation activities of local governments are discussed by exception. Where applicable, reporting of specific Australian, state and territory government adaptation activities reflect the priorities for adaptation action.

6.2 CLIMATE CHANGE IMPACTS

Australia is already experiencing the impacts of a changing climate, particularly changes associated with increases in temperature, the frequency and intensity of extreme heat events, extreme fire weather, and drought. Climate observations and projections show ongoing, long-term change from the historical climate, interacting with underlying natural variability.

A summary of observed and potential future impacts of climate change across the priority areas for adaptation action is provided in this section.

More information on general climate impacts across Australia is provided in the [State of the Climate 2016](#) report or on the website [Climate Change in Australia](#).

Most state and territory governments have produced publicly accessible material describing the potential impacts of climate change specific to their jurisdiction. [AdaptNSW](#), [Qld regional climate change impact summaries](#), [Climate Futures for Tasmania](#), and [Climate-Ready Victoria](#) are examples of material produced by state and territory governments to communicate the impacts of climate change.

6.2.1 Climate variables

The fourth biennial [State of the Climate](#) report for Australia was released by the Bureau of Meteorology and CSIRO in 2016. This report draws on the latest monitoring, science and projection information to describe variability and changes in Australia's climate, and how it is likely to change in the future.

Key findings are:

- Australia's climate has warmed in both mean surface air temperature and surrounding sea surface temperature by around 1°C since 1910.
- The duration, frequency and intensity of extreme heat events have increased across large parts of Australia.
- There has been an increase in extreme fire weather and a longer fire season, across large parts of Australia since the 1970s.
- May-July rainfall has reduced by around 19 per cent since 1970 in the southwest of Australia.
- There has been a decline in rainfall of around 11 per cent since the mid-1990s in the April-October growing season in the continental southeast.
- Rainfall has increased across parts of northern Australia since the 1970s.
- Oceans around Australia have warmed and ocean acidity levels have increased.
- Sea levels have risen around Australia. This rise in mean sea level amplifies the effects of high tides and storm surges.

Projections for the future are:

- Australian temperatures are projected to continue increasing with more extremely hot days and fewer extremely cool days.
- The number of days with weather conducive to fire in southern and eastern Australia is projected to increase.
- Winter and spring rainfall is projected to decrease across southern continental Australia, with more time spent in drought.
- Past and ongoing greenhouse gas emissions mean further warming of ocean temperatures.
- Sea-level rise and ocean acidification around Australia are projected to continue.

Case study: Temperature

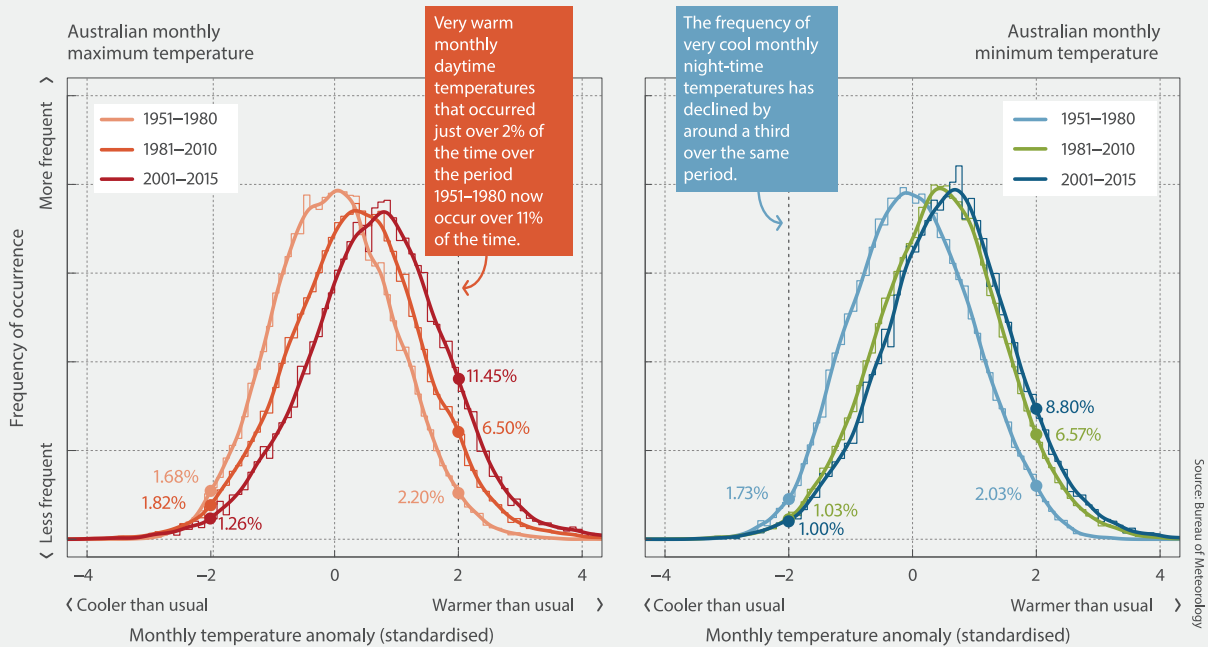
Australia has warmed by around 1°C since 1910, with most warming since 1950. Australia's top six warmest years on record included each of the last four years—2013, 2014, 2015 and 2016. Australia's warmest year on record was 2013, with average temperature 1.2°C above the 1961-1990 average. The warming trend occurs against a background of year-to-year climate variability, mostly associated with El Niño and La Niña events in the tropical Pacific Ocean.

Sea surface temperatures have warmed substantially around Australia and have been persistently high in recent years. The top six warmest sea surface temperatures of the Australian region included each of the last four years—2013, 2014, 2015 and 2016. The 2016 sea surface temperature anomaly for the Australian region was the highest on record (since 1900), 0.73°C above the 1961-1990 average.

The duration, frequency and intensity of extreme heat events have increased across large parts of Australia. Increases in average monthly maximum and minimum temperatures across the country have shifted the temperature distribution, and led to an increase in warm extremes. As illustrated in Figure 6.1, very warm monthly maximum temperatures that occurred around 2 per cent of the time during the period 1951-1980

occurred more than 11 per cent of the time during the period 2011-2015. Very warm monthly minimum, or night time, temperatures that occurred 2 per cent of the time in the 1951-1980 period now occur nearly 9 per cent of the time.

Figure 6.1: Distribution of monthly day and night-time temperature anomalies



Temperatures have been standardised with respect to the 1951-1980 base period and aggregated across 104 locations and all months of the year for three periods: 1951-1980 (orange, light blue), 1981-2010 (red, green) and 2001-2015 (dark red, dark blue). Very warm months correspond to two standard deviations from the mean. Detection and attribution studies use various methods to understand the significance of these distribution shifts and their cause.

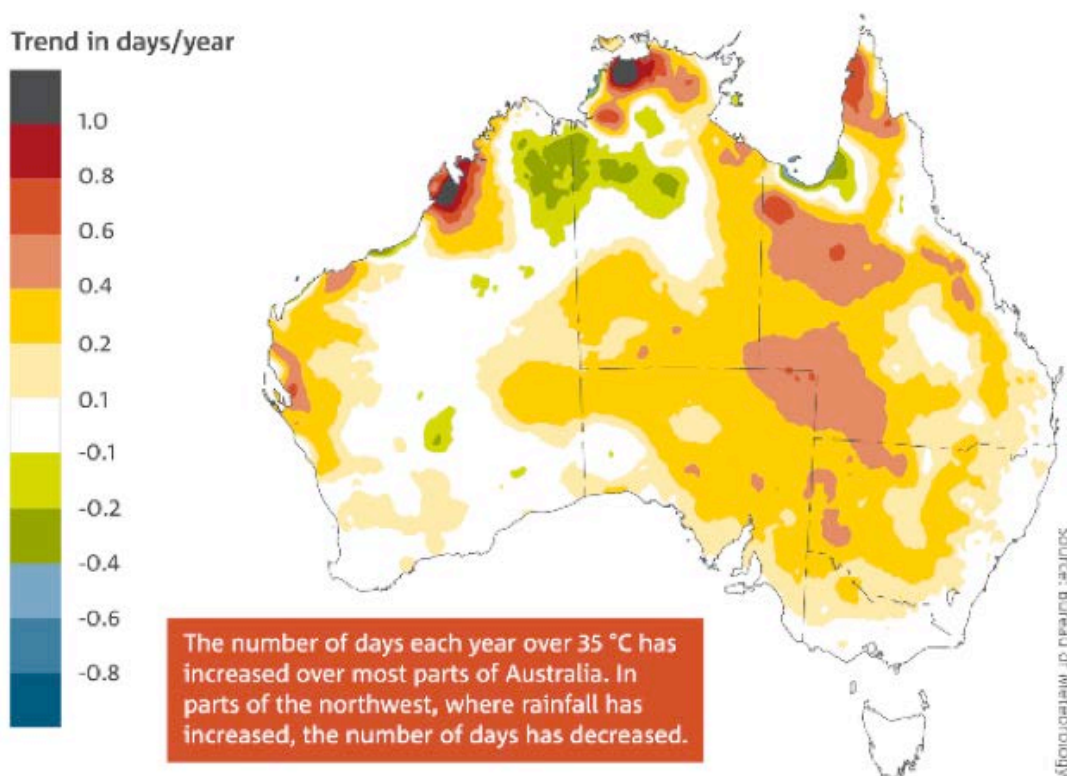
Source: Bureau of Meteorology and CSIRO 2016

A growing amount of research estimates the relative contribution of natural variability and climate change to individual extreme events. For example, a Bureau of Meteorology study found that about 15 per cent of the temperature anomaly in Australia's record-breaking temperatures of September 2013 can be explained by global warming.

Extreme temperature events that occur over large areas of the continent are increasing in frequency. This is illustrated by an increase in the number of days per year when the Australian area-average daily mean temperature is extreme. In this instance, extreme days are defined as those above the 99th percentile of each month from the year 1910-2015. In 2013 there were 28 days over this threshold. This compared to the period prior to 1950 when more than half the years had no extreme days.

The number of days per year with maximum temperatures greater than 35°C varies across Australia. Overall, the number of days each year over 35°C has increased over most parts of Australia. In parts of the northwest, where rainfall has increased, the number of days has decreased (see Figure 6.2).

Figure 6.2: The trend in annual number of days per year above 35°C from 1957-2015.



An increase of 0.2 days/year since 1957 means, on average, that there are almost 12 more days per year over 35°C.

Source: Bureau of Meteorology and CSIRO 2016

6.2.2 Coasts

The coast is a relatively narrow dynamic zone where the atmosphere, ocean and land interact. The coast is not only the shoreline, it includes estuary systems which are permanently or sometimes connected to the ocean and extend inland. More than 85 per cent of Australians live within 50 km of the shoreline, and the coastal region generates most of the country's economic activity.

Climatically, coastal areas are exposed to sea-level fluctuations, coastal inundation and river flooding from short-term weather cycles and episodes of extreme events, even without climate change. This poses risks to households and settlements, businesses, infrastructure and essential services (water and energy) and industry such as fishing and tourism.

Projected climate change will exacerbate the coast's climate risks and create new risks:

- Global and regional sea level rises are already occurring and future rises will be determined by global emissions. Since 1993, the rates of sea-level rise to the north, west and southeast of Australia have been higher than the global average, and rates of sea-level rise on the central east and southern coasts of the continent have been closer to the global average.
- Rising sea levels will increase the risk of damage caused by storm surges. This in turn will exacerbate coastal erosion, with the risk of damage to coastal infrastructure, removal of sediment from beaches and loss of land.
- Current and planned coastal settlements may be affected by flooding, particularly in low-lying communities. Rising sea levels, combined with extreme events, like inland flooding, could result in further damage.
- Coastal assets are at risk from other variables and hazards, such as ocean acidification, warmer sea surface temperatures, bushfires, increased wind speeds, and the increased frequency and intensity of heatwaves.

Case study: Torres Strait region

The Torres Strait region is made up of more than 300 islands, located between North Queensland in mainland Australia and Papua New Guinea. The region's environmental and cultural values are of national and international significance. Climate change brings risks to the Torres Strait region's environment, community health and wellbeing, and local economies, infrastructure and services. Some communities in the Torres Strait are already being impacted by rising sea levels and many of the region's coral reefs have been severely impacted by increased sea surface temperatures.

The Torres Strait Regional Authority, in collaboration with partner organisations, developed the [Torres Strait Climate Change Strategy 2014-2018](#) which considers local climate change projections, likely impacts and actions aimed at addressing knowledge gaps and risks. In December 2016, the [Torres Strait Regional Adaptation and Resilience Plan 2016-2021](#) was released. It assesses climate change risks in greater detail for a number of areas. The Plan identifies actions to reduce climate risks and build regional and community resilience.



Poruma Island local, Olandi Pearson, shows Mary Bani (TSRA) severe coastal erosion, a source of great concern to the inhabitants of this remote coral cay. Photo: John Rainbird

Case study: Coastal Climate Change Risks Assessments (2015) in Victoria

Coastal Climate Change Risk Assessments (2015) assessed risks to significant public assets from future coastal flooding and erosion in three coastal regions in Victoria. Four Local Coastal Hazard Assessments have been completed, for [Bellarine Corio Bay](#), [Gippsland Lakes – Ninety Mile Beach](#), [Port Fairy](#) and [Western Port](#). These assessments evaluate hazards to coastal communities, infrastructure and the environment, including sea-level rise and coastal erosion. They have been used as the basis for planning scheme amendments, infrastructure upgrades, and better integrated emergency and hazard management. Local governments are using these assessments in adaptation planning.

6.2.3 Cities and the built environment

Climate change and natural disasters will impact the location and design of our cities and the built environment, and the way we manage the natural resources that support human settlements. Climate change will pose challenges to a range of publicly and privately-owned and managed assets.

Key climate risks to Australian cities include:

- Gradual impacts (sea-level and temperature rise) and extreme events (floods, heatwaves and bushfires) may pose challenges to assets and infrastructure, including commercial and residential buildings, energy, water and communications utilities, and transport systems.
- Hotter, drier conditions, and increased bushfire risk and the incidence of heatwaves, means greater risk of human injury and interrupted labour force productivity.
- In the coastal zone, more intense storms and cyclones and rising sea levels could worsen storm surge, coastal inundation and erosion with impacts on the built environment.
- Damage to biodiversity and ecosystems that support social wellbeing, provide services such as clean air and fresh water, and offer protection from natural disasters.
- Failure in one part of a city's social, economic or infrastructure networks may have cascading or unanticipated effects elsewhere.

The extent that population growth and urbanisation shifts to areas at higher risk of adverse climate change impacts could increase Australia's exposure to natural hazards as a whole.

6.2.4 Agriculture, forestry and fisheries

Primary industries, such as agriculture, forestry and fisheries, are highly sensitive to weather extremes and variations in climate. Climate change is presenting new challenges in some locations and industries, while presenting new opportunities in others. Over the coming decades, projected climate change is likely to increase productivity risks for agriculture, forestry and fisheries in different ways:

- The increased frequency of drought conditions in southern Australia has the potential to affect agricultural yields.
- Increasing temperatures and more frequent extreme heat events are likely to place livestock at greater risk of heat stress, reducing livestock productivity and reproductive rates.
- Forestry is facing an increased risk of declining productivity and tree mortality as a result of reduced rainfall, increased temperatures, natural disasters and water loss.
- Crops and horticulture are facing changes in growing season and changed frequency and intensity of heatwaves and storms.

Case study: New South Wales assessing climate change impacts for primary industries

The New South Wales (NSW) Government has assessed climate change impacts and vulnerability of primary industries using a range of global climate models and emissions scenarios, including regionally downscaled data. The climate data are incorporated into biophysical and economic models to determine the impacts of climate change on current farming systems. A variety of adaptation options are then tested under future climate scenarios to determine biophysical and economic effectiveness. Research areas include:

- broadacre cropping, including rotations and optimising nitrogen application
- irrigation, including investigating water allocation scenarios
- mixed farming systems, including adjusting enterprise mix to suit future climates
- horticulture, including the effect of climate change on flowering and fruit setting
- biosecurity, including the change in distribution of pests under future climates.

6.2.5 Water resources

Australia's rainfall varies greatly from one year to the next and from one decade to the next, and is strongly influenced by phenomena such as El Niño and La Niña. Despite this large natural variability, underlying longer-term trends are evident in some regions.

There has been significant drying across southern Australia, especially across the cool April-October growing season. For the continental southeast, rainfall for the period 1996 to 2015 decreased by about 11 per cent since national rainfall records began in 1900. The drying trend is dominant between May and July over southwest Western Australia, with rainfall since 1970 around 19 per cent less than the long-term average. Since 1996, this decline from the long-term average has increased to around 25 per cent.

The recent decrease in rainfall across southern Australia, at an agriculturally and hydrologically important time of the year, is associated with a trend towards high atmospheric pressure (high mean sea level pressure) in the region. This trend is associated with a shift in large-scale weather patterns. There has been a reduction in the number of cold fronts impacting the southwest and a decrease in the incidence and intensity of weather systems known as 'cut-off lows' in the southeast. A recent attribution study shows extremely high pressures seen across southeast Australia in August 2014 are more likely to occur in the future due to climate change.

There has been a net increase in summer rainfall across much of the continent over the past 30 years. Research is continuing into the underlying cause.

Groundwater is vulnerable to climate change and climate variability. Potential climate risks for groundwater include reduced groundwater recharge and supplies, seawater intrusion to coastal aquifers, reduction of freshwater availability on small islands, and increased demand from communities and industries.

Supply from surface and groundwater is not the only risk to our water resources. For example, increased extreme weather events, such as bushfires and floods, can affect water quality and water infrastructure. Increasing temperatures may increase the risk of bacterial contamination in water supplies, blue-green algal outbreaks and acid-sulphate soil issues.

Case study: Climate change impact modelling on water resources in South Australia

Since 2014, climate change impact modelling has been undertaken by the South Australian Government and the Goyder Institute (a government and academic partnership to offer independent expert science advice) for a range of critical water resources in South Australia. This work includes:

- Development of an [agreed set of climate change projections for South Australia](#) (2015).
- Research into impacts of climate change on surface water in the Onkaparinga catchment located in the southern region of the City of Adelaide (2014).
- Hydrological modelling with future climate scenarios of changes in surface water runoff in reservoir water catchments in the [Mount Lofty Ranges](#) (2015) and [Kangaroo Island](#) (2015), and changes to occurrence of groundwater recharge in areas of high demand for groundwater for irrigation and public water supply.

Case study: The impact of climate change on water availability in Victoria

As of 2017, all Victorian water corporations have developed 50-year [Urban Water Strategies](#) that examine the effect of climate change on water supply. Under population growth and a high climate change scenario for 2065, Melbourne is expected to see approximately 36 per cent reduction in water yield and a total water demand more than twice the available water supply.

The [Victorian Climate Initiative](#) (2013-2016) was a three-year regional research initiative by the Victorian Government and research partners the Bureau of Meteorology and CSIRO. It was designed to further improve understanding of climate impacts on water availability to inform Victorian water resource planning and management.

6.2.6 Natural ecosystems

The [2016 State of the Environment report](#) found climate change is one of the main pressures on the Australian environment and exacerbates other pressures including land-use change, habitat fragmentation and degradation, and invasive species.

Climate change, particularly rising temperatures, increases the impact of these existing pressures, undermining the resilience of native species.

Scientists expect climate change to cause changes to the abundance and geographic range of many species, restrict or alter species movement and interfere with their lifecycles (such as the timing of germination). Climate change presents a biosecurity risk for Australia's ecosystems by altering the distribution of pest and weed species.

Ecosystems have a limited capacity to manage these multiple pressures compared to human systems. Rates of climate change, together with other pressures, limit the capacity of species to adapt in situ or migrate to more climatically suitable areas, where such areas exist.

Case study: Assessing climate change impact in NSW alpine areas

Australia's alpine areas are particularly vulnerable to climate change with recent regional climate projections indicating major impacts on human and natural systems in this region. The NSW Government is assessing climate change impacts in NSW alpine areas, including on water availability, bushfire, biodiversity and habitat, soil erosion and agriculture. This information can be used to develop an effective climate change adaptation plan for the region.

NSW National Parks and Wildlife Service (NPWS) has developed a draft Climate Change Adaptation Strategy. The draft Strategy sets out a two stage process for trialling and then implementing adaptation action into NPWS strategic and operational planning.



View of hillside boulders and snow gums at Charlotte Pass, New South Wales in late spring. Photo: Grant H Phillips

Case study: Mangrove dieback along the Gulf of Carpentaria

At the end of 2015, approximately 7,400ha of mangroves died along the coastline of the Gulf of Carpentaria in northern Australia. Satellite data suggests the trees were already not as green as usual at the end of the preceding wet season (March–April 2015) and throughout 2015, suggesting the dieback may have been the result of cumulative stress. Low local sea levels primarily associated with the 2015–16 El Niño and unusually hot and dry conditions likely provided a stressful environment for the mangroves. The combination of dry and warm conditions in the six to nine months preceding the dieback had not been experienced since records began in 1971.

Case study: Cumulative health impacts on the Great Barrier Reef

The Great Barrier Reef is affected by a range of pressures at local, regional and Reef-wide scales. These include pressures such as nutrient and sediment runoff from the adjacent catchments, and pressures such as heat stress related to global climate change. Since 2014, reefs around the world, including the Great Barrier Reef, have been affected by a coral bleaching event of global extent. Over those years about three-quarters of the 29 World Heritage coral reef properties have been affected by the severe heat stress which causes bleaching.

While some pressures arise from natural processes, climate change is bringing more severe, widespread and frequent impacts. These climate-related impacts are major risks to the future health and resilience of the Great Barrier Reef. Temperature conditions through the 2015 and 2016 summers, combined with the influence of ocean currents and regional weather patterns, resulted in an historic two consecutive years of severe mass coral bleaching.

Across an area the size of the Great Barrier Reef Marine Park (344,400 square kilometres) the impacts of bleaching and related mortality are variable. The 2016 bleaching event resulted in an estimated 29 per cent loss of shallow-water coral, with the most severe bleaching occurring in the Far Northern management region. Data from the 2017 bleaching event shows bleaching extended further south than in 2016. As a result of the 2016 and 2017 events, severe coral bleaching has occurred throughout three of the four Marine Park management regions.

Coincident with the 2017 mass bleaching event, severe tropical cyclone Debbie crossed the Reef in the Whitsundays region in March 2017. Approximately 28 per cent of the total reef area of the Marine Park was in the 'catastrophic damage zone' of the cyclone's path. Debbie was the tenth severe category cyclone to affect the Great Barrier Reef since 2005.

The Australian Government is well placed to bolster the Reef's resilience to these pressures through its acclaimed *Reef 2050 Long-Term Sustainability Plan*, an exemplar management plan for guiding actions that will have a direct and positive benefit to the Reef's health. The Plan is supported by an estimated \$2 billion of investment over the next decade from the Australian and Queensland Governments – investment which can be adapted to address particular challenges or changing priorities over time.

Managing the complex and widely-distributed threats facing the Reef requires collaboration across sectors and with local communities. The Australian Government is investing through the Reef Trust with NGOs and the private sector to lever greater effort at a local scale, but for wider Reef benefits. Encouragingly, small pilot projects such as breeding of the crown-of-thorns starfish-eating Giant Triton snail, or human-assisted coral spawning and reef re-seeding, could be scaled up to bring about a more resilient Reef for the future.

Most recently, and in direct response to the recent bleaching events, the intergovernmental Great Barrier Reef Ministerial Forum announced urgent action, including:

- The early commencement of the mid-term review of the Reef 2050 Plan, our 35-year blueprint to improve the health and resilience of the reef by reducing local and regional pressures.
- Seeking advice from the Reef 2050 Plan Independent Expert Panel on innovative approaches to addressing key problems on the Reef. An innovation challenge will be run, inviting local, regional and global communities to bring forward their best ideas to boost coral recruitment.

Australia has a steadfast commitment to managing the Reef and is taking strong climate action by meeting or beating our 2030 emissions targets. Our domestic actions, coupled with ongoing support for climate action from the wider global community, gives rise to hope of seeing a healthy and productive Great Barrier Reef enjoyed by future generations.

Case study: 2016 bushfire in Tasmanian Wilderness World Heritage Area

In early 2016, the Tasmanian Wilderness World Heritage Area experienced bushfires which impacted its globally significant natural and cultural values. It also impacted Tasmania's energy infrastructure and involved an unprecedented firefighting effort. The fires occurred after one of the driest summers on record and are likely to have been ignited by lightning strikes on peat soils. Tasmanian alpine flora is not resilient to infrequent, large fires and is highly vulnerable to changing fire frequency.

In response, the Tasmanian Government delivered an AU\$250,000 [research project](#) examining the impacts of a changing climate on bushfire risk in the Tasmanian Wilderness World Heritage Area and ways to improve Tasmania's preparation for, and response to, bushfires. The Tasmanian Government is using the findings of the research to protect the natural and cultural values of the World Heritage Area.



Beautiful rugged scenery with glacial lakes and alpine heath on remote mountain plateau at Hartz Mountains National Park, Tasmania. Photo: Nicole Kwiatkowski

6.2.7 Health and wellbeing

Human health is linked with environmental factors such as temperature, and air and water quality. Australia's greatest health threats from climate change are expected to come from extreme weather events (such as heatwaves), rising temperatures and the changing variability of rainfall.

- The increasing incidence of heat waves is leading to a greater risk of injury, disease and death. Heat waves have caused more loss of life than any other natural hazard in Australia over the past 100 years.
- The increasing frequency and intensity of other extreme weather events poses risks to human health, including injuries, disease and death, and disruption to health services.
- Drought has been linked to decreased mental health, particularly in rural communities.

6.2.8 Disaster risk management

The costs of extreme weather events range from environmental impacts and financial costs incurred by governments, businesses and households to impacts on the physical and psychological health of individuals. Although Australia is experienced at preparing for and responding to natural disasters, the influence of climate change on extreme weather will place pressure on our capacity to manage these events.

For example, the changing frequency, magnitude and distribution of extreme weather may result in natural disasters occurring in new areas and where emergency management experience is limited. Natural disasters could increasingly occur in close succession, limiting the time available for a community to recover between events.

Over many parts of Australia there has been an increase in extreme fire weather as indicated by the Forest Fire Danger Index, and an increase in the length of the fire season since the 1970s. This increase is especially pronounced in southern and eastern Australia, driven by higher temperatures and reductions in cool-season rainfall. There is substantial variability from year to year, with generally lower fire danger in major La Niña years such as 2010–11.

Some parts of Australia do show a tendency over the post-1950 period towards a higher proportion of rainfall from extreme events. Extreme rainfall events are highly variable in time and space, and any underlying trend would need to be large in order to be detectable with a high level of statistical significance. Climate model projections generally indicate a higher proportion of total rainfall from extreme events, with more extreme rainfall events projected even in those regions where total rainfall is expected to decrease.

The number of tropical cyclones in the Australian region varies with El Niño and La Niña events. Once variability is accounted for, observations show that since 1982 (when high quality data became available) a reduced number of tropical cyclones in the region which Australia is responsible for observing. There is no clear trend over this time in tropical cyclone intensity. Climate model projections generally indicate a likely decrease in tropical cyclone numbers but an increase in the intensity of those cyclones which do occur.

6.3 CLIMATE CHANGE PROJECTIONS

Since the Sixth National Communication, Australia has continued to build its understanding of projected climate change.

6.3.1 National climate change projections: Climate Change in Australia

In early 2015, CSIRO and the Bureau of Meteorology released [Climate Change in Australia](#), a website with the most comprehensive set of climate projections ever developed for Australia.

The climate change projections use up to 40 global climate models driven by four greenhouse gas and aerosol emission scenarios and are presented for eight regions of Australia which will be affected differently by climate change. Results have been prepared for 21 climate variables (both on the land and in the ocean) and for four 20-year time periods (centred on 2030, 2050, 2070 and 2090).

To help improve accessibility, useability and relevancy of the projections for the Australian public, the website houses 14 interactive tools for exploring the data at different levels of complexity. This ranges from the Regional Climate Change Explorer, a tool which presents statements of projected change for each region, through to a projections data download facility, the Climate Futures Tool. Climate Change in Australia hosts a 'Climate Campus' for learning more about climate science and using projections in climate change impact assessments.

6.3.2 Regional climate projections

Since the Sixth National Communication, state and territory governments have produced downscaled climate projections and climate scenarios to inform their climate change adaptation responses.

The Queensland, Tasmanian and Victorian Governments have committed to developing or investing further in regional climate projections under their state adaptation plans. Projections undertaken by states and territories since the Sixth National Communication are summarised in Table 6.1.

Table 6.1: Regional climate change projections commissioned by state and territory governments

Project name	Description
NSW and ACT Regional Climate Modelling (NARCLiM)	<p>NSW and ACT governments, in collaboration with University of New South Wales</p> <p>Since 2013, NARCLiM has delivered fine-resolution climate projections for the NSW and ACT region based on an ensemble of regional climate model simulations.</p> <p>NARCLiM has provided robust projections spanning the range of likely future changes in climate. A wide variety of climate variables have been made available at high temporal and spatial resolution and have informed decision making in various sectors in different regions of NSW.</p> <p>The projections have been used in impact assessments related to extreme heat events, bushfire, biodiversity, water availability, soil properties and erosion throughout NSW. A rigorous summary of the information on impacts on heatwaves, urban heat, human health, floods and storms, sea levels and coasts, bushfire, soil, water resources and biodiversity has been published.</p> <p>The Australian Capital Territory: Climate change snapshot summarises NARCLiM for the ACT.</p> <p>Research stimulated by the NARCLiM project has already generated at least 16 peer-reviewed papers in scientific journals, covering climate change modelling, projections and impacts. NARCLiM-based research is ongoing.</p>
Climate Change in Queensland	<p>Queensland Government</p> <p>Released in 2016, Climate Change in Queensland is an online map application providing climate information at the state level and across the state's 13 regions for the years 2030, 2050, 2070.</p>
High Resolution Climate Change Projection Data for Queensland	<p>Queensland Government</p> <p>Released in 2016, High Resolution Climate Change Projection Data for Queensland provides dynamically downscaled climate change projections with high resolution data for Queensland's regions at a 10km grid for 11 climate models.</p>
SA Climate Ready	<p>Goyder Institute for Water Research in partnership with South Australian Government</p> <p>Released in 2015, SA Climate Ready represents the most comprehensive set of downscaled climate projections data available for South Australia. Data is available to 2100 for a number of climate variables including rainfall, maximum and minimum temperature and evaporation, for each of the state's individual rainfall stations.</p>
Enterprise suitability mapping - Tasmania	<p>Tasmanian Government</p> <p>In 2014–15, the Tasmanian Government incorporated Climate Futures for Tasmania climate projections with enterprise suitability modelling.</p> <p>Enterprise suitability maps help farmers match local soil and climate information with the right crops for those conditions. The maps combine new digital soil mapping, localised climate data and crop rules. These help farmers or investors to prepare a short-list of potential crops or enterprises for further investigation. The mapping process also identifies the likely risks or barriers to growing the crops.</p>

Project name	Description
	<p>The project shows how five crops (poppies, wheat, potatoes, wine grapes and barley) could be productively grown in the future under different climate scenarios. The project produced enterprise suitability mapping and a report outlining the project's conclusions. The report highlights areas of Tasmania that are likely to become more or less suitable for cropping in response to changes in climate, particularly in relation to frost risk and growing degree days to help assess crop development. This information will support agricultural decision making in Tasmania.</p> <p>Climate Futures for Tasmania (2010–12) provided the first regional climate change projections for the state, and is a key component in the Tasmanian Government's response to climate change. By downscaling six global climate models under both high and low emissions scenarios, the project has generated projections at a resolution of roughly 10 kilometres for 1961–2100.</p>

6.4 ADAPTATION POLICIES AND STRATEGIES: AUSTRALIAN AND STATE AND TERRITORY GOVERNMENTS

As noted in section 6.1 of this chapter, Australia's different levels of government have distinct roles and responsibilities for adaptation. This section reports on the adaptation policies, risk assessments, adaptation actions and monitoring and evaluation underway by the Australian Government and the eight state and territory governments; Queensland, New South Wales, South Australia, Tasmania, Victoria and Western Australia, Australian Capital Territory and Northern Territory. Local governments are discussed by exception only.

6.4.1 Australian Government

6.4.1.1 Adaptation policy

Since the Sixth National Communication the Australian Government developed the [National Climate Resilience and Adaptation Strategy](#) which was released in December 2015. The Strategy articulates how Australia is managing the risks of a variable and changing climate. It identifies a set of principles to guide effective adaptation practice and resilience building, and outlines the Australian Government's vision for a climate-resilient future.

6.4.1.2 Progress of adaptation action

Incorporating disaster and climate resilience in Australian Government decision making

The Australian Government is integrating disaster and climate resilience in its policies, programs and assets. The Australian Government Disaster and Climate Resilience Reference Group is a coordinating group of senior officials which considers the risks and opportunities arising from climate change and natural disasters. The Reference Group's current activities include developing:

- a set of principles to help Australian Government agencies consider disaster and climate resilience
- guidance and case studies to enable disaster and climate resilience decision making
- a map of policies, programs and assets relating to disaster and climate resilience, and identifying their linkages and interdependencies.

Since July 2016, the Australian Government has been working with the CSIRO to develop a prototype online decision-support tool called the Climate Risk Information and Services Platform. The tool brings together expertise on best practice adaptation and climate data and projections. It aims to assist decision makers consider how to manage implications from a changing climate for their project or program.

The prototype has been developed to inform infrastructure planning and investment in south-east Queensland. It has been designed so it can evolve to help users in other sectors and regions make informed decisions for managing climate risks.

Supporting research in climate change adaptation

The Australian Government provided a second phase of funding to the [National Climate Change Adaptation Research Facility](#) (2014 to 2017) to help governments, businesses and communities manage climate risks, particularly in the coastal zone. This built on the first phase of the Facility (2007 to 2013) which delivered a wealth of research material, including more than 144 adaptation research projects, and National Adaptation Research Plans to guide priority research for adaptation.

This second phase of funding delivered three major bodies of work:

- [CoastAdapt](#), released in May 2017, an online tool to support local governments and businesses to identify, assess and respond to climate risks in the coastal zone. In August 2017, CoastAdapt attracted 2,380 unique website visits.
- Summaries of the first phase of research for policy and decision makers. Topics include heatwaves, floods, cyclones, bushfires, community vulnerability and resilience, and terrestrial ecosystems. Webinars based on this material had 1,344 registrations.
- Support for four research networks to maintain national adaptation research capability in: natural ecosystems; settlements and infrastructure; social, economic and institutional dimensions; and vulnerable communities. The networks updated six National Adaptation Research Plans and provided other research outputs, capacity building and engagement activities. The networks had a combined reach of over 3,500 people.

In May 2017, the Australian Government announced an Adaptation Partnership bringing together expertise on climate resilience and adaptation to support climate risk management. The Partnership includes the National Climate Change Adaptation Research Facility, the CSIRO and the Department of the Environment and Energy.

Water resources

The Australian Government continues to work with state and territory governments, farmers, communities, and industry on sustainable, efficient, and productive water management and use. Irrigators are assisted to overcome challenges including climate variability, drought and water scarcity.

The Australian Government's approach to water management is set out in the National Water Initiative (2004), Australia's blueprint for water reform. Through the initiative, governments across Australia agreed to actions to achieve a national approach to manage, measure, plan for, price and trade water. The implementation of the Initiative has helped facilitate the development of water markets, which have allowed for an efficient allocation of water rights amongst users as well as setting a price for water rights. In turn, this has supported the development of water savings technologies by creating incentives for water to move to higher value use, and encourage more efficient water use.

In 2017, the Government released the [Considering Climate Change and Extreme Events in Water Planning and Management module](#), a supporting document to the [National Water Initiative Policy Guidelines for Water Planning and Management](#). The module provides guidance to jurisdictions on how to consider and incorporate possible impacts from climate change and extreme events in water planning and management. It provides a suite of options for managing climate risks, allowing water planners to develop an approach tailored to their local circumstances such as the type of water resource, and level of demand for water.

To meet the challenge of future demand for water, the Australian Government has established long-term programs in the Murray-Darling Basin, an important water source for Australia. The Basin takes in 23 rivers and their catchments. Almost four million people, inside and outside the Basin, need its water for the survival of their families, communities and industries. The Basin crosses five states and territories with ecosystems ranging from subtropical rainfall to alpine meadows and snowfields to semi-arid desert.

The [Sustainable Rural Water Use and Infrastructure Program](#) is one of these programs. It is investing \$10 billion in rural water use, management and efficiency, improved water knowledge, market reform and upgrades to on-farm and off-farm water infrastructure. Some projects under the program are delivering water savings by reducing the loss of water from irrigation networks and farms through seepage, evaporation and escape. In doing so, the program is helping secure a sustainable future for irrigated agriculture and communities, deliver substantial and lasting returns to the environment and improve the health of rivers, wetlands and freshwater ecosystems.

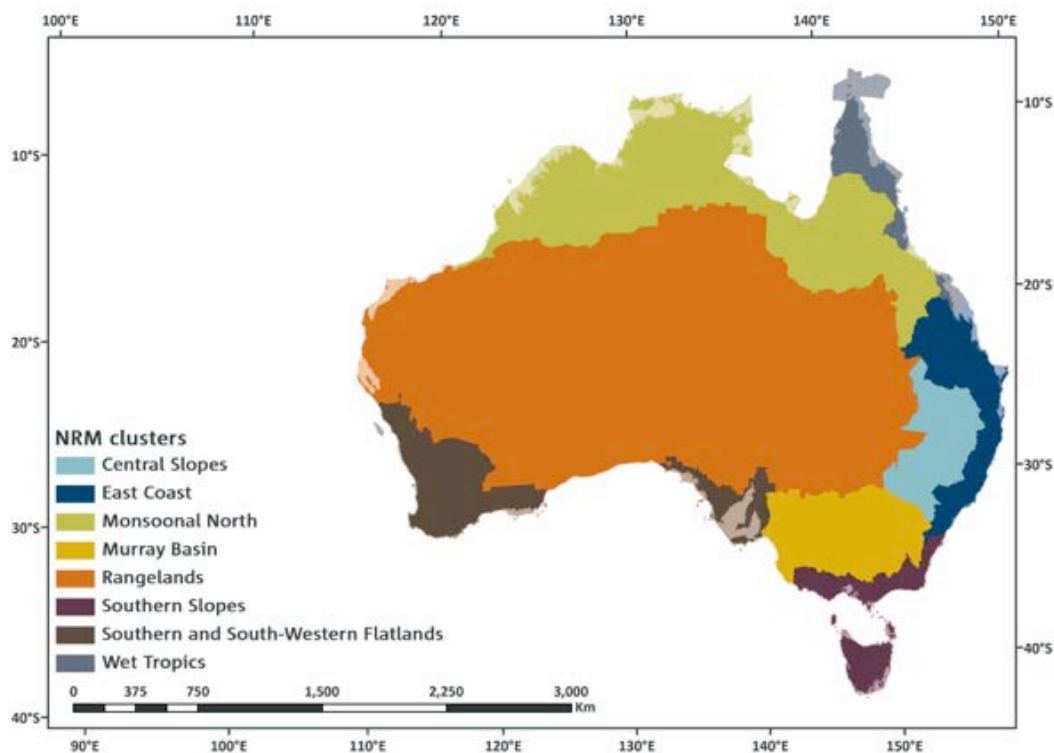
Between July 2005 and June 2017 the Australian Government committed over \$2.4 billion in funding for six urban water programs to improve water security in cities and towns across Australia, including remote and regional communities. These programs reduced the demand on potable water supplies by reducing water usage and loss from distribution systems and accelerating the development and uptake of smart water technologies and alternative water supplies.

Agriculture, forestry and fisheries and natural ecosystems

As part of the Natural Resource Management (NRM) Planning for Climate Change Fund (2013-2016), the Australian Government invested in adaptation research and guidance to help NRM groups across the country understand and manage the impacts of a change in climate.

Adaptation research and guidance was produced to meet the needs of the eight Climate Change in Australia regions (see Figure 6.4). Research was designed with NRM groups, and ranged from technical environmental mapping, vulnerability assessments, and carbon sequestration research to guidance on developing adaptation pathways. Research outputs for each region are available in the [Impacts and Adaptation Information for Australia's NRM Regions](#) section of the Climate Change in Australia website.

Figure 6.3: Australia's natural resource management (NRM) clusters used in the NRM Planning for Climate Change Fund (2013-2016).



These NRM clusters were used to produce the regional climate change projections available through Climate Change in Australia and the subsequent adaptation research and guidance products to help NRM groups understand and manage the impacts of climate change.

Source: [Climate Change Australia](#)

As part of this program, [AdaptNRM](#) (produced by CSIRO and the National Climate Change Adaptation Research Facility) was developed to take national-level adaptation approaches and information sources and make them accessible and relevant for regional planning. There are five modules for AdaptNRM:

- **Adaptation planning:** the NRM Adaptation Checklist helps planners develop climate adaptation plans.
- **Weeds and climate change:** a summary of knowledge about potential changes in weeds and weed management under climate change, with a framework for developing adaptation-ready weed management plans.
- **Implications for biodiversity:** background about a technique used to model biodiversity and demonstrate how the results can be used to evaluate potential implications of climate change for vascular plants, mammals, reptiles and amphibians.
- **Adaptation of biodiversity:** guides decisions regarding potential on-ground options for considering climate change adaptation in biodiversity management.
- **Shared learning:** provides lessons from engaging with science and stakeholders on adaptation.

Disaster risk management

In 2015, Australia committed to the *Sendai Framework for Disaster Risk Reduction 2015-2030* which emphasises management of disaster risk, as opposed to focussing solely on disaster response or recovery. Progress implementing the Framework also represents progress towards meeting the Sustainable Development Goals, ten of which relate to disaster risk reduction and climate action.

The Australian Government supports state and territory governments to invest in priority disaster resilience projects. Since 2013, the Australian Government has provided \$26.1 million annually through the [National Partnership Agreement on Natural Disaster Resilience](#). The states and territories match this support with funding or in-kind resources.

The Australian Government has funded the development of the next generation National Fire Danger Rating System. The system aims to help emergency managers in their decision making process as well as aiding in better communication of fire danger to the community. It will include the latest fire science research, along with local weather and topographical data. The New South Wales Rural Fire Service is testing the prototype over the 2017-18 summer. The new National Fire Danger Rating System will be a nationally consistent approach to issuing fire danger ratings. This system will be modular, allowing it to be updated and improved as conditions change or our understanding of fire science improves. Further social research will be conducted to better understand how to effectively convey information to the community.

The joint Australian, state and territory government [Natural Disaster Relief and Recovery Arrangements initiative](#) provides funding to state and territory governments for certain relief and recovery assistance measures made available in response to natural disasters such as bushfires, flooding and cyclones. Following the 2015 outcomes of the [Productivity Commission inquiry into natural disaster funding arrangements](#), the Australian Government has been consulting with state and territory governments to reform the current arrangements as they relate to the reconstruction of disaster damaged public infrastructure. The proposed reforms will give greater autonomy to the state and territory governments to deliver practical reconstruction that best suit the needs of their communities. Where applicable it will enable them to apply funding towards disaster mitigation activities that align with a set of overarching principles. Following final consideration by the Australian Government, it is the intention that new disaster recovery funding arrangements take effect nationally from 1 July 2018.

The Australian Government encourages critical infrastructure owners and operators to better manage foreseeable and unexpected risks to the continuity of their operations through the [Critical Infrastructure Resilience Strategy](#) (2015). It is accompanied by the Critical Infrastructure Resilience Strategy Plan that outlines activities to be undertaken to build resilience within and amongst critical infrastructure sectors.

6.4.2 Australian Capital Territory Government

6.4.2.1 Adaptation policy

The [Climate Change and Greenhouse Gas Reduction Act 2010](#) provides the legislative foundation for climate change action in the Australian Capital Territory (ACT), including adapting to climate change. The ACT's second [climate change action plan](#) (2012) provides the strategy and actions for achieving mitigation and adaptation targets and outcomes under the Act.

The [ACT Climate Change Adaptation Strategy – Living with a Warming Climate](#) (2016-2020) aims to help the ACT adapt to climate change and become more resilient to the project impacts by:

- communicating the risks and impacts of climate change to the ACT and region
- incorporating climate change risk considerations and adaptation actions in ACT Government policies, programs and practices
- encouraging the community to understand the shared responsibility to reduce vulnerability and increase resilience, while fostering emerging opportunities.

The ACT Government has recognised the need to increase existing adaptation work and are undertaking high priority short-term (2017-2020) actions. A number of additional actions, to ensure cross-agency coordination, are underway.

6.4.2.2 Climate risk assessment

In 2014, as a precursor to developing the adaptation policy, the ACT undertook a risk assessment, [Enabling Adaptation in the ACT](#), using a sector based method. The sectors assessed were: disaster and emergency management; community health and wellbeing; settlements and infrastructure; water and natural resources and ecosystems; and agriculture.

More specific climate risk assessments of ACT Government assets, operations and services are being undertaken as part of the Adaptation Strategy.

6.4.2.3 Progress of adaptation action

Innovation and integration

The ACT Government is investing in more effective sharing of adaptation information through sustained promotion and engagement including updates on regional climate impacts.

It is collaborating with vocational and academic institutions and peak bodies to deliver programs for adaptation education, training and upskilling of builders and tradespeople and continuing professional development for the region's built environment professionals.

The ACT Government is fostering climate adaptation innovation for new or existing public infrastructure by initiating trials to innovate in:

- materials, surfaces, structure, products or methods
- maximising capture and re-use of stormwater
- making public realm landscape treatments more climate resilient.

The ACT Government is building on existing engagements with peak bodies and local knowledge brokers to create a cross-sector alliance to share climate change adaptation information, seek input into ACT adaptation policy and program issues and facilitate collaboration between sectors.

Cities and the built environment

Some Canberra households and commercial developers are building to higher sustainability standards than the mandatory minimum. To encourage this the ACT Government has introduced a 25 per cent remission on Lease Variation Charges for commercial buildings built to the Green Building Council of Australia's 'Greenstar' standards and for residential buildings constructed at higher environmental performance standards.

To maximise voluntary change towards climate-wise building design and construction, the Adaptation Strategy includes government collaboration with peak industry bodies and academia to develop guidance and training.

The ACT's urban forest, already facing health and longevity issues, will be under further pressure from a warming climate. The Adaptation Strategy calls for climate resilience considerations in the review of the ACT's Design Standards for Urban Infrastructure and introduction of a living (green) infrastructure strategy.

Water resources

ACT's water policies and action plans take climate impacts into consideration. Flood risk management planning is underway (including stormwater capacity and infrastructure vulnerability) for public and private land.

The ACT Government has committed to reduce per capita water use by 25 per cent in Canberra by 2023 from 2004 levels. The target for new developments and renewal, including extension and refurbishment, is 40 per cent. While these targets are currently being met, the challenge will be to continue to meet targets as climate pressure increases.

An Australian and ACT government funded Basin Priority Project, to be completed by 2019, has commenced to address water quality issues in the ACT under current and future climate scenarios.

Natural ecosystems

The [ACT Nature Conservation Strategy 2013–23](#) sets priorities for conservation action, and the [ACT Biosecurity Strategy 2015–25](#) prioritises threats to both biodiversity and productive landscapes. Both of these strategies have actions to address the risks posed by the changing climate.

To enhance the resilience of natural landscapes across the region habitat rehabilitation and enhancement of ecological connectivity is being funded to catchment groups, Greening Australia, ParkCare, rural landholders and community volunteers.

Health and wellbeing

Actions in the Adaptation Strategy build on existing government policies and programs to foster healthy living and safety.

To help housing be functional, comfortable and affordable year round, the ACT Government promotes the benefits of good design and the Actsmart programs assist the most disadvantaged with energy and water efficiency measures.

Disaster risk management

The [Territory Wide Risk Assessment](#) is being refreshed in 2017 and includes those hazards from, or exacerbated by, climate change.

Under the ACT's [Emergency Management Plan](#) (2014), hazard-specific sub plans are regularly updated to address natural disaster and extreme weather events. These include the Strategic Bushfire Management Plan, Extreme Heat Sub Plan, Flood Emergency Plan and Storm Emergency Sub Plan.

Community service announcements and notifications are made in advance of heatwaves and other predicted extreme weather events as part of implementing the Emergency Plan. Public announcements and awareness campaigns are undertaken regularly and routinely, before and during the fire and storm seasons as well as when heatwaves are anticipated. Additional education and services are provided to higher risk sectors in the community, such as those at the urban edge.

6.4.2.4 Monitoring and evaluation

Under the Adaptation Strategy a monitoring and evaluation framework is being established with measurable and repeatable indicators to evaluate resilience across sectors.

Surveys to understand community views on climate change were implemented in 2013 and 2016. A longitudinal survey is being initiated in 2017 to provide the baseline for understanding community resilience.

6.4.3 New South Wales Government

6.4.3.1 Adaptation policy

The [NSW Climate Change Policy Framework](#) outlines the NSW Government's long-term objectives to achieve net-zero emissions by 2050 and to make the state more resilient to a changing climate.

In 2016, the NSW Government released the *Draft Climate Change Fund Strategic Plan 2017 to 2022* for public consultation. Feedback on this draft plan will inform the development of actions to help the state prepare for a changing climate.

6.4.3.2 Climate risk assessment

In 2009, the NSW Government began [Integrated Regional Vulnerability Assessments](#) that combine information on regional climate change impacts and socioeconomic and demographic changes. Workshops have been held with participants from different sectors to assess likely climate change impacts, regional vulnerability, adaptive capacity and adaptation responses.

An integrated regional vulnerability assessment has been completed or commenced in eight of the ten state planning regions, engaging over 1,200 decision makers.

6.4.3.3 Progress of adaptation action

Supporting NSW local governments

The NSW Government facilitates adaptation through engagement with the local government sector. Over 82 per cent of local government councils have undertaken climate change risk assessments and most councils have formalised adaptation actions in strategic documents.

The [Building Resilience to Climate Change](#) grants program has seed funded 22 climate adaptation projects resulting in partnerships with 92 local governments (71 per cent of all NSW local governments), nine NSW agencies, six research institutions, two professional organisations, three community groups and six businesses. Completed projects include:

- development of a method for assessing infrastructure interdependencies (Manly AdaptRoads)
- an Information Technology Infrastructure pilot project which has improved the heat resilience of key information technology systems to 60°C in the southern region of NSW
- hot spots mapping in Sydney suburbs resulting in changes to Development Control plans and the Cooling the City Strategy for Penrith, tree planting, and a design competition for climate adapted bus shelters.

Supporting research in climate change adaptation

Adaptation activities in NSW are supported by research conducted by the [NSW Adaptation Research Hub](#), a collaboration between NSW universities and the NSW Government launched in August 2013. The Hub is delivering major research outcomes in three main areas:

- identification of refuges where species can survive extreme events and exploring how integrated decision making on local land use can optimise biodiversity outcomes
- the assessment and management of the impacts of climate change on coastal and estuary zones to inform decisions and actions taken by local communities
- research into ways urban and rural communities can best adapt and respond to climate change, and ways the government can provide support to local communities to build resilience.

Coasts

Reforms in 2016 to NSW [coastal management](#) legislation are improving planning for development and natural hazards along the NSW coastline. These reforms will better equip local government and coastal communities to plan for and effectively respond to coastal climate change impacts.

The NSW Government's Coastal Management Program is investing around \$63 million to support local government to implement actions that reduce exposure to coastal hazards. Local governments can receive up to 50 per cent funding to implement coastal zone management plans, hazards assessments and coastal management tools and to undertake environmental repairs and construction works.

Cities and the built environment

The NSW Government has been promoting the use of [Urban Green Cover](#) (permeable, reflective and vegetated surfaces) to mitigate urban heat. The program has developed research, technical guidelines and peer-to-peer networks to encourage and support the use of Urban Green Cover for climate adaptation.

Disaster risk management

The NSW Government has provided \$62.5 million between 2011 and 2016 to significantly expand existing fire management programs in NSW. Hazard reduction activities, rapid bushfire response and fire-related equipment have been enhanced to help minimise the risk to the community from extreme bushfire events.

NSW State Emergency Management Committee has also developed guidance to assist local governments reduce the impacts of extreme heat events and better understand their roles and responsibilities under the state's Heatwave Sub Plan.

6.4.3.4 Monitoring and evaluation

The NSW Government has recently developed a new evaluation framework for climate change programs. The framework will help ensure the State Government's climate change policies and programs are working together to deliver long-term climate change objectives.

The NSW Government is trialing 'process benchmarking' to monitor the adaptation process at a regional scale. This has been trialed in five state planning regions avoiding the need to assess and aggregate local-scale adaptation actions. It assesses how effectively government agencies are employing adaptation processes rather than the effectiveness of specific adaptation processes or interventions. This assumes good process leads to good adaptation decisions.

6.4.4 Northern Territory Government

6.4.4.1 Adaptation policy

The Northern Territory Government is developing a framework for the territory to respond to climate change. The framework will be finalised by mid-2018. It will include a review of the likely impact of climate change on industry and geographic areas of the Northern Territory, possible monitoring mechanisms, and potential options to mitigate or adapt to potential impacts.

The risks of, and vulnerability to, climate change will be considered during the development of the Northern Territory framework.

6.4.4.2 Progress of adaptation actions

Cities and built environment

The vulnerability of housing, buildings and infrastructure to climate change is of concern to the Northern Territory Government. Storm surge and flood mapping for the Northern Territory's capital city, Darwin was last updated in 2011. These maps took the likely effects of climate change on sea level rise into consideration.

The [Northern Territory Planning Scheme](#) includes planning principles for flooding and storm surge levels and likely effects of climate change on storm surge levels at specific locations. The scheme ensures development in coastal areas is appropriate in regard to the impact of cyclones and associated storm surge.

6.4.4.3 Monitoring and evaluation

The development of a framework for the Northern Territory to respond to climate change will include an appropriate monitoring regime.

6.4.5 Queensland Government

6.4.5.1 Adaptation policy

The Queensland Government released the Queensland Climate Change Response in 2017, including the [Queensland Climate Adaptation Strategy](#) (Q-CAS).

The Q-CAS outlines how the government will support and work with Queensland's households, communities and businesses to prepare for current and future impacts of a changing climate, reduce exposure to climate risk and increase resilience. It builds on existing adaptation expertise and activities of local governments and businesses.

The Q-CAS outlines 18 actions across four pathways to address the multiple climate adaptation needs of the community, governments and businesses:

- People and knowledge: empower best-practice climate science, education and engagement to support climate risk management within Queensland's communities.
- State government: embed the consideration of climate adaptation into policies, regulations and procedures, and address risks to assets and services.
- Local governments and regions: partner with local governments and other regional organisations to develop regional adaptation solutions, including embedding climate risk in planning and development decisions.
- Sectors and systems: assist sector leaders to collaborate with government agencies, local governments and other stakeholders to identify adaptation needs and prioritise adaptation activities.

6.4.5.2 Progress of adaptation actions

Supporting Queensland local governments

The Queensland Government established a three-year (2016-2019) partnership with the Local Government Association of Queensland to strengthen local governments' decision-making processes to better respond to climate change.

The [Queensland Climate Resilient Councils](#) program helps each local government understand how well its current governance arrangements will support efficient and effective climate change action. Governance Assessments allow comparisons against other similar councils and provides recommendations for improvement.

Coasts

The Queensland Government is investing \$12 million to help coastal councils and their communities plan and prepare for storm surge, coastal erosion and rising sea levels through the QCoast2100 program.

The aim of the QCoast2100 program, delivered in partnership with the Local Government Association of Queensland, is to support coastal councils in their progression from identifying coastal hazards and climate change risks through to decision making and implementation phases. A Coastal Hazard Adaptation Strategy is designed to assess the risk from the projected climate change effects, propose adaptation measures and establish an implementation program. As of October 2017, 20 coastal councils had been awarded funding under [QCoast2100](#).

Agriculture, forestry and fisheries

The Queensland Government's [LongPaddock](#) website provides climate information, seasonal forecasts and decision support tools to help producers improve their climate risk management.

Supporting sector-based adaptation

Two Sector Adaptation Plans have been completed for the [agriculture](#) (2017) and [built environment and infrastructure sectors](#) (2017). Six more Sector Adaptation Plans will be completed during the 2017-18 financial year: tourism; human health and wellbeing; biodiversity and ecosystems; small and medium business; industry and resources; and emergency services.

Incorporating climate change into state government decision making

A Government Adaptation Action Plan is in development.

6.4.5.3 Monitoring and evaluation

The Queensland Government is developing a monitoring and evaluation framework for both climate change adaptation and mitigation activities.

6.4.6 South Australian Government

6.4.6.1 Adaptation policy

The [Climate Change and Greenhouse Emissions Reduction Act 2007](#) sets South Australia's legislative framework for action on climate change.

South Australia's adaptation framework [Prospering in a Changing Climate: A Climate Change Adaptation Framework for South Australia \(2012\)](#) supports the development of locally relevant adaptation responses across the state.

In 2012, the regions of South Australia began preparing [Regional Adaptation Plans](#) in partnership with local governments, natural resource management boards and Regional Development Australia, with support from the South Australian and Australian governments. By the end of 2016, regional plans were in place in all 12 state government regions. The plans identify actions to reduce or address key vulnerabilities to climate change, and indicate areas to build resilience and take advantage of opportunities specific to a region.

South Australia made a commitment at the United Nations Conference of the Parties in 2015 to develop a State Adaptation Action Plan.

6.4.6.2 Climate risk assessment

Climate risks for South Australia have been assessed at regional scales using an integrated vulnerability approach in the development of [Regional Adaptation Plans](#).

6.4.6.3 Progress of adaptation actions

Coasts

Since 1994, development plans are used across the South Australian coastal zone to manage development in at risk areas and include allowances for projected sea-level rise, in accordance with Coast Protection Board policy. Detailed adaptation strategies have been identified for some coastal areas. Structural and infrastructure protections have been developed for others. Long-term monitoring, over 40 years, funded by the [Coast Protection Board](#) and mapping are being undertaken to better understand impacts of sea-level rise and understand present and future risks.

Water resources

To prepare for reduced water availability, local governments, research institutions and primary industries are working to change irrigation and farm management practices, crop types, and industry diversification. Reduced water allocations, water trade, and water use restrictions are used to manage limited water supplies.

South Australia is diversifying water supplies and storages including through the use of desalinated water, recycled water, and stormwater capture and reuse to augment supplies.

Natural ecosystems

In 2015, the South Australian Government undertook a risk assessment of the vulnerability to climate change of aquatic ecosystems of the South East Natural Resource Management Region. The assessment considered opportunities for the region's engineered drainage network to be used to mitigate wetland decline due to a drying climate.

Disaster risk management

Many in the South Australian community are taking action to adapt to extreme heat, including by the SA and local governments, regional stakeholders and research institutions.

For example, SA Health is undertaking community education and engagement to manage personal heat health impacts. Businesses and organisations are changing requirements for working in extreme heat conditions. Heat and green infrastructure mapping are being undertaken to understand and prioritise treatments for extreme heat. The SA and local governments are working to plan for bushfire risk and response efforts, including restricting activities on total fire ban days.

Research continues on the potential impacts of increased temperatures and extreme heat on the community and the use of early warning systems for emergency events.

Heavy rainfall events and flooding are being managed through state emergency management frameworks for prevention, preparedness, response and recovery and the use of early warning systems. Investments in water sensitive urban design, stormwater infrastructure, and green infrastructure are being made to manage the impact of excess water in the landscape.

6.4.6.4 Monitoring and evaluation

The *Climate Change and Greenhouse Emissions Reduction Act 2007* sets out biennial reporting obligations for the Government of South Australia.

All [reports](#) under the Act are publicly available.

6.4.7 Tasmanian Government

6.4.7.1 Adaptation policy

[Climate Action 21](#) (2017) sets the Tasmanian Government's agenda for action on climate change through to 2021. It reflects the Government's commitment to addressing climate change and articulates how Tasmania will play its role in the global response to climate change.

A priority under [Climate Action 21](#) is to build climate resilience to enhance the state's capacity to withstand and recover from extreme weather events and better understand and manage the risks of a changing climate.

The [Climate Change \(State Action\) Act 2008](#) sets the Tasmanian Government's legislative framework for action on climate change.

6.4.7.2 Progress of adaptation action

Incorporating climate change into state and local government decision making

The Tasmanian Government is committed to building the capacity of its agencies and local governments to consider climate change risks in strategic planning, purchasing and decision making. This includes considering climate change projections and impacts in long-term decisions on assets and infrastructure. Incorporating climate change into government decision making was identified as a key recommendation through the 2016 Independent Review of the *Climate Change (State Action) Act 2008*.

The Tasmanian Government recently commenced work on the Climate Resilient Councils project. The project includes working closely with local governments to enhance consideration of climate change impacts when making business decisions. This will reduce long-term risks and costs to assets, infrastructure, services and the community.

Coasts

In 2016, the Tasmanian Government engaged CSIRO to provide accurate and up-to-date sea-level rise projections and planning allowances for the state. This is the first time Tasmania has had sea-level rise planning allowances unique to each coastal municipality, as well as state wide averages for 2050 and 2100.

The Tasmanian Government has used the sea-level rise projections and planning allowances to develop coastal inundation and erosion maps. This will show how sea-level rise and major storm events are projected to affect Tasmania's coastline. The coastal hazard maps are an important input into the new [Tasmanian Planning Scheme](#), which will include state-wide planning policies and provisions for risks, and hazards from coastal erosion and inundation.

The work to develop coastal hazard mapping and sea-level rise planning allowances will help ensure consistency in how planners, developers, property owners and managers take into account sea-level rise in any new coastal developments.

Since 2011, the Tasmanian Government has been working with communities vulnerable to coastal hazards through the [Tasmanian Coastal Adaptation Pathways](#) project. The project aims to raise awareness of coastal hazards and partner with communities to manage risks into the future. Through the project, the Government has worked in partnership with local governments in 11 of the communities at risk from coastal erosion and inundation including, the local governments of Hobart City, Huon Valley, Kingborough and Glamorgan Spring Bay.

Cities and the built environment

The Tasmanian Energy Security Taskforce is undertaking an independent energy security risk assessment for Tasmania, which includes the potential impact of climate change on energy security and supply.

Two reviews have recently been conducted examining Tasmania's energy security issues of 2016:

- the Energy Security Taskforce's Final Report released on 16 August 2017
- the Public Accounts Committee's Inquiry into the financial position and performance of Government owned energy entities, tabled in Parliament on 15 August 2017.

The Energy Security Taskforce's Terms of Reference (ToRs) included giving consideration to the potential impact of climate change on energy security and supply. The Public Accounts Committee's ToRs included consideration of past and current Government's energy security policies and management including risk management strategies and plans. The recommendation of a 100 per cent renewable energy target (that Tasmania will be renewable energy self-sufficient) came from these two reports.

The Tasmanian Government supports the work of the Australian Building Codes Board to improve the thermal performance of new building construction, which can lead to improved health outcomes for Tasmanians during heatwaves.

Disaster risk management

The Tasmanian Government is helping Tasmanians understand their flood risks by implementing a community project to raise awareness of flood risks, and a state-wide system for flood warnings and alerts.

The Tasmanian Government has delivered a range of materials to support Tasmanian businesses to better prepare for, and recover from, extreme weather events, and continues to reach out to the businesses sector.

The Tasmanian Government continues to deliver a comprehensive fuel reduction program involving the Tasmania Fire Service, the Tasmania Parks and Wildlife Service, Sustainable Timber Tasmania, local government, private contractors, landowners and industry. The program conducts strategic fuel reduction burns to reduce bushfire risk in the state.

The Tasmanian Government continues to deliver the [Community Protection Planning, Bushfire-Ready Neighbourhoods](#) and [Bushfire-Ready Schools](#) programs to assist communities at risk from bushfire.

6.4.7.3 Monitoring and evaluation

To monitor and evaluate Climate Action 21 (2017-2021), Tasmanian Government agencies, in collaboration with partner organisations, are responsible for monitoring and evaluating the actions they deliver. Monitoring will be based on the milestones identified for each of the actions and a public annual progress report.

6.4.8 Victorian Government

6.4.8.1 Adaptation policy

The [Climate Change Act 2017](#) provides the legislative framework for climate change mitigation and adaptation activity in Victoria.

[Victoria's Climate Change Framework](#) outlines a vision for a climate resilient state in 2050, as well as pathways and actions for achieving this vision.

[Victoria's Climate Change Adaptation Plan 2017- 2020](#) sets out the Victorian Government's strategic priorities, measures and responses for adaptation in Victoria over the next four years. The Adaptation Plan explains how the Victorian Government will support adaptation and coordinate action on different scales (local, regional and sectoral). Pilot Adaptation Action Plans in the health and human services, agriculture and the water sectors are under development. They will test the new sector-based approach to adaptation introduced by the *Climate Change Act 2017* and prepare sectors to develop mandatory Adaptation Action Plans in 2021.

6.4.8.2 Climate change risk assessment

A state-wide vulnerability assessment is underway. The first phase of this assessment focuses on economic vulnerability of Victoria's regions and economic sectors to flood and fire. The second stage will examine economic vulnerability to extreme heat.

Since the Sixth National Communication, the Victorian Government has completed, is updating or undertaking the following risk assessments related to climate change: health and human services, extreme weather and emergency management, and coastal regions.

6.4.8.3 Progress of adaptation action

Coasts

The Victorian Government has integrated climate change risks into coastal management through the [Victorian Coastal Strategy](#) (2014). The strategy outlines principles and tools for decision making that factor in climate change impacts, and priority actions for building the resilience of coastal areas.

The Victorian Government is monitoring coastal erosion and flooding and maintaining infrastructure. This will help coastal heritage, environments and assets withstand storms, flooding and erosion through the Climate-Ready Victorian Infrastructure – Critical Coastal Protection Assets program (2015 2019).

The Victorian Government is developing new Marine and Coastal legislation to improve the way coastal and marine areas are managed. It is proposed the legislation will recognise objectives for adaptation based on the *Climate Change Act 2017*, and ensure consideration of climate change is embedded in coastal management.

Cities and the built environment

The need to better integrate climate change into land use planning was one of the key drivers for reviewing and updating Melbourne's metropolitan planning strategy, [Plan Melbourne 2017-2050](#). It includes measures to build the resilience of urban settlements and encourage urban cooling and greening.

The Victorian Government is undertaking an analysis of land-use planning policies and provisions (2017-2018) to improve how land-use planning manages natural hazards, climate change and environmental risks.

Water resources

[Water for Victoria](#), the Victorian Government's water plan (2016), includes a range of mechanisms to address the impact of climate change on the state's water resources. The Victorian water sector is developing a pilot water cycle Adaptation Action Plan to be delivered in 2018. It will determine actions to improve adaptation in water, sewerage, drainage and flooding.

Drought Preparedness Plans are prepared by all Victorian water corporations and set out the actions needed to prepare for and respond to water shortages if they arise in the immediate to short-term. A Drought Preparedness

Plan describes how a water corporation will prepare for and manage its systems during an extreme dry period and/or a water quality event.

The Victorian Government has developed guidelines for assessing the impact of climate change on water supplies, to help water corporations plan effectively.

Water for Victoria also includes specific actions to ensure irrigators and irrigation delivery organisations consider and adapt to a future with less water.

Natural ecosystems

Victoria's biodiversity plan, [Protecting Victoria's Environment - Biodiversity 2037 \(2017\)](#) sets out the Victorian Government's long-term approach to protecting biodiversity and managing growing pressures caused by climate change and population growth. Implementation of the plan will improve understanding of the impacts of climate change on biodiversity and test new approaches to target setting and conservation planning. It will inform an adaptive management framework to help maintain a healthy natural environment in the long term.

Over three years (2013-2016), Catchment Management Authorities across Victoria developed climate change adaptation plans or strategies. These plans identify priority landscapes and natural resource management actions for climate change adaptation and carbon sequestration.

Health and wellbeing

The [Victorian Public Health and Wellbeing Plan](#) (2015-2019) emphasises the importance of adapting to climate change and building community resilience. Local governments are required to consider climate change in their health and wellbeing plans.

The pilot Adaptation Action Plan for the health and human services sector is currently under development. It includes a sector-wide risk analysis for built assets and services and community service organisations providing health and wellbeing services. Stakeholders can use the results of this analysis to identify shared priorities, test and scale up pilots, and incorporate results into long-term adaptation planning for health and human services. The pilot plan is expected to be completed in June 2018.

The [Heat Health Plan for Victoria](#) (last updated in 2015) described the actions and systems in place to support those most at risk in periods of extreme heat.

The Community Services Climate Resilience Program (2015-2018) helps health and community service organisations to better manage the risks and impacts of climate change on their services.

The Victorian Government is assessing cost impacts of climate change on social determinants of health and wellbeing (2016-2018). This work will analyse the costs to the Victorian Government and the economy of climate change impacts on housing and the urban environment.

Disaster risk management

Victoria's [Emergency Management Strategic Action Plan](#) (2015-2018) outlines state-wide priorities and actions to create safer, more resilient communities in the context of climate change.

The Emergency Management Climate Change Program (commenced in 2017) will help communities, businesses and local governments integrate climate change considerations into emergency management.

It includes:

- community-based emergency management planning
- incorporating climate change projections into risk data
- climate change and emergency management forums.

[Safer Together](#) (2015) is a new approach to managing bushfires that recognises climate change is increasing bushfire risk. Strategic bushfire management plans acknowledge the likely influence of climate change on the length and severity of future bushfire seasons.

The [Floodplain Management Strategy](#) (2016) recognises climate change will increase flood risks. It clarifies the roles and responsibilities of Victorian Government agencies and authorities for managing floods, and commits to improving flood warnings and information for communities.

6.4.8.4 Monitoring and evaluation

A Monitoring, Evaluation, Reporting and Improvement Framework for adaptation in Victoria is being developed to analyse how successfully Victoria is adapting to the risks and impacts of climate change. This includes the effectiveness of implementing actions in Victoria's Climate Change Adaptation Plan 2017-2020, the outcomes of these actions and how the state is adapting overall.

The first Victorian Climate Change Adaptation Plan (2013-2016) was evaluated in 2016. The recommendations of the evaluation were considered in the development of Victoria's Climate Change Adaptation Plan 2017-2020, and particularly in designing the scope and purpose of the Monitoring, Evaluation, Reporting and Improvement Framework.

6.4.9 Western Australian Government

6.4.9.1 Adaptation policy

The Western Australian Government is committed to playing a positive role in climate change policy, including in reducing emissions and investing in renewable energy and adaptation. The Government recently undertook a stocktake of current climate change actions and measures across the state government. This stocktake will be used to identify opportunities for action and inform the development of the state's future approach and priorities to address climate change across sectors.

6.4.9.2 Progress of adaptation action

Coasts

[State Planning Policy No. 2.6 State Coastal Planning Policy](#) (2013: SPP2.6) provides state-wide statutory guidance for coastal land use and development. It requires consideration of sea-level rise (a benchmark of 0.9m over a 100-year planning timeframe) and the development of a Coastal Hazard Risk Management and Action Plan for new coastal development in areas at risk.

Grant funding is available for local governments and other coastal managers to implement the policy and undertake coastal climate change adaptation projects. [Coastal plans and vulnerability assessments](#) undertaken across the state are published by the Western Australia Government to improve community knowledge and awareness of coastal hazards.

To inform decision making under SPP 2.6, including setback distances and the designation of foreshore reserves, the Western Australian Government developed the [WA State Coastal Landform Map](#). The map identifies coastal landform types including sandy, rocky, lowlands and inland waters and a coastal erosion hotspot watch list. In addition, 700km of coastline has now been surveyed via a seamless high-resolution [LiDAR and bathymetric](#) coastal map that can be used to identify coastal vulnerability.

Cities and built environment

Main Roads Western Australia incorporates climate change considerations into its standards for road and traffic engineering and undertakes climate change risk assessments for all major projects. Coastal roads and infrastructure are designed and built to consider the implications of sea-level rise and rising temperatures in the design and construction of bridges and pavements.

For example, the south Perth section of the Kwinana Freeway is one of the major transport routes identified as at risk from inundation. Climate change impacts, particularly sea level rise, have been considered in the [design of the Kwinana Freeway foreshore area](#) and associated infrastructure such as pedestrian bridge design, rock walls and piers.

The Public Transport Authority also assess the risk posed by a changing climate for all of its large projects.

The Western Australian Government considers sea-level rise, storm surge intensity, extreme weather events and bushfires in its investment in non-residential buildings across the state. This can drive decisions on the locations for new projects and assessment of risks. Critical infrastructure, like hospitals, are required to be built to withstand and function in extreme conditions. For example, minimum floor level requirements (0.3m above the 500 year Average Recurrence Interval event) and roof and site drainage are designed with risk of extreme rainfall events in mind.

Agriculture, forestry and fisheries

In 2016 the WA Government released [Climate-ready agriculture: A situation statement for Western Australia](#) and [Climate change: Impacts and adaptation for agriculture in Western Australia](#) to help farmers consider their climate risks and responses.

A [2015 risk assessment](#) of WA's fisheries identified the climate change impacts and risk rankings of marine fish and invertebrate species in Western Australian waters.

Water resources

Over the last decade, there has been significant investment in developing new water sources and building a more diversified and climate resilient water supply scheme for Perth through the [Water Corporation's Water Forever, Whatever the Weather](#) (2011) ten-year water supply strategy.

Perth was traditionally reliant on water from shallow aquifers and dams, but seawater desalination now provides half of Perth's scheme supply at about 150 billion litres per year. Two desalination plants are operating, including the Perth Seawater plant which has been operating since 2006. Further expansion of climate-independent desalination capacity is planned to offset the continuing trend of declining inflow to dams.

In addition to the development of desalination plants, the Water Corporation has trialled and constructed a groundwater replenishment scheme. By replenishing the deep aquifers with treated recycled water, more water can be abstracted without affecting the natural environment. Two new sources, including the [Beenyup Groundwater Replenishment Scheme](#) (2017-2019), are in development to provide a further 25 gigalitres per annum of water in the five-year groundwater replenishment program.

Other climate change adaptation efforts in the water sector include:

- integration of water-sensitive urban design into strategic planning
- incorporation of future climate projections into water allocation plans
- [State Groundwater Investigation Program](#).

Disaster risk management

[State Planning Policy 3.7 - Planning for Bushfire Prone Areas](#) (2015) provides state-wide guidance and requirements for building and development in bushfire prone areas. These areas are identified in the [mapping of bushfire prone areas](#) (2017). The Bushfire Risk Management Planning program provides assistance to local governments, state agencies and other stakeholders to prioritise and mitigate the risk posed by bushfire.

The Western Australian [State Risk Project](#) assessed the 27 natural hazards identified in the state's emergency management legislation to provide a consistent and comprehensive understanding of the risks posed to the state. Six of these natural hazards are influenced by climate, including bushfires, cyclones, floods, heatwaves, tsunamis (increasing potential height due to sea-level rise) and storms.

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7. FINANCIAL RESOURCES AND TECHNOLOGY TRANSFER

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Key Developments

The Paris Agreement provides a strong framework for climate efforts by all countries for coming decades. It sets a direction for transition to a lower-emissions, more climate resilient global economy, and signals the transformation of major sectors, such as agriculture, infrastructure and transport. In accordance with our commitments, Australia provides support for developing countries to build climate resilience and reduce emissions and is working to mobilise private sector support for the global economic transition.

At the Conference of Parties (COP21) in Paris the Prime Minister pledged AUD1 billion over five years to build climate resilience and reduce emissions. This includes a commitment of AUD200 million to the Green Climate Fund (GCF) (2014-2018) and AUD300 million to address climate change in Pacific Island Countries (PICs), which the Prime Minister announced in Pohnpei in September 2016. The AUD300 million climate finance commitment to the Pacific will, over four years, comprise AUD150 million in bilateral aid investments, AUD75 million through disaster resilience investments and AUD75 million in regional investments.

Australia is integrating climate action across our aid program to ensure our development assistance supports partners to reduce emissions and address the impacts of climate change. This includes mainstreaming climate action across aid program investments through climate risk analysis; climate-proofing new investments, institutional, policy and program capacity-building. It also includes targeted climate change mitigation and adaptation investments.

In 2010, the UNFCCC Conference of Parties agreed to a collective goal of mobilising USD100 billion a year in climate finance for developing countries by 2020. As part of COP21 in Paris 2015, developed countries were urged to scale-up their level of support and provide a 'concrete roadmap' to achieve the USD100 billion goal. Australia, with the United Kingdom, led developed countries to deliver this Roadmap. The Roadmap aims to provide increased predictability and transparency about how the goal will be reached, and sets out the range of actions developed countries will take to meet it. Drawing on analysis by the OECD, the Roadmap shows developed countries are well-placed to meet the USD100 billion goal, through a combination of public and mobilised private finance. Australia is committed to doing its part to meet the USD100 billion goal, and to support the broader transformation of finance flows needed to implement the Paris Agreement.

Australia recognises the importance of supporting developing countries to take ownership of their mitigation and adaptation agendas by helping build domestic capacity and expertise. Australia takes a country-driven approach to the delivery of support, acknowledging climate finance investments are more sustainable and effective when owned by partner governments. Australia focuses on delivering tangible results responsive to developing country needs as reflected in their Nationally Determined Contributions (NDCs), National Adaptation Plans and development plans. Australian aid underpins effective domestic actions, while leveraging greater investments through innovation and cooperation. In line with this approach, Australia's bilateral climate support relationships are administered through partnership agreements ensuring our assistance targets partner countries' priorities and climate finance needs. Australia's climate support is focused on the Indo-Pacific, a region highly vulnerable to the impacts of climate change and where assistance can make the most difference.

Australia sources its climate finance from new and additional aid budget appropriations from the Australian Parliament's annual budget process. This finance flows to developing country partners through targeted bilateral and multilateral climate investments. Mainstreaming climate considerations in the aid program allows better identification of, and support for climate related needs and opportunities. Australia's climate finance contributes to the collective global effort to provide and mobilise USD100 billion by 2020. In 2015, the OECD, in collaboration with the Climate Policy Initiative, prepared a report on climate finance. The report estimated the aggregate volume of public and private climate finance mobilised by developed countries for developing countries reached USD62 billion in 2014, up from USD52 billion in 2013.⁸

8. OECD (2015), "Climate finance in 2013-14 and the USD 100 billion goal", a report by the Organisation for Economic Co-operation and Development (OECD) in collaboration with Climate Policy Initiative (CPI), <http://www.oecd.org/environment/cc/OECD-CPI-Climate-Finance-Report.htm>

Australia takes a whole of government approach to providing support and building the capacity of partner governments. This engages a wide range of government agencies and non-government partners, including the Department of Foreign Affairs and Trade (DFAT); Department of the Environment and Energy ; Department of Industry, Innovation and Science (DIIS); Bureau of Meteorology (BOM); Commonwealth Scientific and Industrial Research Organisation (CSIRO); non-government organisations; charities; and universities.

To continuously improve the effectiveness and impacts of this work, Australia is undertaking a strategic evaluation of climate change assistance. This evaluation will distil lessons on successfully incorporating climate change into investment design and implementation. This will be achieved by assessing the performance of a number of past and current climate change investments with a focus on effectiveness, sustainability and value for money. DFAT is increasingly integrating assessments of climate risk across our aid investments as part of our investment quality system.

7.1 NATIONAL APPROACH TO TRACKING AND REPORTING PROVISION OF SUPPORT

Australia is strongly committed to transparency and actively participates in all required reporting and review processes under the UNFCCC to build confidence and illustrate shared learnings on effectiveness. Our accounting system is based on the Organisation for Economic Cooperation and Development (OECD) Development Assessment Committee guidelines and is complemented by actions such as a stocktake of the Pacific climate change investments to verify our expenditure. We will build on the success of this activity and expand it to other regions. Australia and other donor countries are working hard to improve domestic systems for climate finance tracking, including mainstreaming and refining methods. We are committed to working with other countries and in international forums to address finance tracking challenges relating to methods for mobilised private finance and lack of data on finance received.

Australia's climate support is largely drawn from its development assistance program and is tracked through DFAT's AidWorks. This tracking system integrates program management and delivery with the enabling capabilities associated with financial, procurement, agreement, quality and performance management. Australia's development assistance, including climate support activities, is subject to mandatory quality and performance reporting.

A portion of Australia's climate support is drawn from official flows outside of development assistance. This support is tracked on an investment by investment basis by the administering agency (for example research fellowships and scholarships awarded by the Australian Renewable Energy Agency).

Australia's method for tracking climate finance involves methods for four main modalities:

1. Core contributions to climate change related multilateral funds.
2. Core contributions to climate change related multilateral development banks and UN institutions.
3. Bilateral support where the investment is targeted at climate change mitigation or adaptation.
4. Other official flows related to climate change.

Multilateral contributions: Where climate change is the primary focus of the institution (e.g. the Green Climate Fund), Australia counts 100 per cent of the core contribution as climate finance. Where climate change is one of several work areas of the institution (e.g. the World Bank, Asian Development Bank), Australia applies international standard coefficients to determine the climate change component of the core contribution. Further details are provided in Chapter 6 of the Biennial Report 3.

Bilateral and regional support: Where the investment targets climate change mitigation or adaptation as a principal objective, Australia counts 100 per cent as climate support. Where climate change is a secondary objective or climate risk is mainstreamed into an investment, a project-by-project assessment is undertaken to determine the climate change component to be counted as climate support. Where it is not possible to disaggregate the climate change component, Australia uses the average of the mainstreamed portfolio percentages (30 per cent).

Other official flows: Where the investment targets climate change mitigation or adaptation as a principal objective of the non-ODA investment, Australia counts 100 per cent as climate support. Australia makes climate finance investments through other official flows where climate change is not the principal objective. However, these are not currently counted towards Australia's climate finance. We will consider including other official flows where climate change is mainstreamed into the investment as more robust methods become available.

Mobilised private sector investment: Australia does not currently count private sector investment leveraged by our public interventions towards our climate finance contribution. Australia is continuing to work with international partners to improve methods for tracking leveraged private sector investment. This includes through ongoing engagement in the OECD Climate Change Experts' Group (CCXG), and our AUD80,000 contribution to the CCXG in 2014–15. The CCXG aims to promote dialogue among developed and developing countries on technical issues in the international climate change negotiations. Papers published in the reporting period include *The Role of the 2015 Agreement in Mobilising Climate Finance*.

7.2 INFORMATION ON AUSTRALIA'S CLIMATE FINANCE DISBURSED

Australia's climate finance contributions have averaged over AUD200 million per year from 2010-11 to 2015–16. Australia's AUD1 billion climate finance commitment aims to assist vulnerable nations reduce emissions, build resilience and reduce vulnerability to climate change. In 2014–15 Australia provided over AUD262 million in climate finance to developing countries, and over AUD268 million in 2015–16. Australia delivered on this commitment primarily through public climate finance in our development assistance program, with additional non-ODA finance. Australian aid assisted countries in our region to leverage further investment from the private sector.

Australia's climate finance is provided in accordance with the Australian aid policy, *Australian aid: Promoting prosperity, reducing poverty, enhancing stability*⁹. This policy highlights the need to build resilience to climate-related shocks, and to working with the private sector to increase our impact, particularly in the Indo-Pacific.

DFAT is integrating climate action and disaster resilience across the entire aid program, bilaterally, regionally and globally in two ways:

- mainstreaming climate action across the aid program portfolio investments, comprising: climate risk analysis; climate-proofing new investments; institutional, policy and program capacity-building
- targeted climate-change mitigation and adaptation investments.
- Australia's investments have focused on targeting the following areas, according to the priorities, needs and systems of recipient countries:
 - climate mitigation, lower emissions alternatives and adaptation – from policy development to practical support
 - building resilience to climate shocks and incorporating climate change and disasters into risk management best practice
 - cooperation on technology development and transfer with developing countries
 - removing barriers to investment and exploring innovative ways to promote private sector engagement and growth
 - efforts to promote gender equality and the active participation of women, people with disabilities and a diversity of age groups
 - increased transparency and results through mutual accountability
 - increased effectiveness through results focused investments and close collaboration with investment partners.

9. <https://dfat.gov.au/about-us/publications/.../australian-aid-development-policy.pdf>

DFAT's longstanding partnerships with Australian and international NGOs remain a pillar of the Australian aid program. DFAT undertakes ODA investments in partnership with individual countries, regional organisations, and multilateral banks and funds. DFAT works collaboratively on various ODA climate change investments with other Australian Government departments, including the: BOM; CSIRO; Australian Centre for International Agricultural Research (ACIAR); Department of the Environment and Energy. In line with the Australian aid policy, DFAT is enhancing collaboration and partnerships with the private sector including through roundtables that aim bring together the private sector, NGOs, government and academia to overcome barriers to increasing climate finance.

7.2.1 Bilateral and regional

Over the reporting period, Australia's bilateral and regional climate finance support was:

- entirely grant-based
- primarily focused on small island developing states (SIDS) and least developed countries
- used to mobilise private finance for the transition to a low-emissions, climate resilient global economy
- balanced between adaptation and mitigation based on priorities of partner governments
- based on actual expenditure, meaning all finance has been disbursed.

As climate change threatens development outcomes, DFAT investments span governance, economic and social policy, agriculture, water, forestry and infrastructure portfolios.

The threat and impacts of climate change are priority issues for the Pacific region. We work closely with Pacific island countries to build resilience to the impacts of climate change. We have sustained and increased funding to sectors affected by climate change such as fisheries and disaster preparedness.

Australia's ongoing investment in climate science and data services continues to underpin good planning and hazards management in the Pacific. As Pacific island countries have prioritised reducing their reliance on fossil fuels, as outlined in NDCs, Australia is supporting renewable energy across the Pacific. Australia's adaptation and resilience building investments in Asia similarly span sectors from disaster management to agricultural livelihoods, including a focus on water management with a view to the potential future social, political and economic-impacts of water scarcity. Bilateral investments during the reporting period include:

- **Environmental governance and climate change response program:** to prevent smoke haze and emissions in the forestry and land use sectors in Indonesia. Australia has committed AUD10 million to the program from 2015 to 2019.
- **Vanuatu Roads for Development:** improving key roads at high risk of climate impacts (such as extreme rainfall and flooding). Australia has committed AUD28.5 million to the program from 2012 to 2018.
- **Tuvalu Environment and Climate Change Initiative:** supports the implementation of Tuvalu's National Adaptation Plan of Action Project. Australia has committed AUD2.5 million to the initiative from 2011 to 2017, focusing on improving agricultural food security and water management.
- **The Philippines Disaster and Climate Risks Management Initiative (the Philippines, AUD31.4 million):** strengthening the Philippines government's capacity for disaster preparedness, via:
 - i) technical agencies' capacity building (disaster response and monitoring, early warning and forecasting, hazard and risk analysis, climate science and adaptation options) to better inform disaster and climate risk management in vulnerable areas
 - ii) technical and policy support on integrating disaster and climate change risk management and mainstreaming across government and development sectors
 - iii) facilitating linkages between technical agencies in the Philippines with their Australian counterparts and non-government organisations.

- The **Integrated Coastal Management Program**: supporting the Vietnam government to strengthen planning, technical and financial capacities to foster climate-resilient development of the Mekong Delta. Activities include: cost-effective mangrove rehabilitation and coastal forest protection; promotion of alternative income opportunities for communities; alternative farming practices; and improvement of dyke construction and management. Australia has invested AUD8 million for this program since 2011.
- **Marine Biodiversity Conservation and Management Memoranda of Understanding**: announced in November 2017, under these MOU Australia will support Malaysia and the Philippines to manage their marine ecosystems and build their knowledge of marine ecosystem science.

Australia supports regional approaches where issues are trans-boundary in nature. For example, in South Asia regional cooperation is needed to meet increased demand for water, food and energy in the face of population growth and to mitigate disaster risks due to climate variability. In South-East Asia, our support to the Mekong River Commission is strengthening sustainable water management in the region, taking into account the likely impacts of climate change. In the Pacific, Australia has joined Pacific Leaders in endorsing the Framework for Resilient Development through the Pohnpei Statement: Strengthening Pacific Resilience to Climate Change and Disaster Risk. Australia has supported Pacific regional organisations to build climate and disaster resilience across the Pacific region. Regional investments in the Indo-Pacific region include:

- **Responsible Asia Forestry and Trade (RAFT)**: to reduce deforestation and improve sustainable forest management in the Asia-Pacific. Australia has provided AUD6 million to RAFT since 2015.
- **Coral Triangle Initiative**: promoting the health and sustainable use of coral reefs in the Pacific and South-East Asia. Australia has provided AUD13.4 million to the initiative since 2014.
- **Climate and Oceans Support Program in the Pacific**: building tools to forecast and report on climate tides and sea level monitoring, and assist decision making in disaster preparedness, agriculture, fishing and the tourism industry. Australia has committed AUD38 million to this program from 2012 to 2018.
- **The Small Island Developing States Community-Based Adaptation Program**: providing grants to communities to fund priority climate change adaptation activities at the local level. Australia has provided AUD12 million to the program since 2009.
- **Variable Renewable Energy Grid Integration Program**¹⁰: supporting 10 Pacific Island countries (Fiji, Micronesia, Kiribati, Marshall Islands, Palau, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu) to integrate solar and wind into electricity grids while maintaining reliability, affordability and adequacy of supply. The program will provide capacity building related to long-term power systems planning, market design, renewable energy support schemes, rules of access for renewable energy to the grid, and strengthening dispatch and transmission systems. Australia has provided AUD1.5 million to the program since 2015–16.
- **Sustainable Development Investment Portfolio**: supporting the integrated management of water, energy and food in three major Himalayan river basins covering Pakistan, northern India, Bangladesh, Nepal and Bhutan. Australia has invested AUD87 million¹¹ in the portfolio from 2012 to 2020.
- **Mekong River Commission**: supporting the Mekong River Commission to improve: engagement with civil society, research institutions and private sector developers; implementation of water management procedures; regional basin planning; dialogue between Mekong countries on sustainable and equitable development in the Mekong River basin; and national capacity building support to enable regional water-related cooperation. Australia has contributed AUD6 million to the commission between 2015 and 2019.
- **Australian Water Partnership**: a platform to share Australia's water experience and expertise with countries in the Indo-Pacific region, with a particular focus on climate change. Australia has invested AUD20 million between 2015 and 2020.
- **Strengthening Agriculture Practices**: a new project announced in November 2017 to share Australia's expertise in agriculture and lessons learned from agriculture projects under the Emissions Reduction Fund.

10. This Program forms part of the World Bank's Energy Sector Management Assistance Program (ESMAP) (World Bank).

11. Comprising two phases of: i) approximately AUD45 million (2012-2016); and ii) AUD42 million (2016-2020).

7.2.2 Multilateral contributions

UNFCCC and the Kyoto Protocol

Australia has been a long-term supporter and contributor to the UNFCCC. Australia contributed over AUD2.5 million to the core budget of the UNFCCC for the period 2013-14 to 2015-16, in line with the UN scale of assessment.

The Green Climate Fund

The Green Climate Fund (GCF) is the world's largest multilateral climate fund and aims to mobilise funding at scale for low-emissions and climate resilient development in developing countries. The GCF has attracted over USD10.3 billion in pledges from 43 national and sub-national governments. Australia has committed AUD200 million over four years (2015-2018) to the GCF, holds a seat on the Board and was elected co-chair in 2016 and 2017.

As Co-Chair, Australia has highlighted the vulnerability and needs of the Indo-Pacific region and helped increased accessibility to the Fund for all countries. As at September 2017, the GCF Board has approved 43 funding proposals totalling over USD2.2 billion. Over half of this funding was approved for climate projects and programs designed to support private sector investments in developing countries.

Australia continues to work actively on the GCF Board to strengthen the GCF's governance, effectiveness and streamlined operations to assist developing countries address the impacts of climate change by building resilience and reducing emissions.

Global Environment Facility

The Global Environment Facility (GEF) is a multi-stakeholder partnership working to address global environmental issues. Since its inception in 1991, the GEF has directly funded almost US\$16 billion (and leveraged USD93 billion through external co-financing) for 4377 projects related to climate change, biodiversity, international waters, land degradation, the ozone layer, and persistent organic pollutants. The GEF serves as the financial mechanism for five major international environmental conventions and manages three multilateral environmental trust funds.

Australia has been a contributing donor to the GEF since its inception. To date, Australia has contributed AUD442 million to the GEF, including AUD93 million to the GEF's sixth replenishment from 2014 to 2018. Australia holds a seat as member on the GEF Council in a donor constituency with New Zealand and the Republic of Korea.

The Global Green Growth Institute

The Global Green Growth Institute (GGGI) assists developing countries to pursue green growth and deliver on their future commitments under international agreements including the Paris Agreement and Sustainable Development Goals. The GGGI supports developing countries by providing policy and investment advice and capacity building, with a focus on green cities, sustainable energy, sustainable landscapes, and water and sanitation.

Australia is a founding member and core contributor to the GGGI. Through our seat on the GGGI's council, Australia provides strategic direction and oversight of the Institute's policy direction, work program and budget. From 2012-13 to 2015-16, Australia contributed AUD28.3 million to the GGGI. By 2016, this contribution supported operations in 25 developing countries, strengthening green growth planning, financing, and institutional frameworks.

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change, and a source of scientific information and technical guidance for Parties to the UN climate treaties. Over the reporting period, Australia provided approximately AUD900,000 to the IPCC. This funding has supported Australian authors' participation in the development of IPCC reports including the Fifth Assessment Report and special and technical report and the hosting of author meetings in Australia. Voluntary contributions to the IPCC Trust Fund have supported developing countries' attendance at IPCC meetings.

7.2.3 Other official flows

Australia's International Climate Change Engagement Program encourages the development of international policies and measures on climate change through the pursuit of international climate action and agreement. Over the reporting period, Australia's key focus for the Program was engaging major partners in the Indo-Pacific region, gender and leveraging private sector finance. Activities under this program include training for Pacific female climate change negotiators and funding to the the Private Financing Advisory Network (PFAN) to help mobilise financing for clean energy projects in India.

7.2.4 Private sector finance

Australia is committed to supporting developing countries to mobilise private finance for the transition to a lower-emissions, climate resilient global economy. Mobilisation of private sector capital is vital to implementing the goals of the Paris Agreement, including reaching the global goal of mobilising USD100 billion climate finance per year by 2020. The Roadmap to USD100 billion demonstrates how developed countries are creating pathways using public finance, policy settings and financial instruments, to ensure private finance flows to developing countries. Australia recognises developing countries can experience challenges in attracting and gaining access to private finance for climate action, particularly in the Pacific.

Australia is helping to develop a pipeline of investment-ready projects to facilitate increased private finance, including by bridging the gap between project proponents and financiers. Working closely with partners and donors to secure increased investment from the private sector in the Pacific, DFAT is increasing efforts under the aid program to identify opportunities:

- Supporting the Private Financing Advisory Network (PFAN), which helps business to mobilise financing for clean energy projects in developing economies. With Australia's support, PFAN is expanding its work in the Asia and Pacific regions. Australia has committed over AUD4 million in funding for PFAN since 2015–16, and been elected as the interim chair of the PFAN board.
- Providing matching finance for clean energy projects under DFAT's Business Partnerships Platform (BPP). Under the BPP, Australia has committed AUD500,000 to a joint investment with Digicel for affordable and reliable solar energy in PNG in 2015–16.
- Using public funding to support the broader transformation of finance flows needed to implement the Paris Agreement. For example, Australia has committed AUD32 million between 2013 and 2020 to the Private Infrastructure Development Group which provides guarantees for clean energy investment in developing countries. Australia has also committed AUD26.7 million since 2009 to support the Tina River Hydropower Project, a major infrastructure project for Solomon Islands. The project will build a 15 megawatt hydropower facility with the potential to meet two thirds of Honiara's forecast 2022 energy demand, mostly powered by expensive and unreliable diesel energy. It will enable the Solomon Islands Government to meet its Nationally Determined Contribution under the Paris Agreement.
- Australia continues to facilitate networks and partnerships to accelerate mobilisation of climate finance. In 2015–16, Australia held a roundtable series to bring together domestic actors from the private sector, government and non-government organisations to share expertise, establish critical relationships, and promote new initiatives and better ways of working together. Through the Asia Pacific Rainforest Partnership, a dedicated Private Sector Roundtable is considering the approaches to private sector investment in forest projects.

7.3 CAPACITY BUILDING

Australia has focused on bolstering institutional and technical capacity of countries in our region to support their domestic climate change activities and priorities. By sharing our specialist expertise and supporting local efforts, we are able to assist countries to create mitigation and adaptation policies, build systems to measure and report on emissions and engage effectively in climate change negotiations.

Small Island Developing States Negotiator Training

The Australian Government funded two negotiator training workshops to improve the skills of Pacific, Atlantic, Caribbean and Indian Ocean officials attending UNFCCC meetings and other climate change forums. The Australian Government engaged the United Nations Development Programme Barbados and the Organisation of East Caribbean States to assist with delivery. In addition, Australia has also supported negotiator training for 45 Pacific women delegates new to the climate negotiations to enable them to engage effectively in negotiations and build understanding of the gender dimensions of climate change (see case study below).

In 2017, Australia also supported training for South East Asian women delegates and announced a contribution of AUD1.5 million over four years to harness the talents of the next generation of climate leaders from the Pacific.

International Coral Reef Initiative

Coral reefs around the world are being impacted by climate change faster than anticipated. Through world-first initiatives on genome sequencing, remote sensing, data interoperability and ocean monitoring, Australian experts are helping develop a better understanding and improved management of the impacts of climate change on coral reefs. Australia has established a \$5 million Coral Reef Innovation Facility to harness this deep Australian expertise and help find, incubate, and accelerate solutions to coral reef management challenges in developing countries. Australia is also a founding member of the International Coral Reef Initiative (ICRI). ICRI brings together the world's key coral reef countries and organisations, representing the best coral reef expertise the world has to offer. In 2016, Australia partnered with France to launch a new Plan of Action for ICRI that focuses on the impacts of climate change on coral reefs and efforts that can be taken to build reef resilience. Australia has committed AUD2 million to sharing coral reef expertise and knowledge with developing countries under the banner of ICRI.

International Partnership for Blue Carbon

The International Partnership for Blue Carbon was announced by Australia at the UN Climate Change Conference in Paris in 2015. The Partnership brings together governments, non-government organisations and research institutes who are working to enhance the protection and restoration of coastal blue carbon ecosystems - mangroves, tidal marshes and seagrasses. When degraded or lost, blue carbon ecosystems can become significant emission sources. Protection and restoration of these ecosystems can contribute to climate change mitigation, increase coastal resilience and protection from storm surges, and deliver a range of co-benefits for food security, fisheries and sustainable livelihoods. In November 2017, the Australian Government announced a AUD6 million initiative to support efforts to protect and manage coastal blue carbon ecosystems in the Pacific. This initiative will aim to strengthen blue carbon expertise and data in the Pacific, support its integration into national greenhouse gas accounting and climate policy, and encourage public and private sector investment. Australia has also supported a blue carbon workshop for Coral Triangle Initiative countries and will provide the Government's peak scientific body - CSIRO - with close to AUD0.5 million to take forward blue carbon initiatives in the Indian Ocean region. This work has been supported by an Australia Awards Fellowships program to build capacity on managing the blue economy, with a particular focus on Blue Carbon, for fellows from Madagascar, Mauritius and the Seychelles.

Global Forest Observations Initiative

The Global Forest Observations Initiative (GFOI) is an international partnership established in 2013 to assist countries in the design and implementation of robust forest monitoring systems and associated emissions measurement, reporting and verification (MRV) procedures. There is active collaboration between the governments of Australia, Norway, the United Kingdom and the United States, and the Food and Agriculture Organization of the United Nations, the European Space Agency, the Committee on Earth Observation Satellites, and the World Bank. Australia, as a founding member of the GFOI, has led the development of the GFOI Methods and Guidance Documentation, providing practical advice aligned with UNFCCC reporting requirements. Australia's leadership on the methodological component is based on domestic expertise and extensive experience in greenhouse gas emissions accounting from the land sector. Australia developed [REDDcompass](#), an interactive version which provides the framework for the REDD+ capacity building initiatives of all GFOI partners. The Australian Government has provided dedicated capacity development training for Indonesia and Pacific Island nations.

Asia Pacific Rainforest Partnership

The Asia-Pacific Rainforest Partnership promotes action and provides a platform to progress activities to reduce emissions from deforestation and forest degradation in the Asia-Pacific region. The Partnership works with governments, the private sector, and civil society to support the implementation of the Paris Climate Change Agreement and REDD+ in the region. Regional collaboration under the Partnership focuses on: restoring degraded landscapes and protecting high conservation value forests; informing national policies that contribute to reducing rainforest loss and support sustainable economic development; and increasing the knowledge, understanding and conservation of the region's biodiversity, threatened species and watersheds.

Under the Partnership, summits bring together government, private sector, civil society and academic representatives to discuss forest conservation, climate change, and the implementation of the Paris Agreement in the Asia-Pacific region. The first [Asia Pacific Rainforest Summit](#) was held in Sydney, Australia in November 2014. The second in [Bandar Seri Begawan, Brunei Darussalam](#) in August, 2016. Indonesia will host the third Asia-Pacific Rainforest Summit in Yogyakarta in April 2018.

System for Land-based Emissions Estimation in Kenya

Australia has provided \$12.7 million to support the development and implementation of a measurement, reporting and verification (MRV) system for Kenya's land sector greenhouse gas accounting. The project has delivered to the Government of Kenya a tailor-made, world-class carbon accounting system to enable Kenya to meet international reporting obligations to the UNFCCC. It comprises 30,000 plus spatial layers, sixteen land-cover maps and multiple empirical models. In 2016, the Kenyan Government commenced funding the SLEEK Management unit. Ongoing capacity development is being supported through the 22 scholarships for Masters and PhD students researching topics to enhance the system. The centrepiece of the investment is open source software that can be tailored to individual countries' circumstances and used for land sector MRV systems. The activity supports Kenya to share this technology with the broader east-African community.

Indonesia land sector Measurement, Reporting and Verification support

Since 2009, Australia has supported Indonesia to develop a forest monitoring system. This system will assist the development of policies to achieve Indonesia's domestic and international forest commitments, including efforts to reduce emissions from deforestation and forest degradation. In 2016 Australia announced an additional AUD1 million to Indonesia to build and maintain capacity for MRV activities of the land sector. This includes the operationalisation of the MRV system within the Indonesian Government, undertaking international emissions reporting in accordance with the UNFCCC framework and sharing experiences with other developing countries. The program takes into account the importance of peatland management in Indonesia for the mitigation of climate change.

South Africa Land Sector Measurement, Reporting and Verification Capacity Development

This AUD0.875 million project enhances South Africa's ability to monitor and measure emissions from land use, which improves the country's ability to meet international reporting requirements and gain accreditation for climate finance. The project commenced in 2013 and is operating until 2017. The Government of South Africa's Project Steering Committee approved the Strategic Plan in February 2016. Australia assisted South Africa to undertake the initial implementation of a Strategic Plan for MRV, which included stakeholder outreach activities to establish the governance and institutional arrangements critical for a robust national land sector MRV system. In addition to the enabling benefits of the project for South Africa's national land sector MRV framework, the program has facilitated transparent and effective cooperation across South African Government agencies and built the technical skillset of South African Government officers.

Savanna Fire Management

Following the ongoing success of Australia's domestic savanna fire management methods, Australia supported the International Savanna Fire Management Initiative. This involved: assessing and promoting the feasibility of establishing emissions projects in developing countries; sharing Australia's lessons learned to fire management practitioners and Indigenous representatives in other countries; and identifying regions in developing countries to pilot savanna fire management.

A number of international workshops and study tours in Australia and overseas were held:

- introductory workshop, Darwin, 24 to 25 May 2013
- Australia-Brazil learning exchange, Northern Australia 12 to 27 May 2014
- Namibia Learning Exchange and Southern Africa Regional Workshop, November 24 to 6 December 2014
- Asia Workshop, 18 to 21 May 2015, Kupang, Indonesia.

These events allowed for discussions among land management experts and indigenous representatives from key countries suitable for savanna fire management activities. Academics and Australian Aboriginal rangers with widespread experience in the field shared Australia's experience in introducing indigenous savanna fire management. In November 2017, the Australian Government announced a program for savanna fire management in Botswana. This project has the potential to encourage investment in fire management globally, driving greater efforts to reduce land-based emissions.

Thailand's Greenhouse Gas Emissions Inventory System (TGEIS)

Australia is strengthening Thailand's capacity to fulfil its commitments under the Paris Agreement by supporting the design and development of Thailand's national greenhouse gas emissions inventory system, known as TGEIS. The TGEIS is based on the Australian Greenhouse Emissions Information System (AGEIS) - an inventory database managed by the Department of the Environment and Energy which centralises national greenhouse gas emissions estimation, national account compilation, and international reporting into a single IT system. Once commissioned, TGEIS will be a key asset in enabling Thailand to deliver timely, high quality and transparent greenhouse gas emissions data, to inform effective domestic emission abatement policies, and help achieve its Paris Agreement commitments.

Australia-China Collaboration on National Greenhouse Gas Inventories

The Australia-China collaboration project on national greenhouse gas inventories and supporting information systems commenced in 2016 between the Australian Department of the Environment and Energy and China's National Centre for Climate Change Strategy and International Cooperation (NCSC). Australia is undertaking capacity building in MRV of greenhouse gas emissions to support China's inventory.

Australia-Singapore workshops on the international Measurement, Verification and Reporting Framework

Australia and the Government of Singapore are working together to help build the capacity of countries in our region to improve their understanding of climate change mitigation and adaptation needs and assist with reporting under the UNFCCC. During the reporting period, two regional capacity building workshops were held in Asia to support countries in producing their Biennial Update Reports and to undertake the International Consultation and Analysis process under the UNFCCC.

Case study: Strengthening women's participation at the UNFCCC

In 2015–16 Australia supported negotiator training for 45 Pacific women delegates new to the climate negotiations over two workshops. This training enables them to engage effectively in negotiations and build understanding of the gender dimensions of climate change. Australia was an advocate for the inclusion of gender in the Paris Agreement. Australia is committed to increasing the influence of women in driving solutions to climate change.



Pacific Women's Climate Change Negotiators workshop participants, Pacific Islands Forum Secretariat, Suva, Fiji

7.4 TECHNOLOGY DEVELOPMENT AND TRANSFER

Australia is active in a range of international technology-based partnerships and programs aimed at accelerating the development and diffusion of climate-friendly technology. Over the reporting period, these partnerships included: the Major Economies Forum, International Partnership for Hydrogen and Fuel Cells in the Economy, International Partnership for Geothermal Technology, Carbon Sequestration Leadership Forum, Climate Technology Initiative, International Institute for Applied Systems Analysis, International Partnership for Energy Efficiency Cooperation and the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants. Australia has supported countries through the transfer and tailoring of measurement, reporting and verification technology as described in section 7.3 of this chapter.

Mission Innovation

Australia has committed to double its public investment in clean energy research and development by 2020 as part of the global Mission Innovation initiative. We are working with other countries to bring our best researchers together to address new challenges and accelerate technology breakthroughs. For example, we are seeking to establish cooperation on hydrogen technology through Mission Innovation under the Converting Sunlight Innovation Challenge.

Global Carbon Capture and Storage Institute

The Global Carbon Capture and Storage Institute (Global CCS Institute) was established by the Australian Government in 2009 to address the barriers to the commercial deployment of carbon capture and storage (CCS) through fact-based advocacy and knowledge-sharing activities. The Institute shares lessons learned 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, policy makers, researchers and others with an interest in the deployment of CCS, and was originally supported by AUD270 million from the Australian Government. The Global CCS Institute is headquartered in Melbourne with offices in Washington DC, Brussels, Beijing and Tokyo.

The Clean Energy Ministerial

The Clean Energy Ministerial (CEM) is a global forum to promote policies and share best practices to accelerate the global transition to clean energy. CEM initiatives and campaigns help reduce emissions, improve energy security, provide energy access and sustain economic growth.

Participation in the CEM is action-oriented and flexible and clean energy initiatives and campaigns are based on areas of common interest. Countries lead or support initiatives and campaigns matching their national priorities.

The initiatives are grouped into four theme areas:

- Energy Demand: initiatives helping countries and industries increase energy efficiency, increase energy productivity, and effectively manage energy demand.
- Energy Supply: initiatives accelerating deployment of clean energy supply technologies, such as solar and wind.
- Energy Systems and Integration: initiatives accelerating the pace of decarbonisation in global power systems while extending energy access.
- Crosscutting Support: initiatives advancing workforce diversity and building policy expertise to support a more rapid transition to clean energy.

The CEM comprises ten initiatives and seven campaigns. Australia is a member of four: the Clean Energy Solutions Centre (CESC); the Super-efficient Equipment and Appliance Deployment initiative; the International Smart Grid Action Network; and the Clean Energy Education and Empowerment Women's Initiative.

The CESC has been co-led and co-funded by Australia and the US since its inception in 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 supporting a community of energy policy experts, and an expert assistance service for policy makers. The majority of CESC users are from developing countries.

The International Renewable Energy Agency (IRENA)

IRENA is a treaty-level inter-governmental organisation of more than 150 member states. IRENA aims to work with member countries and international organisations to accelerate the development and deployment of renewable energy. The Australian Government ratified the statute of IRENA in January 2011 and served as a member of the IRENA Council from its inception until April 2013.

Australia contributes to IRENA's Global Renewable Energy Atlas and other products and resources IRENA is developing to support developing countries grow renewable energy resources and industries. Since 2010, Australia has assisted IRENA with its engagement with Pacific Island countries, including by providing assistance to IRENA's first Pacific Island Renewable Energy Experts Meeting in Sydney.

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. Under the JCG, Australia works closely with China's National Energy Administration on a range of collaborative low emission fossil fuel technology activities.

Table 7.1: Description of selected projects or programmes that promoted practicable steps to facilitate and/or finance the transfer of, or access to, environmentally-sound technologies (as per Table 6 of UNFCCC National Communications Guidelines)

Project / programme title:			
Pacific Appliance Labelling and Standards Program (PALS)			
Purpose:			
Assist Pacific Island countries to implement standards and labelling regulations for appliances such as refrigerators, air conditioners and lighting.			
Recipient countries	Sector	Total funding	Years in Operation
Cook Islands, Fiji, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu	Energy	A\$3 million	2012-2017
Description:			
Australia has funded the PALS Program in partnership with the Secretariat of the Pacific Community, which represents 22 Pacific Island countries and territories. 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, and Fiji has put in place legislation.			
Indicate factors which led to project's success:			
Working with a trusted regional partners (Secretariat of the Pacific Community)			
Working with the appropriate government officials to design standards, labelling and legislation			
Technology transferred:			
Facilities and capacity building to facilitate the dissemination of more energy efficient household appliances, including lighting testing equipment, registration databases and technical training.			
Impact on greenhouse gas emissions/sinks (optional):			
Introducing appliance energy efficiency standards and labelling in the Pacific region could reduce emissions by up to 2.2 Mt CO ₂ -e.			

7.5 MEASURES RELEVANT TO THE IMPACT OF RESPONSE MEASURES

Australia routinely considers the impacts of its climate change response measures. Overall, the economic cost of reducing emissions is lower than the cost of inaction on climate change.¹² While action on climate change has significant economic, social and environmental benefits, particularly for developing countries most vulnerable to climate impacts, Australia seeks to identify possible impacts of climate action and minimise any negative economic and social consequences.

Australia's bilateral consultations and engagement in international platforms, such as the UNFCCC Forum on the Impact of the Implementation of Response Measures, helps build understanding of positive and negative impacts. It allows countries to raise concerns and suggest ways to minimise adverse impacts.

Australia provides a range of assistance (see sections 7.21 and 7.4 of this chapter) designed to encourage economic diversification and transition, thus helping developing countries become more resilient to the economic and social impacts of response measures on developing countries. Mandatory safeguards requirements apply to all Australian aid investments, including our bilateral climate finance program, to ensure potential adverse social and environmental impacts are identified and adequately addressed.

12. Stern, N. (2006). What is the economics of climate change? *World Economics - Henley on Thames 7(2)*; Garnaut, R. (2008). *The Garnaut climate change review*. Cambridge, Cambridge; Garnaut, R. (2011). *The Garnaut review 2011: Australia in the global response to climate change*. Cambridge University Press.



8. RESEARCH AND SYSTEMATIC OBSERVATION

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Key developments

Australia has made substantial progress in climate science research since the Sixth National Communication on Climate Change.

Research efforts have led to a greater understanding of the El Niño Southern Oscillation and Indian Ocean Dipole. These climate processes are a major influence on Australia's rainfall and seasonal weather patterns.

Australia continues to be a leader in research in the Southern Ocean and Antarctica. This research improves understanding of the Southern Ocean's role in moderating the Earth's average surface climate and how heat and carbon dioxide move into the ocean interior.

Regionally, Australia plays an important role in systematic observation. Observations contribute to global advancement and understanding of climate science. For example, Cape Grim Baseline Air Pollution Station, on Tasmania's west coast, is one of the three premier Baseline Air Pollution Stations in the World. Air samples have been collected at Cape Grim since the mid-1970s to show changes in greenhouse gas levels and other air pollutants over time.

Australian scientists continue to make valuable contributions to global understanding of climate change. Australians have acted as authors or editors on the International Panel on Climate Change (IPCC) Reports, including contributing to the Sixth Assessment Report and the special reports on oceans and land. Australia used its national climate model (ACCESS) to simulate past climate, and provide future climate projections for a range of future greenhouse gas and aerosol concentration scenarios. These projections contribute to international modelling for the Coupled Model Intercomparison Project Phase 6 underpinning components of the IPCC's Sixth Assessment Report.

The Australian Government has established a National Climate Science Advisory Committee to set Australia's future climate science research priorities and develop a national strategy. The Committee drives collaboration across climate science agencies and will assist in enhancing Australia's climate science research capability.

8.1 GENERAL POLICY ON AND FUNDING OF RESEARCH AND SYSTEMATIC OBSERVATION

In 2016, the Australian Government established [Innovation and Science Australia](#) as an independent statutory body responsible for providing strategic, whole of government advice on science, research and innovation matters. Innovation and Science Australia is reviewing the performance of the innovation, science and research system in Australia and developing a strategic plan to 2030. The Plan will identify investment and infrastructure priorities and areas for consideration by government.

In this context, the [National Science Statement](#) sets long-term science objectives and principles for the Australian Government. The Statement provides a framework to guide science policies and initiatives into the future.

The Government established an independent [National Climate Science Advisory Committee](#) in 2016 to inform the future direction of Australia's climate science capability and research priorities. The Committee is developing a national climate science strategy to identify national research priorities and guide investment in current and future climate science research. The strategy will articulate the benefits of Australia's climate science research effort and identify further opportunities for international collaboration.

The Committee includes senior representatives from across Australian climate science research, investment and policy agencies and institutions. This broad representation will nurture and facilitate collaboration across agencies and sectors to improve coordination and prioritisation of climate science activities.

8.1.1 Key science and research organisations

The Australian Government provides climate science and information for decision makers in government, business and the community to better understand impacts of changing climate and manage risk. This includes the ongoing contribution of science and research organisations and funding for major research programs. State and territory governments contribute funding to many research programs and collaborate with Australian Government research organisations and programs.

The [Commonwealth Scientific and Industrial Research Organisation](#) (CSIRO) is the national agency for scientific research in Australia. CSIRO research includes climate adaptation and mitigation; modelling and observing systems needed to monitor, understand and predict climate variability; investigation of the impact of weather and climate variability and change; and research into emissions reduction technologies.

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.

The [Collaboration for Australian Weather and Climate Research](#) (CAWCR) is a research partnership between CSIRO and the Bureau, focused on the Earth's climate system. CAWCR has undertaken Earth system science, with emphasis on weather and ocean forecasting, seasonal prediction, climate variability and change, and science to support national responses to weather and climate-related hazards.

The [Australian Institute of Marine Science](#) is Australia's premiere tropical marine research agency. It provides large-scale, long-term and world-class research to inform governments, industry and the community's decisions about the management of Australia's marine estate. The Institute creates tools to enable improved planning and decision making. The Institute's research seeks to sustain and repair marine ecosystems in the face of a changing climate.

Other national agencies contributing to Australia's science and research efforts include [Geoscience Australia](#) which provides geological and geographic information, and the [Australian Nuclear Science and Technology Organisation](#), which provides specialised advice on nuclear science and technology.

8.1.2 Major research programs

Climate research is supported by the [National Collaborative Research Infrastructure Strategy](#) (NCRIS) which drives research excellence and collaboration between 35,000 researchers, government and industry. Since 2004, the Australian Government has invested over \$2.8 billion to deliver world-class research infrastructure. This has attracted more than \$1 billion in co-investment from state and territory governments, universities, research facilities and industry. [Infrastructure projects funded by NCRIS](#) include the Integrated Marine Observing System, Terrestrial Ecosystem Research Network and the National Computational Infrastructure.

The NCRIS network supports national research capability through 27 active projects and comprises 222 institutions, employing over 1,700 highly skilled technical experts, researchers and facility managers. NCRIS facilities are used by over 35,000 researchers, both domestically and internationally.

The [2016 National Research Infrastructure Roadmap](#) outlines national research infrastructure required over the coming decade to ensure Australia's world class research system continues to improve productivity, create jobs, lift economic growth and support a healthy environment. The [2016 Roadmap was provided to the Australian Government in February 2017](#).

The [National Environmental Science Program](#) (NESP) is a long-term commitment by the Australian Government to environment and climate research. NESP has funding of \$145 million over the six years from 2015 to 2021. It supports six themed research hubs, along with projects to address emerging environmental research needs. NESP research has impact through partnerships and collaboration between policy makers and scientists, delivering practical and applied science to inform environmental decision making.

The six themed research hubs are:

- [Earth Systems and Climate Change Hub](#)
- [Clean Air and Urban Landscapes Hub](#)
- [Marine Biodiversity Hub](#)
- [Northern Australia Environmental Resources Hub](#)
- [Threatened Species Recovery Hub](#)
- [Tropical Water Quality Hub](#).

The \$23.9 million Earth Systems and Climate Change Hub intends to improve climate and weather information for Australia through a greater understanding of the drivers of Australia's climate. Other hubs are supporting research into climate change adaptation, such as the \$8.88 million Clean Air and Urban Landscape Hub which has a focus on Australia's urban areas.

The Earth Systems and Climate Change Hub builds on research undertaken through the Australian Climate Change Science Programme (1989–2016). The Hub expands on the legacy program by building a national partnership with world-leading capability in multi-disciplinary Earth systems, climate change science and modelling. The Hub is led by CSIRO in partnership with: the Australian National University, Bureau of Meteorology, Monash University, University of Melbourne, University of New South Wales and University of Tasmania. The goal of the Hub is to provide Earth systems and climate change science to inform Australia's policies and management decisions.

The Hub's research priorities are:

- Improving observations and understanding of past and current climate
- Improving understanding of how the climate systems may change in the future
- Building the utility of Earth systems and climate change information.

The Hub's research will be used to generate data, information, products, tools and services for end users including [government](#), the [private sector](#), non-government organisations, and Australian communities.

The [Australian Antarctic Science Program](#) is led and managed by the Australian Antarctic Division of the Department of the Environment and Energy and delivered in collaboration with Australian and international research institutions. Through the [Australian Antarctic Strategy and the 20 Year Action Plan](#) (released in 2016), the Australian Government is providing \$255 million over the next ten years to enhance Australia's Antarctic logistics and science capabilities.

In 2017 the Australian Government confirmed funding of \$49.8 million to provide continued year round support for high priority science and long-term monitoring on the World Heritage Listed Macquarie Island. In addition, the Government has invested \$1.9 billion in a new icebreaker vessel to support Australia's scientific research and leadership in Antarctica.

The [Australian Antarctic Science Strategic Plan](#), released in 2014, will improve the understanding of the role of the east Antarctic and adjacent Southern Ocean in the global climate system, with a focus on addressing critical gaps in knowledge identified by the IPCC. The program identifies priority research areas including: ice sheet and sea level; southern ocean and sea-ice; atmosphere and weather; and past climate and ice cores.

The [Antarctic Climate and Ecosystem Cooperative Research Centre](#) (ACE CRC) is Australia's largest institution for Antarctic and Southern Ocean climate and ecosystem research. It has established itself as a world leader in polar and southern hemisphere climate research. ACE CRC is a partnership of seven core participants, including the Australian Antarctic Division, Bureau of Meteorology, CSIRO and University of Tasmania, with thirteen national and international supporting research and commercial organisations. The ACE CRC leads Australia's effort to understand the roles of Antarctica and the Southern Ocean in the global climate system and climate change. The work of the ACE CRC is supported by many of the other institutions which together create a cluster of climate research expertise in southern Tasmania.

The [Antarctic Gateway Partnership](#) is an Australian Government funded initiative to build further polar research capability in Tasmania. The Partnership recognises Tasmania's expertise as a global leader in Antarctic and Southern Ocean science and as a gateway for Antarctic research, education, innovation and logistics. The partnership involves the University of Tasmania, Institute for Marine and Antarctic Studies, Australian Maritime College, CSIRO, and the Australian Antarctic Division. The research undertaken by the Partnership complements the work of the ACE CRC. This includes the development of a new remotely operated underwater vehicle that will be specifically designed to address the challenges of Antarctic waters but applicable in any ice-covered environment. Funding of \$24 million over three years for the Antarctic Gateway Partnership is being provided through the Australian Research Council's Special Research Initiatives scheme.

In 2016, Australia established the [CSIRO Climate Science Centre](#), to bring together the core of CSIRO's capability in climate modelling and projections; and observations, analyses and modelling of the atmosphere, ocean and climate system. The mission of the Centre is to deliver the climate knowledge Australia needs to inform an effective national response to the challenges of a variable and changing climate. Research in the Centre will:

1. Take a leading role in national observing programs and networks in the oceans and atmosphere, such as the Integrated Marine Observing System (IMOS); the Cape Grim Science Program; ocean physics and chemistry; greenhouse gas, and aerosols observing networks.
2. Make observations and analyses to better understand and assess climate change and variability in the past, present and future; climate and ocean dynamics; and carbon – climate feedbacks.
3. Build a multi-annual to decadal climate forecasting system, and associated process studies and data assimilation systems.
4. Develop Australian Community Climate and Earth System Simulator (ACCESS) in partnership with the Bureau of Meteorology and universities to provide a national weather, climate and Earth System modelling capability for operations and research.
5. Develop and deliver:
 - the Community Atmosphere Biosphere Land Exchange (CABLE) to be a world-class, community land surface model, for use in weather, climate and Earth System modelling, and resource management, applications
 - air quality assessments and forecasts for communities, industry and regulatory authorities
 - ocean and coastal forecasts for national security, marine industry, emergency response, and management of marine resources
 - national and regional climate forecasts and projections for climate impact assessments, and to inform climate adaptation and mitigation responses
 - targeted climate, ocean and atmospheric observations, products and services
 - renewable energy resource assessments and forecasts to research and technology partners
 - assessment of environmental impacts of unconventional gas extraction.

The CSIRO Climate Science Centre values national and international partnerships. In May 2017, the [Centre for Southern Hemisphere Oceans Research](#) (CSHOR) opened within the CSIRO Climate Science Centre. CSHOR focuses on the role of the Southern Hemisphere oceans in the global climate. The CSHOR is a collaboration between CSIRO, China's Qingdao National Laboratory for Marine Science and Technology, with support from the University of Tasmania and the University of New South Wales. CSHOR's research includes a new initiative launched in 2016 to develop and test a decadal forecasting system. With 10 years of committed funding (\$37 million) and 15 research staff, the project will consider the processes influencing multi-annual to decadal climate variability in the Australasian region. The results of this project will support decision-makers across numerous industry sectors (e.g. agriculture, energy, water, health, financial and insurance sectors) to manage the risks and opportunities arising from decadal variations in climate.

Universities across Australia are active in various aspects of climate change research, from ocean and terrestrial observational studies to emissions reduction and adaptation responses. This includes a number of climate change focused centres and collaborations.

The [Australian Research Council's \(ARC\) Centre of Excellence for Climate System Science](#), established in 2011, continues to focus on climate system research. It brings together the expertise of five Australian universities and a suite of outstanding national and international Partner Organisations including the UK Met Office Hadley Centre. The Centre builds on existing understanding of regional climate modelling to enhance responses to the impact of a changing climate, particularly in the Australian region.

A new [ARC Centre of Excellence for Climate Extremes](#) commenced in 2017 focused on understanding and prediction of climate extremes. The Centre brings together data and information from universities to reduce vulnerability to climate extremes and enhance forecasts of how extreme events will change in the future. The Centre aims to use its researchers, data, modelling, and collaboration to transform Australia's capacity to predict climate extremes. The Centre has four core research programs: extreme rainfall, heatwaves and cold air outbreaks, drought, and climate variability.

The Centre extends the research collaboration of the [ARC Centre of Excellence for Climate System Science](#) and includes researchers from the [Australian National University](#), [Monash University](#), the [University of Melbourne](#), [University of New South Wales](#) and the [University of Tasmania](#). The New South Wales Government is a partner in the Centre of Excellence for Climate System Science and the Centre for Climate Extremes.

The [Cooperative Research Centre \(CRC\) for Low Carbon Living](#) is a national research and innovation hub working with industry and academic partners to establish a globally competitive low carbon built environment sector in Australia. The CRC brings together property, planning, engineering, and policy organisations with leading Australian researchers. The CRC develops new social, technological and policy tools for facilitating the development of low carbon products and services to reduce greenhouse gas emissions in the built environment.

The Bushfire and Natural Hazards CRC is funded by the Australian Government and conducts research programs on natural disasters in Australia, including research on climate change adaptation, and climate related disaster events. The Centre conducts coordinated and interdisciplinary research, and supports the development of cohesive, evidence-based policies, strategies, programs and tools to build a more disaster resilient Australia.

State and territory government policies and programs are discussed in Chapter 4 and Chapter 6. A selection of major state and territory focused research programs is set out below.

The New South Wales (NSW) and Australian Capital Territory (ACT) Governments have contributed to research on future regional climate conditions via the [NSW and ACT Regional Climate Modelling \(NARClIM\)](#) project and the NSW Government has led the [Eastern Seaboard Climate Change Initiative](#) investigating the behaviour of coastal storms and how they influence extreme rainfall, coastal processes and water security in southeast Australia. Climate change adaptation activities in NSW are supported by research conducted by the NSW Adaptation Research Hub, resourced through co-investment with leading NSW universities. The Hub delivers research outcomes tied to adaptation policy and operational priorities.

NSW has established an Energy and Resource Efficiency Research Hub to investigate opportunities to reduce greenhouse gas emissions and save energy across NSW. The Hub operates through collaboration, knowledge exchange and co-investment.

The NSW Government supports the expansion of these activities and greenhouse gas mitigation efforts through research to promote the use of renewable energy and energy efficiency. NSW Government agencies are partners in several Australian Research Council Linkage Projects investigating the impacts of climate change on NSW, including on river estuaries, drought mortality for key tree species and marine food webs.

The [Victorian Climate Initiative](#) (2013–2016) was a three-year regional research initiative by the Victorian Government in partnership with the Bureau of Meteorology and CSIRO. It improved Victorian water resource planning and management by developing understanding of climate impacts on water availability. The research looked at past climate variability and change, seasonal climate prediction, and future climate and associated risks to water resources. The Victorian Government has provided additional funding to extend the work of the

Victorian Climate Initiative. The Victorian Department of Environment, Land, Water and Planning is collaborating with communities, local government, Indigenous groups, research institutions and the water sector to share knowledge and apply research to policy, planning and practice.

The [Goyder Institute](#) brings together South Australia's leading water research capabilities to find new ways to save, access and deliver water. The Institute is a partnership between the South Australian Government, CSIRO, South Australian Universities, and the International Centre of Excellence in Water Resources Management.

The Tasmanian Government continues to partner with communities, businesses and organisations to understand and address their needs in relation to climate projections. This includes a commitment by the Tasmanian Government, under [Climate Action 21](#), to invest in further research on Tasmania's climate change projections to ensure Tasmania has access to accurate and up-to-date climate science for decision making.

8.2 RESEARCH

Australian climate change science research falls into four key categories:

1. process studies and research into the impacts of climate change – examining the mechanisms driving climate change, its effects and informing approaches to adaptation and mitigation.
2. climate monitoring and analysis - to measure climate variables.
3. climate models – using simulations of past, current and future climate scenarios to help Australia better understand climate and project future climate, at both global and regional scales.
4. emissions reduction technologies – developing technologies that reduce emissions.

8.2.1 Climate process studies and research into the impacts of climate change

8.2.1.1 Tropical ocean influences - El Niño–Southern Oscillation and the Indian Ocean Dipole

Understanding of the drivers of Australian climate variability and their causes, and how they may change in a changing climate has transformed in recent years. The tropical Indian and Pacific Oceans play a large role in dictating Australia's climate variability. The state of the Pacific Ocean can be described by the phase of the El Niño–Southern Oscillation (ENSO) via its two extremes – El Niño and La Niña.

El Niño and La Niña markedly alter risks associated with drought, flood and severe weather in many countries, including Australia, from one year to the next. El Niño events are often associated with drier than normal conditions across eastern and northern Australia, while La Niña events are often associated with wetter than normal conditions in these regions.

Research from the NESP Earth Systems and Climate Change Hub (building on the work of the Australian Climate Change Science Programme) produced a breakthrough in the understanding of these climate processes. It showed, for the first time, the impact of El Niño and La Niña on Pacific rainfall is projected to intensify over the coming century. The research found the frequency of major disruptions to Pacific rainfall caused by ENSO has already increased, and will continue to increase with a risk of major rainfall disruption locked in for the 21st century, even if global warming is restricted to below 2°C.

The state of the Indian Ocean also influences Australia's climate. The Indian Ocean Dipole has been identified as an important mode of variability, particularly when it aligns with the phase of ENSO to enhance impacts across Australia.

In the Indian Ocean, the positive phase of the Indian Ocean Dipole means warmer than normal waters in the western Indian Ocean can change the path of weather systems coming from Australia's west. As a result, southern and south-east Australia experience less rainfall and higher temperatures during winter and spring. Drawing on observations and climate model simulations, Australian Climate Change Science Programme researchers showed the positive Indian Ocean Dipole affects bushfire risk and severe droughts over south-east Australia. Recent research under NESP Earth Systems and Climate Change Hub showed the frequency of extreme Indian Ocean Dipole events is expected to increase over the 21st century in response to high emissions.

For southern Australia, the intensity of the impacts from the state of ENSO and the Indian Ocean Dipole can be further amplified or muted depending on the phase of the Southern Annular Mode. Findings from the Victorian Climate Initiative indicate that the observed warming of the waters to the north of Australia can also enhance the influence from La Niña and Southern Annular Mode. Along with the expansion of the tropics, research under the Victorian Climate Initiative highlights the complex interplay between these factors, which drives the strong variability of Australia's climate and contributes to the robust trend towards cool seasons with less rainfall.

In a warming climate, the impact of El Niño on tropical rainfall is likely to intensify, and the frequency of extreme El Niño events will increase. A warming climate also leads to more frequent extreme La Niña events, and more frequent consecutive extreme climate events (an extreme El Niño preceded by an extreme positive Indian Ocean Dipole event and followed by an extreme La Niña).

The northern Australian climate has a pronounced seasonal rainfall cycle with monsoons. Australian Climate Change Science Programme research found ENSO changes and warming over the Indian Ocean may lead to a delay in the onset of the Australian monsoon in the future. NESP Earth Systems and Climate Change Hub research also determined Australian monsoon rainfall could become more variable on a range of time scales, from daily to year-to-year to decadal, by the end of this century due to increasing emissions.

Projections of rainfall change in northern Australia vary between models, with some projecting large increases while others project large decreases. Work is continuing to better understand why some models project a much wetter or much drier future. It is not clear whether the main cause of recent observed increases in northwest Australian rainfall is increased greenhouse gases or other factors such as aerosols or natural decadal variability.

8.2.1.2 Extreme climate events, including fire weather

Extreme climate events, experienced in Australia, include heat waves, cold snaps, tropical cyclones, storm surges, floods, droughts and bushfires. They can have a serious impact on the environment and society, including loss of life, property and livelihoods. While many extreme events are primarily due to natural climate variability, there is increasing evidence that the number and intensity of extreme events may be changing, partly as a result of human influence on climate. The NESP Earth Systems and Climate Change Hub continues to build on climate extremes research completed through the Australian Climate Change Science Programme.

This research has improved understanding of tropical cyclone formation. Researchers found distinct regional differences in favourable conditions for tropical cyclone formation across the Australian region. The research developed a method to identify geographic boundaries for regions where tropical cyclones can and cannot form. Under the NESP Earth Systems and Climate Change Hub the method will be applied to increase confidence in projections of tropical cyclone numbers. Projections from earlier work under the Australian Climate Change Science Programme using two other tropical cyclone detection methods show a decrease in tropical cyclone numbers in the west, but a possible increase or little change in the east towards the end of the century.

The Bureau of Meteorology issues 'Fire Weather Warnings' when weather conditions are conducive to the spread of dangerous bushfires. A key piece of research into fire weather was completed through funding from the NESP Earth Systems and Climate Change Hub and the Bureau of Meteorology. The McArthur Forest Fire Danger Index was calculated based on analysis of daily observations data from 1950–2016 throughout Australia. This dataset provides an indication of how extreme the regional conditions were for a particular period (week, month or season) as compared with conditions experienced previously (back to 1950). This work also developed a system that automatically updates daily to provide the latest information. Fire agencies around the country now receive this information to inform their understanding of the severity of current conditions relative to the past climate.

East coast lows are intense low-pressure systems which occur on average several times each year off the eastern coast of Australia, in particular across southern Queensland, NSW and eastern Victoria. East coast lows can generate storm force winds along the coast, heavy widespread rainfall leading to flash or major river flooding, and very rough seas over coastal and ocean waters which can cause damage to the coastline. Research on east coast lows showed these weather systems are the sole cause of seven metres high or higher waves along the central and southern parts of Australia's east coast.

East coast lows are, however, important for water security, contributing the heavy soaking rainfall that fills dams along the east coast and adjacent Tablelands. Researchers in NSW have shown that under high greenhouse gas emissions, there could be 20 per cent fewer winter-time east coast lows by the end of the century. Climate change may affect the intensity, frequency and duration of east coast lows with implications for coastal erosion, inundation, flooding, and water security. The NSW Government's [Eastern Seaboard Climate Change Initiative](#) investigated past, recent and future east coast lows and their effects on rainfall, coastal processes and water security in southeast Australia. Climate modelling based on the NSW and ACT Regional Climate Modelling Projections indicate a decrease in the number of small to moderate east coast lows in the cool season with little change in these storms during the warm season. However, extreme east coast lows in the warmer months may increase in number but extreme east coast lows in cool seasons may not change. The Eastern Seaboard Climate Change Initiative found that there are several types of east coast lows, and this affects the storm's impacts, and that clustering of storms may be more important than individual storms.

8.2.1.3 Better understanding of the Oceans surrounding Australia, including the Southern Ocean

The Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) has contributed important new insights into the role of Antarctica and the Southern Ocean in past, present and future climate and sea level. Highlights include studies documenting rapid changes underway in the Antarctic bottom water layer. These include reduction in the salinity of dense shelf water and a subsequent decrease in density of bottom water in the deep ocean following calving of the Mertz Glacier Tongue in February 2010.

The Integrated Marine Observing System (IMOS) provides much of Australia's contribution to global ocean observing for climate. IMOS facilities include Argo profiling floats, animal tracking, surface ocean carbon, ocean acidification and Southern Ocean moorings.

Australia's Argo program has contributed to the comprehensive study of the world's oceans, revealing the ongoing and steady rise of global ocean heat content, occurring predominantly in the Southern Hemisphere and extending down to 2000 metres and deeper. Australia is the third largest contributor of active floats to the global Argo array (after the USA and Japan). Argo floats provide measurements of temperature, salinity and currents in the upper 2000 metres of the ocean.

The Southern Ocean data from Argo is helping to understand the important role of the Southern Ocean in moderating the Earth's average surface climate. The Southern Ocean is the major location where heat and carbon dioxide move into the ocean interior (the water between the bottom and surface layers of the ocean).

Data gained from animal tracking, has helped to understand more about Antarctica's ice shelves, and to monitor temperature changes. Data from tagged animals helped reveal that fresh water from Antarctica's melting ice shelves slows the production of powerful deep-water ocean currents responsible for regulating global temperatures.

Scientists are contributing to international Southern Ocean research. Their data on the Southern Ocean carbon cycle has allowed a re-assessment of the variation in transfer of carbon dioxide between the Southern Ocean and the atmosphere over the past decade (the surface ocean carbon dioxide atlas (SOCAT)). The SOCAT data revealed the Southern Ocean is again absorbing carbon dioxide in proportion to the rise in atmospheric carbon dioxide concentrations, after a period during which uptake slowed.

Research into ocean acidification rates in Antarctic coastal waters shows acidification is occurring at nearly twice the expected rate. This is the result of reduced primary production which counters acidification by fixing carbon dioxide into organic matter. Australian scientists determined these rates by comparing full seasonal records obtained near Australia's Davis Station with previous work in the 1990s.

Scientists have collected the first ocean observations near the Totten Ice Shelf, the largest glacier of the largest ice sheet in the world. The unprecedented results, published in 2016, show the East Antarctic Ice Sheet is more vulnerable to climate change than previously thought. The ice sheet is melting rapidly as warm water is flowing in below the ice shelf and will contribute substantially to future sea-level rise. This is counter to long-standing expectations East Antarctica was isolated from warm ocean waters. Phase sensitive radars installed on the Sørsdal and Totten Glaciers are collecting the first direct measurements of ice shelf basal melt and its connection to ice flow.

8.2.1.4 Cryospheric climate processes

The Australian Antarctic Science Program has undertaken 56 projects on Antarctica and Southern Ocean climate research since the 2012–13 Antarctic summer season. These projects cover the cryosphere (places where water is in solid form, frozen as ice or snow) from ice-sheets and sea-level to oceanography, sea-ice, atmospheric processes, and paleoclimate. They are contributing to international knowledge of the long-term climate of Antarctica, the Southern Ocean and the globe more generally, and how the oceans, atmosphere, cryosphere and ecosystems interact on a wide-range of spatial and temporal scales. The Program undertakes strategic scientific research to address current national and international scientific priorities, conducts a range of unique and long-term measurements in the Antarctic region, and informs a variety of international assessments, conventions and bodies.

Extensive regions of uncharted bedrock in East Antarctica have been mapped using airborne geophysical surveys as part of the International Climate and Environmental Change Assessment Project. This work has identified potential for large scale ice sheet retreat with over three and a half metres of sea-level equivalent in the Totten Glacier catchment—a region exhibiting overall ice loss through much of the last two to three decades. Integrated studies combining oceanographic measurements in the coastal shelf seas with modelling and airborne data are shedding light on ocean-driven changes in Totten in the East Antarctic.

Antarctic researchers conducted a free ocean carbon dioxide enrichment experiment to estimate the effects of ocean acidification on benthic habitats. This was the world's first in-situ polar sea floor carbon dioxide enrichment experiment exploring the impact of rising ocean acidity on sea life in a natural Southern Ocean benthic community.

Sea-ice research included a seven week voyage to the sea-ice zone off East Antarctica to examine the physics, chemistry and biology of the sea-ice zone. The integrated study used autonomous and remotely controlled vehicles to make intensive measurements of ice thickness and processes. The work extended two previous studies in the same region, providing a longer term perspective on sea-ice processes.

Australian scientists have gained new insights to help predict the impact of variations in ozone levels on the climate in the Antarctic and Southern Ocean. This research is being used to model future scenarios through the first [Chemistry-Climate Model Intercomparison](#) project (CCMI-1) and feeds into the quadrennial assessments of ozone depletion undertaken by the United Nations Environment Programme and the World Meteorological Organisation.

8.2.1.5 Paleoclimatic studies

Australian research is contributing to international knowledge of past climates and how climate has changed over time.

The ACE CRC has contributed to syntheses of regional, continental and hemispheric paleoclimate studies. This work has brought together climate data from ice cores, corals, sediments and tree rings to identify:

- human-induced global warming from about 180 years ago
- Antarctic climate variability at regional and continental scales over the last 2000 years
- a review of regional Antarctic snow accumulation over the past 1000 years
- development of a global database of paleo-water isotopes covering the past 2000 years.

The Australian Antarctic Science Program ice core paleoclimate studies focused on the Past Global Changes (PAGES) Project for 2000 year records. This study synthesised high resolution Antarctic ice core data to provide the first Antarctic continental temperature reconstructions for the last 2000 years.

The Australian Antarctic Science Program contributed to Southern Hemisphere climate reconstructions using the PAGES paleoclimate database. This included studies of relationships between Antarctic ice core proxies and Australian rainfall, which have since been developed by researchers at ACE CRC and the Australian Antarctic Division to support hydrological studies.

The Queensland Government collaborated with research agencies on a pilot project based on the PAGES work to incorporate paleoclimate data into water security planning in a Queensland context. The pilot:

- demonstrated the use of a paleoclimate approach in producing robust catchment statistics
- improved insights into the characteristics and risk of hydroclimate extremes in South East Queensland for water security planning
- supported South East Queensland water managers to optimise risk strategies and solutions.

This paleoclimate information confirmed the post-1900 period does not capture the full range of variability that has occurred. Further research is being considered to apply this method across Queensland.

The NSW Government's [Eastern Seaboard Climate Change Initiative](#) examined the paleo-climate record of the last 1200 years and discovered that the period from 1600–1900 was much stormier than now along the eastern seaboard of NSW. During these centuries there were many more decades of high and persistent storm activity than we see today.

CSIRO, working closely with the Australian Antarctic Division, analyse air extracted from ice cores and firn ice to reconstruct the long-term record of atmospheric greenhouse gas concentrations over the last 800,000 years, which extends the recent instrumental record. These data are used as input to the global climate models used in the Coupled Model Intercomparison Project (CMIP) and also to advance our understanding of the feedbacks between the carbon cycle and climate.

8.2.2 Modelling and Prediction

8.2.2.1 Australia's Weather, Climate and Earth System modelling system

As detailed in the Sixth National Communication, scientists have developed a weather and climate model for Australia using earth system modelling—the Australian Community Climate and Earth-System Simulator (ACCESS). ACCESS represents a huge advance over earlier, simpler climate models, and is tested and fed by data from earth-observing satellites and other climate sensors.

ACCESS creates models and modelling outcomes to:

- 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
- enable Australia to contribute appropriate climate projections and scenarios for inclusion into the IPCC Sixth Assessment Report and future scientific assessments.

ACCESS has been further developed since the submission of Versions 1.0 and 1.3 to the IPCC's Coupled Model Intercomparison Project Phase 5. ACCESS 1.4 is the basis of Australia's first Earth System model (ACCESS-ESM1) and a new climate and Earth system model ACCESS-CM2/ESM2. Further improvements are being made with investment from the National Environmental Science Program and CSIRO. ACCESS 1.4 will be upgraded to provide enhanced resolution, and include carbon and biophysical processes to provide a more complete Earth system modelling capability.

One of the major achievements of ACCESS is the improvement of weather forecasts. The atmospheric component of ACCESS is the basis for the Bureau of Meteorology's new multi-week and seasonal forecast system (ACCESS-S), due for release in February 2018. This system will greatly improve seasonal prediction capability, the ability to prepare for extreme events, and decision making on seasonal time scales. This will deliver economic benefits and enhance our resilience to climate variability.

In early 2015, CSIRO and the Bureau of Meteorology released [Climate Change in Australia](#), a website with the most comprehensive set of regional climate projections ever developed for Australia.

Several state and territory governments have used ACCESS to undertake climate modelling for their region; these are discussed in detail in Chapter 6.3: Climate Change Projections. This modelling assists state, territory and local governments to plan for the impacts of a changing climate. State and regional climate modelling and prediction includes:

- The NSW and ACT governments completed fine-scale climate projections from the NARClIM project to assess a wide range of climate change impacts, including impacts on heatwaves, storms, bushfire, soil, water resources, biodiversity and agriculture. Further climate change impact assessments are underway. For example, the NSW government has built on this work to assess climate change impacts, such as impacts on water availability, bushfire, biodiversity and habitat, soil erosion and agriculture, in NSW alpine areas.
- The [Victorian Climate Initiative](#) (2013–2016) was a regional research initiative to improve understanding of past climate variability and change, seasonal climate prediction, and future climate and the associated risks to water resources. Data on climate variability, predictability, and change is being used to improve predictions of water availability in the short term (seasonal to inter-annual timescales). The data will underpin an improved assessment of the risks to water supplies from changes in climate over the medium to longer term.
- Since 2010, Tasmania has applied downscaled climate projections to planning and decision making. These projections were developed by the [Climate Futures for Tasmania](#) project. This project was undertaken by ACE CRC with funding from the Tasmanian Government and other parties.
- In 2016, the Queensland Government released downscaled climate change projections providing high resolution data for Queensland's regions at a 10 km grid for 11 climate models (See [High Resolution Climate Change Projection Data for Queensland](#)).
- In 2015, South Australia released SA Climate Ready which represents the most comprehensive set of downscaled climate projections data available for South Australia. Data is available through to 2100 for a number of climate variables including rainfall, maximum and minimum temperature and evaporation, for each of the state's individual rainfall stations.

The Australian Government has completed and published regional climate projections for Australia's 54 Natural resource management regions (2015) (see [Climate Change in Australia](#) website).

8.2.3 Research and development of mitigation and adaptation approaches, including technologies

The Australian Government supports development of mitigation and adaptation approaches including clean energy innovation across the spectrum of research and development, demonstration and deployment.

In June 2017, the Australian Government released a [Low Emissions Technology Roadmap](#). The Roadmap, prepared by the CSIRO, highlights opportunities to grow Australia's clean technology sector, fast track emissions reductions and be part of future global supply chains.

The roadmap considered the scope for new technology to reduce greenhouse gas emissions from the energy sector. This included electricity generation, heat production, direct combustion, transport, electricity and fuel consumption and fugitive emissions from coal mines, coal seam gas operations and gas pipelines.

It considered the mix of energy technologies that could be used if the energy sector is to make a greater contribution to meeting Australia's 2030 emissions reduction target (and longer term emissions reduction goals) at least cost, with a particular focus on technologies where Australia can become a major part of a global supply chain.

Based on research, modelling and consultation, the report found:

- Australia is endowed with energy-rich resources and is well positioned to benefit from innovation in low emission technologies.
- Energy productivity will remain important in reducing energy costs and emission levels throughout the transition to a low carbon economy.
- Modelling conducted as part of the report suggests new energy generation is likely to be mainly in wind, solar PV, storage and gas to meet Australia's 2030 emissions reduction targets.
- While the technology pathways are comparable in terms of cost, they carry different levels of commercial, technical, social and stakeholder risks.
- Given these risks, a technology neutral approach is recommended to support the lowest cost solutions to emerge.

The [Australian Renewable Energy Agency](#) (ARENA) provides research, development and deployment grant funding to improve the affordability and increase the supply of renewable energy in Australia. As at 30 June 2017, ARENA had committed around \$1 billion to over 317 projects. This has been matched by around \$2.5 billion in co funding, making the total over \$3.5 billion. These funds have supported projects spanning the commercialisation pathway, from research and development to demonstration and near-commercial deployment projects.

Funding from ARENA has helped to achieve 14 world or Australian-firsts, ten of which occurred in 2015–16. Projects have helped to break at least 11 solar cell efficiency world records, including a record for sunlight-to-electricity conversion efficiency using unfocused sunlight.

The \$200 million [Clean Energy Innovation Fund](#) supports early stage and emerging clean energy technologies. This fund is co-managed by ARENA and the Clean Energy Finance Corporation. Clean Energy Innovation Fund investments include:

- \$5 million to GreenSync, an innovative Melbourne-based company aiming to bring smart technology solutions to the energy grid of the future, as part of an \$11.5 million capital raising.
- \$10 million to the \$50 million capital raising of Carbon Revolution, a Geelong, Victoria-based company producing one-piece carbon fibre car wheels that, through their light weight, help reduce energy consumption and carbon emissions from lighter vehicles.
- \$10 million cornerstone commitment to the \$20 million Clean Energy Seed Fund to unearth and finance emerging innovations and start-ups in clean energy.

The Australian Government and private sector are supporting carbon capture and storage research, and development and demonstration activities, including:

- The **CarbonNet Project** (CarbonNet) is investigating the potential for a commercial scale carbon capture and storage (CCS) network in the Gippsland region of Victoria. The network could integrate multiple carbon dioxide (CO₂) capture projects in the Latrobe Valley, transporting CO₂ via a common-use pipeline and injecting it deep beneath the Gippsland Basin to be securely stored within suitable geological formations.
- The **Cooperative Research Centre for Greenhouse Gas Technologies Otway research facility** is Australia's first demonstration of the deep geological storage of CO₂. The facility demonstrates that carbon capture and storage is safe, cost-effective and meets the expectations of government and the community.
- The **CCS Research Development and Demonstration Fund** provides funding for carbon capture and storage projects with a particular focus on transport and storage. It supports the Australian Government's commitment to reduce the technical and commercial barriers to the deployment of large-scale CCS projects.

The Australian Government contributed funding and support for an industry-led [Carbon Capture and Storage Roadmap](#) for Australia, released in February 2017.

The Department of Foreign Affairs and Trade has committed \$4 million over five years (2017-2021) to the jointly-funded Australia-Germany Energy Transition Hub. The Hub will facilitate collaboration between five prominent Australian and German institutions¹³ to work together on challenges of developing sustainable clean energy for the future. It aims to develop and commercialise advanced energy innovation through coordination of research between Australian and German institutions, the public sector and industry.

State and Territory governments are contributing to research and development of adaptation and mitigation approaches. A selection of state government research is outlined below.

Victorian research is generating new options for reducing emissions and adapting to the impacts of climate change in the agriculture sector. This includes work from the [Primary Industries Climate Challenges Centre](#) (established in 2011 with the University of Melbourne) which is a research partnership to build the capacity of Victoria's primary industries to manage risks and opportunities of climate change.

New genetics, feeding systems and management practices have been developed in Victoria's dairy and lamb industries. These approaches reduce methane emissions, increase tolerance to and more effectively manage heat stress on cows, and increase the production of milk from cows and meat from sheep.

New tillage practices, crop options, and fertiliser strategies have been developed to reduce nitrous oxide emissions from soils, understand the impact of higher carbon dioxide levels on wheat and pulse crops, and develop new farming systems for the grains industry. The Australian Grains Free Air Carbon dioxide Enrichment facility, a collaboration between the Primary Industries Climate Challenges Centre partners Agriculture Victoria and the University of Melbourne, enables the exposure of field-grown crops to elevated carbon dioxide levels under dryland field conditions for research purposes.

New fruit orchard management practices have been developed to reduce the negative impacts of fewer chill days in pome and stone fruit [and smoke taint \(caused by wildfires\) in](#) wine, and to cope with reductions and variations in water allocations.

The Victorian Government is building climate-adapted public housing (2016–2018) designed to stay cool during hot days and heatwaves without active cooling. Several apartment buildings are being constructed and monitored; the project evaluation will inform future investment in public housing.

Over 30 distinct research projects have been delivered through the NSW Adaptation Research Hub, which is being expanded to harness more research capacity for the state's operational and policy adaptation priorities. The Hub is developing economic analysis of adaptation pathways for NSW regions to capture non-monetary benefits. Examples of non-monetary benefits include a more resilient environment and improved management of electricity supply to reduce peak loads.

The NSW Office of Environment and Heritage is working with the private sector and key asset owners to develop a tool to quantify direct weather and climate change risks to infrastructure, and identify opportunities to work together on responses. A pilot [Cross Dependency Initiative](#) project is underway in Sydney.

8.3 SYSTEMATIC OBSERVATION

Australia's Global Climate Observing System (GCOS) related activity is coordinated through the Bureau of Meteorology. Australia follows World Meteorological Organization policies on sharing data. Planning is undertaken to ensure appropriate correlation between Australian and international needs and the data collected.

The Bureau of Meteorology 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.

Australia makes many climate observations freely available on the internet. Where [additional data](#) must be provided manually, or when additional analysis is needed on data, charges may apply.

13. University of Melbourne; Australian National University; the Potsdam Institute for Climate Impact Research; Münster University's Centre of Applied Economic Research; and the Mercator Research Institute of Global Commons and Climate Change.

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 continuity of observations. The Bureau of Meteorology manages changes in site exposure where necessary and continues to transition manual stations to automated observations to support technology improvements and improved consistency.

The World Meteorological Organization has established the concept and criteria for Centennial observing stations which have a high quality, 100 year record of at least one climate variable. Three Bureau of Meteorology sites have been successfully nominated and approved as Centennial stations.

8.3.1 Atmospheric climate observing systems, including those measuring atmospheric constituents

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 the globe. As Australia's contribution to the Global Atmosphere Watch Programme, extensive data are collected for use in studies of sources and sinks of greenhouse and ozone-depleting gases and in assessments of future atmospheric concentrations. Measurement and analyses of these gases, for submission to the Global Atmosphere Watch Programme and the Advanced Global Atmospheric Gases Experiment, are supported by the Cape Grim Science Program.

Cape Grim is an important site, as the air sampled arrives at Cape Grim after long trajectories over the Southern Ocean, under conditions described as 'baseline'. This baseline air is representative of a large area of the Southern Hemisphere, unaffected by regional pollution sources (there are no nearby cities or industry to contaminate the air quality).

Air sampling is also conducted at Australia's research stations in the Antarctic and subantarctic.

Other contributions to the Global Atmosphere Watch Programme include the total column ozone network and the Ozonesonde Network, which continue systematic long-term monitoring of stratospheric ozone, and the atmospheric transmission network. Australia operates two sites of the international Total Column Carbon Observing Network (Darwin and Wollongong), managed by University of Wollongong in NSW.

The Bureau of Meteorology operates three sites of the GCOS Baseline Surface Radiation Network to monitor long-term changes in solar and terrestrial irradiance, and ten other solar and terrestrial irradiance sites that follow GCOS Global Climate Monitoring Principles.

Case Study: 40th Anniversary of Cape Grim Baseline Air Pollution Station

In 2016, the Cape Grim station located at the north-west tip of Tasmania, celebrated 40 years of continuous operation. Commencing in 1976, the Baseline Air Pollution Station at Cape Grim is Australia's contribution to international efforts for monitoring the global background atmosphere for trends due to human activities and natural variability.

The Cape Grim station is operated and funded by the Australian [Bureau of Meteorology](#), with the [Cape Grim Science Program](#) jointly supervised by [CSIRO](#), the Bureau of Meteorology, [University of Wollongong](#) and Australian Nuclear Science and Technology Organisation.

It is one of the three premier stations in the Global Atmosphere Watch network of the World Meteorological Organization. Cape Grim observations make a major contribution to the Global Atmosphere Watch program. Research results are published in peer-reviewed international journals of the highest quality, are frequently cited, and feed into the international/global assessments, for example the IPCC. The data are used for prediction, to guide development of mitigation policies, and to verify the effectiveness of global mitigation actions.

8.3.2 Ocean climate observing systems

The [Integrated Marine Observing System](#) (IMOS) was established in 2007 as a nationwide collaborative research infrastructure initiative with a distributed observing network and information services designed to observe Australian oceans. Sustained ocean observations under this initiative are helping to improve understanding of the role of the ocean in the global climate system, and the impact of Australia's major boundary currents on continental shelf environments, ecosystems and biodiversity.

IMOS infrastructure is integrated across scales spanning the coast, continental shelf, and open ocean; and across disciplines from physics to biology and ecosystems. IMOS operates the open access data portal—the Australian Ocean Data Network.

The [Australian Ocean Data Network](#) is a single access point for marine data collected by all other IMOS facilities and datasets published by Australian Government agencies. The Network's international collaborations include being a member of the Research Data Alliance, the Federation of Earth Science Information Partners, the Open Geospatial Consortium and the Ocean Data Interoperability Platform. The Ocean Data Interoperability Platform is a project with the European Union and United States of America which contributes to the removal of barriers hindering data sharing across scientific domains and international boundaries.

IMOS is funded under the National Collaborative Research Infrastructure Strategy. IMOS facilities include: Argo floats, various mooring types, ships of opportunity program, ocean gliders, autonomous underwater vehicles, animal-tracking program, satellite remote sensing, and ocean radars. Many of the Southern Ocean facilities operate with the support of the Australian Antarctic Program. The observations collected by IMOS are made freely available on the [Australian Ocean Data Network](#).

Australia, through IMOS and other programs, makes major contributions to building long term ocean climate records in the Global Ocean Observing System and its component programs. Australia:

- maintains several repeat hydrographic lines under the Global Ocean Ship-Based Hydrographic Investigations Program
- maintains the third largest active array of floats in the global Argo program behind the United States of America and Japan
- 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.

CSIRO and the Bureau of Meteorology jointly operate the Expendable Bathythermograph Ship of Opportunity Program, with support from the Royal Australian Navy and international partners. This program monitors long-term trends in major oceanic circulation pathways around Australia and has maintained seven repeat lines in the Indian, Southern and Pacific Oceans for over two decades. About 20 drifting buoys are deployed each year by the Bureau of Meteorology on an opportunity basis in the Southern and Indian Oceans. The Bureau of Meteorology also provides logistic support to other agencies wanting to deploy drifting buoys in the Indian Ocean. Most deployments are from merchant ships on commercial shipping lines. These efforts contribute to the Global Drifter Program and collect data predominantly on sea surface temperature for calibrating and validating satellite data. The satellite data is used in constructing climatologies and on barometric pressure used for weather forecasting purposes, including Numerical Weather Prediction models.

Australia monitors sea level for the purpose of deriving trends in absolute sea level. This includes engineering, management and operational support to the [Australian Baseline Sea Level Monitoring Array](#) and the [Pacific Sea Level Monitoring Project](#) operated by the Bureau of Meteorology on behalf of the Department of Foreign Affairs and Trade. These projects monitor changes in sea level around Australia and the South West Pacific in collaboration with Geoscience Australia who determines the land movement component of the measurement.

The Bureau of Meteorology's [National Tidal Unit](#) specialises in sea level analysis for the production of national tide predictions, tide streams and related information. They also undertake specialist research into particular sea levels and tides. The unit is responsible for managing a quality controlled national database of observations made available to the scientific and wider communities.

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 products in the following areas:

- sea-ice detection—mapping sea-ice change and variability, as well as fast ice that is of importance for climate modelling
- altimetry (a measure of sea surface height)—processing altimetry data for assimilation by ocean models to estimate ocean currents
- ocean colour—high-resolution datasets generated from satellite imagery for water quality monitoring over the Great Barrier Reef
- sea-surface temperature—high-resolution datasets generated from unique advanced very high resolution radiometer archives
- IMOS supports satellite calibration and validation activities for Altimetry, Ocean colour and Sea surface temperature and funds the Bureau of Meteorology and CSIRO to produce national products.

8.3.3 Atmospheric and terrestrial climate observing systems and datasets

The [Terrestrial Ecosystem Research Network](#) continues to coordinate 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. It supports OzFlux network of flux towers providing continuous observations of the land-air exchange of heat, water vapour (evapotranspiration) and carbon dioxide. OzFlux is part of the global FluxNet network of over 500 towers.

Surface Air Temperature is recorded through the [Australian Climate Observations Reference Network – Surface Air Temperature](#) (ACORN-SAT) dataset. The dataset employs the latest analysis techniques and takes advantage of digitised observational data to provide a daily record of Australian temperatures since 1910. The ACORN-SAT homogenised temperature database comprises 112 carefully chosen locations that maximise both length of record and network coverage across the continent. The data is robust and comparable through time. This enables climate researchers to better understand long-term changes in monthly and seasonal climate, and changes in day-to-day weather, such as the frequency of heat and cold extremes.

In January 2015, the Australian Government announced the establishment of a Technical Advisory Forum to advise the Bureau on the development and operation of the ACORN-SAT dataset, and comment on further possible developments. In 2017, the Technical Advisory Forum completed its third and final annual report.

Australian freshwater observations are collected by a range of Australian, state and local government agencies as well as private organisations. These observations include streamflow, groundwater, surface water storages, meteorological variables, rural and urban water use, water trading information and water quality. Most of these data are provided to Australia's national hydrology agency, the Bureau of Meteorology, on an ongoing basis, with provision frequencies varying from daily to annually.

The Bureau of Meteorology operates the [Australian Water Resources Information System](#) as a single national repository for many of Australia's surface water observations. This system, which holds over 40 million files and over 4.5 billion time series observations, is being expanded to include further freshwater data types and observations from more data providers.

The Bureau of Meteorology uses these observations to provide a range of value-added information on the prior, current and future status of Australia's water resources. This includes making the observations openly available through web-based products and web data services, providing daily-updated assessments of the nation's surface water situation, regularly updated hydrological projections out to three months ahead, and publishing annual integrated reports of the nation's freshwater resources.

As a large continent, Australia is dependent on satellites for some aspects of terrestrial observation. The unique Advanced Very High Resolution Radiometer direct broadcast record, of around 25 years, is being used to create a time series of Normalised Difference Vegetation Index and other land-cover products.

Since the 1990's, geostationary satellites have been used to estimate daily solar exposure, supporting the Australian energy sector. More recently, hourly time series and climatological averages of solar exposure have been developed. The Advanced Himawari Imager, launched in 2014, offers the prospect of solar exposure products with improved temporal and spatial resolution.

8.3.4 Cryosphere climate observing systems

The [Australian Antarctic Data Centre](#) manages data collected within the Australian Antarctic Science Program and helps fulfil Australia's obligations under Article (III)(1)(c) of the Antarctic Treaty which states "*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 data centre.

Australia operates observing systems based at the three continental stations, Mawson, Davis and Casey as well as Macquarie Island. In addition, ship-based observations and a network of automatic weather stations contribute Antarctic observation to the global observing network. This includes conducting regular measurements of ozone and atmospheric winds, sea-ice charting and ad hoc process-based observations as detailed in section 8.2 of this chapter.

8.3.5 Support for developing countries to establish and maintain observing systems and related data and monitoring systems

The Australian Government is supporting Pacific Island countries to adapt to and mitigate the impacts of climate variability. A major part of Australia's assistance is the \$39 million [Climate and Oceans Support Program in the Pacific](#) (COSPPac) 2012–2018.

Australian Government officials work with government agencies and scientists in the Islands to build tools to forecast and report on climate, tides and the ocean, and determine how best to communicate this information to communities, businesses and governments.

COSPPac builds on research and systems established under the Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) program which ran from 2011–2015. The research was aimed at improving understanding of climate change in Pacific Island nations and Timor Leste. PACCSAP produced several major technical reports, including an update of a comprehensive report on climate change for the Pacific, as well as updated individual reports for 14 Pacific Island countries and Timor Leste. These reports provided the most comprehensive assessment of historical and future climate change for these island nations to date.

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The Hon Josh Frydenberg, MP, Minister the Environment and Energy with the winning students of Australian Antarctic Program 'Name our Icebreaker' competition. The ship will be named RSV Nuyina, meaning 'Southern Lights' in palawa kani, the language of Tasmanian Aborigines.

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

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Key developments

Government websites have been developed to support sustainability and energy efficiency for households and business, resulting in emissions reductions and resilience to the effects of climate change.

The nation-wide Australian Curriculum, endorsed in 2015 by state and territory Education Ministers, ensures quality and consistency of education for all students. An understanding of environmental sustainability is a priority capability for students and will be incorporated into the design of the Australian Curriculum by 2018.

Climate change education for primary and secondary schools has been facilitated through the provision of digital teaching resources and professional development for teachers by the Australian and state governments.

Over the past four years, the Australian Government has created data sets and resources to help decision makers and communities understand and respond to the impacts of a change in climate. These include the [State of the Climate](#) and [State of the Environment](#) reports, [CoastAdapt](#), and [Your Home](#) and [Your Energy Savings](#) websites.

State and territory governments are promoting public awareness and participation in addressing climate change. Pledges, action plans and grant programs, coupled with the provision of information, training and networking opportunities are helping to mobilise climate change action at a local level.

Non-government organisations, including industry peak bodies, are leveraging industry specific expertise and networks to provide tailored support for climate change adaptation in the building, engineering and investment sectors.

Non-government organisations and research institutes are providing important links between the public, educators and decision-makers. Their engagement is supporting networks to drive public participation in the development of responses to climate change, such as the Australian Government's review of climate change policies.

9.1 SCHOOL EDUCATION FOUNDATIONS

9.1.1 Education in Australia

The Australian Government, in partnership with state and territory government and non-government education authorities, ensures a high-quality curriculum is accessible to all Australians. This includes providing a foundational understanding of science, skills in scientific inquiry, knowledge communication, and evidence based decision making.

The Australian Government has a leadership role in identifying and promoting national standards and priorities for students. State and territory government and non-government education institutions implement the Australian Curriculum and deliver school educational programs. The endorsement of the nation-wide Australian Curriculum by all Education Ministers in 2015 was a key development in this reporting period. The Australian Curriculum ensures consistency across states and territories in determining what students should know, understand and be able to do, regardless of where they go to school.

Sustainability is one of three cross-curriculum priorities in the Australian Curriculum. This highlights the importance the Australian Government places on ensuring young Australians develop the knowledge, skills, values and world views to contribute to more sustainable patterns of living. The Australian Curriculum contains content relating to climate change and the impacts of carbon emissions.

9.1.2 Investment in digital education

The Organisation for Economic Co-operation and Development (OECD) identifies information and communication technologies (ICTs) as a major factor in improving environmental performance and addressing climate change. The OECD asks members to promote sustainability through green ICT related education, training and skill development to meet industry demand for environmental skills and expertise.

The Australian Government is supporting implementation of these priorities through [Sustainable Futures](#), a teacher support program developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Sustainable Futures encourages climate science and sustainability education in schools. Over 450 Australian schools are registered, with teachers receiving free access to digital teaching resources and professional development workshops.

State governments are investing in digital education. Since the Sixth National Communication, four state governments have developed programs to increase the delivery of climate change and sustainability education in primary and secondary schools (see Table 9.1).

Table 9.1: State government-led climate change school education programs

Government	Program	Details
Queensland	Queensland Sustainable Schools	Websites provide educational resources for teachers, including lesson plans, work units, supporting materials and environmental grants information.
New South Wales (NSW)	Sustainable Schools NSW	
Western Australia (WA)	Sustainable Schools WA	Educational topics include climate change, energy and water consumption.
Victoria	ResourceSmart Schools	<p>Approximately 63 per cent of NSW schools, 75 per cent of Queensland schools and 46 per cent of WA schools are participating.</p> <p>Assists students, teachers, school administrators and parents to embed sustainability into their school operations, curriculum and community engagement.</p> <p>Provides schools with access to guidelines, checklists, teaching resources and online portals.</p> <p>Helps schools track their progress towards sustainability.</p> <p>In 2016, participating schools collectively saved \$3.4 million by adopting more sustainable practices.</p>

9.2 CONTINUING EDUCATION

9.2.1 Universities

Australian universities provide world-class specialised climate change qualifications and training across the disciplines of science, engineering, social science, business and economics at undergraduate and postgraduate levels. Further uptake of climate change education by university students of other disciplines is provided through electives across a number of multidisciplinary degrees.

By including climate change issues across multiple disciplines of Australian tertiary education, the domestic and international workforce and researchers are equipped with the expertise to manage climate change. Global knowledge transfer occurs through Australia's tertiary education institutes, with a 15 per cent growth in international student numbers between July 2016 and July 2017. Australia's universities are fulfilling an important role in helping to train global personnel to respond to the impacts of a changing climate.

A snapshot of climate change-related qualifications offered by leading Australian universities is in Table 9.2.

Table 9.2: Tertiary qualifications integrating climate change/sustainability education in Australia*^

Discipline	Qualification (specialisations) University
Science	Bachelor Advanced Science (Oceanography; Climate Dynamics; Climate Systems; Earth Science; Ecology; Marine & Coastal Studies) <i>UNSW</i>
	Bachelor Environmental Management <i>UoM</i>
	Bachelor of Science (Climate & Weather; Environmental Engineering Systems) <i>UoM</i>
	Bachelor of Agriculture <i>UoM</i>
	Bushfire & Climate elective <i>UoM</i>
	Bachelor of Science (Climate Science) <i>MU</i>
	Bachelor of Science – Global Challenges (Climate Science) <i>Monash</i>
	Bachelor of Environment (Climate Science) <i>MU</i>
	Bachelor of Marine Science <i>MU</i>
	Bachelor of Environmental Science <i>UWA</i>
	Bachelor of Science (Environment & Sustainability) <i>USQ</i>
	Master of Science (Environment & Sustainability) <i>USQ</i>
	Master of Sustainability <i>USyd</i>
	Electives:
	<ul style="list-style-type: none"> • Climate Change: Agricultural Impacts & Adaptation <i>UoM</i> • Global Environment & Sustainability <i>UoM</i>
Engineering	Bachelor Photovoltaics & Solar Energy Engineering <i>UNSW</i>
	Bachelor Renewable Energy Engineering <i>UNSW</i>
	Bachelor Environmental Engineering <i>UNSW</i>
	Bachelor of Engineering (Environmental Engineering; Sustainable Systems Engineering) <i>RMIT</i>
	Master of Energy Efficient & Sustainable Building <i>RMIT</i>
	Master of Engineering (Environmental Engineering; Sustainable Energy) <i>RMIT</i>
	Master of Environmental Science & Technology <i>RMIT</i>
Elective:	
<ul style="list-style-type: none"> • Energy Efficiency <i>UNSW</i> 	
Arts & Social Sciences	Bachelor Arts (Environmental Humanities) <i>UNSW</i>
	Bachelor of Arts (Environmental Studies) <i>UoM</i>
	Bachelor Social Research & Policy (Environmental Humanities) <i>UNSW</i>
Business / Economics/ Management	Graduate Certificate of Social Impact <i>SUT, UNSW, UWA</i>
	Master of Environmental & Resource Economics <i>ANU</i>
	Master of Economics (Environmental Management) <i>JCU</i>
	Electives:
	<ul style="list-style-type: none"> • Business Ethics & Sustainability <i>UNSW</i> • Climate Change & Sustainable Business Futures <i>UoC</i> • Sustainability & Corporate Social Responsibility, Accountability & Reporting <i>ANU</i> • The Economics of Climate Change <i>UQ, UoA</i>

Discipline	Qualification (specialisations) University
Design	Bachelor of Architectural Studies <i>UNSW</i>
	Bachelor of Design <i>UoM</i>
	Master of Sustainable Built Environment <i>UNSW</i>
	Elective: <ul style="list-style-type: none"> Sustainable Design: Theories & Practice <i>UNSW</i>
Law	Graduate Diploma in Environmental Law <i>UoM</i>
	Elective: <ul style="list-style-type: none"> Climate Law <i>UNSW</i>
Medicine	Master of Public Health <i>Monash</i>
	Electives: <ul style="list-style-type: none"> Climate Change & Public Health <i>USyd</i> Environmental Health <i>UNSW</i>
Cross-discipline	Master of Climate Change <i>ANU</i>
	Master of Energy Change <i>ANU</i>
	Master of Environment (Climate Science & Policy) <i>ANU</i>
	Master of Environmental Management & Development <i>ANU</i>
	Master of Environment (Education & Social Change; Energy Efficiency Modelling & Implementation; Environment & Public Health; Climate Change; Governance Policy & Markets; Sustainable Cities, Sustainable Regions) <i>UoM</i>
	Graduate Certificate in Climate Change for Primary Industries <i>UoM</i>
	Master of Energy Systems <i>UoM</i>
	Master of Sustainability & Climate Policy <i>Curtin</i>
	Master of Sustainable Futures <i>UTS</i>
	Electives: <ul style="list-style-type: none"> Climate Change & Adaptation Strategies in Water & Environmental Management <i>UniSA</i>

* Note: This list is not exhaustive.

^ ANU (Australian National University); Curtin (Curtin University); JCU (James Cook University); Monash (Monash University) MU (Macquarie University); SUT (Swinburne University of Technology); UniSA (University of South Australia); UNSW (University of New South Wales); UoA (University of Adelaide); UoC (University of Canberra); UoM (University of Melbourne); UQ (University of Queensland); USQ (University of Southern Queensland); USyd (University of Sydney); UTS (University of Technology, Sydney); UWA (University of Western Australia)

9.2.2 Vocational Education and Training

Australia's vocational education and training (VET) sector is building workforce skills and knowledge to identify and manage climate change risks. Registered Training Organisations (RTOs) deliver nationally recognised training in: environmental management and sustainability; conservation and land management; environmental technology; sustainable operations; renewable and sustainable energy; energy and water efficiency; and retrofitting buildings.

A snapshot of climate and sustainability related VET qualifications that can be delivered by Australian RTOs is at Table 9.3.

Table 9.3: VET Qualifications relating to climate and sustainability*^

Industry	Qualification and Code
Agriculture, Horticulture and Conservation and Land Management	Certificate I in Conservation and Land Management (AHC10116)
	Certificate II in Conservation and Land Management (AHC21016)
	Certificate III in Conservation and Land Management (AHC31416)
	Certificate IV in Conservation and Land Management (AHC40916)
	Diploma of Conservation and Land Management (AHC51116)
	Advanced Diploma of Conservation and Land Management (AHC60415)
Business Services	Certificate IV in Environmental Management and Sustainability (BSB42315)
Electricity Supply Generation	Certificate IV in Large Scale Wind Generation - Electrical (UEP40612)
Electrotechnology	Certificate II in Sustainable Energy (Career Start) (UEE22111)
	Certificate III in Renewable Energy - ELV (UEE32011)
	Certificate IV in Energy Management and Control (UEE41011)
	Certificate IV in Renewable Energy (UEE41611)
	Certificate IV in Electrical - Renewable Energy (UEE41911)
	Certificate IV in Electrical - Photovoltaic systems (UEE42011)
	Certificate IV in Energy Efficiency and Assessment (UEE43111)
	Diploma of Renewable Energy Engineering (UEE50711)
	Advanced Diploma of Renewable Energy Engineering (UEE60911)
Advanced Diploma of Engineering Technology - Renewable Energy (UEE62011)	
Forestry and Wood Products	Advanced Diploma of Forest Industry Sustainability (FWP60116)
Local Government	Certificate IV in Local Government (Land Management) (LGA40604)
Property Services	Certificate IV in Home Sustainability (CPP41110)
	Certificate IV in Nationwide House Energy Rating Scheme Assessment (CPP41212)
	Diploma of Residential Building Energy Assessment (CPP51012)
Seafood	Certificate III in Seafood Industry (Environmental Management Support) (SFI30311)
	Certificate IV in Seafood Industry (Environmental Management) (SFI40311)
Sustainability	Certificate IV in Sustainable Operations (MSS40116)
	Certificate IV in Environmental Monitoring and Technology (MSS40216)
	Diploma of Sustainable Operations (MSS50116)
	Diploma of Environmental Monitoring and Technology (MSS50216)
	Diploma of Competitive Systems and Practices (MSS50316)
	Graduate Certificate in Sustainable Operations (MSS80116)
	Graduate Certificate in Environmental Management (MSS80216)
Graduate Diploma of Competitive Systems and Practices (MSS80416)	

* Note: This list is not exhaustive.

^ For current information on nationally recognised training and RTOs that are authorised to deliver the qualifications listed above, please visit the National Register for VET – training.gov.au.

9.3 PUBLIC INFORMATION AND INVOLVEMENT

The Australian public's participation in decision making and action on climate change is enhanced by the collective efforts of the Australian, state and territory governments, non-government organisations (NGOs), peak bodies and research institutes. Initiatives to support public participation include the establishment of networks and forums, state and territory action plans and engagement forums, and the delivery of public and industry views to policy makers. These initiatives bring resources and training with opportunities for peer-to-peer learning and access to experts in the field.

9.3.1 Access to knowledge and data

Australian households, business and industry benefit from the Australian Government's support for the collection and analysis of data and the building of climate change knowledge. Australia has world leading expertise in climate change science and policy, and strong public and private research capability (further detail is provided in Chapter 8). This enables the Australian Government to provide current, reliable and tailored information for the unique challenges of mitigating and adapting to a changing climate in the Australian context.

The Australian Government Department of the Environment and Energy publishes comprehensive data on Australia's emissions and projected emissions. The [National Greenhouse Accounts](#) is a series of comprehensive reports and databases that estimate, and account for, Australia's greenhouse gas emissions on a national, state and territory basis. Individuals and households can obtain: emissions data for states and territories, economic sectors and years from the [Australian Greenhouse Emissions Information System](#); and the latest available data from the [Quarterly Update of Australia's national greenhouse gas inventory. Australia's emissions projections](#) provide detailed information on Australia's emissions trends and how we are tracking against our emissions reduction targets, including sector specific analysis.

Australia publishes a number of comprehensive public reports on climate change and environmental data designed for policy makers, businesses, the education sector and the public.

The CSIRO and the Bureau of Meteorology publishes the biennial State of the Climate Report. The report draws on the latest monitoring, science and climate change projections to describe variability and changes in Australia's climate. The [2016 State of the Climate Report](#) indicates observations and climate modelling, painting a consistent picture of ongoing, long-term climate change interacting with underlying natural variability. Between reporting periods, CSIRO and the Bureau of Meteorology deliver information about the climate on their websites. This includes user-friendly summaries and detailed technical reports discussing historical, recent and projected climate trends in Australia.

In 2015, CSIRO and the Bureau of Meteorology released climate change projections for Australia to update national and regional information on how the climate may change to the end of the 21st century. The projections are the most comprehensive ever released for Australia and were prepared with an emphasis on informing impact assessment and planning for natural resource management. Information was drawn from simulations based on up to 40 global climate models. Climate change projections for Australia were funded by the (then) Australian Department of the Environment with co funding from CSIRO and the Bureau of Meteorology.

The Australian Government commissions a comprehensive review of the state of the Australian environment every five years. A team of independent experts led the preparation of the [State of the Environment 2016](#) report, supported by the Department of the Environment and Energy. It provides Australians with authoritative information on the state of the environment, including the impacts of climate change.

In 2015, the (then) Australian Department of the Environment provided funding to the Australian Academy of Science to update the Academy's [Science of Climate Change: Questions and Answers](#) report. The report explains current climate science, including where there is consensus in the scientific community and where uncertainties exist. The Academy is a not-for-profit organisation comprising individuals elected for their outstanding contributions to science and research. The report was prepared by a working group of nine Academy members. An oversight committee, of eight Academy members all with world-class experience in climate science, reviewed the report.

The South Australian Department of Primary Industries and Regions' [New Horizons](#) program was designed to make dryland farming more productive through soil modification and improvement. Since 2013, extensive trials have successfully demonstrated how new advances in soil science and management can improve soil structure resulting in improved crop yields. The research identified potential additional benefits of the techniques to increase soil organic carbon levels and provide carbon offsetting opportunities. In 2016, the project was incorporated into a Grain Research and Development Corporation project, which combines research from South Australia, New South Wales and Victoria. New Horizons is an example of regional government programs supporting industry to actively improve business resource efficiency and reduce emissions.

9.3.2 Government user friendly tools and resources

Governments in Australia invest in public good information to assist households, businesses and communities manage the risks of a change in climate. Over the past four years, the Australian Government launched several websites containing up to date and easily accessible information to support everyday decision making on how to reduce emissions and adapt to a change in climate.

This information is designed for optimal usability and content delivery is continually evolving to improve public engagement. For example [YourHome.gov.au](#) was the product of consultation with end users like homeowners and architects. [SoE Digital](#) is the Australia State of the Environment 2016 report's interactive digital platform. It allows readers to compare findings with the previous assessment; search for trends; interact with over 300 maps and graphs; filter content by theme, topic, grade or reporting framework; and access data underpinning graphs and maps. It was a finalist in the Institute of Public Administration Australia's 2017 Public Sector Innovation Awards.

The Australian Government's [Your Home](#) and [Your Energy](#) digital platforms are tailored to encourage household energy efficiency and sustainable living, while supporting climate change adaptation actions. Your Home is a guide to building, buying or renovating a home with information on new technologies and approaches; and specifications and construction techniques for Australia's major climate zones. The Your Energy website outlines how to reduce energy use, save money and lower environmental impact at home and work. It provides information on the government programs, financial support and tailored guides for renters, seniors, home-based businesses, expecting parents and technology users. Some information is translated into 32 languages to increase accessibility.

Australian consumers can be guided by the Australian Government's Greenhouse and Energy Minimum Standards (GEMS), the minimum energy performance standards (MEPS) and the energy rating labels (ERL) requirements. The GEMS Act is a national framework for product energy efficiency in Australia and regulates 22 products from small household appliances to larger industrial equipment. The MEPS and ERL requirements address market failures that prevent the uptake of cost-effective energy efficiency opportunities. The GEMS Act is supported by the Inter-Governmental Agreement and operationalised through the cross jurisdictional [Equipment Energy Efficiency Program](#) under the Council of Australian Governments Energy Council.

[Green Vehicle Guide](#) is an Australian Government initiative to assist buyers on the performance of light vehicles sold in Australia to reduce the impact on the environment. Work is also underway to reduce emissions from light vehicles through consultations with industry and improve the quality of Australia's transport fuels. As well as reducing emissions, this could also cut consumer fuel costs, reduce health costs and help give Australians better access to the latest vehicle technology.

The Australian Government's [Business.gov.au](#), [Energy Efficiency Exchange](#) and [Energy Efficiency Project Map](#) are digital tools designed to support businesses energy efficiency and climate change adaptation actions and capacity development. Business.gov.au provides advice to new and growing businesses listing government grants for energy efficiency and sustainability improvement. The Energy Efficiency Exchange, developed in conjunction with state and territory governments, supports businesses to develop and implement energy management and efficiency strategies. Providing quality information from respected national and international sources in one location, it complements other energy efficiency initiatives administered by Australian governments under the National Energy Productivity Plan (further detail is provided in Chapter 4). The Energy Efficiency Project Map is an interactive map providing access to the results and lessons learnt from hundreds of energy efficiency trial

projects. It includes project summaries, case studies, reports, data, media links, and fact sheets on businesses and non-profit organisations awarded energy efficiency grants through AusIndustry (the Australian Department of Industry, Innovation and Science's business program delivery division).

[CoastAdapt](#), an online map-based tool and guidance material, was launched in 2017. The tool synthesises Australian climate change research from multiple disciplines and institutions to provide projections and management knowledge for coastal adaptation. Developed through a three year program by the National Climate Change Adaptation Research Facility, CoastAdapt provides location-specific knowledge and decision support to coastal managers and local governments seeking to adapt to climate change and sea-level rise. Substantial consultation with end users from build to evaluation was key in this product's design. CoastAdapt provides all Australian coastal local councils access to reliable projected sea-level rise information for timeframes up to the year 2100. The support network function of CoastAdapt is covered in section 9.4 of this chapter.

In 2016, the Cooperative Research Centre for Spatial Information (CRCSI) and private company NGIS Australia released the [Coastal Risk Australia](#) web tool. The tool uses Geoscience Australia's open source data to provide easy-to-use coastal maps and national tidal and storm surge data. The CRCSI sits within the Australian Department of Industry portfolio and conducts research in spatial information addressing issues of national importance. The web tool is helping local and state and territory governments communicate the risks of flooding from sea-level rise and storm surge to communities and local businesses.

9.3.2.1 State government initiatives

The Tasmanian Government's [Climate Action 21](#), is a plan for action on climate change from 2017 to 2021. Through Climate Action 21, the Tasmanian Government will deliver practical actions to support local governments, business, industry and the community to reduce their energy use and emissions and build resilience in a changing climate. Initiatives include: an \$850,000 home energy saving program for low-income households; support to coastal managers on understanding and managing coastal hazards; a business resource efficiency program to assist small and medium-sized businesses to reduce their emissions and energy costs; and resources to support businesses to better prepare for, respond to, and recover from extreme weather events.

The Victorian Government's program delivery agency, Sustainability Victoria, developed [TAKE2](#), a collective climate change pledge for the state to reach net zero emissions by 2050. TAKE2 supports Victorian individuals, business, government and educational and community organisations to undertake meaningful action to reduce climate change. The pledge has been taken by around 7,700 individuals, over 150 community organisations, 35 local governments, and over 400 small and large, national and multinational businesses in Victoria. Over 70,000 sustainability actions have been pledged through the TAKE2 online platform.

[Sustainability Advantage](#), a New South Wales Government program helping over 500 organisations increase competitiveness and improve bottom lines through better environmental practices. Member organisations are assessed to identify opportunities for achieving sustainability improvements and business benefits. These opportunities are translated into a tailored course of action including the provision of expertise, training and business tools, one-to-one support, networking and information products. Participants are formally recognised as partners in the state's Sustainability Advantage Recognition scheme.

In 2015, the South Australian government assisted the Conservation Council of South Australia to engage the South Australian community on climate change. A range of activities were progressed, including: exploring community owned energy schemes; a public art project in the central business district; a Roadmap for Energy Transition developed with unions and industry; and a series of expert speaker seminars.

9.3.3 Non-government organisations, industry and research institutes

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. These non-government organisations cover all sectors of the Australian economy, ranging from industry and business organisations to conservation, research and welfare organisations. Below is an overview of some of these organisations.

Community based organisations such as the Australian Conservation Foundation and the World Wildlife Fund are independent, non-partisan, non-profit environmental organisations with a strong focus on advocacy and community engagement through their membership. These organisations conduct public campaigns on environmental issues of clean energy and protection of the environment and animals. The Australian Council of Social Service (ACOSS) is a peak body for the community services sector in Australia engaging communities in climate change action. ACOSS ensures government has an understanding of the impacts of climate change on Australians, particularly on low income and vulnerable households. In 2017, it co hosted a solutions-focused conversation with the community and environment sectors.

A number of industry peak bodies work to adapt the built environment to a changing climate providing advice to government, educating industry and advancing new technologies and approaches. The Planning Institute of Australia, a national body representing planning professionals, hosts the Australian Sustainable Built Environment Council (ASBEC). ASBEC is the peak body and forum of key organisations committed to developing a sustainable built environment in Australia. The Green Building Council of Australia (GBCA) aims to educate industry and government practitioners and decision makers, and promote green building programs, technologies, design practices and operations. In 2017, GBCA hosted the Climate Adaptation and Resilience Masterclass in Melbourne and Sydney. These classes provided a practical overview of adaptation and resilience issues, equipping participants with the skills to deliver more adaptable and resilient buildings and communities.

The Australian Industry Greenhouse Network (AIGN) is a network of industry associations and individual businesses contributing to the climate change policy debate. AIGN provides information, advice and a forum for the analysis and formulation of public policy making on climate change. Engineers Australia advocates that engineers must act proactively to address climate change as an ecological, social and economic risk. Engineers Australia offers training and complementary education through site visits and major conferences.

The Infrastructure Sustainability Council of Australia (ISCA) the peak industry body for advancing sustainability in Australia's infrastructure. It administers an infrastructure sustainability ratings scheme that evaluates the sustainability (including environmental, social, economic and governance aspects) of infrastructure projects and assets. The ratings tool categories include climate change adaptation and energy and carbon. The scheme includes infrastructure sustainability training courses delivered through webinars and workshops tailored for professionals, planners and project managers.

The Carbon Market Institute (an independent, non partisan peak industry body for climate change and business) and the Investor Group on Climate Change (collaboration of Australian and New Zealand investors) focus on climate change impacts on business and finance. They work to share knowledge and raise awareness with policy makers, thought leaders, industry, corporate and the community sectors. The Australian Carbon Marketplace website, developed by the Carbon Market Institute, provides resources and information on developments in the carbon market, and connects buyers and sellers of carbon credits.

Australia is home to numerous independent research institutes focused on climate change or sustainable futures; many are hosted by the country's leading universities. These institutes are active in disseminating knowledge to policymakers and encouraging public participation in the climate change dialogue. They do this through building networks and providing free seminars and online education (see Table 9.4).

Learning to Adapt, a professional development program for established environmental professionals, delivering practical skills and knowledge on climate change adaptation. The program provides leadership to a broad range of professionals by bringing together leading scientists, regulators, policy developers and business people to discuss approaches to climate change risk and adaptation measures. The forums provide an opportunity to build an understanding across the sector and of the benefits of a cross sectoral approach. Learning to Adapt was developed with the Environmental Institute of Australia (New South Wales branch) and New Zealand. The program was piloted in partnership with the NSW Government Office of Environment and Heritage and has been delivered in Sydney, Melbourne, Brisbane and Canberra. The program was delivered with the support of the Australian Department of the Environment and Energy, NSW Government Office of Environment and Heritage, the Green Building Council of Australia, the Infrastructure Sustainability Council of Australia, and the National Climate Change Adaptation Research Facility.

Table 9.4: Participation of research institutes

Research Institute	Description	Public participation initiatives
Australian National University Climate Change Institute (Australian National University)	<ul style="list-style-type: none"> comprises climate change related researchers and teachers from throughout the Australian National University contributes to climate change solutions through innovative, interdisciplinary approaches to research and teaching 	<ul style="list-style-type: none"> engages with policy-makers at international, national, and state and territory levels on an ongoing basis hosts public lectures and discussion groups addressing the different aspects of climate change
Centre for Climate Futures (Macquarie University)	<ul style="list-style-type: none"> comprises researchers from all faculties of the university with work in the climate change area 	<ul style="list-style-type: none"> engages with government and industry partners to develop long term research projects and educational initiatives hub for interactions between leading climate researchers, government decision makers, NGOs, businesses and vulnerable communities
Centre for Tropical Biodiversity and Climate Change (James Cook University)	<ul style="list-style-type: none"> premier tropical terrestrial biology research group in Australia, with links to: Earthwatch; International Union for Conservation of Nature; National Environmental Research Program; and the National Climate Change Adaptation Research Facility 	<ul style="list-style-type: none"> shares knowledge with policy makers, natural resource managers, conservation organisations and community groups to support decision making on tropical biodiversity
Climate Change Research Centre (University of New South Wales)	<ul style="list-style-type: none"> houses research expertise in the key areas of the Earth's climate, including atmospheric, oceanic and terrestrial processes applies basic scientific principles to pressing questions on climate dynamics, global climate change, and weather and climate extremes 	<ul style="list-style-type: none"> works with the Australian and state governments to provide planning relevant guidance on future climate change scenarios
ClimateWorks Australia (Monash University)	<ul style="list-style-type: none"> identify and quantify the most efficient opportunities to reduce emissions across all sectors of the economy, and the barriers that prevent them being implemented 	<ul style="list-style-type: none"> partners with business, government and communities to unblock the barriers to reducing carbon emissions provides advice to government, business, industry, investors and peak bodies on addressing emission reduction barriers
Global Change Institute (University of Queensland)	<ul style="list-style-type: none"> works to address the impacts of climate change, technological innovation and population growth through collaborative research across key themes: clean energy, food systems, healthy oceans, and sustainable water is a flagship for sustainability, based in a \$32 million 'Living Building' which generates more energy than it consumes multi-disciplinary research collaboration between social scientists, economists, lawyers, marine biologists, physicists and medical practitioners 	<ul style="list-style-type: none"> provides free public seminars and online courses
Goyder Institute for Water Research	<ul style="list-style-type: none"> partnership model that brings together South Australia's (SA) leading water research capabilities research program guided by SA Government strategies, policy and implementation documents and agreements key research project areas in economic development, healthy ecosystems, climate action, and water research 	<ul style="list-style-type: none"> collaborates with the SA Government, the Commonwealth Scientific Industrial and Research Organisations, Flinders University, University of Adelaide, University of South Australia, International Centre of Excellence in Water Resources Management hosts events, including Water Forum 2017, showcasing SA's expertise in water management across a range of disciplines and sectors
Grattan Institute	<ul style="list-style-type: none"> independent and non-partisan think tank 	<ul style="list-style-type: none"> runs an energy policy program that discusses policies the Australian Government could implement and technologies it should promote to tackle climate change

Research Institute	Description	Public participation initiatives
Institute for Future Environments (Queensland University of Technology)	<ul style="list-style-type: none"> studies how our natural, built and virtual environments interact, change and converge finds ways to increase the sustainability, security and resilience of our natural, built and virtual environments 	<ul style="list-style-type: none"> partners with national and international industry, government and community organisations to ensure research has lasting impact
Melbourne Sustainable Society Institute (University of Melbourne)	<ul style="list-style-type: none"> focused on climate transformations as one of its two research clusters over the next two years promotes increased understanding of sustainability and resilience trends, challenges and solutions 	<ul style="list-style-type: none"> aims to facilitate and enable research linkages and partnerships domestically and internationally hosts free public lectures, seminars, workshops with guest speakers on topics aligning with their research
Monash Sustainable Development Institute (Monash University)	<ul style="list-style-type: none"> large-scale, interdisciplinary projects addressing global issues aligned to the United Nations' 17 Sustainable Development Goals comprises Monash University's leading researchers 	<ul style="list-style-type: none"> provides a platform for sharing sustainable development expertise with industry, government and the community through partnerships, education, capacity development, and student leadership

9.4 INTERNATIONAL EDUCATION

Australia actively partners with other nations and multilateral organisations to advance climate change knowledge, education and awareness. Australia shares its climate change expertise through research collaborations, scholarships and international partnerships, and as a provider of high-quality university education in climate change (see section 9.2 of this chapter). Examples are:

- Australia Awards Scholarships:** Administered by the Australian Department of Foreign Affairs and Trade, the awards 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 developing countries, particularly in the Indo-Pacific region, to undertake undergraduate or postgraduate study at Australian universities and Technical and Further Education institutions. The study and research opportunities 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.
- The PACsafe Project:** Delivered by Geoscience Australia, the PACsafe Project is building the research capacity of Pacific Island countries and providing them with tools and training to better understand disaster impacts in their countries. The project engages with representatives from national disaster management offices and related agencies in Samoa and Tonga. PACsafe is a free and open-source software tool providing planners and responders with the ability to visualise disaster impacts. Disaster managers can easily quantify the number of homes likely to have been damaged or people needing to be evacuated from a particular region for a disaster scenario. This information can help save lives and reduce the impact of such events.

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**AUSTRALIA'S
7TH NATIONAL
COMMUNICATION
ON CLIMATE CHANGE**

ANNEX A. BIENNIAL REPORT 3

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1. INTRODUCTION

Australia is pleased to submit its third Biennial Report in conjunction with the Seventh National Communication on Climate Change.

2. INFORMATION ON GREENHOUSE GAS EMISSIONS AND TRENDS

Summary information on greenhouse gas emissions and trends

Since its second Biennial Report Australia has:

- compiled more accurate and comprehensive emissions estimates following the refinement of existing-and adoption of new-data, methods and source/sink categories;
 - In particular, Australia has implemented two significant recalculations; in the *land use, land-use change and forestry (LULUCF)* sector, and in the *oil and gas fugitives* sector. The adoption of advanced methods, estimation and calibration techniques have significantly increased the level of confidence in the sectors' emissions estimates.
- incorporated data collected each year under the *National Greenhouse and Energy Reporting Act 2007* into the national inventory; and
- improved the national inventory system through strengthening of quality assurance and control systems.
 - In particular, the Australian national inventory was subject to a performance audit by the Australian National Audit Office (ANAO). The audit concluded Australia has appropriate procedures for data processing, emissions calculations and reporting. See section 7 of this Annex for further details.

In 2015, Australia's total greenhouse gas emissions – including *LULUCF* – were 526.5 million tonnes (Mt) carbon dioxide equivalent (CO₂-e). Australia's net greenhouse gas emissions excluding *LULUCF* were 533.3 Mt CO₂-e. energy-related emissions (*stationary energy, transport and fugitives emissions*) dominate Australia's emissions profile: contributing 78.7 per cent of total emissions excluding *LULUCF* in 2015. The *agriculture* sector contributes 13.1 per cent. Emissions from *the industrial processes and product use* (6.1 per cent) and *waste* (2.1 per cent) sectors are relatively minor. The *LULUCF* sector was a net sink of 7.7 Mt CO₂-e in 2015.

Australia's total greenhouse gas emissions including the *LULUCF* sector decreased by 9.3 per cent between 1990 and 2015. When the *LULUCF* sector emissions and removals are excluded, Australia's net greenhouse gas emissions in 2015 increased by 27 per cent compared with 1990 levels.

In 2015, carbon dioxide had the largest share of Australia's inventory (72.4 per cent), followed by methane (20.8 per cent) and nitrous oxide (4.5 per cent). Other greenhouse gases made up the remaining 2.2 per cent of Australia's inventory.

Summary information on Australia's national inventory arrangements, including changes since Australia's second Biennial Report, are detailed in Chapter 3 of Australia's Seventh National Communication on Climate Change.

Further detail on Australia's greenhouse gas emissions can be found in Chapter 3 of the Seventh National Communication and Common Tabular Format (CTF) Table 1 of this Annex¹.

1. To the extent of any inconsistency between the numbers and information provided in the Common Tabular Format (CTC) Tables in this document and those in the Biennial Report Common Tabular Format Application, the Australian Government considers those numbers submitted in the CTF Application to be authoritative.

Greenhouse Gas Emissions	Change from base to latest reported year	
	kt CO ₂ e	(%)
2015	533283	525565
2014	525792	526816
2013	531326	523665
2012	541258	535147
2011	538544	556619
2010	537159	562037
2009	540358	584333
2008	536214	589825
2007	532540	606053
2006	525202	610176
2005	521253	597424
2004	514657	573819
2003	497453	561383
2002	496055	567945
2001	492365	570040
2000	484842	551257
1999	474028	541015
1998	468313	520496
1997	454479	515497
1996	442451	500549
1995	435384	490539
1994	426075	496109
1993	426128	500791
1992	425821	516464
1991	420927	557560
1990	419843	579348
Base year ^a	419843	579348
Total (without LULUCF)	27	
Total (with LULUCF)	-9	
Total (without LULUCF, with indirect)	NA	NA
Total (with LULUCF, with indirect)	NA	NA

Abbreviation: LULUCF = Land use, land-use change and forestry, NO = Not Occurring, NE = Not Estimated, IE = Included Elsewhere and NA = Not Applicable

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 CO₂, CH₄ and N₂O from LULUCF.

CTF Table 1.1(b): Greenhouse Gas Source and Sink Categories (kt CO₂-e)

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year					
	kt CO ₂ -e					
	2015	2014	2013	2012	2011	2010
1. Energy	419576	408582	414253	422326	417067	420423
2. Industrial processes and product use	32327	32399	32491	33836	35942	35363
3. Agriculture	70012	72802	72735	72443	71227	66450
4. Land use, land-use change and forestry ^b	-7718	1024	-7660	-6111	18075	24878
5. Waste	11368	12009	11847	12654	14309	14923
6. Other	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	525565	526816	523665	535147	556619	562037
	43	24	-13	-105	-42	-9
	2009	2008	2007	2006	2005	2004
	2003	2002	2001	2000	1999	1998
	1997	1996	1995	1994	1993	1992
	1991	1990	Base year ^a			
	293926	26081	80179	159505	19658	579348
	293926	26081	80179	159505	19658	579348

Abbreviation: LULUCF = Land use, land-use change and forestry, NO = Not Occurring, NE = Not Estimated, IE = Included Elsewhere and NA = Not Applicable

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 CO₂, CH₄ and N₂O from LULUCF.

CTF Table 1.2: Emissions Trends: CO₂

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year																												
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a	(%)	
1. Energy	380324	372075	376095	383507	378042	381052	385504	379083	372800	366144	361495	355927	343637	338524	334149	326421	319840	311304	298091	289923	283315	272330	269615	265496	260949	258959	258959	47	
A. Fuel combustion (sectoral approach)	370008	362678	367229	375202	370146	372845	377523	371589	365283	359080	354567	349053	336470	330512	325972	318461	312666	304390	291385	283144	276243	265436	262401	258171	253931	251676	251676	47	
A.1. Energy industries	209861	203223	209327	220249	219047	224608	230483	224490	222728	219705	215220	212592	203856	200599	198481	191301	188415	181228	168676	162066	157481	151679	150857	149114	145799	142551	142551	47	
A.2. Manufacturing industries and construction	43862	46179	46094	43915	41313	41148	42065	42551	40458	40191	41127	40064	39195	38705	38028	38508	37695	37441	37342	37258	37243	36314	35543	34992	35412	35867	35867	22	
A.3. Transport	93276	91060	90059	89829	88918	86566	84906	84428	82402	79725	78995	77672	74691	73057	71659	71712	70157	69394	69277	68032	66232	62998	61562	60088	59164	59822	59822	56	
A.4. Other sectors	22140	21295	20891	20436	20080	19642	19254	19085	18694	18809	18608	18147	18172	17565	17170	16312	15774	15276	15276	15014	14599	13887	13939	13485	13114	13018	13018	70	
A.5. Other	869	921	858	773	788	881	816	1034	1001	649	618	578	556	585	633	629	627	702	813	774	690	559	500	493	442	419	419	108	
B. Fugitive emissions from fuels	10315	9397	8866	8305	7896	8207	7981	7494	7517	7064	6928	6874	7167	8012	8177	7960	7174	6914	6706	6779	7072	6893	7214	7325	7018	7283	7283	42	
B.1. Solid fuels	1908	1918	1888	1580	1546	1292	1308	1162	1287	1215	1298	1058	1099	1240	1218	1151	1128	1321	1333	1223	1112	1119	1195	1301	1172	1184	1184	61	
B.2. Oil and natural gas and other emissions from energy production	8408	7479	6978	6725	6350	6915	6673	6332	6230	5849	5630	5816	6068	6772	6959	6809	6046	5593	5372	5556	5960	5774	6019	6024	5847	6099	6099	38	
C. CO ₂ transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year		kt CO ₂ -e		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015								
	(%)																																										
2. Industrial processes and product use	3																																										
A. Mineral industry	2																																										
B. Chemical industry	193																																										
C. Metal industry	-16																																										
D. Non-energy products from fuels and solvent use	-35																																										
E. Electronic industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA				
F. Product uses as ODS substitutes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO			
H. Other	190																																										
3. Agriculture	343																																										
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	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	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	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	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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
F. Field burning of agricultural residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Base year ^a	18739	5490	1113	11773	280	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582	83	582

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year (%)	kt CO ₂ -e																											
		2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a	
C. Incineration and open burning of waste	-58	30	31	30	30	30	30	29	29	29	28	28	28	28	28	28	29	28	28	58	80	74	74	74	74	74	73	73	
D. Waste water treatment and discharge	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Memo items:																													
International bunkers	109	13522	14128	12970	12919	12288	12442	12188	12209	11926	11555	10948	9993	8771	9620	10490	10193	9805	9533	9142	9111	8614	7432	7050	6646	6436	6460	6460	
Aviation	170	11821	11893	11026	10472	10423	10348	9474	9272	9358	8394	8292	7174	5975	6752	7861	7394	7329	7293	6596	6364	5908	5397	5244	4837	4559	4383	4383	
Navigation	-18	1701	2235	1944	2447	1865	2095	2714	2938	2568	3161	2656	2819	2796	2868	2628	2798	2476	2240	2546	2748	2705	2035	1806	1808	1877	2078	2078	
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO ₂ emissions from biomass	22	18426	17213	17303	16299	15941	17025	14557	19669	19273	19106	19092	18828	18217	16549	18430	19244	19067	19329	19021	18141	17110	16319	15367	13705	15018	15142	15142	
CO ₂ captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Long-term storage of carbon (storage of carbon in waste disposal)	59	71916	71057	70173	69265	68295	67327	66268	65136	63996	62838	61621	60393	59255	58165	57037	55870	54761	53656	52614	51555	50441	49404	48387	47365	46314	45238	45238	
Indirect N ₂ O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect CO ₂	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
Total CO ₂ equivalent emissions without LULUCF	44	402160	393572	398293	407140	404273	406811	408752	404890	399297	391364	385807	382021	368785	361966	357462	349984	343850	334427	320558	312185	305261	293929	289231	284840	279807	278353	278353	
Total CO ₂ equivalent emissions with LULUCF	-9	380320	378270	376908	387454	404520	414665	437002	442397	455655	458801	446052	425285	415882	417865	418835	399175	393254	371088	365828	354929	344783	349335	349086	359746	398820	418476	418476	

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year	
	2015	(%)
	2015	NA
	2014	NA
	2013	NA
	2012	NA
	2011	NA
	2010	NA
	2009	NA
	2008	NA
	2007	NA
	2006	NA
	2005	NA
	2004	NA
	2003	NA
	2002	NA
	2001	NA
	2000	NA
	1999	NA
	1998	NA
	1997	NA
	1996	NA
	1995	NA
	1994	NA
	1993	NA
	1992	NA
	1991	NA
	1990	NA
	Base year ^a	NA
Total CO ₂ equivalent emissions, including indirect CO ₂ without land use, land-use change and forestry	kt CO ₂ -e	
Total CO ₂ equivalent emissions, including indirect CO ₂ with land use, land-use change and forestry		

Abbreviation: LULUCF = Land use, land-use change and forestry, ODS = Ozone Depleting Substances, NO = Not Occurring, NE = Not Estimated, IE = Included Elsewhere and NA = Not Applicable

- 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 CO₂, CH₄ and N₂O from LULUCF.

CTF Table 1.3: Emissions Trends: CH₄

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year																													
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a			
1. Energy	1441	74	20	3	14	37	0.03	1367	1017	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9
A. Fuel combustion (sectoral approach)	74	-42	1077	24	-46	-62	15	15	21	-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-42	
A.1. Energy industries	20	3	14	37	0.03	1367	1017	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1077	
A.2. Manufacturing industries and construction	3	15	38	0.04	1250	929	321	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24	
A.3. Transport	14	37	0.03	1313	973	340	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-46	
A.4. Other sectors	37	0.04	1250	929	321	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-62	
A.5. Other	0.03	1250	929	321	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15	
B. Fugitive emissions from fuels	1367	1017	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15	
B.1. Solid fuels	1017	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21	
B.2. Oil and natural gas and other emissions from energy production	350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-1	
C. CO ₂ transport and storage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
2. Industrial processes and product use	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-16	
A. Mineral industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	32
C. Metal industry	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	NO,NA	0.6	2.2	-23	
D. Non-energy products from fuels and solvent use	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	
E. Electronic industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year (%)												kt CO ₂ -e															
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a	
F. Product uses as ODS substitutes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	2158	2034	103	13	23	-20																						
A. Enteric fermentation	2250	2124	102	16	-21																							
B. Manure management	2274	2145	96	22	23																							
C. Rice cultivation	2260	2130	99	20	-42																							
D. Agricultural soils	2217	2091	100	16																								
E. Prescribed burning of savannas	2082	1973	98	4																								
F. Field burning of agricultural residues	2174	2070	94	2																								
G. Liming	2187	2086	94	0																								
H. Urea application	2282	2171	102	3																								
I. Other carbon-containing fertilizers	2369	2231	106	21																								
J. Other	2422	2294	109	9																								
4. Land use, land-use change and forestry ^b	2390	2272	92	13																								
A. Forest land	2322	2214	94	8																								
B. Cropland	2469	2326	100	29																								
C. Grassland	2486	2341	95	36																								
	2525	2396	90	26																								
	2444	2310	89	30																								
	2460	2328	90	28																								
	2469	2337	84	32																								
	2453	2328	83	29																								
	2407	2289	84	25																								
	2503	2375	88	26																								
	2516	2396	84	24																								
	2594	2477	82	24																								
	2679	2569	81	18																								
	2703	2585	83	22																								
	2703	2585	83	22																								

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year (%)	kt CO ₂ -e																										
		2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a
D. Wetlands	NO,NE,IE	1	1	1	1	1	1	1	1	2	3	3	2	2	2	2	2	2	2	2	2	3	3	4	4	5	7	7
E. Settlements	NO,NE,IE	1	1	1	1	1	1	1	1	2	3	3	2	2	2	2	2	2	2	2	2	3	3	4	4	5	7	7
F. Other land	NO,NE,IE	1	1	1	1	1	1	1	1	2	3	3	2	2	2	2	2	2	2	2	2	3	3	4	4	5	7	7
G. Harvested wood 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	NA	NA	NA	NA
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Waste		434	461	456	489	556	581	568	570	552	539	548	553	570	614	610	602	626	623	656	665	728	729	756	761	771	771	
A. Solid waste disposal		337	357	356	387	439	456	445	448	432	420	431	438	456	494	488	486	494	490	519	524	581	576	600	602	609	610	
B. Biological treatment of solid waste		4.2	4.2	4.1	4.0	4.0	3.4	3.0	2.9	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.5	1.4	1.3	1.1	1.0	0.9	0.9	0.6	0.5	0.4	
C. Incineration and open burning of waste	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	0.06	0.09	0.09	0.09	0.09	0.09	0.09	
D. Waste water treatment and discharge		93	100	96	97	114	122	120	119	118	116	114	113	112	118	120	114	130	132	136	140	146	152	155	158	161	161	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH ₄ emissions without CH ₄ from LULUCF		4036	4036	4115	4158	4190	4097	4176	4202	4281	4293	4317	4250	4169	4380	4455	4513	4374	4537	4580	4465	4457	4513	4646	4781	4796	4797	
Total CH ₄ emissions with CH ₄ from LULUCF		4382	4419	4473	4511	4570	4492	4575	4607	4725	4733	4733	4643	4600	4814	4889	4953	4798	4936	4977	4846	4832	4878	5024	5181	5267	5307	
Memo items:																												
International bunkers		0.19	0.24	0.21	0.25	0.20	0.22	0.28	0.30	0.26	0.32	0.27	0.28	0.28	0.29	0.26	0.28	0.25	0.23	0.26	0.27	0.27	0.21	0.18	0.18	0.21	0.21	
Aviation		0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Navigation		-0.19	-0.21	-0.19	-0.23	-0.18	-0.20	-0.26	-0.28	-0.25	-0.30	-0.25	-0.27	-0.27	-0.29	-0.26	-0.28	-0.25	-0.23	-0.26	-0.27	-0.27	-0.21	-0.17	-0.17	-0.18	-0.20	

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year																												
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a		
	kt CO ₂ -e																										(%)		
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	NA	NA	NA	NA	
CO ₂ captured	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Long-term storage of carbon in waste disposal sites	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Indirect N ₂ O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Indirect CO ₂	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Abbreviation: LULUCF = Land use, land-use change and forestry, ODS = Ozone Depleting Substances, NO = Not Occurring, NE = Not Estimated, IE = Included Elsewhere and NA = Not Applicable

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 CO₂, CH₄ and N₂O from LULUCF.

CTF Table 1.4: Emissions Trends: N₂O

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year (%)																												
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a		
1. Energy	11	12	12	12	12	12	12	13	13	13	13	13	12	11	11	10	10	9	9	8	8	8	8	7	7	7	7	7	
A. Fuel combustion (sectoral approach)	11	12	12	12	12	12	12	13	13	13	13	13	12	11	11	10	10	9	9	8	8	8	8	7	7	7	7	7	
1. Energy industries	3	4	4	4	4	4	4	4	4	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	
2. Manufacturing industries and construction	1.5	1.5	1.5	1.4	1.3	1.3	1.1	1.4	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.0	1.1	1.1	1.1	
3. Transport	5	5	6	6	6	6	7	7	7	7	7	7	7	6	6	6	6	5	5	5	4	4	4	4	4	3	3	3	
4. Other sectors	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	
5. Other	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	
B. Fugitive emissions from fuels	0.14	0.12	0.12	0.11	0.08	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.10	0.11	0.10	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.13	0.13	0.12	0.14	0.14	
1. Solid fuels	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2. Oil and natural gas and other emissions from energy production	0.14	0.12	0.12	0.11	0.08	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.10	0.11	0.10	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.13	0.13	0.12	0.14	0.14	0.14
C. CO ₂ transport and storage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Industrial processes and product use	4	8	7	8	9	11	10	10	9	9	9	8	8	8	7	6	6	6	5	5	5	5	5	5	4	3	3	3	3
A. Mineral industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	4	8	6	8	9	11	10	10	9	9	9	8	8	7	6	6	5	6	5	5	5	5	5	5	4	3	3	3	3
C. Metal industry	0.05	0.05	0.06	0.06	0.08	0.08	0.06	0.08	0.08	0.07	0.07	0.09	0.09	0.08	0.08	0.07	0.09	0.08	0.09	0.09	0.07	0.07	0.08	0.08	0.08	0.07	0.08	0.08	0.08
D. Non-energy products from fuels and solvent use	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
E. Electronic industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Product uses as ODS substitutes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year	kt CO ₂ -e															Change from base to latest reported year (%)											
		2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001		2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
G. Other product manufacture and use	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Agriculture	45	47	46	47	46	41	41	39	42	45	46	46	42	46	46	44	43	42	42	41	39	40	38	40	40	40	40	40
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	NA	NA	NA	NA
B. Manure management	153	3.1	3.0	2.9	3.0	2.8	2.7	2.7	3.3	3.2	3.1	2.7	2.7	2.6	2.3	2.0	1.9	1.7	1.8	1.8	1.6	1.5	1.5	1.4	1.4	1.4	1.4	
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	NA	NA	NA	NA
D. Agricultural soils	8	44	43	43	42	38	36	38	38	41	42	42	39	43	43	42	40	40	38	37	37	36	38	38	38	38	39	39
E. Prescribed burning of savannas	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
F. Field burning of agricultural residues	-24	0.37	0.41	0.42	0.42	0.28	0.32	0.26	0.20	0.47	0.37	0.57	0.27	0.59	0.57	0.64	0.58	0.64	0.53	0.34	0.60	0.52	0.44	0.46	0.47	0.47	0.47	
G. Liming	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
H. Urea application	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
I. Other carbon containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry ^b	-17	23	16	16	28	24	19	20	20	22	19	20	20	17	18	23	19	20	20	21	23	19	18	19	20	20	22	22
A. Forest land	-3	2.8	2.6	2.7	3.0	2.9	2.8	2.8	2.7	2.5	2.5	2.4	2.6	2.4	2.6	2.5	2.4	2.4	2.5	2.6	2.5	2.5	2.5	2.5	2.6	2.5	2.6	2.6
B. Cropland	-63	0.19	0.17	0.19	0.26	0.25	0.19	0.24	0.29	0.28	0.32	0.31	0.32	0.29	0.30	0.24	0.20	0.19	0.20	0.30	0.24	0.23	0.23	0.30	0.42	0.47	0.47	
C. Grassland	-19	15	11	11	18	16	13	14	14	15	13	14	14	12	14	16	13	14	13	14	16	11	11	13	13	13	15	15
D. Wetlands	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year		kt CO ₂ -e	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a
	(%)																													
E. Settlements		-69		0.04	0.04	0.05	0.06	0.07	0.05	0.05	0.06	0.06	0.08	0.08	0.07	0.06	0.06	0.06	0.07	0.08	0.07	0.07	0.07	0.08	0.09	0.09	0.11	0.12	0.14	
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood 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	NA	NA	NA	NA	NA	NA
H. Other		1276		0.11	0.10	0.10	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	
5. Waste		56		1.6	1.5	1.4	1.4	1.3	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
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	NA	NA	NA	NA	NA	NA
B. Biological treatment of solid waste		1102		0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	
C. Incineration and open burning of waste	NO,NE			NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	0.02	0.04	1.04	1.06	1.05	1.03	1.02	
D. Waste water treatment and discharge		58		1.61	1.46	1.36	1.34	1.24	1.18	1.25	1.32	1.26	1.24	1.22	1.21	1.20	1.18	1.17	1.16	1.15	1.14	1.13	1.06	1.03	1.04	1.06	1.05	1.03	1.02	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N ₂ O emissions without N ₂ O from LULUCF		20		62	68	66	68	68	65	65	63	65	68	69	68	64	66	65	64	61	59	58	55	53	53	51	51	50	51	
Total direct N ₂ O emissions with N ₂ O from LULUCF		9		80	90	83	84	96	89	84	83	85	90	88	88	84	84	83	84	84	78	77	75	74	72	69	71	70	74	
Memo items:																														
International bunkers		33		0.11	0.12	0.11	0.12	0.10	0.11	0.12	0.13	0.12	0.13	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.11	0.10	0.08	0.08	0.07	0.08	0.08	
Aviation		161		0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	
Navigation		-18		0.05	0.06	0.05	0.07	0.05	0.06	0.07	0.08	0.07	0.09	0.07	0.08	0.08	0.08	0.07	0.08	0.06	0.06	0.07	0.08	0.06	0.06	0.05	0.05	0.05	0.06	
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

CTF Table 1.5: Emissions Trends: HFCs, PFCs, SF₆, NF₃

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year (%)		kt CO ₂ -e																									
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Base year ^a	
Emissions of HFCs and PFCs ^b - (kt CO ₂ equivalent)	93	706	-99.48																									
Emissions of HFCs ^b - (kt CO ₂ equivalent)																												
HFC-23																												
HFC-32																												
HFC-41																												
HFC-43-10mee																												
HFC-125																												
HFC-134																												
HFC-134a																												
HFC-143																												
HFC-143a																												
HFC-152																												
HFC-152a																												
HFC-161																												
HFC-227ea																												
HFC-236cb																												

Greenhouse Gas Source and Sink Categories	Change from base to latest reported year	
	kt CO ₂ -e	(%)
Emissions of SF ₆ - (kt CO ₂ equivalent)	2015	131
	2014	130
	2013	129
	2012	128
	2011	125
	2010	121
	2009	119
	2008	151
	2007	162
	2006	173
	2005	182
	2004	208
	2003	206
	2002	202
	2001	197
	2000	191
	1999	196
	1998	223
	1997	248
	1996	270
	1995	302
1994	283	
1993	265	
1992	247	
1991	229	
1990	211	
Base year ^a	211	
Emissions of NF ₃ - (kt CO ₂ equivalent)	2015	NE
	2014	NE
	2013	NE
	2012	NE
	2011	NE
	2010	NE
	2009	NE
	2008	NE
	2007	NE
	2006	NE
	2005	NE
	2004	NE
	2003	NE
	2002	NE
	2001	NE
	2000	NE
	1999	NE
	1998	NE
	1997	NE
	1996	NE
	1995	NE
1994	NE	
1993	NE	
1992	NE	
1991	NE	
1990	NE	
Base year ^a	NE	

- 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 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 CO₂ equivalent emissions.
- c 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 CO₂ equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

3. QUANTIFIED ECONOMY-WIDE EMISSION REDUCTION TARGET

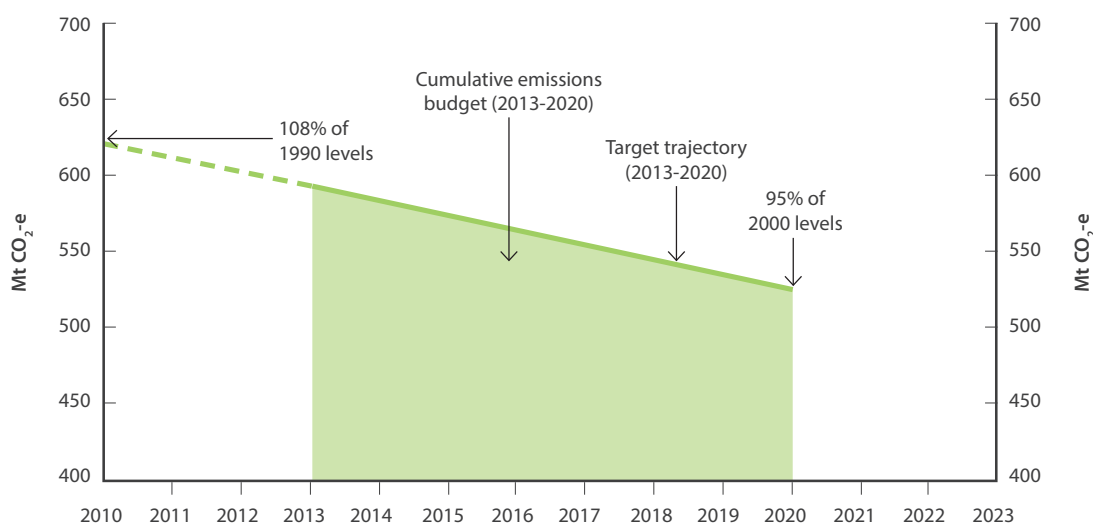
The Australian Government is committed to an unconditional Quantified Economy-wide Emission Reduction Target (QEERT) of five per cent on 2000 levels by 2020 (see CTF Table 2(a)). Australia's target represents a substantial reduction from business-as-usual emissions on a range of indicators. Australia is tracking progress in this report against its unconditional QEERT under the Convention. In tracking progress against the unconditional QEERT, Australia applies Kyoto Protocol (KP) classifications for the land use, land use change and forestry (LULUCF) sector, as described below and in Chapter 5 of the Seventh National Communication.

3.1 DETAILS OF AUSTRALIA'S 2020 TARGET

Australia's unconditional QEERT is a decrease of five per cent on 2000 levels by 2020 (see CTF Table 2(a)). Australia assesses its progress towards the QEERT using an emissions budget approach for the period 2013 to 2020. As shown in Figure 1, the emissions budget is calculated using a trajectory from Australia's first commitment period target (CP1) under the KP to the 2020 target. A linear decrease is taken, from 2010 to 2020, beginning from the KP CP1 target level which was 108 per cent of 1990 levels and finishing at five per cent below 2000 levels in 2020. The area under the trajectory for the period 2013-2020 is the emissions budget.

The current estimate of the emissions budget for 2013 to 2020 is 4,500Mt of CO₂-e. This value is subject to change based on recalculations to Australia's national greenhouse gas inventory.

Figure 3.1: Australia's QEERT



Source: Department of the Environment and Energy 2017

Australia's QEERT is based on its Kyoto Protocol inventory, submitted as supplementary information in its annual national inventory report (Chapters ES.2.2 and 11)³. The QEERT includes emissions and removals from the energy, industrial processes and product use, agriculture and waste sectors and the following KP *LULUCF* sub-classifications: deforestation, afforestation, reforestation, forest management, cropland management, grazing land management and revegetation. The target includes all greenhouse gas emissions (GHGs) included in the UNFCCC Annex I inventory reporting guidelines, namely CO₂, CH₄, N₂O, HFCs, PFCs, SF₆ and NF₃. The global warming potentials (GWPs) used are from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report prescribed in decision 24/CP.19 (see CTF Table 2(b)). Carbon dioxide equivalents (CO₂-e) of these gases are calculated using the GWP for a 100-year time horizon (see CTF Table 2(c)). Australia's target represents net emissions.

3. Australia's 2017 National Inventory Report Submission is available on the UNFCCC website: <https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/submissions/national-inventory-submissions-2017>.

3.2 APPROACH TO REPORTING PROGRESS UNDER THE QEERT

To track and report progress against the QEERT, Australia compares cumulative net emissions from 2013 to 2020 (actuals where available and projections thereafter) with the overall emissions budget for that period.

Progress towards Australia's QEERT is based on Kyoto Protocol inventory estimates, including for LULUCF classifications, as indicated above and in Australia's First and Second Biennial Reports⁴. Australia's approach to counting emissions and removals from the LULUCF sector is set out in CTF Table 2(d). Emissions and removals for each LULUCF sub-classification are estimated applying methodologies and activity definitions from the IPCC's *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*. The concordance between UNFCCC LULUCF classifications and KP LULUCF classifications used by Australia is given in Table 4.2 in section 4.2.1. In aggregate there is little difference in the trend estimates between the KP LULUCF and UNFCCC LULUCF inventories. In practice, the most significant difference is in the scope of forest lands. Under the KP classifications, Australia uses a narrow approach to Forest Management that restricts the inclusion of forests to those lands where forests are managed for timber production. Under the UNFCCC classification system all forest lands are included. Further detail on Australia's approach to land sector reporting and coverage is provided in section 4.2.1 of this Biennial Report.

3.3 CARRY-OVER AND MARKET-BASED MECHANISMS

Australia will carry-over an overachievement from the first commitment period of the KP (represented by first commitment period Assigned Amount Units) into its Previous Period Surplus Reserve Account. An amount of these units will be used towards Australia's QEERT in accordance with KP accounting rules. Australia is focusing on domestic action to meet its unconditional QEERT. This approach is consistent with the principle of supplementarity. In accordance with KP rules, Australia will use Clean Development Mechanism units received through a voluntary Waste Industry Protocol towards its unconditional 2020 target. They include first commitment period Certified Emission Reduction units confirmed eligible for carry-over into the second commitment period, and second commitment period Certified Emission Reduction units. Further information on the voluntary Waste Industry Protocol is available at: www.environment.gov.au/climate-change/publications/voluntary-waste-industry-protocol. Further to this, the Government may consider the use of international units towards meeting its target. Further information on Australia's approach to market-based mechanisms is set out in CTF Tables 2(e)I and 2(e)II.

CTF Table 2(a): Description of quantified economy-wide emission reduction target: base year^a

Base year/base period	2000
Emissions reduction target (% of base year/base period)	5.00%
Period for reaching target	2013-2020

a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice 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.

Australia's 2020 target range is based on the 100 year GWP values consistent with the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention contained in decision 24/CP.19, and as set out below.

4. The inventory estimates reported in chapter 2 of Australia's third Biennial Report and chapter 3 of the 7th National Communication are from Australia's 2017 submission of its annual National Inventory Report under the UNFCCC, prepared and reported in accordance with decision 24/CP.19.

CTF Table 2(b): Description of quantified economy-wide emission reduction target: global warming potential values (GWP)

Gases Covered	Covered	Base Year	GWP reference source
CO ₂	Yes	2000	IPCC Fourth Assessment Report
CH ₄	Yes	2000	
N ₂ O	Yes	2000	
HFCs	Yes	2000	
PFCs	Yes	2000	
SF ₆	Yes	2000	
NF ₃	Yes	2000	
Other gases (specify) ^a	-	-	

Abbreviations: GWP = global warming potential

a Specify other gases

CTF Table 2(c): Description of quantified economy-wide emission reduction target: sectors covered

Sectors Covered	Covered
Energy	Yes
Transport ^a	Yes
Industrial processes ^b	Yes
Agriculture	Yes
LULUCF	Yes
Waste	Yes
Other sectors (specify) ^c	-

Abbreviations: LULUCF = land use, land-use change and forestry.

a Transport is reported as a subsector of the energy sector.

b Industrial processes refer to the industrial processes and product use sectors.

c Specify other sectors

CTF Table 2(d): Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector

LULUCF in base year level and target	Included
Contribution of LULUCF is calculated using	Based on KP-LULUCF classification system: <i>deforestation, afforestation, reforestation, forest management, cropland management, grazing land management and revegetation</i>

CTF Table 2(e)I: Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention^a

Units	
Possible scale of contributions of market-based mechanisms under the convention (estimated kt CO ₂ -e)	156,139.74
CERs (kt CO ₂ -e)	6,720.688 (CP2)
ERUs	-
AAUs ^b	-
Carry-over units ^{c①}	149,419.06
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 prejudice 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 KP, 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.
- ① Australia will carry-over 127,650.77 kt CO₂-e overachievement from the first commitment period of the KP (represented by CP1 AAUs) into the Previous Period Surplus Reserve Account. An amount of these units will be used towards Australia's QEERT in accordance with KP rules. In addition, Australia will carry-over 21,768.29 kt CO₂-e of CP1 CERs to use towards our QEERT.

CTF Table 2(e)II: Description of quantified economy-wide emission reduction target: other market-based mechanisms^a

Units	Possible scale of contributions (estimated kt CO ₂ -e)
-	-

- a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice 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}

Any other information ^b	<p>Australia's quantified economy-wide emission reduction target is unconditional.</p> <p>Under the voluntary Waste Industry Protocol the Australian Government has been gifted 21,768.29 kt CO₂-e CP1 CERs (confirmed as eligible for carry-over into CP2) and 6,720.688 kt CO₂-e CP2 CERs by landfill operators. Australia will use units received through the voluntary Waste Industry Protocol to contribute to its unconditional 2020 target.</p>
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- a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice 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 QUANTIFIED ECONOMY-WIDE EMISSION REDUCTION TARGET

Mitigation action and progress towards Australia's Quantified Economy-wide Emission Reduction Target (QEERT)

The Australian Government has a suite of policies and measures to meet Australia's 2020 emissions reduction target, of five per cent below 2000 levels. The policies and measures facilitate greenhouse gas emissions reductions across the economy, transition the electricity sector to low emissions, increase energy efficiency and fast track development and uptake of clean energy.

Australia's main climate change policies are the Emissions Reduction Fund and its Safeguard Mechanism, the Renewable Energy Target, the National Energy Productivity Plan and the Clean Energy Innovation Fund.

When announcing Australia's 2030 target (a reduction of 26 to 28 per cent below 2005 levels), the Australian Government committed to review its climate change policies. The aim of the review was to ensure Australia's policies remain effective in achieving Australia's 2030 target and Paris Agreement commitments.

Further information on the Australian Government's climate change policies and the review of these policies can be found in Chapter 4: Policies and measures of the Seventh National Communication. Further information on meeting Australia's emissions reduction target can be found in Chapter 3: National Greenhouse Gas Inventory of the Seventh National Communication.

Domestic institutional arrangements relating to Australia's QEERT

Australia's policies and measures are developed based on expert advice and continuous consultation with industry and the community; they are often implemented by independent bodies and within strict governance frameworks. Policies are regularly reviewed to ensure they remain effective in meeting Australia's commitments under the UNFCCC and Paris Agreement.

The **Australian Department of the Environment and Energy** develops and implements a national response to climate change. The **Climate Change Authority** provides advice to the Minister for the Environment and Energy on climate change issues. The **Clean Energy Regulator** is responsible for administering schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions. This includes the Emissions Reduction Fund, the Safeguard Mechanism and the Renewable Energy Target. The **Australian Renewable Energy Agency** makes renewable energy solutions more affordable and increases the amount of renewable energy used in Australia. The **Clean Energy Finance Corporation** co-invests with the private sector to increase the flow of funds into renewable energy, energy efficiency and low emissions technologies.

Further information on the Climate Change Authority, the Clean Energy Regulator, the Australian Renewable Energy Agency and the Clean Energy Finance Corporation can be found in Chapter 4 of the Seventh National Communication.

4.1 GREENHOUSE GAS EMISSIONS IN RELATION TO THE QEERT

To assess how Australia is tracking against its 2020 target, cumulative net emissions (actuals from 2013 to 2015 and projections from 2016 to 2020) are compared to the emissions budget. Cumulative emissions from 2013 to 2015 were 1598 Mt CO₂-e, and projected net emissions from 2016-2020 were 2757 Mt CO₂-e. The total is 4354 Mt CO₂-e, compared to the emissions budget of 4500 Mt CO₂-e, indicating Australia is on track to meet its 2020 target.

Table 4.1: Net emissions associated with Australia's QEERT

KP Classification sector and subsector	Emissions (Mt CO ₂ -e)								
	2000	2013	2014	2015	2016	2017	2018	2019	2020
1. Energy	364.0	414.3	408.6	419.6	431.7	432.8	430.9	431.4	432.9
2. Industrial Processes and Product Use	26.8	32.5	32.4	32.3	33.1	34.1	34.1	34.2	34.3
3. Agriculture	78.6	72.7	72.8	70.0	68.7	71.5	71.6	73.2	74.8
4. LULUCF activities	69.6	-1.9	4.9	4.6	-2.4	6.3	4.4	4.7	2.6
5. Waste	15.4	11.8	12.0	11.4	11.6	10.7	10.0	9.7	9.5
Total net emissions (including LULUCF)	554.4	529.5	530.7	537.9	542.8	555.5	550.9	553.2	554.1
Cumulative total	-	529.5	1060.2	1598.0	2140.8	2696.3	3247.2	3800.4	4354.5

The estimates in Table 4.1, as per the latest National Inventory Report 2017 (NIR 2017) and Australia's emissions projections 2017 (Kyoto Protocol classifications), include emissions and removals from energy, industrial processes and product use, agriculture and waste sectors and the following *KP-LULUCF subclassifications: deforestation, afforestation, reforestation, forest management, cropland management, grazing land management and revegetation*.

Australia's policies and measures that have contributed to the reductions of greenhouse gases in these sectors are described in this section and in CTF Table 3.

4.2 ESTIMATES OF EMISSION REDUCTIONS AND REMOVALS FROM LULUCF

Australia has used the KP classification system for reporting estimates from the *LULUCF* sector, as discussed in section 3.2. For all *LULUCF* classifications, emission estimates in the reporting period are compared with estimates in the base-year, which is 2000. In summary, the net emissions from the *LULUCF* sector were 4.6 Mt CO₂-e in 2015, which were 65.0 Mt CO₂-e less than net emissions in 2000. Information on the contribution of the *LULUCF* sector to Australia's progress towards its QEERT is provided in CTF Tables 4, 4(a) and 4(b).

4.2.1 Coverage

Australia reported net emissions from *deforestation, afforestation/reforestation, forest management, cropland management, grazing land management and revegetation*. The concordance between the two classification systems is set out in Table 4.2.

Table 4.2: Reconciliation table between UNFCCC and KP classifications

UNFCCC	Kyoto Protocol
Forest land	-
Forest land – multiple use forests	Forest Management
Forest land – pre-1990 plantations	Forest Management
Forest land – private native forests	Monitored for Forest Management activity
Forest land – conservation reserves	Monitored for Forest Management activity
Forest land – other native forest	Monitored for Forest Management activity

UNFCCC	Kyoto Protocol
Land converted to forest	-
New plantations since 1990	Afforestation / Reforestation
Native regeneration since 1990 – direct human induced	Afforestation / Reforestation
Cropland	-
Croplands – permanent	Cropland management
Forest converted to crops	Deforestation
Grassland converted to crops	Cropland management
Grassland	-
Grasslands – permanent	Grazing land management
Forest converted to grass since 1990 – direct human induced	Deforestation
Forest converted to grass – pre-1990 conversion – direct human induced	Grazing land management
Crop converted to grass	Grazing land management
Settlements	Revegetation
Wetlands	Revegetation

4.2.1.1 Deforestation

The net emissions from *Deforestation* were 31.1 Mt CO₂-e in 2015, which was 37.6 Mt CO₂-e less than in 2000. The classification definitions and the methodologies used to derive the estimates are described in the latest NIR 2017 Volume 3.

4.2.1.2 Afforestation / Reforestation

The net emissions from the *Afforestation / Reforestation* classification were -12.6 Mt CO₂-e in 2015, which was 5.5 Mt CO₂-e less than in 2000. The classification definitions and the methodologies used to derive the estimates are described in the NIR 2017 Volume 3.

4.2.1.3 Forest Management

The net emissions from *Forest Management* classification were -18.4 Mt CO₂-e in 2015, which was 10.9 Mt CO₂-e less than in 2000. For *Forest Management*, reference level accounting, as is applicable under the KP, has not been applied. Instead, *Forest Management* is treated the same way as is any other sector.

Harvested wood products are estimated using the IPCC production approach.

Natural disturbance (fire, cyclones) impacts are not excluded from the accounting but are subject to a national methodology approach that takes into account the IPCC method for treatment of natural disturbances as explained in the latest NIR 2017 Volume 3.

Natural disturbance impacts are “beyond control” and “not materially influenced” by Australia, as they occur in spite of significant and costly efforts to manage disturbance. Australia engages in on-going efforts to prevent, manage and control natural disturbances to the extent practicable (and as reported in the latest NIR 2017).

Australia's national forest carbon monitoring system is used to estimate the emissions and is also used to identify any subsequent removals from the lands affected by natural disturbances, as well as to monitor lands affected by natural disturbances for salvage logging or subsequent land-use change in order to account for any associated emissions.

Australia does not apply a cap in accounting for Forest Management.

4.2.1.4 Cropland Management

The net emissions from Cropland Management classification were -4.2 Mt CO₂-e in 2015, which was 5.2 Mt CO₂-e less than in 2000. The classification definitions and the methodologies used to derive the estimates are described in the NIR 2017 Volume 3.

4.2.1.5 Grazing land Management

The net emissions from Grazing land Management were 8.7 Mt CO₂-e for 2015, which was 5.5 Mt CO₂-e less than in 2000. The classification definitions and the methodologies used to derive the estimates are described in the NIR 2017 Volume 3.

4.2.1.6 Revegetation

The net emissions from Revegetation were -0.11 Mt CO₂-e for 2015, which was 0.29 Mt CO₂-e less than in 2000. The classification definitions and the methodologies used to derive the estimates are described in the NIR 2017 Volume 3.

4.2.1.7 Other

Australia does not include estimates of emissions from drainage and re-wetting of organic soils.

CTF Table 3: Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Emissions Reduction Fund*	Transport, agriculture, LULUCF, waste, energy efficiency, mining oil & gas, industrial facilities	CO ₂ , CH ₄ , N ₂ O	To help reduce Australia's emissions through the generation of carbon credits from projects which avoid greenhouse gas emissions or sequester carbon.	Government Contracts	Implemented	The ERF purchases low cost abatement in the form of ACCU's generated by eligible activities under a method which has met offset integrity standards.	Initiated 2011. Revised 24 Nov 2014	Carbon Credits (Carbon Farming Initiative) Act 2011, administered by the Clean Energy Regulator	21,825 ⁹
Safeguard Mechanism*	Industrial, mining, oil & gas, transport, waste, energy	CO ₂ , CH ₄ , N ₂ O	To ensure that emissions reductions purchased by the Australian Government are not offset by significant increases in emissions above business-as-usual levels elsewhere in the economy.	Regulatory	Implemented	The Safeguard Mechanism places emissions limits (baselines) on facilities which emit > 100,000 t CO ₂ -e per year. Facilities covered by the Safeguard Mechanism are required to reduce emissions or purchase carbon credits to ensure net emissions remain below the baseline.	1 July 2016	National Greenhouse and Energy Reporting Act 2007, and National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015, administered by the Clean Energy Regulator	Not estimated. The mitigation impact would be calculated as the difference between emissions above the baseline and the safeguard baseline.
Large-scale Renewable Energy Target (RET)*	Energy	CO ₂ , CH ₄ , N ₂ O	To reduce emissions of greenhouse gases in the electricity sector by encouraging the additional generation of electricity from renewable sources.	Regulatory	Implemented	The Large-scale RET of 33,000 GWh by 2020 encourages investment in large-scale renewable energy projects.	1 April 2001	Renewable Energy (Electricity) Act 2000, administered by the Clean Energy Regulator	19,838

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ e)
Small-scale Renewable Energy Scheme (SRES)	Energy, energy efficiency	CO ₂ , CH ₄ , N ₂ O	To reduce emissions of greenhouse gases in the electricity sector by encouraging the additional generation of electricity from renewable sources.	Regulatory	Implemented	The SRES helps home-owners and small businesses to install eligible small-scale renewable energy systems and solar hot water systems.	1 April 2001	Renewable Energy (Electricity) Act 2000, administered by the Clean Energy Regulator	Not estimated. Solar PV generation in Australia is projected to be around 10,000 GWh in 2020. This can be attributed to the SRES as well as other various state/territory policies including state feed-in tariffs, the individual mitigation impact of which has not been separately quantified.
National Energy Productivity Plan (NEPP)*	Buildings, government operations, renewable energy, gas, National Electricity Market, transport, SMEs, Industrial.	CO ₂ , CH ₄ , N ₂ O	To deliver the Commonwealth's commitment to improve Australia's energy productivity by 40% between 2015 and 2030.	Fiscal, regulatory, voluntary, information and research instruments.	1) Commercial Buildings Disclosure program expansion – implemented. (2) Introduction of a Clean Energy Innovation Fund and its commitment to expand the role of ARENA – Implemented. 3) New prioritisation plan to accelerate the impact of the successful Equipment Energy Efficiency program, with new proposed standards released on air conditioners and refrigerated cabinets – Implemented.	The NEPP covers 34 economy-wide measures across most sectors supporting smarter energy choices and better energy services.	2015	CEFC, ARENA, Department of the Environment and Energy, Department of Infrastructure and Regional Development, COAG Energy Council, all Australian states and territories	Existing Commercial Building Disclosure: 381; Existing E3 program: 6,227 Note: the NEPP was not included in the 2016 emissions projections, as design of the full package of NEPP measures had not been finalised.

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Ministerial Forum on Vehicle Emissions	Light vehicles	CO ₂	To improve the fuel efficiency of new light vehicles sold in Australia	Regulatory	Planned	The policy would set a fleet-wide fuel efficiency target to reduce emissions emitted by light vehicles.	Subject to government decision and legislation	Department of Infrastructure and Regional Development	Not estimated, as final design and implementation is subject to government decision.
Hydrofluorocarbon (HFC) management	Industrial - Refrigeration and air conditioning	HFC	To reduce HFC imports (and thus emissions) to 15% of baseline	Legislation	Adopted	The policy will reduce HFC imports by 85% by 2036 from a baseline of 8000 kt CO ₂ -e	2018	Department of the Environment and Energy	Zero, the impact of this measure is estimated to be after 2020. This measure was not included in the 2016 projections as it had not yet been legislated.
HFC management	Industrial - refrigeration and air conditioning	SGGs including HFCs	To reduce leakage of SGGs and increase energy efficiency	Education	Planned	The policy is intended to change behaviour by providing information about benefits of leak testing and servicing of installed equipment.	2018	Department of the Environment and Energy	Not estimated as final design and implementation is subject to government decision.
Australian Renewable Energy Agency (ARENA)	Energy, including energy-related transport and industrial process emissions.	GHGs	To improve the competitiveness of renewable energy technologies, and increase the supply of renewable energy in Australia.	Research funding; information.	Implemented	ARENA is a statutory authority providing research, development, demonstration and deployment grant funding to improve the affordability and increase the supply of renewable energy in Australia.	2012	Department of the Environment and Energy	ARENA's activities are an enabler for greenhouse gas emissions reduction. Improving the competitiveness of renewable energy provides the option to scale up renewable energy generation at lower cost, bringing down the cost of emissions reductions.

Name of policy or measure	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation (implemented, adopted or planned)	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact in 2020 (not cumulative, in kt CO ₂ -e)
Clean Energy Finance Corporation (CEFC)	Energy sector primarily, and through energy efficiency, support across the economy, including built environment, transport, manufacturing and agribusiness	GHGs	To reduce emissions from energy and industrial processes, and include investments in solar energy and energy storage.	Economic	Implemented	CEFC is a statutory authority that uses debt and equity funding to promote investment in clean energy technologies, namely renewable energy technologies, energy efficiency technologies and low emissions technologies and their supply chains	2013	Department of the Environment and Energy; Clean Energy Finance Corporation	The CEFC's current commitments will contribute funding to projects, that once fully constructed and operational, are estimated to achieve annual abatement of 9 million tonnes CO ₂ -e in 2020. Note the CEFC does not claim that this abatement occurs independent of complementary policy such as the RET.

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
- g This does not take into account results from the sixth ERF Auction which were not available at the time of finalising this estimate.

Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry activities

Information is provided in CTF Tables 4, 4(a) II and 4(b).

CTF Table 4: Reporting on progress^{a,b}

Base Year/Base period		2000	2010	2011	2012	2013	2014	2015	2016
	Unit								
Total emissions without LULUCF^①	kt CO ₂ -e	484,841.72	537,159.26	538,544.09	541,258.26	531,325.63	525,792.13	533,282.71	-
Contribution from LULUCF^c	kt CO ₂ -e	69,564.93	26,633.08	17,717.26	6,448.98	-1,853.51	4,902.75	4,567.81	-
Market based mechanisms under the Convention^②	Number of units	0	0	0	0	0	0	0	-
	kt CO ₂ -e	0	0	0	0	0	0	0	-
Other market based mechanisms	Number of units	0	0	0	0	0	0	0	-
	kt CO ₂ -e	0	0	0	0	0	0	0	-

Abbreviation: GHG – greenhouse gas, *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 prejudice 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 For the base year, information reported on the emission reduction target shall include the following : (a) total GHG emissions, excluding emissions and removals from the *LULUCF* sector: (b) emissions and/or removals from the *LULUCF* sector based on the accounting approach identified taking into consideration any relevant decisions of the Conference of Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the *LULUCF* sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a-c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.
 - c Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the *LULUCF* contribution is reported in table 1 of this common tabular format can refer to table 1.
- ① For this table, data for the year 2015 are consistent with Australia’s National Inventory Report 2015. Data for the year 2016 can be made available upon finalisation of *Australia’s National Inventory Report 2016*
- ② Australia understands surrender as distinct from holding

**CTF Table 4(a)I–1: Progress in achieving the Quantified Economy-wide Emission Reduction Target—
further information on mitigation actions relevant to the contribution of the land use,
land-use change and forestry sector, 2015^{a, b, c}**

Cancun 2020 target inventory: KP *LULUCF* classifications data against UNFCCC *LULUCF* classifications

	Unit	Base year/ period or reference level value ^d	Net GHG emissions/ removals from <i>LULUCF</i> categories ^e	Contribution from <i>LULUCF</i> for reported year	Cumulative contribution from <i>LULUCF</i> ^f	Accounting Approach ^g
2015						
Total <i>LULUCF</i>^o	kt CO ₂ -e	69,565	4,568	- 64,997	NA	
A. Forest land	kt CO ₂ -e	- 14,647	- 31,007	- 16,360	NA	
1. Forest land remaining forest land ^o	kt CO ₂ -e	- 7,517	- 18,394	- 10,876	NA	
2. Land converted to forest land ^o	kt CO ₂ -e	- 7,130	- 12,614	- 5,484	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
B. Cropland	kt CO ₂ -e	10,227	- 456	- 10,682	NA	
1. Cropland remaining cropland	kt CO ₂ -e	1,063	- 4,180	- 5,243	NA	
2. Land converted to cropland	kt CO ₂ -e	9,164	3,725	- 5,440	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
C. Grassland	kt CO ₂ -e	72,050	35,343	- 36,707	NA	
1. Grassland remaining grassland	kt CO ₂ -e	14,218	8,730	- 5,488	NA	
2. Land converted to grassland	kt CO ₂ -e	57,832	26,613	- 31,219	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
D. Wetlands	kt CO ₂ -e	227	- 48	- 274	NA	
1. Wetland remaining wetland	kt CO ₂ -e	200	- 44	- 245	NA	
2. Land converted to wetland	kt CO ₂ -e	27	- 3	- 30	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
E. Settlements	kt CO ₂ -e	1,709	736	- 973	–	
1. Settlements remaining settlements	kt CO ₂ -e	- 22	- 67	- 45	NA	
2. Land converted to settlements	kt CO ₂ -e	1,731	803	- 928	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
F. Other land	kt CO ₂ -e	–	–	–	–	
1. Other land remaining other land	kt CO ₂ -e	NA	NA	NA	NA	
2. Land converted to other land	kt CO ₂ -e	NO	NO	NO	NA	
3. Other ^h	kt CO ₂ -e	–	–	–	–	
G. Harvested wood products	kt CO ₂ -e	IE	IE	IE	NA	

Other (See section 4.7 of this Annex for more details)

Abbreviations: GHG = greenhouse gas, *LULUCF* = land use, land-use change and forestry, NO = Not Occurring, NE = Not Estimated, IE = Included Elsewhere and NA = Not Applicable

- a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice 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 Parties that use the *LULUCF* approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2014 and 2015, where 2017 is the reporting year.

- c CTF table 4(a) has been used to present Australia's *LULUCF* estimates, as it is a better option for reporting purposes than using CTF table 4(a)ii. Each *LULUCF* classification field under the Convention is completed using net emission data according to the *LULUCF* classifications under the KP
 - d For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its KP, explain in the biennial report how the value was derived.
 - e Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.
 - f If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.
 - g Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).
 - h Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its KP.
 - i Australia did not Elect this non-mandatory Activity for reporting.
- ① This table presents KP *LULUCF* classifications data against UNFCCC *LULUCF* classifications to demonstrate progress against Australia's 2020 QEERT. Data for the year 2015 are consistent with Australia's *National Inventory Report 2015* (2017).
- ② Forest land remaining forest land includes forest lands managed for timber production.
- ③ Land converted to forest land includes land converted to forest since 1990.

SUPPLEMENT: Cancun 2020 target inventory: KP *LULUCF* classifications data against KP *LULUCF* classifications

	Unit	Base year/ period or reference level value ^d	Net GHG emissions/ removals from <i>LULUCF</i> categories ^d	Contribution from <i>LULUCF</i> for reported year	Cumulative contribution from <i>LULUCF</i> ^e	Accounting Approach ^f
2015						
This table presents KP <i>LULUCF</i> classifications data against KP <i>LULUCF</i> classifications to demonstrate progress against Australia's 2020 QEERT						
Total KP <i>LULUCF</i>	kt CO ₂ -e	69,565	4,568	-64,997	-201,078	
A. Article 3.3 Activities	kt CO ₂ -e	61,624	18,524	-43,100	-122,025	
A.1. Deforestation	kt CO ₂ -e	68,754	31,138	-37,616	-95,873	
A.2. Afforestation/ Reforestation	kt CO ₂ -e	-7,130	-12,614	-5,484	-26,152	
B. Article 3.4 Activities	kt CO ₂ -e	7,941	-13,956	-21,897	-79,053	Other (See section 4.7 of this Annex for more details)
B.1. Forest Management	kt CO ₂ -e	-7,517	-18,394	-10,876	-40,567	
B.2. Cropland Management	kt CO ₂ -e	1,063	-4,180	-5,243	-16,370	
B.3. Grazing land Management	kt CO ₂ -e	14,218	8,730	-5,488	-21,283	
B.4. Revegetation	kt CO ₂ -e	178	-112	-290	-833	
B.5. Wetland drainage and rewetting^g	kt CO ₂ -e	NA	NA	NA	NA	NA

CTF Table 4(a)I-2: Progress in achieving the Quantified Economy-wide Emission Reduction Target—further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector, 2016^{a, b}

Cancun 2020 target inventory: KP *LULUCF* classifications data against UNFCCC *LULUCF* classifications. Data for the year 2016 can be made available upon finalisation of Australia's National Inventory Report 2016.

	Unit	Base year/ period or reference level value ^d	Net GHG emissions/ removals from <i>LULUCF</i> categories ^d	Contribution from <i>LULUCF</i> for reported year	Cumulative contribution from <i>LULUCF</i> ^e	Accounting Approach ^f
2015						
Total <i>LULUCF</i> ^g	kt CO ₂ -e	–	–	–	–	
A. Forest land	kt CO ₂ -e	–	–	–	–	
1. Forest land remaining forest land ^g	kt CO ₂ -e	–	–	–	–	
2. Land converted to forest land ^g	kt CO ₂ -e	–	–	–	–	
3. Other ^g	kt CO ₂ -e	–	–	–	–	
B. Cropland	kt CO ₂ -e	–	–	–	–	
1. Cropland remaining cropland	kt CO ₂ -e	–	–	–	–	
2. Land converted to cropland	kt CO ₂ -e	–	–	–	–	
3. Other ^g	kt CO ₂ -e	–	–	–	–	
C. Grassland	kt CO ₂ -e	–	–	–	–	
1. Grassland remaining grassland	kt CO ₂ -e	–	–	–	–	
2. Land converted to grassland	kt CO ₂ -e	–	–	–	–	Other (See section 4.7 of this Annex for more details)
3. Other ^g	kt CO ₂ -e	–	–	–	–	
D. Wetlands	kt CO ₂ -e	–	–	–	–	
1. Wetland remaining wetland	kt CO ₂ -e	–	–	–	–	
2. Land converted to wetland	kt CO ₂ -e	–	–	–	–	
3. Other ^g	kt CO ₂ -e	–	–	–	–	
E. Settlements	kt CO ₂ -e	–	–	–	–	
1. Settlements remaining settlements	kt CO ₂ -e	–	–	–	–	
2. Land converted to settlements	kt CO ₂ -e	–	–	–	–	
3. Other ^g	kt CO ₂ -e	–	–	–	–	
F. Other land	kt CO ₂ -e	–	–	–	–	
1. Other land remaining other land	kt CO ₂ -e	–	–	–	–	

	Unit	Base year/ period or reference level value ^d	Net GHG emissions/ removals from LULUCF categories ^d	Contribution from LULUCF for reported year	Cumulative contribution from LULUCF ^e	Accounting Approach ^f
2015						
2. Land converted to other land	kt CO ₂ -e	-	-	-	-	Other (See section 4.7 of this Annex for more details)
3. Other ^g	kt CO ₂ -e	-	-	-	-	
G. Harvested wood products	kt CO ₂ -e	-	-	-	-	

Abbreviations: GHG = greenhouse gas, 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 prejudice 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 Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2014 and 2015, where 2017 is the reporting year.
 - c For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its KP, explain in the biennial report how the value was derived.
 - d Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.
 - e If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.
 - f Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).
 - g Specify what was used for the category "other". Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its KP.
- ① This table presents KP LULUCF classifications data against UNFCCC LULUCF classifications to demonstrate progress against Australia's 2020 QEERT. Data for the year 2015 are consistent with Australia's National Inventory Report 2015 (2017).
 - ② Forest land remaining forest land includes forest lands managed for timber production.
 - ③ Land converted to forest land includes land converted to forest since 1990.

CTF Table 4(b): Reporting on progress^{a,b,c}

Note: Australia understands surrender as distinct from holding. Surrender is when an entity or Party retires a unit for compliance purposes. No units had been surrendered by end 2016.

	Quantity of units	kt CO ₂ -e
2015		
KP units ^d	-	-
AAUs	-	-
ERUs	-	-
CERs	-	-
tCERs	-	-
ICERs	-	-
Units from market-based mechanisms under the Convention ^{d,e}	-	-
Units from other market-based mechanisms ^{d,e}	-	-
Total	-	-
2016		
KP units ^d	-	-
AAUs	-	-
ERUs	-	-
CERs	-	-
tCERs	-	-
ICERs	-	-
Units from market-based mechanisms under the Convention ^{d,e}	-	-
Units from other market-based mechanisms ^{d,e}	-	-
Total	-	-

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, ICERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.

Note: 2015 is the latest reporting year.

- Reporting by a developed country Party on the information specified in the common tabular format does not prejudice 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.
- For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.
- Parties may use this information, as appropriate and if relevant to their target.
- Units surrendered by that Party for that year that have not been previously surrendered by that or any other party
- Additional rows for each market-based mechanisms should be added, if applicable

5. PROJECTIONS

This section presents Australia's projections on a Kyoto Protocol (KP) accounting basis for the purposes of showing how Australia is tracking against its Quantified Economy-wide Emission Reduction Target (QEERT). Australia notes the projections contained in Chapter 5 of the Seventh National Communication are done on a UNFCCC accounting basis.

Australia's projections show it is expected to surpass the emissions reductions required to meet its Quantified Economy-wide Emission Reduction Target of 5 per cent below 2000 levels by 145 Mt CO₂-e. If Australia's carryover of 128 Mt CO₂-e from the first commitment period of the KP and international units are included, the overachievement is 294 Mt CO₂-e.

Further information on Australia's emissions projections (with measures, by sector and by gas) is contained in Chapter 5 of Seventh National Communication and CTF table 6. Information on modelling framework and changes since the last Biennial Report submission is also contained in Chapter 5 of the Seventh National Communication.

CTF Table 5: Summary of key variables and assumptions used in the projections analysis^a

Key underlying assumptions	Historical ^b						Projected			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Australia's population (thousands)	16970	17927	18951	20085	21912	22221	23724	25850	27898	29891
Gross domestic product – Real GDP (2016 AU\$m)	756395	851371	1047898	1228856	1413929	1447480	1617016	1845626	2135148	2446355
Exchange rates (AU\$/US\$)	0.77	0.74	0.63	0.75	0.88	0.99	0.84	0.74	0.74	0.74
Electricity generation – sent out (TWh)	133	147	181	214	238	235	230	250	266	282
Oil price (2016 AU\$/bbl)	-	38	57	77	94	106	90	82	86	92
Thermal and coking coal production (Run of Mine, Mt)	197	238	299	392	476	458	554	575	582	603
LNG production (Mt)	2	7	8	11	18	20	25	77	77	77
Iron ore production (Mt)	110	137	111	251	422	446	776	938	928	949
Aluminium production (kt)	1235	1285	1742	1890	1918	1938	1647	1588	1588	1598
Iron and Steel production (Mt)	6.7	8.4	8.1	7.4	6.9	7.3	4.7	5.3	5.3	5.3
Residential gas consumption (PJ)	88	105	119	128	144	148	162	159	139	121
Commercial gas consumption (PJ)	34	43	50	44	48	50	55	61	64	59
Beef cattle (million heads)	22	23	24	25	24	26	25	27	28	29
Dairy cattle (million heads)	2.6	2.7	3.1	3.1	2.5	2.6	2.8	2.8	3.0	3.1
Solid waste disposal (kt)	16468	17421	19594	20574	19916	19951	18730	19733	21627	22126

a Parties should include key underlying assumptions as appropriate.

b Parties should include historical data used to develop the greenhouse gas projections reported.

CTF Table 6a: Information on updated greenhouse gas projections under a 'with measures' scenario

	Historical - GHG emission and removal (kt CO ₂ -e)						Projected - GHG emission projections (kt CO ₂ -e)				
	Base year	1990	1995	2000	2005	2010	2015	2018	2020	2025	2030
Sector											
Energy	289888	232531	250392	289888	317281	331535	324354	333168	331454	327511	329366
Transport	74139	61395	68269	74139	81633	88888	95222	97766	101485	108480	111887
Industry/industrial processes and product use	26768	26081	25271	26768	32061	35363	32327	34079	34307	33591	32482
Agriculture	78625	80179	72856	78625	76186	66450	70012	71557	74756	79234	82407
Forestry/LULUCF	69565	162910	63654	69565	83726	26633	4568	4354	2590	9317	7596
Waste management/waste	15421	19658	18596	15421	14092	14923	11368	10015	9541	9782	10208
Other		-	-	-	-	-	-	-	-	-	-
Gas											
CO ₂ emissions including net CO ₂ from LULUCF	404571	424507	355628	404571	455405	418207	394069	400584	400776	410185	410971
CO ₂ emissions excluding net CO ₂ from LULUCF	349984	278353	305261	349984	385807	406811	402160	409415	411041	413621	416069
CH ₄ emissions including net CH ₄ from LULUCF	122799	131337	119849	122799	117549	111914	109095	115498	117923	121500	126253
CH ₄ emissions excluding net CH ₄ from LULUCF	112818	119920	111415	112818	107931	102430	100895	106364	109070	112732	117534
N ₂ O emissions including net N ₂ O from LULUCF	23946	20667	20724	23946	25049	25101	22901	22433	22927	23984	24881
N ₂ O emissions excluding net N ₂ O from LULUCF	18949	15327	15871	18949	20538	19348	18443	18382	18925	19999	20905
HFCs	1613	1425	1004	1613	5002	8166	11483	12105	12186	11932	11538
PFCs	1287	4607	1531	1287	1792	283	171	181	182	178	172
SF ₆	191	211	302	191	182	121	131	139	139	137	132
Other (Specify e.g. NF ₃)	-	-	-	-	-	-	-	-	-	-	-
Total with LULUCF^f	554407	582754	499038	554407	604979	563792	537850	550939	554133	567915	573947
Total without LULUCF	484842	419843	435384	484842	521252	537159	533283	546585	551543	558598	566350

The historical and projected emissions are presented on a KP accounting basis to show tracking towards Australia's Quantified Economy-wide Emission Reduction Target (QEERT). The starting year of the emissions projections is 2016. The projections have been scaled to the 2015 National Greenhouse Gas Inventory.

These estimates incorporate policies and measures implemented and adopted at December 2017. These estimates do not include the following planned policies: the National Energy Guarantee; measures to improve the fuel efficiency of Australia's vehicle fleet being considered by the Australian Government's Ministerial Forum on Vehicle Emissions; or the work of the COAG Energy Council.

6. PROVISION OF FINANCIAL, TECHNOLOGICAL AND CAPABILITY-BUILDING SUPPORT TO DEVELOPING COUNTRY PARTIES

Australia provides a range of financial, technological and capability-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 the Seventh National Communication.

Table 7 summarises public financial support over the reporting period (covering two Australian financial years from 2014-15 to 2015-16). Table 7(a) provides information on public financial support through multilateral channels. Table 7(b) provides information on public financial support through bilateral, regional and other channels.

Australia's climate finance for this two-year period was:

- balanced between mitigation and adaptation measures with over half of bilateral, regional and global programs contributing to adaptation
- provided as grants and fully expensed
- prioritised toward countries most vulnerable to climate change, with over two thirds of bilateral, regional and global programs expected to benefit Small Island Developing States (SIDS) and Least Developed Countries (LDCS).

Australia sources its climate finance from new and additional budget appropriations passed by the Australian Parliament on an annual basis. Australia only counts climate finance where the investment targets climate change adaptation or mitigation, in addition to other development outcomes. For the purposes of this report, 'provided' means funds have been transferred from the Australian Government to a recipient (including multilateral organisations).

For multilateral contributions, where climate change is the primary focus of the institution, Australia counts 100 per cent of the core contribution as climate finance. Where climate change is one of several work areas of the institution, Australia applies international standard coefficients to determine the climate change component of the core contribution. These coefficients are derived from the imputed shares calculated by the OECD Development Assistance Committee Secretariat (average of imputed shares for 2013-14 and 2014-15). The coefficients applied are summarised below.

Organisation	Coefficient applied
Green Climate Fund	100%
Global Green Growth Institute	100%
Multilateral Fund for the Implementation of the Montreal Protocol	100%
Global Environment Facility Trust Fund	58.7%
World Bank - International Development Association	18.3%
Asian Development Bank - Asian Development Fund	19.0%

For bilateral, regional and global programs, Australia accounts its climate finance at the individual activity level and then aggregates these figures. Where the activity has an explicit primary climate change objective, the entire activity value is accounted as climate finance. Where the activity has an explicit secondary climate change objective: component activities are identified; the proportion of each component that is delivering climate results is estimated and the total of all components is calculated. The same process is applied to determine the split of adaptation versus mitigation support. In some cases, spending on each activity can be clearly attributed to either mitigation or adaptation. However, in most cases, the activities are achieving both mitigation and adaptation outcomes. In these cases, Australia reports its support as “cross cutting”.

Case study: Kiribati Education Improvement Program

Over three phases of Kiribati Education Improvement Program (KEIP; up to \$70 million, 2011-19), Australia is supporting the implementation of the Kiribati Education Sector Strategic Plan and its goal of improving the quality of education provided in I-Kiribati schools. We are working with the Government of Kiribati to provide safe and healthy learning environments, adequate resources, a modern curriculum, professional teachers, and improved management of the education system. Climate change considerations – both adaptation and mitigation - have been explicitly built into the initiative. These include employing climate-sensitive design and engineering measures such as raising floor heights, and using solar power where ever possible. Of Australia’s \$12 million investment in KEIP during 2014-15 and 2015-16, a total of \$3.6 million has been accounted as contributing to Australia’s climate finance.

Funds are reported in AUD millions. 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.

In addition to Tables 7, 7(a) and 7(b), further information on financial support provided by Australia can be found in Chapter 7 of the Seventh National Communication.

Table 7: Provision of public financial support summary 2014-15
Australia's CTF tables on climate finance can be found on the UNFCCC website

Allocated channels	Domestic currency						USD ^b		
	Core/ General ^c (AUD\$ million)	Climate-specific ^d (AUD\$ million)			Core/ General ^e	Climate-specified			
		Mitigation	Adaptation	Cross Cutting		Other ^f	Mitigation	Adaptation	Cross Cutting
Total contributions through multilateral channels: Multilateral climate change funds ^g	98,951,225							89,432,143	
Other multilateral climate change funds ^h	4,622,505							4,177,820	
Multilateral financial institutions, including regional development banks	61,028,611							52,970,233	
Specialised United National bodies	1,111,534						1,004,604		
Contributions through bilateral, regional and other channels	9,189,246	61,657,173	28,855,299		8,305,241	55,725,753		26,079,419	
Total	9,189,246	61,657,173	191,037,414		8,305,241	55,725,753		172,659,615	

Currency exchange for the information provided in table 7, 7(a) and 7(b) was based on an 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:

- i. These figures on mitigation, adaptation and cross-cutting are drawn from assessments of individual activities and investments.
 - j. Cross-cutting refers to investments and activities that target both adaptation and mitigation outcomes
- USD exchange rates are based on annual average conversion rates for the relevant financial year as published by the Australian Taxation Office: (FY2014/15: 0.9038 FY2015/16: 0.7736).
Source: <https://www.ato.gov.au/Rates/Foreign-exchange-rates/>. The Australian financial year runs from 1 July to 30 June. Therefore, the figures for 2014 are for the period 1 July 2014 – 30 June 2015, and for 2015 are for the period 1 July 2015 – 30 June 2016.

Table 7: Provision of public financial support summary 2015-16
Australia's CTF tables on climate finance can be found on the UNFCCC website

Allocated channels	Domestic currency						USD ^b			
	Core/ General ^c (AUD\$ million)	Climate-specific ^d (AUD\$ million)			Core/ General ^c	Climate-specified				
		Mitigation	Adaptation	Cross Cutting		Other ^e	Mitigation	Adaptation	Cross Cutting	
Total contributions through multilateral channels: Multilateral climate change funds ^g				72,640,830						56,194,946
Other multilateral climate change funds ^h				4,622,505						3,575,970
Multilateral financial institutions, including regional development banks				61,028,611						47,211,733
Specialised United National bodies				1,056,378						817,214
Contributions through bilateral, regional and other channels		12,961,390	78,387,076	38,187,163				10,026,931	60,640,242	29,541,589
Total		12,961,390	78,387,034	176,479,108				10,026,931	60,640,209	136,524,238

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:

i. **These figures on mitigation, adaptation and cross-cutting are drawn from assessments of individual activities and investments.**

USD exchange rates are based on annual average conversion rates for the relevant financial year as published by the Australian Taxation Office: (FY2014/15: 0.9038 FY2015/16: 0.7736).
Source: <https://www.ato.gov.au/Rates/Foreign-exchange-rates/>. The Australian financial year runs from 1 July to 30 June. Therefore, the figures for 2014 are for the period 1 July 2014 – 30 June 2015, and for 2015 are for the period 1 July 2015 – 30 June 2016.

Table 7a: Provision of public financial support: multilateral
Australia's CTF tables on climate finance can be found on the UNFCCC website

Multilateral Organisation	2014-15				2015-16				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	18,284,000	16,525,079	10,732,525	9,700,056	21,535,000	16,659,476	12,640,830	9,778,946	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Least Developed Countries Fund													
Special Climate Change Fund													
Adaptation Fund													
Green Climate Fund	70,000,000	63,266,000	70,000,000	63,266,000	60,000,000	46,416,000	60,000,000	46,416,000	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Global Green Growth Institute	18,218,700	16,466,061	18,218,700	16,466,061					Provided	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	106,502,700	96,257,140	99,691,472	90,101,153	81,535,000	63,075,476	72,640,830	56,194,946				Cross-cutting	
Specialised United Nations bodies													
United Nations Environment Programme													
Inter-Governmental Panel on Climate Change (counted in bilateral, regional and global)	120,000	108,456	120,000	108,456	220,000	170,192	220,000	170,192	Provided	Public	Grant	Cross-cutting	Cross-cutting
United Nations Framework Convention on Climate Change (counted in bilateral, regional and global)	991,534	896,148	991,534	896,148	816,378	631,550	816,378	631,550	Provided	Public	Grant	Cross-cutting	Cross-cutting
United Nations Framework Convention on Climate Change Trust Fund for participation (counted in bilateral, regional and global)					20,000	15,472	20,000	15,472	Provided	Public	Grant	Cross-cutting	Cross-cutting
Multilateral Fund for the Implementation of the Montreal Protocol	4,622,505	4,177,820	4,622,505	4,177,820	4,622,505	3,575,970	4,622,505	3,575,970	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal Specialised United Nations bodies	4,622,505 (excluding IPCC and UNFCCC)	4,177,820	4,622,505 (excluding IPCC and UNFCCC)	4,177,820	4,622,505 (excluding IPCC and UNFCCC)	3,575,970	4,622,505 (excluding IPCC and UNFCCC)	3,575,970					

Multilateral Organisation	2014-15				2015-16				Status	Source	Financial Instrument	Type of Support	Sector
	Core		CC-Specific		Core		CC-Specific						
	AUD	USD	AUD	USD	AUD	USD	AUD	USD					
Multilateral financial institutions, including regional development banks													
World Bank International Development Association	193,024,723	174,455,745	35,359,234	31,957,676	203,468,732	157,403,411	37,272,420	28,833,944	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Asian Development Bank – Asian Development Fund	122,199,799	110,444,178	23,249,123	21,012,557	124,865,000	96,595,564	23,756,191	18,377,789	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Subtotal	315,224,522	284,899,923	58,608,357	52,970,233	328,333,732	253,998,975	61,028,611	47,211,733					
Total	426,349,727	385,334,883	162,182,087	146,580,170	414,491,237	320,650,421	138,291,946	106,982,649					

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: ODS = Ozone Depleting Substances.

Documentation Box:

USD exchange rates are based on annual average conversion rates for the relevant financial year as published by the Australian Taxation Office: (FY2014/15: 0.9038 FY2015/16: 0.7736). Source: <https://www.ato.gov.au/Rates/Foreign-exchange-rates/>. The Australian financial year runs from 1 July to 30 June. Therefore, the figures for 2014 are for the period 1 July 2014 – 30 June 2015, and for 2015 are for the period 1 July 2015 – 30 June 2016.

- a The Green Climate Fund (GCF) secretariat and the OECD are currently in discussion regarding the GCF climate finance imputed share for 2015-16. Until such time as these discussions are resolved, Australia continues to use the imputed share of 100% for the GCF, which was the imputed share for 2013-14 and 2014-15 and is also the imputed share for other climate funds.

Table 7b: Provision of public financial support: bilateral and other 2014-15
Australia's CTF tables on climate finance can be found on the UNFCCC website

Recipient Country/Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support*	Sector ^b	Additional Information
	AUD	USD						
	Climate Specific							
Cambodia	342,000	309,100	Provided	ODA	Grant	Adaptation	Infrastructure	Rural Road Improvement
South East Asia	2,040,000	1,843,752	Provided	ODA	Grant	Adaptation and mitigation	Water, cross-cutting	Support to the Mekong River Commission Water governance and regulation
South East Asia / Pacific	2,400,000	2,169,120	Provided	ODA	Grant	Adaptation and mitigation	Forestry, cross-cutting	Coral Triangle Initiative Responsible Asia Forestry Partnership
Indonesia	6,063,432	5,480,130	Provided	ODA	Grant	Adaptation and mitigation	Infrastructure	Infrastructure
Philippines	3,728,666	3,369,968	Provided	ODA	Grant	Adaptation	Cross-cutting	Post-disaster response Disaster risk reduction Education infrastructure
Timor Leste	110,950	100,277	Provided	ODA	Grant	Adaptation	Agriculture	Agriculture and livelihoods
Vietnam	3,663,466	3,311,041	Provided	ODA	Grant	Adaptation	Cross-cutting	Infrastructure Climate change adaptation
Afghanistan	1,236,091	1,117,179	Provided	ODA	Grant	Adaptation	Cross-cutting	Community resilience Food security
Bangladesh	260,000	234,988	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Support to BRAC Bangladesh
South Asia	5,928,200	5,357,907	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	South Asia Sustainable Development Investment Portfolio – water, energy and food security with a focus on climate change and gender
Pacific regional	14,910,997	13,476,559	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Support to Pacific regional organisations for climate action Community-based fisheries and aquaculture Climate and oceans support program Pacific Risk and Resilience Program Pacific climate science and information programs

Recipient Country/Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support*	Sector ^b	Additional information
	AUD	USD						
	Climate Specific							
Fiji	169,811	153,475	Provided	ODA	Grant	Adaptation	Cross-cutting	Community resilience Disaster risk reduction
Nauru	1,861,944	1,682,825	Provided	ODA	Grant	Adaptation and mitigation	Infrastructure	Infrastructure Education infrastructure
Kiribati	3,100,063	2,801,837	Provided	ODA	Grant	Adaptation and mitigation	Infrastructure	Rural road infrastructure
Papua New Guinea	22,881,491	20,680,292	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Education and health infrastructure and services Community resilience and food security Disaster risk reduction Transport infrastructure
Samoa	130,000	117,494	Provided	ODA	Grant	Adaptation	Infrastructure	Transport infrastructure
Solomon Islands	2,236,220	2,021,096	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Renewable energy Community resilience Rural development Water resource management
Tonga	1,187,152	1,072,948	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Renewable energy Infrastructure and urban development
Tuvalu	1,117,509	1,010,005	Provided	ODA	Grant	Adaptation	Cross-cutting	Environment and climate change initiative Disaster risk reduction Education infrastructure
Vanuatu	15,370,769	13,892,101	Provided	ODA	Grant	Adaptation	Cross-cutting	Skills and education infrastructure Urban infrastructure Transport infrastructure Health preparedness Community awareness and resilience
Federated States of Micronesia	400,000	361,520	Provided	ODA	Grant	Adaptation	Cross-cutting	Climate adaptation, disaster reduction and education

Recipient Country/Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support ^a	Sector ^b	Additional information
	AUD	USD						
Republic of the Marshall Islands	200,000	180,760	Provided	ODA	Grant	Adaptation	Cross-cutting	Climate adaptation, disaster reduction and education
Global	10,362,957	9,366,041	Provided	ODA/public	Grant	Adaptation and mitigation	Cross-cutting	Contributions to specialised UN bodies Australian Volunteers for International Development Australia Awards Australian NGO Cooperation Program Australian Renewable Energy Agency International Climate Change Engagement Program Global Facility for Disaster Reduction and Recovery
Total	99,701,718	90,110,415						

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: ODS = Ozone Depleting Substances.

Documentation Box:

a **Cross-cutting refers to support that targets both adaptation and mitigation outcomes.**

b **Cross-cutting refers to support that targets multiple sectors**

USD exchange rates are based on annual average conversion rates for the relevant financial year as published by the Australian Taxation Office: (FY2014/15: 0.9038 FY2015/16: 0.7736). Source: <https://www.ato.gov.au/Rates/Foreign-exchange-rates/>. The Australian financial year runs from 1 July to 30 June. Therefore, the figures for 2014 are for the period 1 July 2014 – 30 June 2015, and for 2015 are for the period 1 July 2015 – 30 June 2016.

Table 7b: Provision of public financial support: bilateral and other 2015 - 16
Australia's CTF tables on climate finance can be found on the UNFCCC website

Recipient Country/ Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support	Sector	Additional information
	AUD	USD						
	Climate Specific							
Cambodia	495,000	382,932	Provided	ODA	Grant	Adaptation	Infrastructure	Rural Road Improvement
South East Asia	1,239,200	958,645	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Support to the Mekong River Commission Energy infrastructure Renewable energy
South East Asia / Pacific	600,000	464,160	Provided	ODA	Grant	Adaptation	Cross-cutting	Support to the Mekong River Commission Water resource governance Economic governance and policy Renewable energy
Indonesia	15,046,115	11,639,675	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Road and energy infrastructure Forest fire management Community resilience Agricultural research and innovation
Philippines	170,000	131,512	Provided	ODA	Grant	Adaptation	Cross-cutting	Disaster risk reduction
Timor Leste	1,130,500	874,555	Provided	ODA	Grant	Adaptation	Cross-cutting	Agriculture and livelihoods Disaster preparedness
Vietnam	2,165,657	1,675,352	Provided	ODA	Grant	Adaptation	Cross-cutting	Infrastructure Climate change adaptation
Afghanistan	1,760,728	1,362,099	Provided	ODA	Grant	Adaptation	Cross-cutting	Community resilience Disaster preparedness
Pakistan	900,000	696,240	Provided	ODA	Grant	Adaptation	Cross-cutting	Disaster risk reduction
Bangladesh	1,394,189	1,078,545	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Support to BRAC Bangladesh Disaster risk reduction
South Asia	4,410,000	3,411,576	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	South Asia Sustainable Development Investment Portfolio - water, energy and food security with a focus on climate change and gender

Recipient Country/Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support	Sector	Additional information
	AUD	USD						
	Climate Specific							
Global programs	12,370,873	9,570,107	Provided	ODA/public	Grant	Adaptation and mitigation	Cross-cutting	Contributions to specialised UN bodies Food security and agriculture Australian Volunteers for International Development Australia Awards Australian NGO Cooperation Program Australian Renewable Energy Agency International Climate Change Engagement Program Global Facility for Disaster Reduction and Recovery
Pacific regional	17,764,009	13,742,237	Provided	ODA/public	Grant	Adaptation and mitigation	Cross-cutting	Support to Pacific regional organisations Community based fisheries and aquaculture Climate and oceans support program Pacific Risk and Resilience Program Pacific climate science and information programs
Fiji	7,743,750	5,990,565	Provided	ODA	Grant	Adaptation	Cross-cutting	Community resilience Education infrastructure Disaster risk reduction
Kiribati	3,052,103	2,361,107	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Rural road infrastructure Education infrastructure Institution strengthening
Nauru	2,200,000	1,701,920	Provided	ODA	Grant	Adaptation and mitigation	Infrastructure	Infrastructure Education and health infrastructure and services Community resilience and food security Disaster risk reduction Transport infrastructure Support for the Climate Change Development Agency
Papua New Guinea	40,060,500	30,990,803	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	
Republic of the Marshall Islands	240,000	185,664	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Water and sanitation

Recipient Country/Region	Total Amount		Status	Funding Source	Financial Instrument	Type of Support	Sector	Additional information
	AUD	USD						
	Climate Specific							
Samoa	920,000	711,712	Provided	ODA	Grant	Adaptation	Infrastructure	Transport infrastructure Economic governance
Solomon Islands	6,626,087	5,125,941	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Renewable energy Community resilience Transport infrastructure Water resource management and infrastructure Education infrastructure
Tonga	4,110,000	3,179,496	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Renewable energy Infrastructure and urban development
Tuvalu	731,585	565,954	Provided	ODA	Grant	Adaptation and mitigation	Cross-cutting	Environment and climate change initiatives Disaster risk reduction Education infrastructure
Vanuatu	4,405,333	3,407,966	Provided	ODA	Grant	Adaptation	Cross-cutting	Skills and education infrastructure Urban infrastructure Transport infrastructure Health preparedness Community awareness Disaster risk reduction
Total	129,535,629	100,208,763						

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:

a Cross-cutting refers to support that targets both adaptation and mitigation outcomes.

b Cross-cutting refers to support that targets multiple sectors

USD exchange rates are based on annual average conversion rates for the relevant financial year as published by the Australian Taxation Office: (FY2014/15: 0.9038 FY2015/16: 0.7736). Source: <https://www.ato.gov.au/Rates/Foreign-exchange-rates/>. The Australian financial year runs from 1 July to 30 June. Therefore, the figures for 2014 are for the period 1 July 2014 – 30 June 2015, and for 2015 are for the period 1 July 2015 – 30 June 2016.

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
Global	Mitigation	Global Carbon Capture and Storage Institute	Energy	Public	Public and private	Implemented	The Global Carbon Capture and Storage Institute (Global CCS Institute) was established by the Australian Government in 2009 to address 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.
Global	Mitigation	Clean Energy Ministerial	Energy	Public	Public and private	Implemented	The Clean Energy Ministerial (CEM) is a global forum to promote policies and share best practices to accelerate the global transition to clean energy. CEM initiatives and campaigns help reduce emissions, improve energy security, provide energy access and sustain economic growth. The Clean Energy Solutions Centre (CESC) is an online portal of clean energy policy information and tools, offering peer to peer learning, remote expert assistance, and online training. It 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 CESC has been co-led and co-funded by Australia and the US since its inception in 2011.
Global	Mitigation	Support to the International Renewable Energy Agency	Energy	Public	Public	Implemented	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.
Bangladesh, Chile, China, India, Indonesia, Malaysia, Pakistan, Singapore, South Korea, Sri Lanka, Thailand, Vietnam	Mitigation	Australian Renewable Energy Agency solar technologies research fellowships and scholarships	Energy	Public	Public	Implemented	Supporting students from developing countries to undertake solar research at Australia's world leading universities and research institutions. Research areas include solar cell efficiency, solar thermal, thin-film materials, multi-junction cells, energy storage, low-cost manufacturing techniques, solar cell testing equipment, materials science, systems design, solar resource forecasting and mapping.

Recipient country and or region	Targeted area	Measures and activities related to technology transfer	Sector ^a	Source of the funding for technology transfer	Activities Undertaken by	Status	Additional information ^d
Pacific region	Mitigation	Pacific Appliance Labelling and Standards (PALS) Program	Energy	Public	Public	Implemented	Pacific Appliance Labelling and Standards (PALS) Program assisted Pacific Island Countries (PICs) implement standards and labelling (S&L) for energy-using equipment such as refrigerators, air conditioners and lighting.

- 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}
Global	Mitigation	World Bank partnership for Market Readiness	Australia is working with other governments through the World Bank Partnership for Market Readiness to build the capacity of countries to develop domestic carbon market instruments to scale up emission reduction efforts and support low carbon development.
Kenya	Mitigation	System for Land-based Emissions Estimation in Kenya	Australia supported the development and implementation of a measurement, reporting and verification system for Kenya's land sector greenhouse gas accounting. The project has now delivered to the Government of Kenya a tailor-made world-class carbon accounting system that will support Kenya's ability to meet international reporting obligations to the UNFCCC.
Indonesia	Mitigation	Land Sector MRV support	The land sector MRV support helps Indonesia to develop a forest monitoring system which will support Indonesia to develop policies to achieve their domestic and international forest commitments, including efforts to reduce emissions from deforestation and forest degradation
South Africa	Mitigation	South Africa Land Sector Measurement, Reporting and Verification (MRV) Capacity Development	This project enhances South Africa's ability to monitor and measure emissions from land-use, which improves the country's ability to meet international reporting requirements and gain accreditation for climate finance.
Global	Mitigation	International Savanna Fire Management Initiative	Following the ongoing success of Australia's savanna fire management methods domestically, Australia supported the International Savanna Fire Management Initiative to assess and promote the feasibility of establishing emissions projects in developing countries. The Initiative shared lessons learned from Australia's experience to fire management practitioners and Indigenous representatives in other countries, and identified regions in developing countries that could pilot savanna fire management.
Thailand	Mitigation	Thailand's Greenhouse Gas Emissions Inventory System (TGEIS)	Australia is supporting Thailand to strengthen its capacity to fulfil its international climate change reporting commitments by supporting the design and development of Thailand's national greenhouse gas emissions inventory system, known as TGEIS.
China	Mitigation	Australia-China Collaboration on National Greenhouse Gas Inventories	The Australia-China collaboration project on national greenhouse gas inventories and supporting information systems commenced in 2016 between the Australian Department of the Environment and Energy and China's National Centre for Climate Change Strategy and International Cooperation (NCSC). The collaboration will strengthen China's capacity to measure, report and verify greenhouse gas emissions.
Global	Cross-cutting	International Partnership for Blue Carbon	This Partnership to enhance the protection and restoration of coastal blue carbon ecosystems that sequester carbon in mangroves, tidal marshes and seagrasses by building awareness of the importance coastal blue carbon ecosystems for climate change adaptation and mitigation in the international community; sharing knowledge, expertise and experience to build capacity in blue carbon related policy, science and practical action; and accelerating practical action to protect and restore blue carbon ecosystems in identified priority regional 'hot-spots'.

Recipient country/region	Targeted area	Programme or project title	Description of programme or project ^{b,c}
Global	Mitigation	Global Forest Observations Initiative	The Australian Government is a founding member of the Global Forest Observations Initiative (GFOI), which assists countries to design and implement robust forest Measurement, Reporting and Verification (MRV) systems. Australia has led the development of the GFOI Methods and Guidance Documentation (MGD), which provides practical advice for designing and implementing forest MRV systems that comply with UNFCCC reporting requirements, having published Version 1 in 2014 and Version 2 in 2016.
Asia Pacific	Mitigation	Asia-Pacific Rainforest Partnership	The Partnership promotes action and provides a platform to progress activities to reduce emissions from deforestation and forest degradation in the Asia-Pacific region. The Partnership works with governments, the private sector, and civil society to support the implementation of the Paris Climate Change Agreement and REDD+ in the region.
Pacific	Cross-cutting	Pacific women UNFCCC negotiator training	Australia has supported negotiator training for Pacific women delegates new to the climate negotiations to enable them to engage effectively in negotiations and build understanding of the gender dimensions of climate change.

- 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 INPUT

7.1 NATIONAL AUDIT

The Australian National Audit Office (ANAO) is an independent office established under the *Auditor General Act 1997*. Its purpose is to drive accountability and transparency in the Australian Government sector through quality evidence-based audit services and independent reporting to Australian Parliament, the executive (all Australian Government Ministers and Parliamentary Secretaries) and the public, with the result of improving public sector performance.

The ANAO 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 and emissions projections over nine months (August 2016 to April 2017). Its objective was to assess the effectiveness of arrangements for the preparation and reporting of Australia's greenhouse gas emissions estimates in the *National Inventory Report 2014 (revised)* and *Australia's Emissions Projections 2016*.

The ANAO reported that the Department of the Environment and Energy has established appropriate processes to prepare, calculate and publish Australia's national inventory for the year 2014 and emissions projections to 2030. The report concluded emissions estimates and projections have been calculated using relevant contemporary data; and appropriate quality assurance and control procedures are in place for inventory and projections data processing, emissions calculations and reporting. The impact of data issues identified in the national inventory across the time series 1990-2014 as a result of the audit of 5000 data points was calculated by the Department of the Environment and Energy as not being material (less than 0.1 per cent in each year).

