Australian Government

Department of Infrastructure and Regional Development

Managing the Carbon Footprint of Australian Aviation

Update August 2017

ISBN 978-1-925531-23-7
August 2017 / INFRASTRUCTURE 3132

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Table of Contents

Chapter 1: Executive Summary

Australia published its first Action Plan, *Managing the Carbon Footprint of Australian Aviation*, in November 2012 in response to the 2010 International Civil Aviation Organization (ICAO) Assembly Resolution A37-19. This updated plan will build on the work of the 2012 plan by outlining Australia's progress in contributing to the ICAO's global aspiration goal of achieving carbon neutral growth by 2020.

Australia's safe, secure and efficient aviation industry underpins a range of business, trade and tourism activities that contribute significantly to our economic prosperity. In the 2015-16 period, more than 36.2 million people and 996,000 tonnes of freight were carried on international air services to and from Australia[1]. In the same period, 60.9 million passengers were carried on domestic flights[2]. Based on 2010-11 data, the Australian Government Bureau of Infrastructure, Transport and Regional Economics (BITRE) has projected the number of passenger movements from all Australian airports to increase by 3.7 percent per annum over the next 20 years, from 135.1 million in 2010-11 to 279.2 million in 2030-31. International and domestic passenger movements are projected to increase by 4.9 and 3.3 per cent respectively per annum over the same period to 72.1 and 207.1 million, respectively, in 2030-31[3].

The growth in airline traffic will contribute to the growth of carbon dioxide (CO_2) emissions despite improvements in aircraft technology and operations, more efficient use of airspace, and the increasing uptake of sustainable alternative fuels for aviation. The Australian Government Department of the Environment and Energy has estimated that CO_2 emissions from domestic aviation are projected to rise steadily at an average of 2.2 per cent per annum out to 2034-35[4]. In the same period, CO_2 emissions from international civil aviation are projected to grow on average by 3 per cent per annum. In 2005, total CO_2 emissions from the combustion of aviation fuels purchased in Australia were 13.6 million tonnes (Mt); in 2015 this figure increased to 20 Mt[5].

Fuel efficiency is however steadily improving. While Australia's aviation industry has seen growth in Revenue-Tonne-Kilometres (RTK) of 24.7 per cent since 2012, its fuel consumption has increased by only 16.8 per cent in the same period, representing a 6.8 per cent efficiency improvement in the rate of fuel consumption, which has in turn slowed the rate of increase in CO_2 emissions. Notwithstanding the general increase in CO_2 emissions from aviation activity to date, Australia is making encouraging progress towards achieving carbon-neutral growth by 2020.

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[1] Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, International airline activity 2015-16, Statistical Report, BITRE, Canberra ACT. See: *https://bitre.gov.au/publications/ongoing/files/International_airline_activity_FY2016.pdf*

[2] Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, Domestic aviation activity 2015-16, Statistical Report, BITRE, Canberra ACT. See: *https://bitre.gov.au/publications/ongoing/files/domestic_airline_activity_2015_2016.pdf*

[3] Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2012, Air passenger movements through capital and non-capital city airports to 2030–31, Report 133, Canberra ACT. See: *https://bitre.gov.au/publications/2012/files/report_133.pdf*

[4] © Commonwealth of Australia (Department of the Environment and Energy) 2016. Australia's Emissions Projections 2016 (unpublished data). See: *http://www.environment.gov.au/system/files/resources/9437fe27-64f4-4d16-b3f1-4e03c2f7b0d7/files/aust-emissions-projections-2016.pdf*

[5] BITRE Aviation Emissions Projections, unpublished data (2016)

Chapter 2: Background

ICAO has been actively progressing work with its 191 Member States and the international aviation sector to achieve its global aspirational goal of carbon neutral growth by 2020 through the adoption of a broad range of practical measures to reduce CO_2 emissions from international aviation operations. This includes technological and operational measures to increase fuel efficiency, the development of a CO_2 standard for new aircraft and the promotion of policies for the wider development and use of sustainable alternative fuels for aviation. The preparation by ICAO Member States of voluntary action plans assists in bringing together and reporting to ICAO on all relevant activities and initiatives being undertaken by States to demonstrate their commitment to and progress toward reducing CO_2 emissions from aviation.

Australia is an active participant and supporter of ICAO's work to develop a multilateral and comprehensive approach to the management of CO_2 emissions from international aviation operations. However, the dynamic nature of the international aviation sector, particularly in relation to the continued growth of air transport, increased competition among airlines globally, and advances in aircraft technology, means there are still many challenges ahead. Challenges include, inter alia, the need to maintain aviation safety as the highest priority, to take account of a range of aircraft environmental impacts incuding noise and emissions, the feasibility and economic viability of adopting new technologies in the near to medium future, and the need to achieve regional and global harmonisation and interoperability to realise economic, operational and environmental benefits. Therefore, managing the growth of Australia's aviation industry in a way which is both economically and environmentally sustainable and responsible will be of chief importance in the coming decades.

Australia is taking a 'Direct Action' approach to reducing its greenhouse gas emissions. At the centre of this approach is the Emission Reduction Fund and its Safeguard Mechanism. The Australian Government Emissions Reduction Fund creates a positive incentive for Australian businesses to adopt smarter practices to cut the amount of greenhouse gases they create. Under the Emissions Reduction Fund, airlines can be credited for reducing the emissions intensity of domestic air transport (i.e. emissions per unit of transportation service). The Safeguard Mechanism puts emissions limits on Australia's largest emitters to prevent significant increases above business-as-usual levels. The Safeguard Mechanism applies to the domestic operations of Australia's major airlines.

Australia also supported the landmark agreement reached at the 39th ICAO Assembly held from 27 September to 6 October 2016 in Montreal, Canada, to adopt a new global market-based measure scheme in the form of a carbon offsetting scheme to help reduce CO_2 emissions from international aviation. Australia joins 70 other countries, representing over 87.7 per cent of total international aviation traffic, in pledging our commitment to join the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (the CORSIA) commencing with the voluntary pilot phase from 2021 to 2023[6].

[6] ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). See: *https://www.icao.int/environmental-protection/Pages/market-based-measures.aspx*

Chapter 3: Highlights

Australia is contributing to ICAO's aspirational goals of achieving a global fuel efficiency improvement of two per cent year-on-year until 2050, as well as capping the global net CO_2 emissions from international aviation at 2020 levels. This is being managed through the implementation of a range of measures progressively introduced since 2012 to improve the efficiency of Australia's aviation system including fleet renewal, improved air traffic management and more efficient on-ground operations. Australia's updated plan includes measures which address CO_2 emissions from both international and domestic aviation operations.

Highlights of those measures are summarised below.

3.1 Fleet Upgrades

The Qantas Group (Qantas)

Qantas is continuing to build its fleet to ensure it remains modern and fuel efficient. Qantas will focus on the B787 Dreamliner powered by the General Electric Next Generation (GEnx) turbofan engine to provide fuel savings on further point-to-point destinations[7].

The Virgin Australia Group (Virgin Australia)

In 2015, Virgin Australia started a major fleet consolidation to reduce the number of aircraft types in operation and to create further synergies to facilitate fuel savings. This process continues and will be further enhanced when the Virgin Australia's 737-800 Max aircraft deliveries commence in 2019. This is a highly efficient aircraft with a fuel efficiency benefit between 14 and 22 per cent depending on the network and flight patterns operated[8].

3.2 Airports Embrace Renewable Energy

Airports Council International (ACI) Airport Carbon Accreditation (ACA) Scheme

Over the past three years, Adelaide, Brisbane, Gold Coast, Hobart, Parafield, Sydney and Sunshine Coast airports have all either achieved or renewed their accreditation with the Airports Council International (ACI) Airport Carbon Accreditation (ACA) Scheme (see **Table 1**). This is an international, voluntary and industry-recognised certification scheme, designed to assess and recognise the efforts of participating airports to map, manage and reduce their greenhouse gas emissions.

[7] Qantas Fleet Developments (2016). See: *http://www.qantas.com.au/travel/airlines/fleet-developments/global/en*
[8] Virgin Australia letter dated 7 April 2017

Table 1: Australian Airports participating in the ACI ACA Scheme

Airport	Level	Current Status
Gold Coast Airport, Australia	1	Mapping
Hobart Airport, Australia	1	Mapping
Adelaide Airport, Australia	3	Optimisation
Brisbane Airport, Australia	3	Optimisation
Parafield Airport, Australia	3	Optimisation
Sydney Airport, Australia	3	Optimisation
Sunshine Coast Airport, Australia	3+	Neutrality

Information in Table 1 provided by Airports Council International Airport Carbon Accreditation Programme

The ACI Asia-Pacific Region recently conducted its inaugural Asia-Pacific Green Airports Recognition 2017 award ceremony to recognise ACI Asia-Pacific airport members who have outstanding accomplishments in their environmental projects.

Two of Australia's airports, Adelaide Airport and Darwin Airport, received recognition for promoting environmental best practices to minimise aviation's impact on the environment in the category of airports with less than 25 million passengers per annum.

On 11 April 2017, the prestigious Platinum award was presented to Darwin Airport and the Gold award to Adelaide Airport during an award presentation ceremony held in Doha, Qatar.

Adelaide Airport

In July 2016, Adelaide Airport completed the installation of Australia's largest rooftop solar power system, bringing the Airport's total solar capacity to 1.28 megawatts or just under 10 per cent of the Airport's annual energy needs.

Darwin Airport

In August 2016, Darwin Airport switched on its $13 million, 4 megawatt solar array capable of offsetting two-thirds of the Airport's peak load or around a quarter of its total energy consumption per year. The installation is currently the largest private sector investment in solar power in Australia, and it is expected to reduce the Airport's power bills by $1.5 million per annum.

Alice Springs Airport

Alice Springs Airport was the first Australian airport to reap the benefits of investing in large scale photovoltaic solar technology feeding back to its internal electricity grid. The airport takes advantage of ten hours of sunshine most days to generate 85 per cent of its energy needs through its solar farm and solar panels mounted on steel parking structures which also provide 98 shaded premium car spaces.

Canberra Airport

Canberra Airport's new terminal is one of the most carbon friendly buildings in Australia, employing water and energy-saving initiatives. This includes the use of two tri-generation plants which produce electricity on-site from natural gas and capture the waste heat to heat the building in winter, generate hot water for domestic use, and cool the building in summer using absorption chillers.

3.3 Airservices Australia Creates Regional Partnerships

The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE)

The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) was established in February 2008 with the aim of helping the airline industry save millions of dollars in fuel and thousands of tonnes of CO_2 emissions through technological innovation and best practice air traffic management. ASPIRE is a joint partnership between Airservices Australia, Airways New Zealand, the Federal Aviation Administration of the United States of America, the Japan Civil Aviation Bureau, the Civil Aviation Authority of Singapore and the Aeronautical Radio of Thailand Limited.

The Indian Ocean Strategic Partnership to Reduce Emissions (INSPIRE)

To complement the work of the ASPIRE partnership, the Indian Ocean Strategic Partnership to Reduce Emissions (INSPIRE) was formed in March 2011 as a collaborative network of partners and peer organisations dedicated to improving the efficiency and sustainability of aviation across the Arabian Sea and Indian Ocean region.

The foundation partners of INSPIRE are like-minded air navigation service providers which have the capacity and capability to provide leadership and contribute resources to the administration of the group. Founding partners include the Airports Authority of India, Airservices Australia and Air Traffic and Navigation Services of South Africa. These partners are supported and assisted by a number of airline and peer organisation members.

3.4 International Engagement on Climate Change

United Nations Framework Convention on Climate Change (UNFCCC)

Ahead of the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris in December 2015, the Australian Government established a UNFCCC Taskforce in the Department of the Prime Minister and Cabinet to coordinate a review of emissions reductions targets. The taskforce consulted widely with stakeholders, including holding roundtables with businesses and non-government organisations, and modelled domestic and international impacts.

The review determined that Australia would continue to strengthen its long-term climate action, building on the unconditional 2020 target and on 11 August 2015 the Australian Government submitted its Nationally Determined Contribution to the UNFCCC to reduce emissions by 26 to 28 per cent below

2005 levels by 2030. On 10 November 2016, Australia ratified the Paris Agreement under the UNFCCC and the Doha Amendment to the Kyoto Protocol, reinforcing our commitment to action on climate change.

International Civil Aviation Organization (ICAO)

At the 2016 ICAO Assembly, Australia supported a landmark agreement by Member States to adopt a global market-based mesure scheme in the form of a carbon offsetting scheme to help reduce CO_2 emissions from international aviation. The agreement is the culmination of over six years of negotiations and is the first time an industry sector has committed to reducing its carbon footprint on a global scale.

Australia joins 70 other countries, representing over 87.7 per cent of total international aviation traffic, in pledging our commitment to join the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (the CORSIA) commencing with the voluntary pilot phase from 2021.

The CORSIA will work in combination with a range of other practical measures such as aircraft technological and operational improvements and the use of sustainable alternative fuels to keep from international aviation at 2020 levels.

The CORSIA has the support of the international aviation industry, including Australia's major airline operators, Qantas and Virgin Australia, who operate internationally.

Chapter 4: Aviation Emissions Trends 2012 to 2016

This section outlines Australia's progress since 2012 in reducing aviation CO_2 emissions. Trends assessed in this chapter include:

- Growth in the domestic and international aviation sectors;
- Reported domestic and international aviation CO_2 emissions;
- Growth in domestic and international aviation CO_2emissions over time; and
- Fuel efficiency improvements in domestic and international aviation.

Australia uses a number of criteria to assess its CO_2 emissions from aviation:

- Revenue-Tonne-Kilometres (RTK): the total tonnes of passengers, freight and mail carried – making up the revenue-generating load – multiplied by the distance flown. It can be broken up into:
  - Passenger RTK: the total tonnes of revenue-paying passengers, produced by multiplying an average passenger weight including baggage estimated at 100 kilograms per passenger by the distance flown; and
  - Cargo RTK: the total tonnes of revenue-generating cargo multiplied by the distance flown.
- Transport CO_2emissions are measured as Carbon Dioxide Equivalent (CO_2-e);
- Fuel Consumption Rates are measured as litres used per RTK; and
- Emissions Intensity is measured as CO_2-e emissions per RTK.

In order to effectively chart aviation activity in Australia against our progress toward reducing emisions, we have taken the main indicator for our Action Plan to be Fuel Consumption Rates and Emissions Intensity. ICAO's stated aim in this regard is an improvement of two per cent per year from 2005 until 2020.

Aviation activity in Australia includes domestic and international aviation. For the purposes of the Action Plan, Australia uses the the Intergovernmental Panel on Climate Change's criteria for defining domestic and international aviation (which differs from the ICAO definition):

- Domestic aviation refers to flights beginning and ending within Australia; and
- International aviation refers to flights whose First Port Of Call is from Australia or whose Last Port Of Call is to Australia, regardless of airline nationality.

Table 2: Absolute and Proportional Changes, 2012 to 2016

	Absolute	Proportional	Annual Rate
Fuel Use (Megalitres)	1226	16.3%	3.3%
CO_2 Emissions (Million tonnes of CO_2-e)	3.08	16.3%	3.3%
Traffic (billions)			
Passenger Revenue-Tonne-Kilometres (Passenger RTK)	6.46	25.6%	5.1%
Cargo Revenue-Tonne-Kilometres (Cargo RTK)	1.36	21.2%	4.2%
Total Revenue-Tonne-Kilometres (RTK)	7.82	24.7%	4.9%
Fuel Consumption Rates			
Litres/Total RTK	-0.0161	-6.8%	-1.4%
Emissions Intensity			
CO_2-e/Total RTK	-41	-6.9%	-1.4%

See Appendix A: Sources and assumptions used to calculate metrics in Tables 2 to 4

Table 2 illustrates the rate of change achieved since Australia's first Action Plan in 2012. Fuel use and CO_2 emissions have increased by 16.3 per cent since 2012, at an annual rate of 3.3 per cent.

Total RTK has increased by 7.82 billion or 24.7 per cent since 2012, at an annual rate of 4.9 per cent. This indicates that more passengers and cargo are being transported than fuel is being used in 2016 compared to 2012.

Fuel consumption rates and emissions intensity has decreased by an annual rate of 1.4 per cent. This has been a consistent improvement since 2013, partially offsetting increasing RTK and demonstrating progress toward meeting ICAO's aspirational goal of two per cent fuel efficiency improvement per annum.

Table 3: Annual Results of Operation, 2012 to 2016

	2012	2013	2014	2015	2016
Fuel Use (Megalitres)	7,546	8,027	8,122	8,248	8,772
CO_2 Emissisons (Million tonnes of CO_2-e)	18.94	20.15	20.38	20.70	22.02
Traffic (billions)					
Passenger Revenue-Tonne-Kilometres (Passenger RTK)	25.26	26.97	28.19	29.56	31.72
Cargo Revenue-Tonne-Kilometres (Cargo RTK)	6.42	6.63	6.82	7.38	7.78
Total Revenue-Tonne-Kilometres (RTK)	31.68	33.59	35.01	36.94	39.50
Fuel Consumption Rate					
Litres/Total RTK	0.2382	0.239	0.232	0.2232	0.2221
Emissions Intensity					
CO_2-e/Total RTK	598	600	582	560	557

See Appendix A: Sources and assumptions used to calculate metrics in Tables 2 to 4

Table 3 illustrates that RTK has increased since 2012, both in terms of passengers and cargo, reflecting growth in aviation traffic. Total RTK has risen from 31.68 billion in 2012 to 39.5 billion in 2016.

Australia's total fuel use and CO_2 emissions are rising due to increasing traffic across the industry. Fuel use has increased from 7,546 megalitres (ML) in 2012 to 8,772 ML in 2016, while emissions have risen from 18.94 Million tonnes (Mt) of CO_2-e in 2012 to 22.02 Mt in 2016.

However, fuel consumption rates and emissions intensity is decreasing, indicating progress in measures being taken to increase fuel efficiencies and related emission intensity (see **Table 2**).

Table 4: International and Domestic Activity, 2016

	International	Domestic	Total
Fuel Use (Megalitres)	4,791	3,981	8,772
CO_2 Emissions (Million tonnes of CO_2-e)	12.02	9.99	22.02
Traffic (billions)			
Passenger Revenue-tonne-kilometres (Pass. RTK)	24.79	6.93	31.72
Cargo Revenue-Tonne-Kilometres (Cargo RTK)	7.46	0.32	7.78
Total Revenue-Tonne-Kilometres (RTK)	32.25	7.25	39.50
Fuel Consumption Rates			
Litres/Total RTK	0.1485	0.5491	0.2221
Emissions Intensity			
CO_2-e/Total RTK	373	1378	557

See Appendix A: Sources and assumptions used to calculate metrics in Tables 2 to 4

Table 4 demonstrates there are distinctions to draw across international and domestic aviation operations. In 2016, Australia's domestic aviation sector used 3,981 Megalitres (ML) of fuel, producing 9.99 Mt of CO_2-e, in comparison with the international sector's consumption of 4,791 ML of fuel, producing 12.02 Mt of CO_2-e.

Domestic aviation recorded 7.25 billion RTK in 2016 while the international sector recorded 32.25 billion, for a total of 39.50 billion RTK. There, international aviation activity accounts for most of Australia's RTK.

The results show that Australia's international aviation activity is significantly more efficient in fuel use and CO_2 emissions than its domestic counterpart. This is likely attributable to the difference in fleet age between international and domestic aviation and the impact of the fuel-intensive stages of every flight being the take off and climb phase.

Chapter 5: Reporting on Specific Measures

5.1 Australian Airlines

Table 5: Measures adopted by Australian Airlines

Measure	Results
Fleet renewal and improvement	The average age of the Qantas fleet is 8.6 years. Qantas is continuing to build its fleet to ensure it remains modern and fuel efficient. Qantas will focus on the B787 Dreamliner to provide fuel savings on further point-to-point destinations. Qantas has chosen the General Electric Next Generation (GEnx) turbofan engine to power its B787 fleet which is expected to reduce fuel consumption by up to 20 per cent compared to current turbofans[9]. Virgin Australia operate a modern fleet, the average age of the airline's fleet is 4.2 years. The company is completing a five year $2.5 billion fleet renewal program and is engaging with industry peers to ensure its fleet renewal program leads to greater fuel efficiency through technological and operational enhancements.
Weight reduction measures	Jet fuel consumption is directly linked to the weight of an aircraft. Newer aircraft such as the B787 and A380 are being made from composite materials that reduce the weight of aircraft. Fleet renewal programs are resulting in our Australian airlines having a greater proportion of lighter, and thus more fuel efficient, aircraft. Qantas and Virgin Australia are also reducing the weight of their aircraft by removing unnecessary items from the cabin, introducing in-flight weight reduction measures such as lighter fittings, cutlery and bottles, and collaborating with manufacturers to capitalise further on streamlined aircraft designs.
Fuel optimisation	Fuel represents the largest portion of an airline's cost base and also generates most of the emissions profile. Qantas and Virgin Australia have long-established fuel optimisation programs aimed at achieving the highest possible levels of operational efficiency. Fuel optimisation encompasses operations from gate-to-gate, such as flight path optimisation, aircraft speed optimisation based on daily weather variations, increased use of airport ground power, use of new technology airframe coatings

[9] Qantas, Boeing 787-9 Dreamliner - Flying into the Future (2016). See: *http://www.qantas.com.au/travel/airlines/aircraft-boeing-787/global/en*

	to improve fuel efficiency, and other efficiency improvements in operational, scheduling and management strategies.
Carbon Offset Schemes	Qantas and Virgin Australia offer carbon neutral passenger flight services and are certified organisations under the Australian Government National Carbon Offset Standard (NCOS) Carbon Neutral Program[10]. Carbon emissions are calculated using a Life Cycle Assessment (LCA) of energy usage, this includes aviation fuel use, on ground activities and embodied energy of the aircraft.
Aviation Biofuels	Qantas and Virgin Australia have contributed technically and financially to foster research and development of sustainable alternative aviation fuels including fuels derived from biomass, such as trees, plants, waste and other organic matter. In March 2016, Virgin Australia, in partnership with Air New Zealand, released a Request for Information to procure 200 million litres of sustainable aviation fuel from 2020 for a period of 10 years. This RFI is focussed on the development of the industry in Australia and our region and requires construction of new facilities to meet this demand[11]. Virgin Australia are continuing discussions during 2017 with a shortlist of companies and are working on closing some knowledge gaps that exist in bringing these fuels into the Australian market.

5.2 Air Navigation Services

Airservices Australia (Airservices), an Australian Government-owned organisation, is Australia's Air Navigation Services Provider. Since 2012, Airservices has invested over $700 million to modernise Australia's air traffic management infrastructure in support of the reduction of emissions, and has developed new approaches to reducing aviation noise and emissions through improvements in air traffic procedures.

Airservices manages airspace covering 11 per cent of the earth's surface and provides air traffic operations for over 90 million passengers on more than four million domestic and international flights each year. Airservices has been working in collaboration with national and regional regulatory authorities, airports and airlines to reduce aviation emissions through the following key initiatives and activities.

[10] Department of the Environment and Energy. See: *https://www.environment.gov.au/climate-change/carbon-neutral/ncos*
[11] Virgin Australia (2017). See: *https://www.virgin.com/news/virgin-australia-launches-search-biofuel-opportunities*

Table 6: Measures adopted by Airservices Australia

Measure	Results
Optimal Climb and Descent Procedures	Arrival and departure procedures that eliminate the need for aircraft to deviate from their ideal climb/descent trajectories. The aim is to reduce fuel consumption, greenhouse gas emissions and aircraft noise by limiting fuel burn associated with aircraft levelling off or increasing descent rate unnecessarily. This approach can save up to 400 kilograms of fuel per arrival.
Airport Capacity Enhancement (ACE)	Improved air traffic flow management program at Australia's major airports. ACE identifies enhancements that can be made utilising existing infrastructure and technologies to increase runway capacity and subsequently generate fuel efficiency improvements.
Advanced Surface Movement Guidance and Control System (A-SMGCS)	A-SMGCS is an air traffic surveillance system that allows Airservices to better manage aircraft on the ground. The system identifies and tracks aircraft, in turn avoiding incursions and collisions and improving airport operations, particularly in low visibility operations.
Performance Based Navigation (PBN)	Performance Based Navigation utilises satellite-based technology (GPS) to enable aircraft to fly with a higher degree of accuracy. Re-design of air routes and terminal procedures to take advantage of PBN capabilities are expected to generate fuel savings by reducing track miles flown and increased surety of arrival in marginal conditions.
Off Air Route Planning Options	Flexible pre-flight planning options taking advantage of high altitude jetstream winds to improve an aircraft's speed or avoid significant headwinds, reducing fuel consumption on long distance flights.
Dynamic Airborne Re-Route Procedure (DARP)	An extension to the pre-flight, planned off airways procedures which allows an aircraft already in flight to propose an amended off air route clearance based on the most recent meteorological information. This procedure is being trialled with one operator on a low volume city pair.
MET CDM	A collaborative decision making process by which Airservices, the Australian Government Bureau of Meteorology, airlines and airports establish and dynamically manage acceptance rates at capacity constrained airports leading to reduced airborne holding. Rates are negotiated on the basis of the most recent weather observations and updated forecasts. In operation at Brisbane, Melbourne and Perth, and a trial recently completed for Sydney.

Model Air Transport Efficiency (MATE)	MATE enables Airservices to periodically review, assess and select flight efficiency metrics for the airspace that Australia manages. Improvements in air traffic management, such as better scheduling, flight efficiency and higher aircraft utilisation rates, contribute to an overall reduction in fuel consumption and operational costs.
Metron Harmony	Metron Harmony is an air traffic management tool which reduces airborne delays by absorbing a portion of necessary delay on the ground prior to departure. This process helps to save fuel and associated emissions, and reduce air traffic congestion at capacity constrained airports. It is currently in use at Sydney, Melbourne, Brisbane and Perth airports. Each year, this difference adds up to approximately 40,000 tonnes of CO_2, which is the equivalent of taking 10,000 cars off the road.

5.3 Airport Operations

Table 7: Measures adopted by Australian airports

Measure	Description	Results
Ground Support Equipment	More efficient use of ground-based vehicles and electrical ground support equipment.	Sydney airport has fixed electrical ground power at new gates to reduce the use of ground support equipment that are harmful to the environment.
Green buildings	Several Australian airports are members of the Green Building Council of Australia (GBCA). The GBCA developed the Green Star rating model, which is the world's first independent, transparent, national scheme designed to assess the sustainability of airport master plans.	Brisbane Airport was awarded Australia's first Green Star Communities rating in December 2014.
	Tri-generation technology reduces carbon emissions by up to 75 per cent compared to most office buildings.	Canberra airport has buildings that provide CO_2 savings through tri-generation plants.

Solar energy	Thermal and solar power stations are utilised at Australian airports through the installation of panels.	Brisbane airport's domestic and international terminals are equipped with solar panels, alternative energy sources are also being explored to power operational facilities.
LED Lighting and Airfield Lighting Solutions	Energy efficient LED lighting is a fixture in terminals across Australia. LED lighting is being used in addition to reflective tiled floors and tri-generation low energy lighting, collectively these measures have reduced the amount of lighting required to operate airports facilities.	Melbourne airport has retrofitted Terminals 2 and 3 with energy efficient LED lighting to reduce energy consumption and operational greenhouse gas emissions.
Ground Transport Plans	Investment in upgrades to vehicle fleet to reduce emissions; this includes fuel efficient vehicles and plug-in electric vehicles for ground staff.	Adelaide and Sydney airport have invested in electric buses and fuel efficient vehicles.

Chapter 6: Outlook

6.1 Progress to Date

Since Australia released its 2012 Action Plan, aviation traffic has increased significantly, with total RTK rising from 31.68 billion to 39.5 billion. Fuel use has also increased by 16.3 per cent, at an annual rate of 3.3 per cent. However, Australia has made progress in curbing the growth rate of CO_2 emissions, with fuel consumption rates and emissions intensity decreasing at an annual rate of 1.4 per cent.

Australia continues to participate in the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection and its working groups to contribute to the development of a range of policies, governance and technical requirements, as well as the ICAO Standards and Recommended Practices, including the new Carbon Offsetting and Reduction Scheme for International Aviation (the CORSIA) in the lead up to the phased implementation of the CORSIA from 2021.

To date, Australia is one of 70 States representing 87.7 per cent of total international aviation traffic volunteering to join the scheme in the pilot phase.

6.2 Looking Ahead

Australia is progressing its implementation plan for an appropriate national framework for the CORSIA including consideration of the necessary governance, infrastructure and legal instruments.

The Department of Infrastructure and Regional Development will continue to engage with other key stakeholders including the Department of the Environment and Energy, the Department of Foreign Affairs and Trade, and the Clean Energy Regulator, as well as aviation industry stakeholders, to promote the CORSIA's integrity and to seek to utilise existing domestic systems and tools, where possible, to minimise the burden on industry.

In line with global predictions on growth in aviation traffic, Australia's aviation activity is expected to continue to grow. Existing airports are undertaking capacity improvements projects incluing the building of new runways, and major new developments such as the Western Sydney Airport are likely to increase overall traffic and thus RTK for Australia. This will increase total fuel use, which, despite increasing efficiencies across a range of measures, will result in an increase in CO_2 emissions. Australia's participation in the CORSIA is likely to make an important contribution over the near-to-medium term towards our commitment to reduce CO_2 emissions.

Sustainable alternative fuels are likely to become increasingly important as they are currently viewed as a possible long-term solution to keeping CO_2 emissions at 2020 levels.

The Australian Government is conducting a review of its climate change policies during 2017. The review will provide the opportunity for the Government's policies remain effective in achieving Australia's 2030 target and Paris Agreement commitments and will consider a potential long-term emissions reduction goal for Australia beyond 2030. The review, among other things, will include consideration of what role

the Australian Government may wish to have in supporting the development of sustainable alternative fuels for aviation. Both Qantas and Virgin Australia are actively engaged with the Government on this issue.

6.3 Conclusion

The Australian Government has demonstrated strong commitment and leadership, including within the the UNFCCC and ICAO, to support a range of practical and economic measures to reduce global CO_2 emissions.

Action plans facilitate international cooperation and capacity building between ICAO Member States in pursuit of a shared purpose. With increased reporting requirements expected in the coming years as part of the ICAO CORSIA, action plans will continue to provide valuable context and data on the activities of States including their progress in reducing CO_2 emissions.

Appendix A: Sources and assumptions used to calculate metrics in Tables 2 to 4

To calculate Fuel Use, Australia has used the following process:

- Assumed petroleum sales to be limited to Aviation Turbine Fuel – 'Avtur' – as opposed to including Aviation Gasoline – 'Avgas'. This has been made for two reasons:
    - Avgas only applies to domestic aviation, and is not relevant for ICAO.
    - Even within domestic aviation, it accounts for only up to 2 per cent of fuel sales.
- Assumed sales of Avtur to be equal to the amount of fuel consumed.

All fuel data has been sourced from the Australian Petroleum Statistics managed by the Australian Government's Department of the Environment and Energy, see *http://www.environment.gov.au/energy/petroleum-statistics*

Had figures for Avgas been included, it would likely have reduced the efficiency of Australia's domestic aviation in **Table 4,** given the use of Propeller Aircraft in the domestic aviation sector.

To produce CO_2-e, Avtur figures are multiplied by ICAO's recommended conversion rates:

- Multiply by 0.795 to account for density
- Multiply by 3.157 to produce the CO_2-e

The RTK data was produced on the basis of flights whose first and last port of calls were to Australia, regardless of airline nationality. The figures were compiled by the Australian Government Bureau of Infrastructure, Transport and Regional Economics (BITRE).