



Australian Government

Department of Infrastructure and Transport



Managing the Carbon Footprint of Australian Aviation

Australia's Action Plan developed in response to the
International Civil Aviation Organization (ICAO) 2010
Assembly Resolution A37-19

October 2012

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Executive Summary

Australia is a vast island nation – aviation connects Australians with each other and with the rest of the world. Worldwide there are strong incentives within the aviation industry to improve fuel efficiency as fuel costs represent more than 30% of airlines' operating costs. Australia's aviation network is one of the most efficient in the world, characterised by a modern fleet and world-leading air traffic management practices. Australia's airlines are continuing to invest in modern, more fuel efficient fleets while our air navigation service provider, Airservices Australia, is continuing to improve air traffic management and operational procedures.

However, despite these improvements in fuel efficiency, there is more to be done to manage the CO₂ emissions from aviation activity. Growth in demand for aviation services continues to outstrip the rate of fuel efficiency improvements. The net carbon footprint continues to grow.

This report provides an overview of the initiatives the Australian Government and aviation industry are undertaking to manage the carbon footprint of Australian aviation. It also provides information on future actions that are being considered or developed to further improve the management of greenhouse gas emissions from Australian aviation.

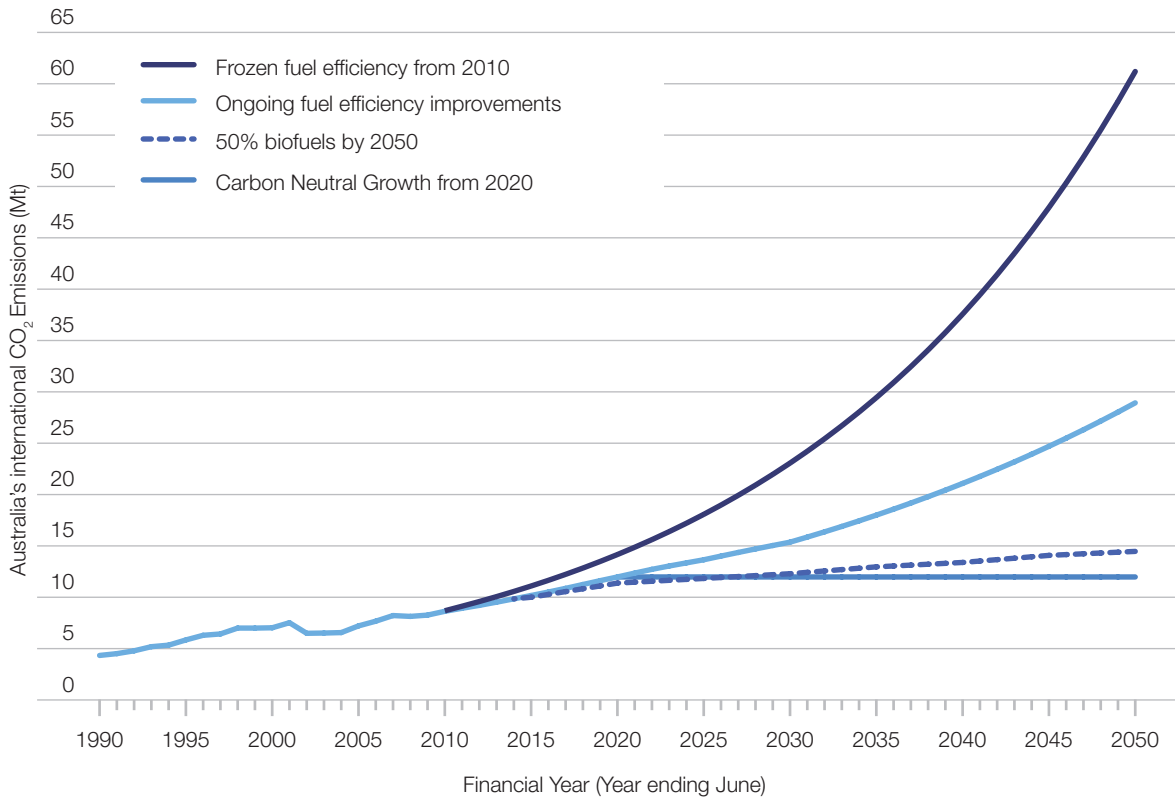
Australia's aviation carbon emissions challenge

Against a background of continuing annual increases in demand of at least 5%, the carbon footprint of Australian aviation is growing at an average of approximately 3% per year.

Figure 1 shows that the industry will continue to improve its efficiency and emissions performance. However, based on current annual increases in demand, Australia's international aviation carbon emissions will increase to more than three times current levels by 2050, despite ongoing improvements in the energy efficiency of aviation operations.

The ongoing improvements in fuel efficiency, brought about by measures such as airline fleet renewal and improvements in air traffic management are estimated to provide savings of around 32 million tonnes (Mt) of CO₂ by 2050. The efficiency measures that are being progressively put in place in the operational environment have provided an annual reduction in carbon emissions per passenger of around 2% per year over the past two decades. However, it is possible that efficiency gains from existing technological measures will level out at some stage. Greater savings will be required to reach more stringent environmental targets.

Figure 1: Australia’s projected international aviation carbon emissions to 2050



Note: An explanation of how the projections were derived is provided in Chapter 4.

Scenarios for Australia’s future aviation carbon footprint

This report considers the trajectory of two potential carbon footprint scenarios. They are:

1. projections of Australia’s future aviation carbon emissions levels based on current ongoing technological and operational measures to reduce emissions; and
2. capping of emissions at 2020 levels – carbon neutral growth.

In developing the scenarios for this Action Plan, it has been important to consider international progress and targets. The Australian Government is an active participant and supporter of the International Civil Aviation Organization’s (ICAO) work to develop a multilateral approach to the management of emissions from international aviation operations. ICAO continues to work towards gaining agreement on the emissions reduction goals for the international aviation sector. Scenario 2 reflects one of the aspirational goals adopted by the ICAO Assembly Resolution A37-19 in 2010 that ICAO states will work together to keep the global net carbon emissions from international aviation at the same level from 2020 onwards.

As part of the 3 yearly review of this document, the scenarios will be reassessed and new trajectories may be included. The revision of scenarios will enable Australia to consider the impact of any targets agreed at future ICAO Assemblies or arising from progress of work under the United Nations Framework Convention on Climate Change (UNFCCC), as well as reflect changes to national emission reduction targets.

Carbon saving measures

Figure 1 indicates that savings of approximately 17 Mt CO₂ will need to be found by 2050 in addition to current ongoing efficiency improvements in order to achieve Scenario 2 (maintaining carbon emissions at 2020 levels). The Action Plan identifies possible carbon saving measures to achieve scenario 1 or 2.

Continuing improvement

For the past two decades ongoing improvements in fuel efficiency have been achieved as part of the aviation sector's business improvement activities. These measures, discussed in Chapters 5 to 10, include new air traffic management procedures, improvements in aircraft utilisation and fleet renewal. They have provided a 100% improvement in fuel efficiency since 1990. Nevertheless, the efficiency improvements provided by these measures will not offset the expected growth in demand.

Carbon pricing – the near term

The Australian Federal Parliament has passed legislation implementing a carbon price to fully capture domestic aviation emissions from 1 July 2012. Discussions are continuing within ICAO on the development of a market-based measures framework for international aviation and Australia is committed to pursuing a global sectoral agreement through ICAO.

Alternative fuels – the medium term

Opportunities to use alternative fuels to reduce carbon emissions are discussed in Section 11.2. The technical feasibility of using biofuels in aviation has now been demonstrated. However the extent to which sustainable biofuels will be able to contribute towards carbon goals will be determined by feedstock and production constraints. A study by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2011 concluded that the Australasian region has sufficient biomass resources to achieve a 5% bioderived jet fuel share by 2020 and a 50% share by 2050.

Monitoring and reporting

The monitoring and reporting of Australia's aviation carbon footprint underpin this report. The Australian Department of Infrastructure and Transport has developed a carbon counting tool – *TNIP Carbon Counter* (based on ICAO's Carbon Calculator) – which computes and reports key metrics.

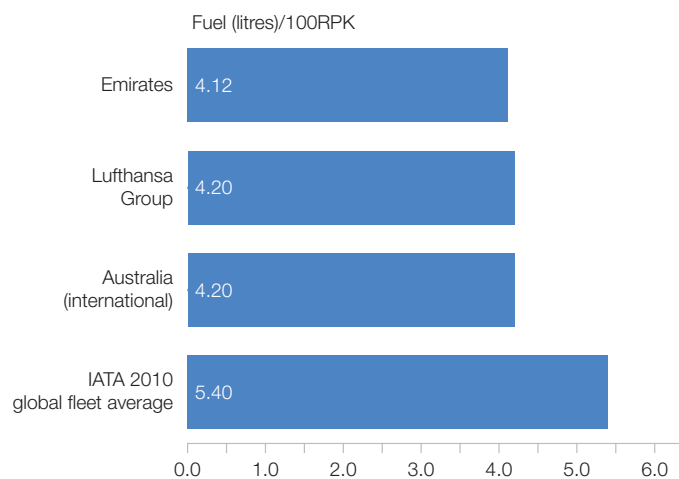
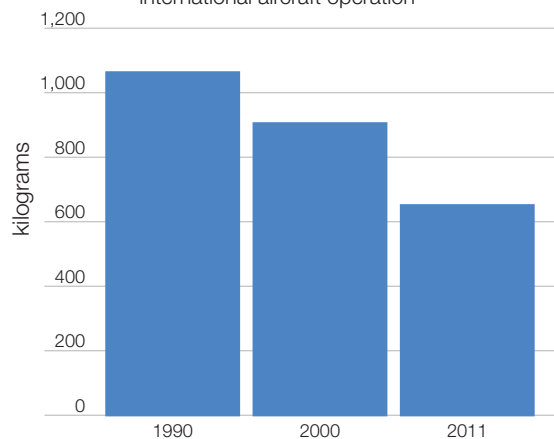
The Australian Government also compiles and reports Australia's national emissions, including Australia's domestic and international aviation emissions, in its annual National Greenhouse Gas Inventory as discussed in Section 10.6. Australian airlines such as Qantas and Virgin Australia also report their aircraft operational emissions and carbon intensity in their annual reports.

Overview of Australia's progress on managing aviation carbon emissions

Progress to date:

- Over the past two decades, Australia's carbon emissions per passenger have decreased by 39% and 35% respectively for international and domestic air travel. This corresponds to an annual average decrease of 2.3% and 2.1% per annum respectively (Section 3.3).
- Australia's average fuel efficiency for international aircraft operations is currently around 4.20 litres per 100 Revenue Passenger Kilometres. This is much better than the global industry average as discussed in Section 3.4.
- Australian airspace has the highest operating efficiency compared to any other air traffic management airspace in the world (Section 7.2).

Changes in the CO₂/passenger for Australia's international aircraft operation



International targets:

ICAO's aspirational goals for international aviation:

- 2% annual fuel efficiency improvements until 2050;
- work towards carbon neutral growth from 2020.

Industry goals for international aviation by the International Air Transport Association (IATA):

- 1.5% annual fuel efficiency improvements until 2020;
- carbon neutral growth from 2020;
- 50% reduction in CO₂ emissions by 2050 relative to 2005 levels.

Measures to reduce the carbon footprint of Australian aviation:

Australian Government initiatives (Section 6):

- introduction of a domestic carbon pricing regime;
- encouraging investment in aircraft efficiency improvements and the development of sustainable biofuels;
- implementing a National Carbon Offset Standard;
- monitoring and reporting Australia's aviation carbon footprint;
- working towards a multilateral approach through ICAO for managing the climate change impacts of international aviation;
- establishment of an annual forum involving relevant Government agencies and industry to facilitate the exchange of information and ideas on mitigating actions and to discuss any obstacles to implementation.

Airservices Australia initiatives to improve air traffic management efficiency (Section 7):

- deployment of best practice satellite-based navigation procedures (Smart Tracking);
- improvement of gate-to-gate sequencing of aircraft;
- provision of daily flexible air traffic routes to optimise flights;
- development of coordinated air traffic control procedures with other air navigation service providers over combined airspace;
- computation of carbon and aircraft noise emissions for air traffic procedures.

Airline initiatives (Section 8):

- ongoing fleet renewal;
- improvement of gate-to-gate fuel efficiency through flight path and aircraft speed optimisation;
- management of onboard weight;
- increased use of ground power units to replace the less efficient use of aircraft auxiliary power;
- provision of passenger voluntary offset schemes;
- corporate offsetting of company emissions;
- participation in the development of sustainable aviation biofuels.

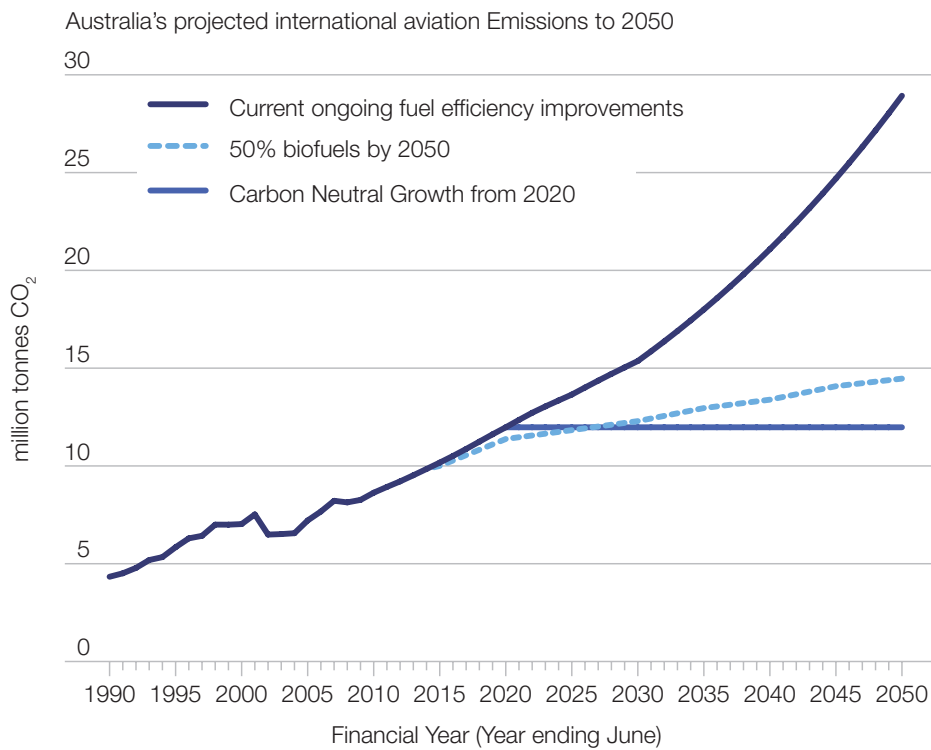
Airport initiatives (Section 9):

- building greener commercial buildings on-site, providing ground power and pre-conditioned air facilities for aircraft, and decreasing the fuel consumption of ground-based vehicles;
- generating electricity through solar installations;
- developing ground transport plans for better linkages with off-airport transport systems;
- preparing carbon footprint reports on airport emissions.

Challenges:

In line with global trends, the carbon emissions from all international flights departing Australia to the first overseas port of call grew from 7.03 to 8.93 million tonnes (Mt) over the last decade, an increase of 27%, while the domestic footprint grew from 5.3 to 8.00 Mt, an increase of 51% (see Table 1 in Section 3.3). The footprints are expected to continue growing at an annual average rate of 1.8% and 2.9% for the domestic and international aviation sectors respectively in the future.

In order to cap Australia’s international aviation emissions at 2020 levels, savings of approximately 17 Mt CO₂ would need to be found by 2050 with current ongoing measures and in the absence of any additional emission reduction measures.



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1. Introduction

Aviation and climate change

Aviation contributes approximately two per cent of global human-induced greenhouse gas emissions. This contribution is expanding as growth in the aviation sector continues to exceed other industry sectors. Australia has been an active player in driving international progress to address climate change. In 2009, the Copenhagen Accord forged a broad agreement to hold any global temperature increase below 2 degrees Celsius. This goal was reaffirmed at the United Nations Framework Convention on Climate Change (UNFCCC) negotiations in December 2010 in Cancun, Mexico. Australia is among 90 countries which have set targets and actions under the UNFCCC to reduce emissions by 2020. These targets cover 80 per cent of the world economy.

According to the fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), to have the best chance of meeting the 2 degrees temperature goal, both developed and developing countries must act quickly to substantially reduce greenhouse gas emissions. In line with these recommendations, Australia has set a longer term target to reduce greenhouse gas emissions by 80% below 2000 levels by 2050. Meeting these international targets will require strong and concerted action on multiple fronts. This is why the Australian Government has introduced a plan for a Clean Energy Future that:

- puts a price on carbon pollution from 1 July 2012 starting at A\$23 per tonne and transitioning to a flexible market price with a cap on total domestic emissions in 2015;
- provides significant support for renewable energy to ensure that 20 per cent of Australia's electricity comes from renewable energy sources by 2020 and mobilising more than A\$13 billion for research, development and deployment of new renewable energy infrastructure and technologies;
- drives improvements in energy efficiency across the economy – in homes, businesses, buildings and industries; and
- creates opportunities for farmers and land managers to reduce emissions or store carbon in the landscape, preserve and restore biodiversity and improve on farm productivity.

As from 1 July 2012, the Australian carbon price applies to emissions from Australian domestic aviation and provides incentives for low-emissions strategies in that sector. The international aviation sector is not included in Australia's domestic carbon pricing scheme or captured by Australia's obligations under the UNFCCC or the Kyoto Protocol. Australia is working with the International Civil Aviation Organization (ICAO) towards a global sectoral agreement for international aviation.

In December 2009, the Australian Government released an Aviation White Paper which included a discussion on aviation's role in reducing global carbon emissions. In the White Paper the Government committed to:

- continue to work through ICAO and other forums to ensure measures to address carbon emissions from international aviation apply equitably to all airlines and do not create market distortions;

- press ahead with the application of improved air traffic management technology and enhanced operational procedures to optimise the efficiency of aircraft operations to and from Australia and in Australian airspace;
- establish a regime which facilitates improvements to airport operations and infrastructure and gate-to-gate efficiencies; and
- ensure that a robust transparent regime for monitoring, assessing and reporting aviation carbon footprints is implemented.

Progress in ICAO

ICAO is the United Nations agency which serves as the forum for cooperation in all fields of civil aviation among its 190 Member States. At ICAO's 37th Assembly in October 2010, Resolution A37-19 was adopted which endorsed a range of measures to address international aviation's contribution to climate change.

The Assembly Resolution requested the 190 ICAO Member States to submit Action Plans to ICAO that set out proposed actions towards achieving the global aspirational goals for international aviation of 2% annual fuel efficiency improvements until 2050. Member States also resolved to strive to keep global net carbon emissions from international aviation at the same level from 2020 onwards (carbon neutral growth). These actions are based on individual national capacities and circumstances. Australia, as a Member State, is working to comply with this Resolution.¹

Australia's situation

Over the past two decades the efficiency of Australian aviation has improved significantly and Australia's aircraft operations are very fuel efficient compared to global standards (see Section 3.4). Despite this, Australia's domestic and international aviation carbon footprint is projected to grow at around 1.8% and 2.9% respectively per annum over the next two decades (see Section 3.1) due to growth in demand and this will require further efficiency improvements in an already highly efficient system.

The Australian Government will continue to track fuel efficiency changes over time to monitor their continued contribution to meeting ICAO's aspirational goals.

Key features of Australia's Strategy

Australia's focus for meeting ICAO's aspirational goals is through the implementation of active CO₂ management measures, rather than through unrealistic constraints on travel. A range of measures have been progressively introduced over the years to improve the efficiency of Australia's aviation system, including fleet renewal, improved air traffic management and more efficient on-ground operations.

There are a number of constraints which influence the adoption of carbon saving measures – these include the need to maintain aviation safety as the highest priority, the need to take account of aircraft noise impacts, and the feasibility and economic viability of adopting new technologies in the near future.

While ICAO's focus is on emissions from the international aviation sector, many of the measures to reduce aviation emissions apply to domestic as well as international services. Australia's ICAO Action Plan encompasses a suite of strategies which address emissions from both international and domestic operations.

¹ ICAO Assembly Resolution A37-19, paragraph 10 (http://www.icao.int/env/A37_Res19_en.pdf).

2. Scope of Australia's ICAO Action Plan

The ICAO guidance material for assisting Member States in the preparation of State Action Plans allows for flexibility in terms of coverage, content and format. In order to avoid any ambiguity in the interpretation of specific terms or the extent of operational coverage, the scope encompassed by Australia's ICAO Action Plan is discussed below.

Definition of domestic and international

This document adopts the United Nations' Intergovernmental Panel on Climate Change's definition of domestic and international aviation whereby flight segments are designated as 'domestic' if they take off and land in Australia, and 'international' if they arrive from or depart to a foreign country. This definition is consistent with Australia's reporting of greenhouse gas emissions agreed as part of the United Nations Framework Convention on Climate Change (UNFCCC). This definition is applied irrespective of the nationality of air carriers operating to and from Australia.

Approximately 55% of CO₂ emissions from the Australian aviation industry are generated by international activity (including overseas airlines servicing Australia), while about 45% of emissions are generated by domestic activity.

Operational coverage

The ICAO Assembly Resolution A37-19 for States to submit action plans only calls for plans applying to the international aviation sector. Greenhouse gas emissions from domestic aircraft operations are accounted for by individual countries under the UNFCCC and Kyoto Protocol accounting methodology. However, given that most measures to reduce aviation emissions are common to both domestic and international sectors, Australia's Action Plan includes policies and actions in Australia to address the carbon footprint of both these sectors.

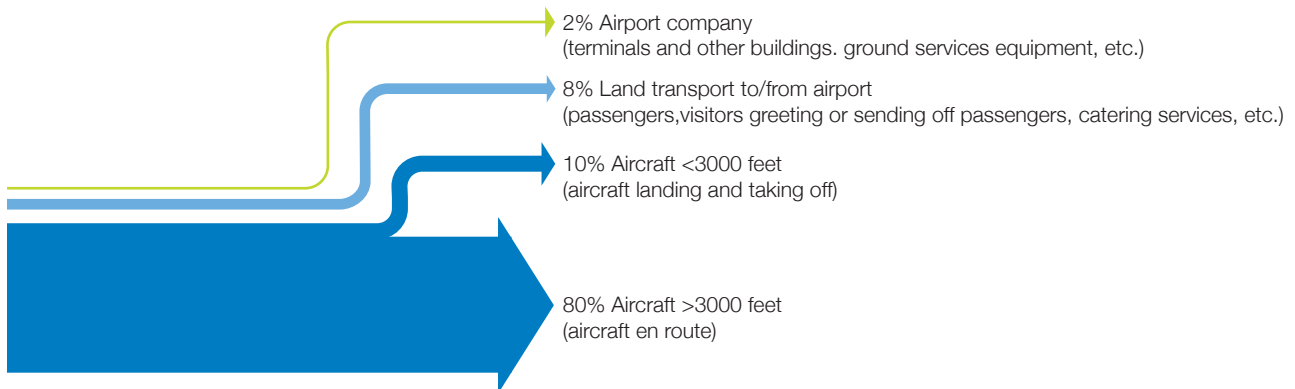
Furthermore, to avoid double counting, only fuel uplifted for aircraft departures is counted towards Australia's aviation carbon footprint. For international departures from Australia, only the fuel used up to the first overseas port of call is accounted for.

Going beyond aircraft operational measures

The purpose of the State Action Plans requested by the ICAO Assembly is to enable ICAO to compile information on achieving the global goals adopted at the 37th ICAO Assembly in 2010. These goals, which relate to improving fuel efficiency and capping global net carbon emissions, apply only to CO₂ emissions from aircraft operations. However, while the overwhelming proportion of aviation's carbon footprint arises from aircraft operations, other sources, such as airport ground-based emissions, are also being actively addressed.

While airport contributions to the aviation carbon footprint are relatively small compared to the contribution from aircraft operations (see Figure 2), Australian airports are implementing a wide range of measures to address climate change.

Figure 2: Indicative contributions to the carbon footprint of aviation²



Some airports in other countries are including carbon emissions from ground transport associated with moving passengers to and from the airport in their carbon footprint reporting. Studies carried out by these airports indicate that this transport is likely to comprise around 8% of the total carbon footprint of aviation if it is included in the airport ‘bubble’.³

Significant improvements have been made in transport links to and from Australian airports in recent years. However there are a number of difficulties in including transport to/from airports in the emissions ‘bubble’, especially given the limited influence and control some airport operators have in this area. It is difficult to robustly compute the quantum of CO₂ associated with off-airport transport and if emissions are included there is a danger of double counting as emissions from off-airport transport are also likely to be captured in land transport carbon footprint management regimes.

Time horizon

In order to align with ICAO’s goals, this document covers the time period from the present to 2050. It is recognised that there will be uncertainty in projections decades into the future, but trend estimates are available. It is intended that the Action Plan will be reviewed on a regular three year basis to enable the modelling of different scenarios to reflect future national and international goals.

² Seattle-Tacoma International Airport, Greenhouse Gas Emissions Inventory – 2006 (<http://airportattorneys.com/files/greenhousegas06.pdf>).

³ See ref [2].

Part 1

National Aviation

Carbon Footprint

3. Australia's Aviation Carbon Footprint

3.1 Trends in Australia's aviation carbon emissions

Australia's domestic and international aviation sectors have been growing significantly over the past few decades. At the same time the industry has been making great strides in improving aircraft and operational fuel efficiency. The demand for air travel, however, has been growing at a much higher rate than the improvements in fuel efficiency, resulting in an overall increase in the aviation carbon footprint. This section outlines the growth in Australia's aviation sector and the improvements in fuel efficiency.

Australia's domestic and international carbon emissions from civil aircraft operations have been increasing at an average annual rate of 3.9% and 4.1% respectively over the 19 year period between financial years 1989–90 and 2008–09 as reported in Australia's National Greenhouse Gas Inventory 2009.⁴

Australia's total aviation emissions more than doubled between 1989–90 and 2008–09 with emissions from the domestic and international sectors increasing by 105% and 116% respectively as shown in Figure 3. By comparison, emissions from Australia's domestic transport sector as a whole (excluding international transport) were 34.6% higher in 2008–09 compared to 1989–90.

The aviation sector has been growing faster than other transport modes for some decades. Correspondingly, the sector's contribution to total transport emissions in Australia has also grown, from 10.7% in 1989–90 to 16.2% in 2008–09.

In terms of Australia's domestic aviation industry, activity increased from 19.8 billion passenger kilometres in 1991–92 to 56.3 billion in 2008–09. Over the same period, fuel efficiency improved substantially due to more fuel efficient aircraft, improved air traffic management procedures and better aircraft utilisation. Domestic aviation fuel efficiency reached 4.2 litres/100 kilometres per person in 2008–09, which is comparable to current better performing motor vehicles.

Figure 4 shows the historic trends in both aviation emissions and emissions intensity for the Australian domestic aviation industry. It can be seen that, while there has been an increase in net emissions by 53.4% between 1991–92 and 2008–09, there has been a 46.1% decrease in the emissions intensity or the emissions per 100 revenue passenger kilometres (RPK).

⁴ National Greenhouse Gas Inventory 2009, Department of Climate Change and Energy Efficiency, (<http://www.climatechange.gov.au/publications/greenhouse-acctg/national-greenhouse-gas-inventory-2009.aspx>).

Figure 3: Australia's aviation emissions, 1989-90 to 2008-09

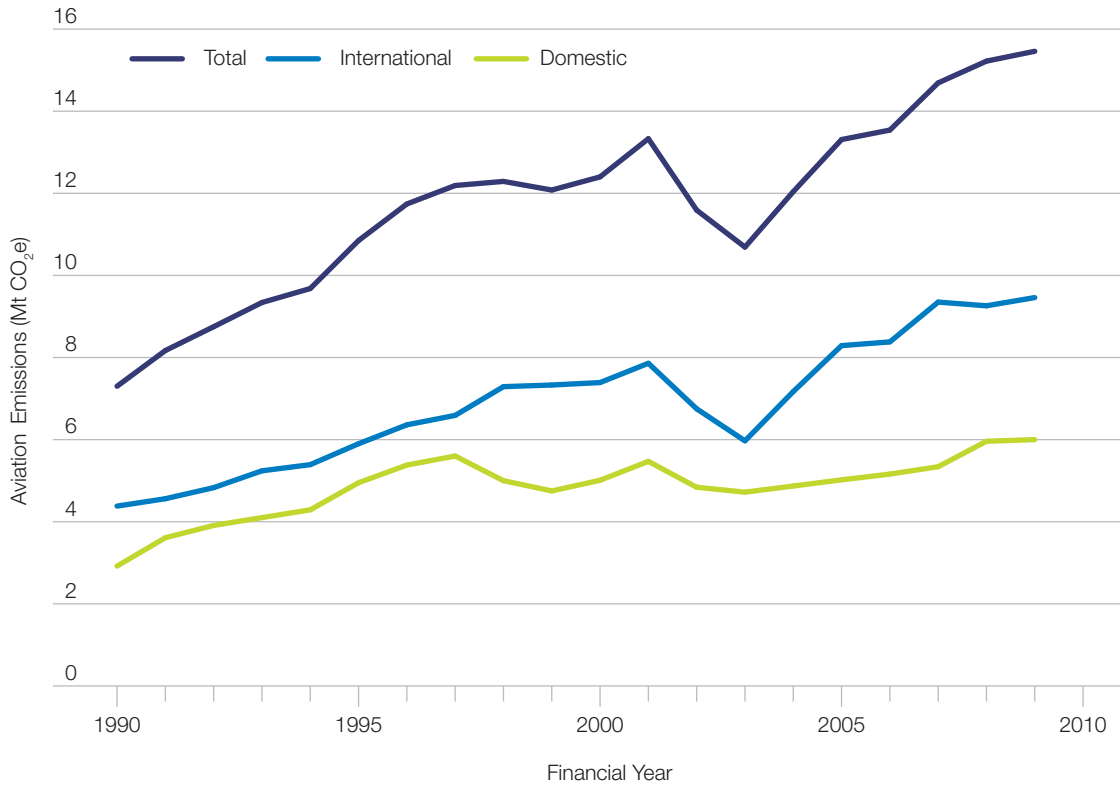
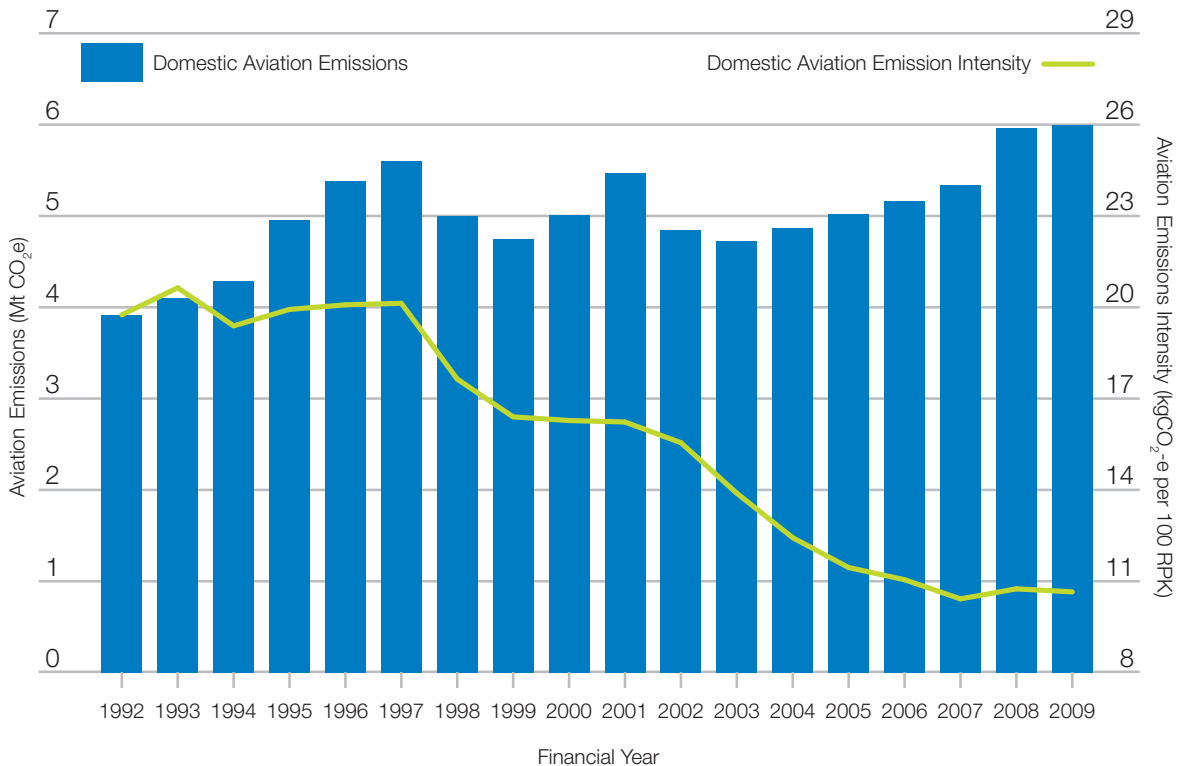


Figure 4: Australia's annual domestic aviation emissions, 1992-2009



Notes: Emissions data is from National Greenhouse Gas Inventory 2009. Domestic RPK data is sourced from BITRE.⁵ International RPK data for total traffic to and from Australia is not available from BITRE, hence it is not possible to produce a similar aviation emissions intensity chart for international operations.

5 BITRE, *Monthly Airline Performance* (<http://www.bitre.gov.au/info.aspx?ResourceId=218&NodeId=103>).

Australia's domestic aviation carbon emissions have been increasing at an annual average rate of 2.5% per annum since 1991–92. The system efficiency (expressed as CO₂-e per 100 RPK) improved at an average annual rate of 4.2% between 1991–92 and 2006–07, so that by 2006–07 it had reached 10.4kg CO₂-e/100RPK (almost half the 1991–92 value).

Growth in Australia's aviation industry is expected to continue with air passengers at all Australian airports projected to increase at an average annual rate of 4.0%, leading to a near doubling of total annual passengers by 2025–26.⁶

The growth in emissions from Australia's domestic and international civil aviation sectors is projected to be around 1.8% and 2.9% respectively per annum between 2010 and 2030.⁷ For comparison, total emissions from motor vehicles in Australia are forecast to grow at approximately 1.3% per annum over the same period, albeit from a much higher base.

3.2 Differentiating between domestic and international operations

Under the Kyoto Protocol, domestic aviation emissions are counted towards national emissions targets, while emissions from fuel sold to aircraft engaged in international transport (also known as bunker fuels) are excluded. In Australia, emissions from domestic aviation are captured by the Australian Government's Clean Energy Future legislation which established a price on carbon emissions from 1 July 2012.

The Kyoto Protocol requires that limitations or reductions of international aviation emissions should be pursued through ICAO. ICAO is continuing to develop a multilateral approach on how emissions from international aviation are to be treated.

Given that the CO₂ emissions from domestic and international aviation are being accounted for under different international processes, the carbon footprint of these two sectors must be disaggregated to ensure consistent reporting and accountability.

As Australia's National Greenhouse Gas Inventory only provides an aggregated picture of Australia's domestic and international aviation emissions, the Department of Infrastructure and Transport has developed a software tool called TNIP Carbon Counter⁸ for computing the carbon footprint of aircraft operations and for analysing and disaggregating carbon footprint data over system-wide operations. More detailed information of the application is available on the Department's website.⁹

TNIP Carbon Counter has been used to produce the detailed carbon footprint information in this document.

The proportion of emissions from international, interstate and intrastate aircraft departures¹⁰ contributing to Australia's total aviation carbon footprint for 2010–11 is shown in Figure 5. Figure 5 shows that for 2010–11 international aircraft operations were the main source of emissions (56.4%) due to the comparatively long distances travelled, even though they comprised only 7.4% of total aircraft departures.

6 *Air passenger movements through capital city airports to 2025–26*, BITRE Working Paper 72, 2008 (<http://www.bitre.gov.au/info.aspx?ResourceId=637&NodeId=59>).

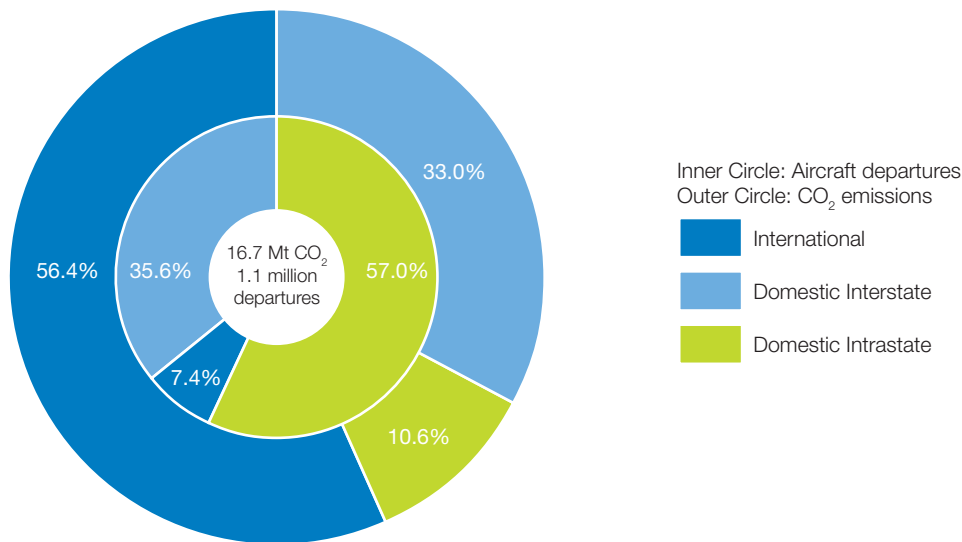
7 BITRE, *Long-term Projections of Australian Transport Emissions: Base Case 2010*; aviation emissions in Table 2.8 (p 133); motor vehicle emissions in Table 1.2A (p 9). (http://www.climatechange.gov.au/publications/projections/~/_media/publications/projections/bitre-transport-modelling-pdf.pdf).

8 TNIP Carbon Counter, ICAO Environmental Report 2010, pp 62-65 (http://www.icao.int/icao/en/env2010/pubs/environmentreport_2010.pdf).

9 TNIP Carbon Counter Software Package and User Manual (http://infrastructure.gov.au/aviation/environmental/transparent_noise/tnip_CC.aspx).

10 Aircraft arrivals are not included to avoid double counting.

Figure 5: Australia's aviation carbon footprint, 2010–11



The majority of aircraft departures (57.0%) were for domestic travel within a state (intrastate travel), but these contributed the least proportion of Australia's total aviation carbon emissions (10.6%) due to the relatively short distances travelled.

3.3 Overview of Australia's aviation carbon footprint

Changes over the past two decades

Table 1 shows the growth in air passenger numbers in Australia for the financial year 2010–11 compared to the start of the last two decades (1989–90 and 1999–2000). Over the past two decades Australia's international passenger numbers have more than tripled, while domestic passengers have more than quadrupled. Since 1989–90, passenger numbers have been increasing at an annual average rate of 5.9% and 7.3% for international and domestic air travel respectively.

Australia's aviation carbon footprint has been growing at an average rate of 3.5% and 5.1% per annum respectively for the international and domestic sectors, resulting in an approximate doubling of the international carbon footprint and an approximate tripling of the domestic footprint in 2010–11 compared to 1989–90.

The slower growth in Australia's aviation carbon footprint compared to the growth in demand reflects the underlying improvements in fuel efficiency across the system. The system efficiency, as measured by the amount of CO₂ per passenger, has been improving at an annual average rate of 2.3% and 2.1% for the international and domestic sectors respectively since 1989–90. Table 1 shows that over the past two decades carbon emissions per passenger have dropped by 39% and 35% respectively for international and domestic air travel.

Table 1: Growth in Australia's aviation activity and carbon footprint over the past two decades

Measure	Financial Year			% change between years	
	1990	2000	2011	1990 to 2011	2000 to 2011
Passengers – international (million)	4.08	7.77	13.71	236.2	76.5
Passengers – domestic (million)	12.27	30.33	54.14	341.1	78.5
Passengers – total (million)	16.35	38.09	67.85	315.0	78.1
CO ₂ – international (Mt)	4.33	7.03	8.93	105.9	27.0
CO ₂ – domestic (Mt)	2.80	5.30	8.00	185.2	51.0
CO ₂ – total (Mt)	7.14	12.33	16.92	137.1	37.3
CO ₂ /passenger – international (kg)	1,063	905	651	-38.8	-28.0
CO ₂ /passenger – domestic (kg)	229	175	148	-35.4	-15.4
CO ₂ /passenger – total (kg)	437	324	249	-42.9	-22.9

Notes: Passenger data is from BITRE's *Monthly Airline Performance Report* (<http://www.bitre.gov.au/info.aspx?ResourceId=218&NodEld=103>). The totals shown for international passengers are for outbound trips only. The carbon emissions data is from BITRE's estimates of the 'business as usual' trend as referenced in Section 4.3. For the latest available financial year of 2010–11, BITRE's estimates of Australia's total aviation carbon footprint (as reported in this table) is 1.1% higher than the result computed using TNIP Carbon Counter as reported in Figure 5.

3.4 Fuel efficiency

Australia continues to operate one of the world's most modern and efficient aviation systems. The Australian Government and industry share a common commitment to maintaining and enhancing the operational efficiency of Australia's aviation network.

At ICAO's 37th Assembly in October 2010, Member States resolved to work through ICAO to achieve a global average fuel efficiency improvement of 2% per annum until 2050 calculated on the basis of volume of fuel used per revenue tonne kilometres (litres/RTK). ICAO has reported that global fuel efficiency improved at an average rate of 2.5% per year between 1991 and 2009.¹¹ ICAO concludes that technological and operational efficiency improvements alone are sufficient to realise the 2% global annual fuel efficiency goal until 2020.¹²

Differentiating between 'Gross' and 'Net' fuel efficiency

Fuel efficiency is generally defined by the amount of fuel used per unit of activity (e.g. litres of fuel per RTK). For the purposes of carbon accounting the term 'Gross' fuel efficiency refers to the actual amount of the specified type of fuel used per unit of activity (e.g. litres of Jet-A1 per RTK). The term 'Net' fuel efficiency is triggered when a proportion of the carbon contained in the fuel is either sourced from nonfossil sources (e.g. biofuels) or has been offset through some form of market-based measure. In these circumstances the 'net' amount of fuel used per unit of activity is computed through:

- in the case of a biofuel, applying life cycle analysis techniques to ascertain the proportion of CO₂ emissions from an aircraft operation that is nonfossil based; and
- for a market-based measure, quantification of the amount of CO₂ that has been offset to an agreed standard (such as the National Carbon Offset Standard).

11 ICAO presentation slides 2010, *Achieving Climate Change Goals for International Aviation*, slide 4 (<http://www2.icao.int/en/NewsRoom/Presentation%20Slides/Achieving%20Climate%20Change%20Goals%20for%20International%20Aviation.pdf>).

12 *ibid*, slide 10.

By way of example, if all the CO₂ generated by an aircraft operation were fully offset, the flight would be deemed to be carbon neutral and the net amount of fuel used for that operation would be zero (e.g. the net fuel efficiency could be expressed as 0 litres/RTK).

A fuel efficiency metric, taking into account market-based measures and sustainable biofuels is now being developed by ICAO through the Committee on Aviation Environmental Protection (CAEP).

Absolute fuel efficiency

As shown in Section 3.1, Australia's aviation sector has achieved an improvement in fuel efficiency, measured as carbon emissions per 100RPK, across its domestic aviation network of around 4.2% per year for about the last two decades. Section 3.3 showed that the total carbon emitted per passenger has also been decreasing at around 2% per annum for both Australia's international and domestic sectors.

Australia's fuel efficiency averaged over its network of international operations is better than global industry averages and is comparable to the efficiency of modern long haul airlines. This is illustrated by several fuel/carbon efficiency metrics as shown in Table 2 and the following discussion.

Table 2: Australia's latest fuel efficiency for aircraft operations, 2010–11

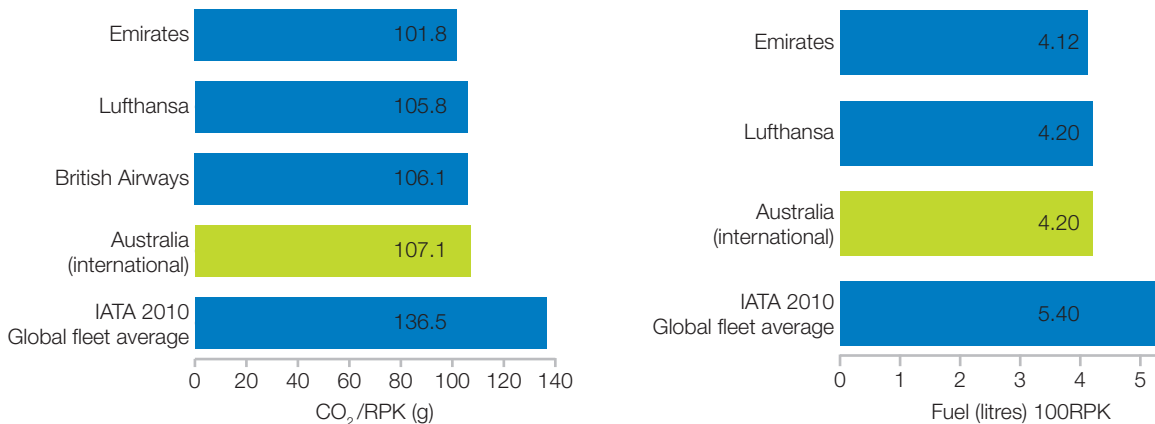
Fuel Efficiency Metric	Financial Year 2010–11		
	International	Domestic	Total
Fuel (litres)/RTK	0.35	0.42	0.37
Fuel (litres)/100RPK	4.20	4.56	4.35
Fuel (litres)/100ASK	3.16	3.50	3.30
CO ₂ /RPK (g)	107.1	116.3	111.0
CO ₂ /ASK (g)	80.5	89.3	84.1

Notes: ASK refers to Available Seat Kilometres, RPK to Revenue Passenger Kilometres and RTK to Revenue Tonne Kilometres. All results were derived using *TNIP Carbon Counter*¹³ and refer to aircraft departures only to avoid double counting.

¹³ TNIP Carbon Counter (http://infrastructure.gov.au/aviation/environmental/transparent_noise/tnip_CC.aspx).

Examples of how Australia's average international aviation fuel efficiency compares with leading international airlines and the global average is given below.

Australia's passenger CO₂ efficiency in terms of CO₂/RPK for international departures covering all aircraft operators for 2010–11 was 107.1g as shown in Table 2. This is 21.5% better than IATA's projected 2010 industry average of 136.5g¹⁴ and is comparable with the efficiencies reported by airline groups such as Emirates (101.8g), Lufthansa Group (105.8g) and British Airways (106.1g).



4. Future carbon footprints – projections and scenarios

4.1 Introduction

Projections of future system wide aviation carbon footprints can be obtained in a number of ways:

- aggregation of potential CO₂ gains across the system on a measure by measure basis;
- applying broad performance assumptions (e.g. assume fuel efficiency gains across the system of 2% per year) to generate system wide projections; or
- extrapolation of past trends.

While examination and aggregation of the CO₂ gains for each individual measure on a case by case basis is likely to be the most informative approach, this is also likely to be the most complex and many of the inputs are uncertain.

Over time, as computational methods mature, more detailed analytical approaches may emerge. In the mean time projections based on broad and aggregated trends are likely to be the best predictor of Australia's future aviation carbon footprint.

4.2 Establishing and using baselines

The broad intent of baselines is to demonstrate the extent to which identified measures have or will contribute to overall performance improvements. Applying a baseline comparison is useful when considering the potential of competing individual measures. For example, in Part 2 of this document, there are examples of the CO₂ gains that may be made with the introduction of individual measures, such as new air traffic management procedures, by comparing fuel consumption against a baseline. However, it can be complex to compute this potential across an aviation network if progressive implementation leads to increasing constraints (e.g. not

¹⁴ The Emirates Group, *Environmental Report 2010–2011*, p50 (<http://www.emirates.com/english/environment/environment.aspx>).

all aircraft operating into and out of an airport can be offered a fuel optimised route due to aircraft separation requirements).

ICAO's Guidance Material states that *"The baseline scenario corresponds to the scenario that reasonably represents the civil aviation CO₂ emissions that would occur in the absence of action. This corresponds to the business as usual or do-nothing additional scenario."*¹⁵ Appendix G of ICAO's Guidance Material describes an approach to establish a baseline by extrapolating past trend data in order to determine future levels of fuel consumption and traffic. In order to be consistent with ICAO's Guidance Material, this approach has been adopted in Section 4.3 below to describe a baseline scenario for Australia's future carbon emissions trajectory. It should be emphasised that the ICAO baseline includes the continuation of existing efficiency trends.

4.3 Carbon footprint scenarios

Scenario 1: Continuation of current trends

Using trends based on historical data and approximations of future activity levels, the Australian Bureau of Infrastructure, Transport and Regional Economics (BITRE) has published forecasts of Australia's aviation carbon emissions out to financial year 2029–30.¹⁶ BITRE's projections for Australia's international aviation carbon emissions are shown by the solid dark blue line in Figure 6. The average CO₂ growth rate of BITRE's estimates from financial years 1990 to 2030 is 3.2% per annum. The dashed line in Figure 6 shows this emissions curve extended to 2050 at the same average annual growth rate.

Figure 7 shows the continuation of current trends for Australia's domestic aviation carbon emissions obtained by extrapolating BITRE's estimates from financial years 1990 to 2030 out to 2050 at the same annual average domestic growth rate of 3.5% per annum as for the first four decades from 1990. Under this projection scenario, Australia's domestic carbon emissions would reach 21.8 Mt CO₂ in 2050.

¹⁵ ICAO Guidance Material for the Development of States' Action Plans, v4.0, p27.

¹⁶ BITRE, Long-term Projections of Australian Transport Emissions: Base Case 2010, Table 2.8, p133 (<http://www.climatechange.gov.au/publications/projections/~media/publications/projections/bitre-transport-modelling-pdf.pdf>).

Figure 6: Projections of Australia’s international aviation carbon emissions to 2050

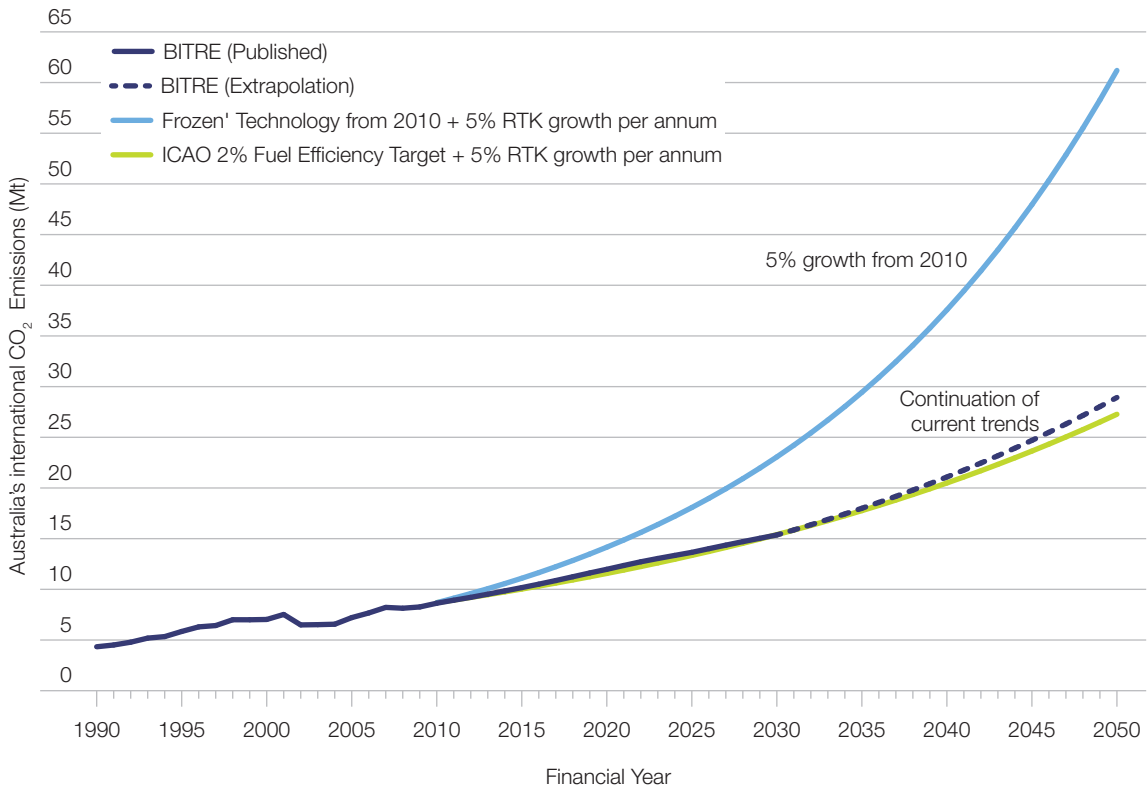
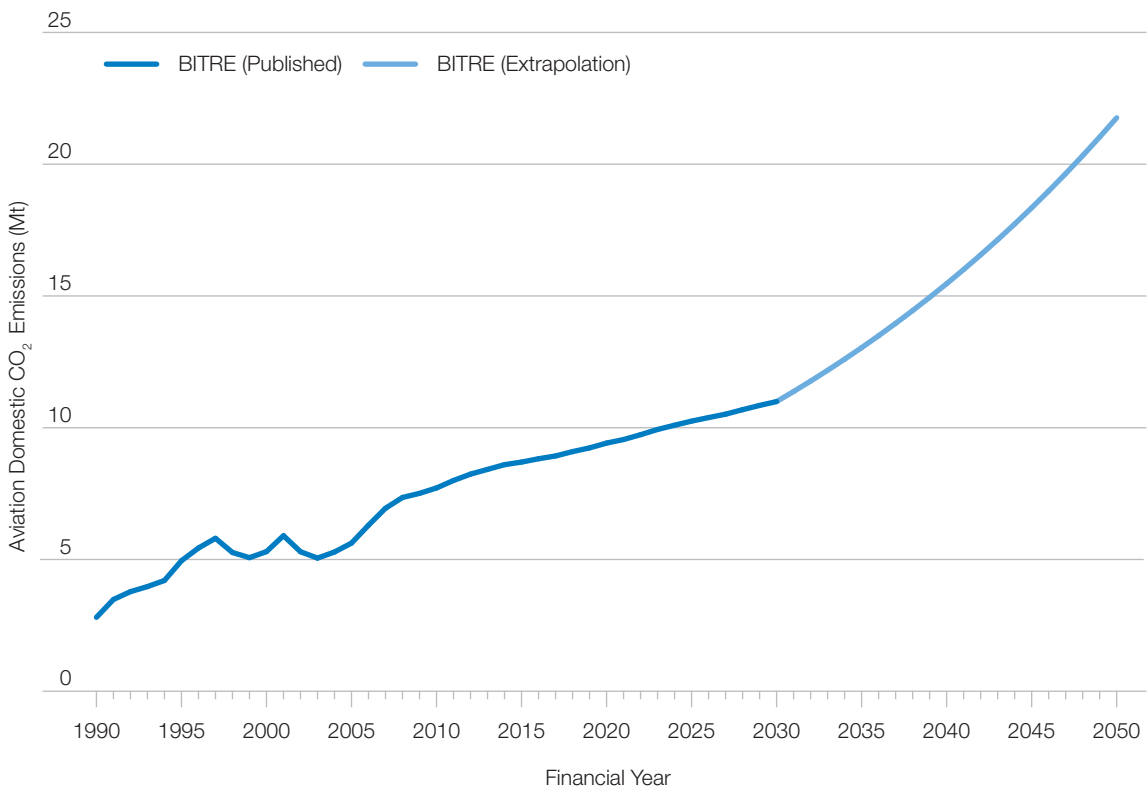


Figure 7: Projections of Australia’s domestic aviation carbon emissions to 2050



Scenario 2: Carbon neutral growth

ICAO's 37th Assembly in October 2010 resolved that "ICAO and its member States with relevant organizations will work together to strive to achieve a collective medium term global aspirational goal of keeping the global net carbon emissions from international aviation from 2020 at the same level...". If Australia were to achieve carbon neutral growth from 2020, it is estimated that net CO₂ emissions from Australia's international aviation sector will need to be capped at around 12 Mt per annum as shown in Figure 8. This would require projected savings of around 17 Mt CO₂ in 2050 compared to the current trends case.

4.4 Assessment of the scenarios

Scenario 1: Continuation of current trends

Figure 4 indicates that for around two decades there have been significant gains in fuel efficiency. Australia's average network fuel efficiency is greater than global averages. There have been ongoing commercial imperatives to minimise fuel use over this time period and technological developments have supported this. However, gains that can be made using existing fuel saving measures may need to be complemented to ensure greater future improvements in fuel efficiency.

Scenario 2: Carbon neutral growth

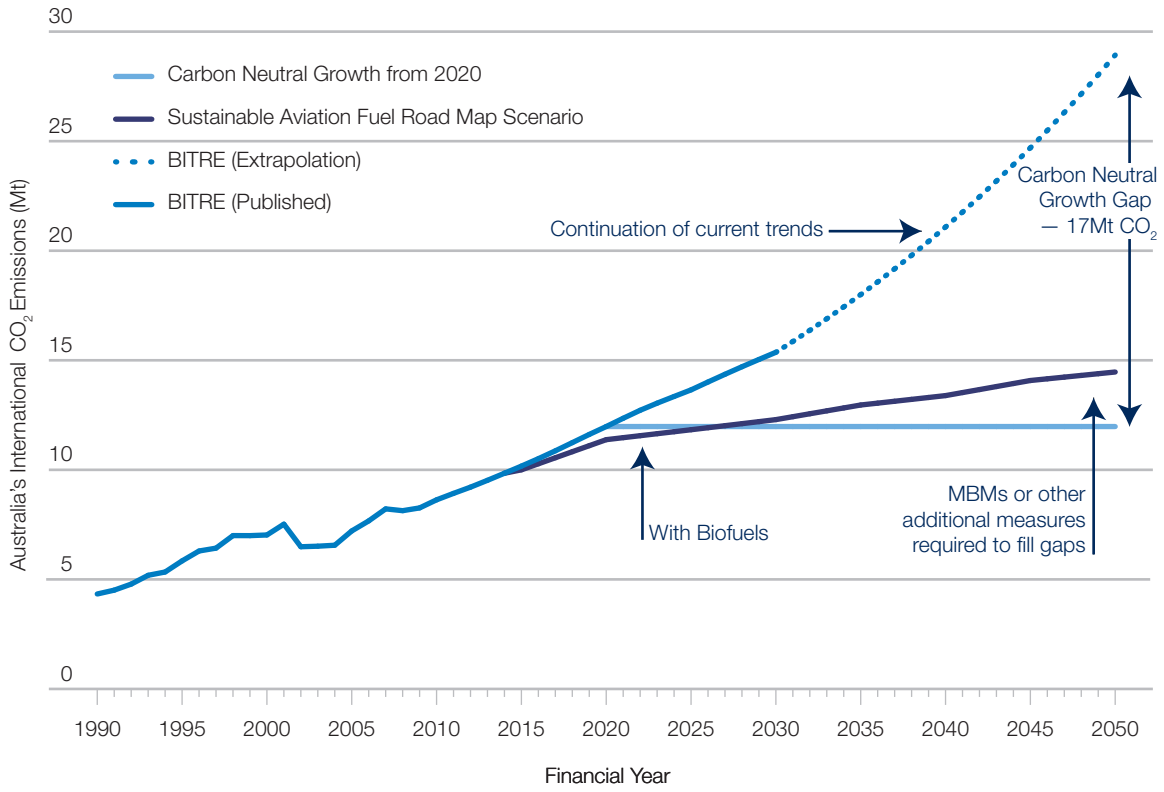
Figure 8 shows that in order to cap net CO₂ emissions from Australia's international operations at 2020 levels, around 17 Mt of CO₂ would need to be offset in 2050. It should be noted that, if internationally agreed, this goal would require an offset of only around 3% of emissions in 2021, increasing gradually as demand growth continued.

If a contribution from biofuels, consistent with the Sustainable Aviation Fuel Road Map Study¹⁷, is factored into the computations and assuming a zero rating for biofuels in terms of net carbon emissions,¹⁸ then an estimated 3.1 Mt of CO₂ would need to be offset in 2050 to achieve carbon neutral growth (see Figure 8).

¹⁷ *Flight Path to Sustainable Aviation*, CSIRO, May 2011, Figure 17, p41 (<http://www.csiro.au/resources/sustainable-aviation-fuel-report.html>).

¹⁸ Discussions are currently being carried out in ICAO's Committee for Environmental Protection (CAEP) on how to account for the contributions of biofuels in reducing the overall carbon footprint from aviation.

Figure 8: Carbon neutral growth and potential biofuel impacts on Australia's projected international aviation carbon emissions to 2050



Part 2

Managing Australia's Aviation Carbon Emissions

5. Identifying Potential Measures

There has been significant discussion within ICAO about the measures that can be employed to manage the carbon footprint of international aviation. The Group on International Aviation and Climate Change (GIACC), which was set up in response to a resolution of the 36th ICAO Assembly in September 2007, developed a 'basket of measures' taking into account the multi-faceted approach required to address climate change. Australia was an active participant in the GIACC process. The measures included in the GIACC 'basket' were divided into five main categories: aircraft-related technology development (including drop-in biofuels); improved air traffic management and infrastructure use; more efficient operations; economic/market-based measures; and regulatory measures.

The GIACC process culminated in a High Level Meeting on International Aviation and Climate Change in October 2009 which issued a Declaration endorsing GIACC's Programme of Action. The GIACC measures are therefore a useful starting point for addressing Australia's international aviation carbon footprint.

The measures contained in this Plan are structured around the responsible implementation bodies (i.e. the document contains sections relating to Airservices Australia, airlines, airports, etc). This enables identification of individual stakeholder contributions towards emissions from the overall aviation industry and the role each can play in reducing these emissions.

This report includes quantitative information on as many aspects of each measure as practical (e.g. CO₂ benefits, cost, timing, etc). Accordingly, measures that have been put in place in recent years and are already providing climate change benefits are discussed and, where possible, quantified.

6. Setting the Policy and Regulatory Framework

6.1 Introduction

Many of the aviation climate change measures and initiatives being implemented at present, or that may be implemented in the future, result from decisions made by private companies such as airlines and airport operators. However, policy and/or regulatory settings established by governments can have a major influence on investment decisions made by these companies.

The types of government policy initiatives that are being put in place, or are under active consideration, by ICAO Member States are diverse. Some initiatives such as economic measures are likely to involve the imposition of direct costs and involve complex policy considerations. Other potential measures such as the provision of research funding are likely to be more targeted and complementary in nature. This section broadly discusses areas where the Australian Government has taken action to reduce the carbon footprint of Australian aviation.

6.2 Economy-wide climate change settings

The Australian Government has implemented measures to secure a clean energy future for Australia based on a four pillar approach: introducing a carbon price; promoting innovation and investment in renewable energy; encouraging energy efficiency; and creating opportunities in the land sector to cut pollution. The legislation sets a fixed domestic carbon price of A\$23 from 1 July 2012 which will rise by 2.5% per financial year in real terms until 1 July 2015, from which time the carbon price will be set by the market.

The rate of domestic aviation fuel excise will be increased by an amount equivalent to the effect of placing a carbon price on aviation fuel in order to provide an effective carbon price for aviation. Adjustments to domestic aviation fuel excise will occur annually during the fixed price phase of the carbon pricing mechanism spanning 1 July 2012 to 30 June 2015. This results in an increase in the fuel excise for aviation kerosene from currently 3.556 cents/L to 9.536 cents/L in 2012–13, 9.838 cents/L in 2013–14 and 10.16 cents/L in 2014–15. From 1 July 2015, the aviation excise will be increased on a six-monthly basis based on the average domestic carbon price over the previous six months that is set by the market.

From 1 July 2013, an 'opt-in scheme' will enable certain businesses paying an effective carbon price through the fuel tax system, to choose to pay the carbon price under the carbon pricing mechanism rather than the fuel tax system. Aviation fuel consumed for international aircraft operations is not subject to the fuel excise.

On 28 August 2012, the Australian Minister for Climate Change and Energy Efficiency and the EU Commissioner for Climate Action announced the linking of the Australian and European Union's emission trading schemes. While Australia's carbon price applies to the domestic economy only and does not include international aviation, from July 2015, Australian businesses will be able to use EU allowances to meet liabilities under Australia's emission trading scheme. A full two-way link will be established by July 2018. Linking the schemes will allow businesses to access more and lower cost emissions abatement units through a well developed, international carbon market. The linking of the schemes relates to the recognition of permits. It does not change the application of the two schemes. It does not signal acceptance of the EU's application of the EU's emission trading scheme to international aviation, nor any intervention by the Australian Government to extend the Australian Emission Trading Scheme to international aviation.

The Australian Government also has broad, economy wide climate change targets. The Government is committed to reducing carbon pollution to 5% below 2000 levels by 2020 irrespective of what other countries do, and by up to 15 or 25% depending on the scale of global action. The Government has also committed to a new 2050 target to reduce domestic emissions by 80% below 2000 levels, in line with targets announced by the United Kingdom¹⁹ and the European Union.²⁰

6.3 Economic measures

If aviation is to make a positive contribution to reducing global CO₂ levels at the least cost, market-based measures could play an important role in the near to medium term.

Domestic aviation implications

Table 1 in Chapter 3 gives the average CO₂ emissions per passenger which indicates that, at a carbon price of \$23 per tonne, all of Australia's domestic aviation carbon emissions could have been accounted for in 2010–11 at an average cost of \$3.40 per passenger. The Australian Government's Clean Energy Future Plan²¹

19 UK *Climate Change Act 2008* (http://www.decc.gov.uk/en/content/cms/legislation/cc_act_08/cc_act_08.aspx).

20 European Union Roadmap for moving to a competitive low-carbon economy in 2050 (http://ec.europa.eu/clima/policies/roadmap/index_en.htm).

21 Australia's *Clean Energy Future* (<http://www.cleanenergyfuture.gov.au/clean-energy-future/>).

which includes the introduction of a domestic carbon price is designed to cut carbon pollution, transform Australia's energy sector away from high polluting carbon sources, promote innovation and investment in renewable energy, encourage energy efficiency and create opportunities in the land sector to store carbon and achieve biodiversity co-benefits through Carbon Farming Initiatives.

Qantas and Virgin Australia have announced that the domestic carbon price will add between \$1.50 and \$6.86 to the price of a domestic airline ticket depending on the length of the flight.²² Australian airlines also offer passengers voluntary offsetting of emissions. This is discussed further in Section 8.4.

International aviation implications

The inclusion of international aviation in emissions trading schemes has been the subject of extensive consideration in ICAO with strong reservations by most countries to any unilateral action in this regard. The Australian Government is opposed to the unilateral application of taxes or charges to international aviation emissions and is committed to the development of a multilateral approach through ICAO. At the ICAO Council Meeting in November 2011, the ICAO Secretary General presented a high level road map to accelerate the work on developing a global framework for market-based measures with actions and milestones mapped out towards the ICAO General Assembly in 2013.

ICAO has established a set of guiding principles for the design and implementation of market-based measures (MBMs) for international aviation, as listed below:

- a. MBMs should support sustainable development of the international aviation sector;
- b. MBMs should support the mitigation of GHG emissions from international aviation;
- c. MBMs should contribute towards achieving global aspirational goals;
- d. MBMs should be transparent and administratively simple;
- e. MBMs should be cost-effective;
- f. MBMs should not be duplicative and international aviation CO₂ emissions should be accounted for only once;
- g. MBMs should minimize carbon leakage and market distortions;
- h. MBMs should ensure the fair treatment of the international aviation sector in relation to other sectors;
- i. MBMs should recognize past and future achievements and investments in aviation fuel efficiency and in other measures to reduce aviation emissions;
- j. MBMs should not impose inappropriate economic burden on international aviation;
- k. MBMs should facilitate appropriate access to all carbon markets;
- l. MBMs should be assessed in relation to various measures on the basis of performance measured in terms of CO₂ emissions reductions or avoidance, where appropriate;
- m. MBMs should include de minimis provisions;
- n. where revenues are generated from MBMs, it is strongly recommended that they should be applied in the first instance to mitigating the environmental impact of aircraft engine emissions, including mitigation and adaptation, as well as assistance to and support for developing States; and
- o. where emissions reductions are achieved through MBMs, they should be identified in States' emissions reporting.

²² Qantas and Virgin Australia's response to the domestic carbon pricing scheme (<http://www.qantas.com.au/travel/airlines/media-releases/feb-2012/5363/global/en>; <http://www.virginaustralia.com/au/en/about-us/media/2012/SURCHARGES-RESPONSE-CARBON/>).

6.4 Potential future action and initiatives

Encouraging investment

Continued investment in modern aircraft will remain important in minimising fuel use and associated greenhouse gas emissions from aviation.

The Australian Government recognises this and provides for accelerated depreciation of aircraft. Under Australian taxation provisions, aircraft can be fully depreciated over a period of 10 years, compared with the economic asset life of 20 years established by the Commissioner of Taxation. This encourages regular modernisation of aircraft assets. Australian airlines operate modern fleets, for example in 2010–11 the average fleet age for Qantas was 8.6 years²³ and for Virgin Australia it was 4.9 years.²⁴ This is below the average global fleet age of approximately 11 years.²⁵

The Australian Government also recognises the importance of developing sustainable fuels. The Government currently provides financial assistance through the Biofuels Capital Grant Program and the Second Generation Biofuels Research and Development Program (Gen2) to encourage the development of new biofuel technologies and sustainable transport fuels, including aviation fuels.²⁶ In the 2011–12 Budget, the Government committed \$20 million to the establishment of an Australian Biofuels Research Institute to conduct research into driving down the costs of next generation biofuel technologies, including for aviation purposes. Part of this money is funding a feasibility study with Qantas into the development of an Australian biofuels industry.²⁷

The Australian Government has a renewable energy target to source 20 per cent of Australia's electricity supply from renewable sources by 2020.²⁸ The Government has provided incentives for industry, schools and residences to install renewable energy systems such as solar power systems. One example is the Alice Springs Airport's large scale solar installation as discussed in Section 9.2.

6.5 Facilitating transparency – building trust

National Carbon Offset Standard

The Australian Government provides for national consistency in the quality of offsets through the National Carbon Offset Standard (NCOS)²⁹ which came into effect on 1 July 2010. It provides a voluntary standard for businesses to use in becoming carbon neutral or developing carbon neutral products. Qantas, Jetstar and Virgin Australia have aligned their carbon offset programs with the NCOS.

In Section 8.4 it is reported that around 10% of Jetstar and Virgin Australia passengers have elected in the past to offset emissions from their flights. For Virgin Australia, this equated to about 4% of its total emissions, while Qantas and Jetstar customer offsets amounted to about 2% of their total emissions in 2008–09. This is not an insignificant level and compares favourably with the level of emissions reductions achievable from

23 Qantas 2011 Annual Report, p115 (<http://www.qantas.com.au/travel/airlines/investors-annual-reports/global/en>).

24 Virgin Australia 2011 Annual Report, p28 (<http://www.virginaustralia.com/AboutUs/Virginbluecorporateinformation/Investorinformation/AnnualReports/>).

25 *Aviation's Role in Society, Economy and the Environment*, IATA, (<http://www.iata.org/whatwedo/environment/pages/sustainability.aspx>).

26 Second Generation Biofuels Research and Development Program (Gen2) (http://www.ret.gov.au/resources/resources_programs/alternative_fuels_programs/Pages/AlternativeFuelsPrograms.aspx).

27 Qantas spruiks biofuels with A330 flight (<http://australianaviation.com.au/2012/04/qantas-spruiks-biofuels-with-a330-flight/>).

28 Renewable Energy Target and Support for Renewables (<http://www.climatechange.gov.au/government/initiatives/renewable-target.aspx>).

29 National Carbon Offset Standard (<http://www.climatechange.gov.au/en/government/initiatives/national-carbon-offset-standard.aspx>).

implementing air traffic management efficiencies. This indicates that there would be merit in encouraging further voluntary offsetting by passengers.

Development of carbon footprinting tools

To support transparency in the development of strategies for managing greenhouse gas emissions from aircraft operations, there need to be structures in place which enable policy makers, researchers and members of the public to gain rapid access to robust disaggregated data on the carbon emissions patterns within a network of aircraft operations. This type of data enables interested parties to understand the drivers behind macro fuel use figures through breaking down the carbon footprint into its constituent elements such as: the impacts of introducing new aircraft types; opening up of new services and/or routes; changing load factors; changing travel demand patterns; etc.

In order to analyse the breakdown of Australia's carbon footprint from aircraft operations, the Department of Infrastructure and Transport has developed a software tool called TNIP Carbon Counter. This is discussed in Section 10.2.

Industry forum on aviation carbon emissions

As a cooperative effort is required by all major aviation stakeholders to manage Australia's aviation carbon footprint, an annual forum involving relevant Government agencies and industry will be established to facilitate the exchange of information and ideas on mitigating actions and to discuss any obstacles to implementation.

6.6 Working toward international agreements

The Australian Government is working actively with other ICAO Member States to manage the climate change impacts of international aviation. To be effective, climate change action for international aviation must take a multilateral approach.

Australia will continue to pursue a global approach on reducing international aviation emissions through ICAO. The Government will ensure that Australia remains fully engaged in ICAO's work and plays an active and constructive role in working towards a comprehensive strategy that is effective in addressing emissions from international aviation without restricting demand for international aviation operations. The Government supports the main outcomes of the 2010 ICAO Assembly Resolution A37-19 and is engaged in work relating to:

- ICAO's request that Member States voluntarily submit Action Plans towards achieving ICAO's aspirational goals (described in Chapter 1);
- ICAO's commitment to develop a framework for market-based measures (MBMs) including guiding principles for Member States to use when designing and implementing MBMs for international aviation.
- ICAO's work on assessing the feasibility of a global MBM scheme for international aviation.

Australia continues to actively support ICAO's work program on MBMs. In the ICAO Council discussions in November 2011 Australia intervened to propose a constructive way forward by recommending that the ICAO Secretariat prepare a work program to develop a global sectoral agreement with key elements identified for consideration at ICAO's 38th Assembly in 2013. Following Australia's intervention, the ICAO Secretary General presented to the Council a high level road map to accelerate the development of a global framework for MBMs by 2013.

Australian Government Initiatives

- Introduction of a carbon pricing regime for the national economy, including domestic aviation, from 1 July 2012.
- Encouragement of investment in improving aircraft efficiency and developing sustainable biofuels through financial and tax incentives.
- Introduction of a National Carbon Offset Standard on 1 July 2010 to improve consumer confidence in the voluntary carbon offset market.
- Development of a carbon footprinting tool to analyse Australia's aviation carbon footprint and the underlying drivers.
- Commitment to the development of a multilateral approach through ICAO for managing the climate change impacts of international aviation.
- Establishment of an annual forum involving relevant Government agencies and industry to facilitate the exchange of information and ideas on mitigating actions and to discuss any obstacles to implementation.

7. The Role of Airservices Australia

7.1 Introduction

Throughout the world air navigation service providers have been continuously working to improve the efficiency of air traffic management in order to facilitate a growing number of aircraft operations in any given airspace.

Airservices Australia has been working in collaboration with regulatory authorities, airports and airlines within Australia to reduce aviation emissions through improved air traffic management (ATM) systems. The initiatives by Airservices Australia take advantage of the increasing sophistication of modern aviation navigation and flight management systems to improve aircraft performance before departure, in the air and on arrival.

Several major issues impose constraints on the extent to which improvements can be made in ATM systems, for example: (i) safety across any and all elements of aircraft operations; (ii) aircraft noise primarily in the broad vicinity of airports (say within a 50km radius of airports); and (iii) airport infrastructure developments (e.g. additional runways to absorb future growth in traffic).

7.2 Achievements to date

Airservices Australia has progressively implemented state of the art air navigation technology over many decades. In recent years it has introduced a number of specific individual procedures designed to improve the efficiency of aircraft operating within its system. Examples are described in Section 7.3.

A study of regional ATM efficiencies released by the Civil Air Navigation Services Organisation (CANSO) in 2008 showed that in 2005 aircraft in Australian airspace were operating at an effective maximum system efficiency of between 98 and 99%, the highest operating efficiency compared to any other ATM region in the world.³⁰

³⁰ CANSO, *ATM Global Environment Efficiency Goals for 2050*, Australia's ATM efficiency shown on page 7 (<http://www.canso.org/cms/showpage.aspx?id=1915>).

Australia's higher ATM efficiency in 2005 reflects the relatively uncongested airspace in this region as well as the advanced performance of our airlines and air navigation service provider.

According to CANSO, today's global airspace is already between 92% and 94% fuel efficient. CANSO's goal is for a global ATM system that is between 95% and 98% efficient by 2050. 100% efficiency is not achievable because of necessary operating constraints (e.g. safety, weather, capacity, noise) and interdependencies in the global aviation system.

Given that Australia is already operating short and medium haul operations at almost peak efficiency, the future challenge for Australia is to maintain this peak performance and to ensure that its ATM efficiency does not decline with future projected increases in air traffic. Airports such as Sydney, Melbourne and Brisbane are consistently operating at maximum movement rates for several hours of each day with peak periods extending further and further into traditional off-peak periods. Additional improvements will be needed to ensure User Preferred Routes (UPRs) are available to all long-haul international operations. This is an area where significant gains can be made as long-haul flights contribute approximately 56% of Australia's total aviation carbon footprint. It is, therefore, important to continue to quantify and monitor Australia's ATM efficiency to track its progress against growth in the industry.

7.3 Examples of current measures

Some examples of procedures that have been introduced by Airservices Australia to improve the efficiency of aircraft operations are discussed briefly in the following paragraphs. Details can be found on Airservices Australia's website.³¹

Flextracks

Flextracks are non-fixed air traffic routes between airports that are designed to take advantage of favourable winds and avoid strong headwinds in order to allow aircraft to improve flight time and reduce fuel burn. Flextracks were first introduced between Australia and the United States in 1995 and across the South Pacific in 1996 with a domestic network introduced in June 2005. Airservices Australia now calculates and publishes flextrack information on a daily basis to provide airlines with flexible air traffic routes that are optimised for prevailing weather.³² At present flextracks are being widely used between Australia and airports in Asia and the Middle East.



Flextracks

Reported CO₂ savings: 3.4 tonnes CO₂ per flight from the Middle East to Australia

Emirates has reported a reduction of 26,644 tonnes of CO₂ over 5 years of flextrack operations on its Australian services.³³ For 592 flights from Dubai to Melbourne and Sydney in 2005–06, Emirates reported a total saving of 628 tonnes of fuel or an average reduction of approximately 3.35 tonnes of CO₂ per flight.³⁴ This saving is approximately 1% of the total CO₂ emitted for a one way flight between Dubai-Melbourne or Dubai-Sydney.

31 Airservices Australia, Aviation & Environment (<http://www.airservicesaustralia.com/environment/>).

32 Australian Organised Track Structure (AUSOTS) (<http://www.airservicesaustralia.com/ausots/default.asp>).

33 *Emirates cites five years of savings with Flex Tracks* (<http://atwonline.com/eco-aviation/article/emirates-cites-five-years-savings-flex-tracks-0309>).

34 New Customers, New Markets: *Ultra-long-haul aircraft and ATM* (<http://www.canso.org/cms/streambin.aspx?requestid=0D8A2B13-B989-47A5-96E5-89D928D003CA>).

RNP approaches and departures

Required Navigation Performance (RNP) procedures take advantage of the most advanced avionics and navigational equipment to deliver significantly more precise aircraft positioning than has previously been possible. This allows for shorter approach paths and continuous descent which reduces fuel burn. Starting with deployment at Brisbane Airport in early 2012, Airservices Australia is continuing the deployment of RNP procedures following consultation with affected communities. RNP approaches and departures are now being trialled at 16 other Australian airports. Airservices Australia aims to progressively implement these procedures at 28 airports over the next five years.



RNPs

Reported CO₂ savings: 400kg of CO₂ per approach

The first stage of the Brisbane Green Project involving Qantas Airways' B737-800 fleet resulted in a reduction of more than 650 tonnes of CO₂ over a 12 month period for 1,612 instrument approaches involving 33 aircraft or approximately 403 kg of CO₂ per approach.³⁵ This is approximately 3% of the total CO₂ emitted for a one way flight from Brisbane to Sydney. Initial estimates from the results of the Brisbane trial suggest RNP procedures can provide a fuel efficiency gain of approximately 1% if implemented across the Australian network.

Improved gate-to-gate management of aircraft

Collaborative Decision Making (CDM) is a joint Airservices/aviation industry initiative aimed at improving air traffic management through increased information exchange between ATM external stakeholders. The CDM program is made up of representatives from the aviation industry who are working together to create technological and procedural solutions to demand/capacity imbalance and airport congestion.

The three capabilities that will be established or improved as part of this program are:³⁶

Air Traffic Flow Management (ATFM)

Introduction of new software tools and supporting procedures will better identify demand and capacity imbalances, both at airports and in airspace volumes. Where imbalances are identified, the system will enable the establishment of traffic management initiatives to reduce airborne delays.

Airport Collaborative Decision Making (A-CDM)

Improved data sharing between airport stakeholders will provide a common operational picture that enables refinement of the turn-around process for aircraft. This in turn, provides for more efficient use of airport infrastructure and resources.

³⁵ The Brisbane Green Project
(http://www.airservicesaustralia.com/wp-content/uploads/RNP_Brisbane_Green_Project_Stage1_Report.pdf).

³⁶ <http://www.airservicesaustralia.com/projects/collaborative-decision-making-cdm/cdm-in-australi/>

Integrated Arrival and Departure Management (A/DMAN)

A/DMAN will provide the capability to dynamically balance airport arrival and departure demand to ensure more efficient use of airports and airspace that will result in further reduction in airborne delays.

CDM Stage 1³⁷ entails the replacement of the Central Traffic Management System (CTMS) tool (which only services Sydney and Perth) with an advanced ATFM application capable of simultaneously managing traffic flows at multiple airports. This new application is called Metron Traffic Flow and it will initially manage traffic flows at Sydney, Perth, Brisbane, and Melbourne via a staged implementation plan.

From a traffic management aspect, where demand exceeds capacity, Metron Traffic Flow will regulate traffic into a designated airport in a similar manner to CTMS through the allocation of ground delay. Metron Traffic Flow will issue ground delays through the allocation of Calculated Off Block Times, previously known as Programmed Gate Departure Times.

Collaborative Decision Making (CDM) is a joint Airservices/aviation industry initiative aimed at improving air traffic management through increased information exchange between ATM external stakeholders. The CDM program is made up of representatives from the aviation industry who are working together to create technological and procedural solutions to demand/capacity imbalance and airport congestion.

Gate-to-gate management

Significant emissions savings from new air traffic system³⁸

The first stage of a new collaborative approach to industry-wide air traffic management in Australia has seen positive results for airlines, with an average reduction of five minutes flight time per flight on the Melbourne-Sydney city pair.

This equates to approximately 40,000 tonnes of CO₂ per year, or taking 10,000 cars off the road. Additionally, the software has also reduced airborne traffic holding for flights into Sydney during peak periods to an average of less than 96 seconds, down from an average of five and a half minutes.³⁹

Collaborative decision making (CDM) sees Airservices, airlines and airports sharing data to maximise use of available airspace and airport capacity, reduce fuel burn and environmental emissions, and enhance safety.

International collaboration

Airservices Australia will continue to develop coordinated air traffic control procedures to improve operational efficiencies in the combined airspace of the Asia Pacific region through the Asia and Pacific Initiative to Reduce Emissions (ASPIRE) in partnership with air navigation service providers from the United States, New Zealand, Japan, Singapore and Thailand. Since it was established in February 2008, ASPIRE has undertaken 5 Trans-Pacific test flights with fuel savings ranging between 3–8% per flight.

³⁷ <http://www.airservicesaustralia.com/projects/collaborative-decision-making-cdm/cdm-stage-1-atfm/>

³⁸ <http://newsroom.airservicesaustralia.com/releases/4c0ae2f1-c74f-4d29-aff7-f387b4ca604>

³⁹ 'Airservices tool saves airlines costly fuel', Aviation Business Asia Pacific, September/October 2012, pp.32-33

ASPIRE**Reported CO₂ savings: 18 tonnes of CO₂ per flight across the Pacific**

In 2008 ASPIRE conducted three test flights which resulted in a total emissions reduction of 54.2 tonnes of CO₂. These flights were from Auckland to San Francisco by Air New Zealand (11.2 tonnes of CO₂ saved on a B777), Melbourne to Los Angeles by Qantas (28 tonnes of CO₂ saved on an A380) and Sydney to San Francisco by United Airlines (15 tonnes of CO₂ saved on a B747-400).⁴⁰ According to the ICAO Carbon Calculator, the average CO₂ per flight one way for Auckland-San Francisco, Melbourne-Los Angeles and Sydney-San Francisco is 277 tonnes, 486 tonnes and 447 tonnes respectively. The three demonstration flights resulted in savings of between 3–6% of the average carbon emissions per flight for the three routes.

Further test flights from Honolulu to Osaka by Japan Airlines in 2009 and from Los Angeles to Singapore via Tokyo in 2010 by Singapore Airlines resulted in a reduction of approximately 13.1 and 33.8 tonnes of CO₂ respectively or 6% and 8% respectively of the average carbon emissions per one way flight.⁴¹

7.4 Potential future action and initiatives^{40,41}

Airservices will continue to progressively implement the procedures cited in the previous section. There are constraints on the extent to which any individual procedure can be implemented across the system (e.g. safety, capacity, aircraft noise), and it will be important to quantify the potential CO₂ savings that could practicably be made through implementing current measures and any other emerging technologies across the aviation network.

Given the current high levels of ATM efficiency in Australia, it will be challenging to maintain the current levels of efficiency over time as traffic grows, and even more challenging to achieve higher levels of efficiency. Part of meeting this challenge is to continue to invest in airport and ATM infrastructure. For its part, Airservices Australia plans to spend \$961 million on capital investment over the next five years.⁴²

Airservices has initiated work in the computational area that is directed at quantifying the potential gains from the introduction of new procedures. In 2008 Airservices Australia began using the Air Traffic and Operations Management Simulator (ATOMS), developed by the University of New South Wales, to study the environmental impacts (both greenhouse gas emissions and noise patterns) of air traffic procedures. The simulator provides an experimental environment to model operational procedures under varying scenarios and to compute the resulting carbon emissions and noise patterns. ATOMS provides Airservices Australia with a means to quantify potential benefits of different ATM strategies.

In 2012 Airservices will re-examine the CANSO efficiency benchmark with a higher fidelity, network wide analysis. This work will be conducted by the University of New South Wales in conjunction with the Airservices Environment Group. This analysis will use an existing methodology developed by EUROCONTROL and the US Federal Aviation Administration (FAA) to develop unimpeded times for airborne phases of flight. This unimpeded baseline plus Great Circle Distances and Vertical Profile Analysis will determine the level of inefficiency that exists in Australian airspace.

40 Airservices Australia media release 4 September 2009: *ASPIRE Annual Report: 'Green' flight tests results released* (<http://www.aspire-green.com/mediapub/docs/0932.pdf>).

41 *JAL to conduct Asia's first environmentally efficient ASPIRE flight* (http://www.aspire-green.com/mediapub/docs/091006_jal_aspire_flight.pdf); *Singapore Airlines completes first ASPIRE multi-sector green flight and saves over 33 tonnes of CO₂ emissions* (<http://www.greenaironline.com/news.php?viewStory=742>).

42 Airservices Australia Corporate Plan 2011–2016, p26 (<http://www.airservicesaustralia.com/wp-content/uploads/corporateplan2011-2016.pdf>).

Airservices Australia Initiatives

- Daily publication of flexible air traffic routes that are optimised for prevailing weather in order to reduce flight times.
- Deployment of Required Navigation Performance (RNP) procedures to increase precision aircraft positioning in flight.
- Continual improvement of gate-to-gate sequencing of aircraft to reduce flight times and save fuel.
- Development of coordinated air traffic control procedures with other air navigation service providers to improve operational efficiencies in combined airspace (e.g. the ASPIRE partnership).
- Computation of carbon and aircraft noise emissions of air traffic procedures through the use of the Air Traffic and Operations Management Simulator (ATOMS).

8. Airline Contribution

8.1 Introduction

With the cost of fuel representing between 25–40% of an airline's overall operational costs, airlines have actively focussed on improving fuel and operational efficiency which, in turn, minimises aviation's carbon footprint. Efforts by the airline industry have particularly centred on more advanced and improved technology.

For some years, Australian airlines have been actively engaged in developing strategies to address international aviation's greenhouse gas emissions. Qantas and Virgin Australia, through membership of the International Air Transport Association (IATA), have had direct links into the ICAO processes directed at managing climate change. Virgin Australia has also been an active member of the Aviation Global Deal (AGD) Group.⁴³

The international airlines which are members of IATA (covering more than 90% of international aviation) have collectively adopted three goals on aviation emissions:

- an average fuel efficiency improvement of 1.5% per year until 2020;
- a cap on aviation CO₂ emissions from 2020 (carbon-neutral growth); and
- a 50% reduction in CO₂ emissions by 2050 relative to 2005 levels.

These goals align with ICAO's aspirational goals of 2% fuel efficiency improvements per year and carbon neutral growth from 2020.

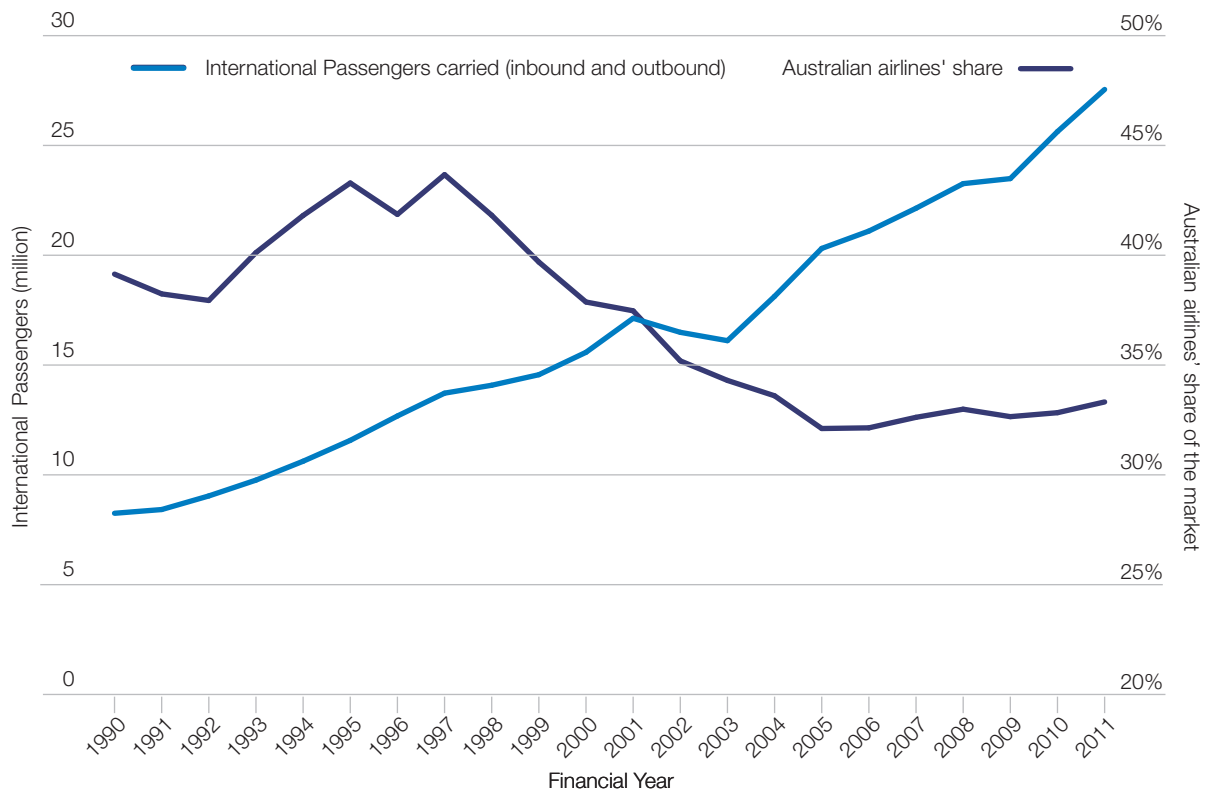
Many of the more significant efficiency improvements recently achieved by the aviation industry have arisen from improved load factors, fleet renewal and changes in passenger demand/route structure. All these factors essentially fall within the domain of the airlines and are broadly discussed in Section 8.3. Other potential fuel-saving measures are discussed in Sections 8.4 and 8.5.

⁴³ Aviation Global Deal Group (<http://www.agdgroup.org/>).

8.2 Australian airlines

Prior to 1993, Qantas was the only Australian carrier operating international flights to and from Australia. In 2011 the number of Australian designated airlines carrying international passengers has expanded to include Qantas, Jetstar and Virgin Australia. Figure 9 shows that international air passenger traffic in Australia has more than tripled over the past two decades, while the market share of Australian designated airlines has gradually declined to around 33% at present from a high of 44% in the mid 1990s. Of the Australian share, approximately 80% of the operations are carried out by Qantas and Jetstar.

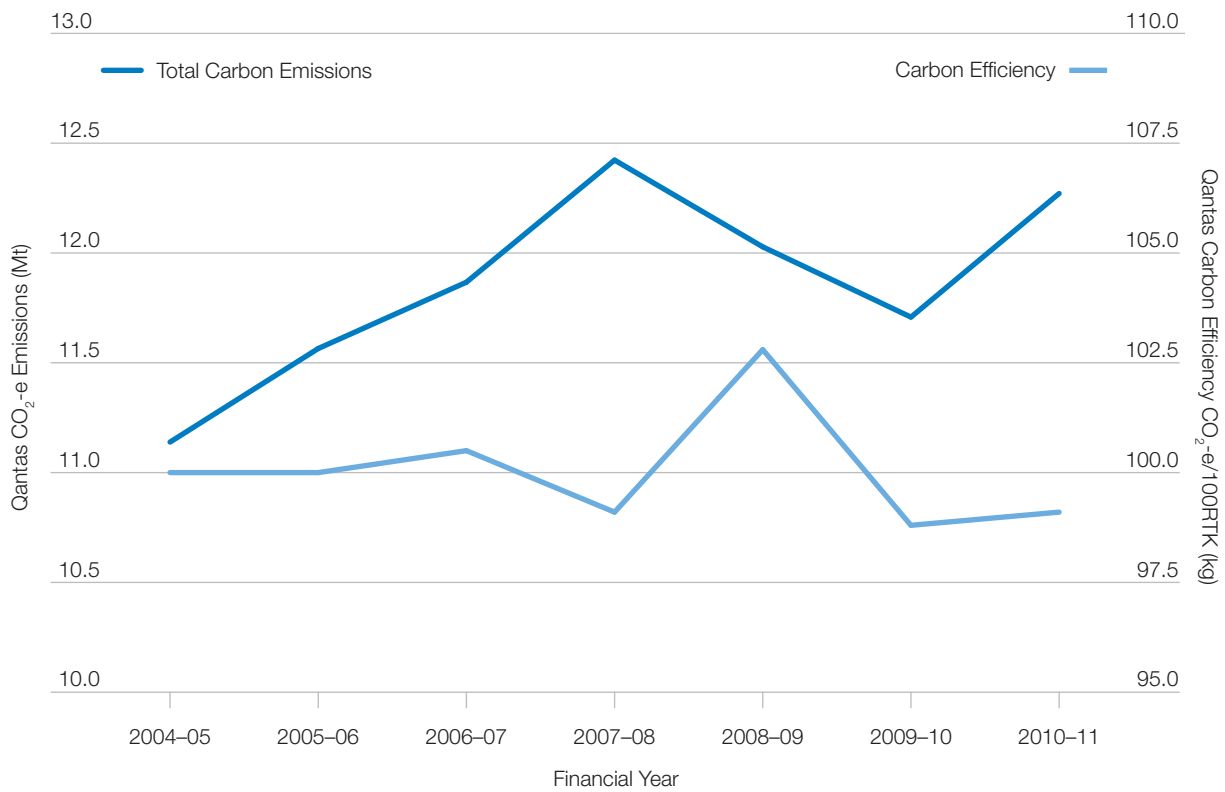
Figure 9: Australian airlines' share of the international air travel market in Australia



For domestic operations, Qantas Group (which includes Jetstar) and Virgin Australia represent approximately 83% of the market.

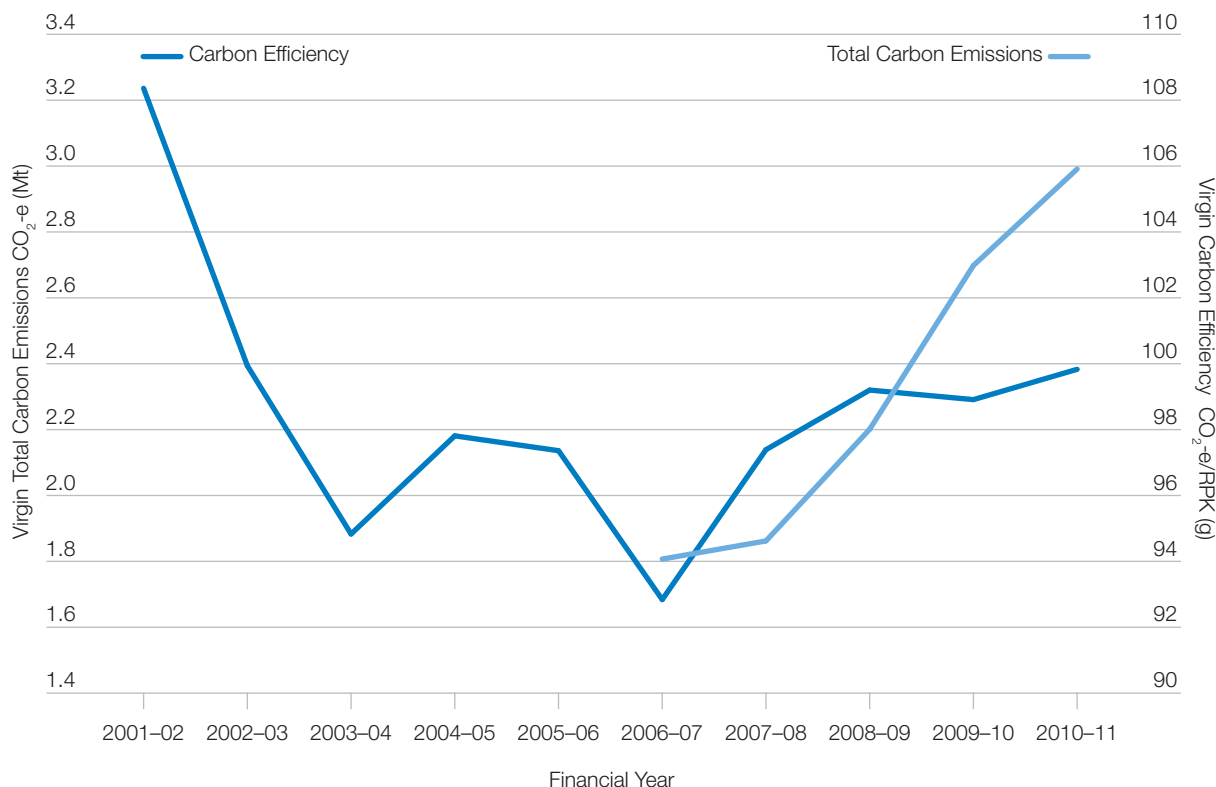
Figure 10 shows Australia's major airlines' current and recent emissions performance. Both Qantas and Virgin Australia's fuel efficiency for aircraft operations are better than global industry averages (see Section 3.4).

Figure 10: Qantas' carbon emissions and carbon efficiency



Notes: The data shown is the total of both domestic and international operations for the Qantas Group as reported in its annual reports (<http://www.qantas.com.au/travel/airlines/investors-annual-reports/global/en>). The Qantas Group consists of Qantas, Jetstar (excluding Jetstar Asia), QantasLink, Jetconnect, Qantas Freight and Network Aviation (from February 2011). The carbon efficiency shown for the years 2006-07, 2007-08 and 2008-09 is for Qantas' core airline only, but from 2009-10 onwards it refers to the Group efficiency.

Figure 11: Virgin Australia's carbon emissions and carbon efficiency



Notes: The data shown is the total of both domestic and international operations for Virgin Australia as reported in its annual reports. (<http://www.virginaustralia.com/AboutUs/Virginbluecorporateinformation/Investorinformation/AnnualReports/>).

8.3 Measures for improving fuel efficiency

Fleet renewal and improvement

Airlines are implementing programmes to gradually renew their fleet with more fuel efficient aircraft. An example of the airline industry's continual efforts to upgrade its fleets to more modern and efficient aircraft is shown in Table 3 for the Qantas Group. The Qantas Group is continuing to build its fleet of A380, B737-800 and A330-200 aircraft, and in future will focus on the B787 Dreamliner to provide fuel savings on further point-to-point destinations.⁴⁴ 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% compared to current turbofans.⁴⁵

The Australian Government has commenced the accession process for the Convention on International Interests in Mobile Equipment as applied to aircraft objects, commonly called the 'Cape Town Convention'. The convention creates a uniform international legal framework to protect financiers of aircraft and aircraft objects through the establishment of an international register of interests in aircraft equipment. Placement of equipment on this register provides greater certainty of asset recovery in the event a debtor defaults on a loan, allowing investors to provide finance with less risk. The Cape Town Convention will support Australian airlines in accessing lower cost finance for aircraft equipment purchases, assisting renewal of the Australian fleet and replacement of older models with newer, more fuel efficient and environmentally friendly aircraft. The Government expects the accession process to be completed in 2014.

⁴⁴ Qantas Fleet Developments (<http://www.qantas.com.au/travel/airlines/fleet-developments/global/en>).

⁴⁵ *Flying into the Future* (<http://www.qantas.com.au/travel/airlines/aircraft-boeing-787/global/en>).

Table 3: Changes in the Qantas Group fleet, 1999–00 to 2010–11

Aircraft type	Number of Aircraft	
	FY 2000	FY 2011
A320–200	0	56
A321–200	0	6
A330–200	0	17
A330–300	0	10
A380	0	10
B717–200	0	11
B737–300	16	0
B737–300SF	0	4
B737–400	22	19
B737–800NG	0	46
B747–200B	3	0
B747–300	5	0
B747–400	24	20
B747–400ER	0	6
B747SP	2	0
B767–200ER	7	0
B767–300	0	1
B767–300ER	22	25
BAe 146	17	0
Dash 8	25	0
EMB 120	0	7
Fokker F100	0	2
Q200/Q300	0	21
Q400	0	22
Shorts SD360	4	0
TOTAL	147	283

Source: Qantas' annual reports (<http://www.qantas.com.au/travel/airlines/investors-annual-reports/global/en>).

Weight reduction measures

Aircraft weight is a key contributor to fuel consumption. Newer aircraft such as the B787 and A380 are being made from composite materials that help to reduce the weight of the aircraft. Airlines have also introduced in-flight weight reduction measures such as lighter fittings, cutlery and bottles, and more options for pricing of baggage allowances, in order to improve fuel efficiency.

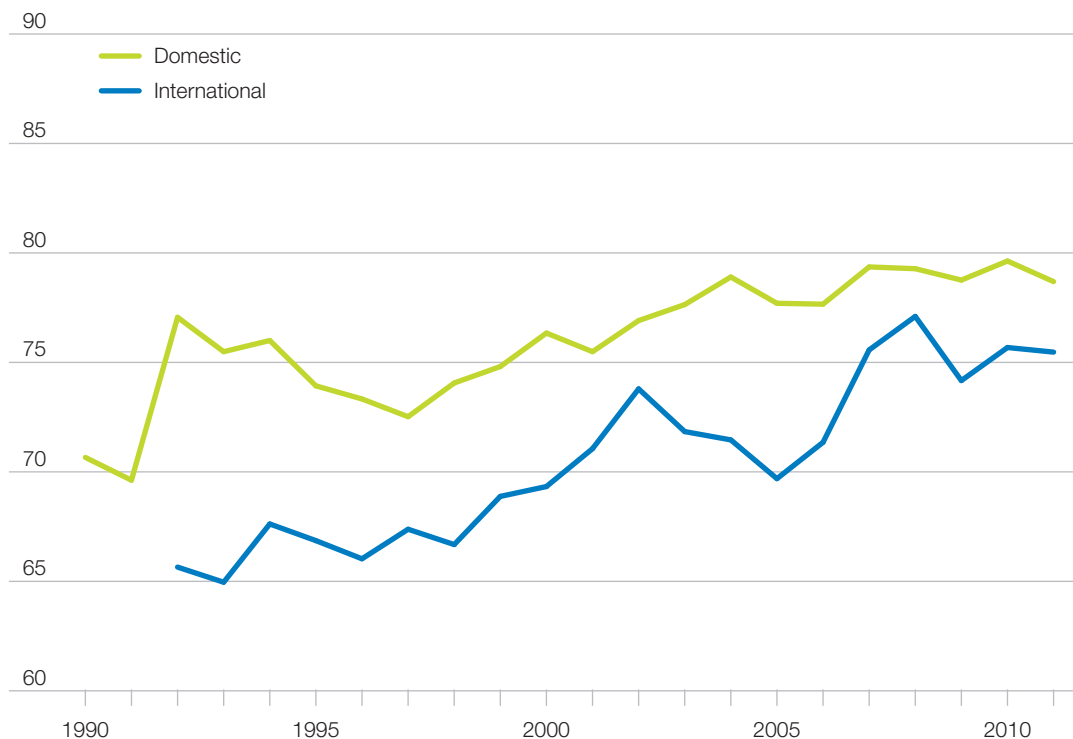
Load factors

All other variables being equal, increasing the load factor increases the fuel efficiency metric on a per passenger-kilometre basis and reduces the CO₂ per passenger on a given flight. There are strong commercial drivers to improve load factors to maximise passenger revenues per available seat-kilometre.

There is an optimum average load factor for an airline fleet which is less than 100%. As the average fleet load factor increases above about 80%, a greater proportion of flights operate at full capacity resulting in an increasing likelihood of the airline not being able to meet customers' demands due to the nonavailability of seats at the passengers' preferred flight times.

Figure 12 shows Australia's annual average load factors for scheduled domestic and international aircraft operations from 1989–90 to 2010–11. As can be seen, Australia's domestic aviation sector has consistently operated at a higher load factor compared to the international sector over the past two decades, although the difference appears to have narrowed in recent years. The annual average domestic load factor has increased by 8.0 percentage points since 1989–90, while the international load factor has increased by 9.8 percentage points since 1991–92 (earliest available data). Over the last five years, the domestic load factor has been averaging around 79.2%, while the international load factor has an average of 75.6%.

Figure 12: Australia's annual average load factors for scheduled aircraft operations



Source: BITRE *Monthly Airline Performance Report* (<http://www.bitre.gov.au/info.aspx?ResourceId=218&NodeId=103>).

Fuel optimisation

Fuel represents the largest portion of an airline's cost base and also generates most of the emissions profile. Premium airlines such as Qantas and Virgin Australia have long established fuel optimisation processes 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 to improve fuel efficiency, and other efficiency improvements in operational, scheduling and management strategies.

8.4 Measures for offsetting emissions

Voluntary offsets by individual air passengers

In Australia, Qantas, Jetstar and Virgin Australia provide passengers with the opportunity to purchase carbon offsets for their individual travel. Reports by Jetstar and Virgin Australia indicate that Australian domestic aviation passengers demonstrate a relatively high uptake of voluntary carbon offsets by international standards, with approximately 10% of passengers electing to offset their flight.⁴⁶ Virgin Australia reported that the amount of carbon offsets in 2009–10 equated to about 4% of its total emissions.⁴⁷ In 2008–09 Qantas and Jetstar customers paid to offset almost 250,000 tonnes of CO₂-e which is just over 2% of the Qantas Group total emissions.⁴⁸

Voluntary offsets by airlines

Both Qantas and Virgin Australia have reported purchasing offsets to cover the emissions resulting from their ground vehicles and employee business travel. In 2008–09, Qantas reported that it offset more than 65,000 tonnes of CO₂-e for its own work travel and ground vehicles.⁴⁹

8.5 Potential future action and initiatives

There are strong commercial incentives for airlines to reduce aircraft fuel consumption through actions such as fleet renewal, weight reductions and increased load factors, with corresponding reductions in aviation emissions. Further initiatives beyond purely commercial incentives are also possible to reduce net emissions.

Alternative fuels

Airlines are basing much of their projected long term carbon emission reductions on the advent of alternative fuels. Australian airlines are currently actively supporting research and pilot studies to produce bio-derived aviation fuel. This issue is discussed further in Section 11.2.

Increasing passenger loads

The number and configuration of seats in an aircraft is heavily influenced by commercial considerations. Airlines, particularly those that employ a low-cost business model, tend to configure their aircraft to accommodate the maximum number of passenger seats. In the future the current optimum seating configurations for aircraft may change in response to changes in market pressures or technological advances. Lighter seats may provide current comfort levels but allow increased passenger loads. Qantas and Virgin Australia's new aircraft are already fitted with slimline seats.

Managing aircraft weight

Measures being taken to lighten the load on aircraft essentially relate to the design of equipment installed or carried on aircraft. A range of initiatives have been introduced which are aimed at reducing the weight of passenger luggage. Charging for excess baggage has been a longstanding practice in the aviation industry but airlines have now introduced charges for any checked baggage. For example, Virgin Australia, Jetstar

46 Carbon Offset Programs by Virgin Australia (<http://www.greenaironline.com/news.php?viewStory=597>) and Jetstar (<http://www.environmentalleader.com/2007/10/05/jetstar-says-voluntary-carbon-offsets-big-success/>).

47 Virgin Australia, *Carbon Disclosure Project 2011*, p8 (http://www.virginaustralia.com/cs/groups/internetcontent/documents/webcontent/~edisp/u_004301.pdf).

48 Qantas Annual Report 2009, p47 (<http://annualreport.qantas.com.au/environment-climate-change/>).

49 Qantas Annual Report 2009, p47 (<http://annualreport.qantas.com.au/environment-climate-change/>).

and Tiger Airways have introduced checked baggage fees for international flights departing Australia and for certain domestic flights.

Increasing the quantum of voluntary offsets

Australian airlines are currently achieving high levels of uptake of voluntary offsets when compared to operators in other countries, although further improvement could be made.

Potential strategies for airlines to make offset purchase more attractive might include: providing a greater range of offsets (both in price and type), offering partial offsets, providing offsetting opportunities at airports or in-flight, matching offsets when passengers convert frequent flyer points into offsets, and fully integrating offset purchasing into the airline booking systems.

The National Carbon Offset Standard (NCOS) established by the Australian Government encourages voluntary purchasing of offsets by increasing consumer confidence in the products (see Section 6.5).

The purchase of voluntary offsets is not restricted to individual air travellers. Many companies are now offsetting some or all of their corporate travel. Some overseas airlines have also adopted a business model where they offer carbon neutral travel by, in effect, incorporating the cost of offsets in their ticket structure.

One of the main issues regarding voluntary offsets that requires further consideration is how to account and provide credit for these offsets in any formal carbon accounting mechanism. While it is important to recognise the contribution these offsets make in capturing a proportion of carbon emissions, there is a need to avoid double counting of carbon which has already been offset.

Australian Airline Initiatives

- Ongoing fleet upgrade and renewal.
- Continuation of gate-to-gate fuel efficiency improvements through
 - flight path optimisation by the use of modern Global Positioning System (GPS) technology, RNP, etc;
 - aircraft speed optimisation;
 - management of onboard weight;
 - increased use of airport ground power units as opposed to more emissions intensive aircraft auxiliary power units.
- Provision of air passenger voluntary offsets.
- Corporate offsetting of employee, vehicle and company emissions.
- Improving load factors.
- Participating in research to develop sustainable aviation biofuels.

9. Airport Contribution

9.1 Introduction

The role of airports in managing the overall carbon footprint of aviation is commonly approached by distinguishing between those activities which airports control and those which they influence. While airports have direct control over approximately 2% of aviation's CO₂ emissions (see Figure 2), they can influence the amount of carbon emissions from aircraft operations through the infrastructure and facilities provided at airports.

Minimising on-ground aviation emissions at airports relies on efficient aircraft and airport interfaces. The availability and capacity of terminal facilities such as parking aprons, aerobridges and gates, can influence aircraft ground running and holding times and therefore engine emissions. Similarly, the availability of terminal electrical power and preconditioned air for aircraft can minimise the use of aircraft auxiliary power units, which consequently reduces aircraft emissions.

The provision of sufficient aircraft handling infrastructure is usually based on commercial agreements between airports and aircraft operators and hence the level of cooperation between these two players in the funding of adequate airport infrastructure can influence on-ground aircraft handling efficiency and associated levels of aviation emissions.

9.2 Examples of emission reduction initiatives at Australian airports

Ground Support Equipment

Sydney Airport's Environment Strategy⁵⁰ provides for more efficient use of ground-based vehicles and examination of the cost effective use of electrical ground support equipment.

Minimisation of the use of APUs

Aircraft auxiliary power units (APUs) provide aircraft on the ground with electrical power for lighting, heating and cooling when the aircraft's main engines are turned off. APUs consume jet fuel and generate of the order of 350 kg of CO₂ per hour.⁵¹ Replacing APUs with ground power units that use diesel fuel saves on fuel costs and helps reduce emissions. Fixed Electrical Ground Power Units and Preconditioned Air units are in place at Sydney, Melbourne and Adelaide Airports.

Green buildings

Canberra Airport has successfully designed and built commercial buildings on its premises which provide significant CO₂ savings through the installation of a trigeneration plant. Tri-generation technology reduces carbon emissions by up to 75% compared to most office buildings.⁵²

50 Sydney Airport Environment Strategy 2010-2015, approved under the *Airports Act 1996* Chapter 4 Environmental Action Plans, page 78 (<http://www.sydneyairport.com.au/SACL/Environment--Environment-Strategy.html>).

51 APU fuel burn per hour (<http://www.pprune.org/tech-log/209594-apu-fuel-burn-hour-a320-757-767-a.html>).

52 Canberra Airport, *Tri-generation* - Providing a clean energy solution for today's business (<http://www.brindabellabusinespark.com.au/bbp-environmental/PDFs/Trigen.pdf>). NABERS refers to the National Australian Built Environment Rating System.

Solar energy

Adelaide Airport has an installation of 760 solar panels on the roof of its Terminal 1 which was completed in May 2008.⁵³ These panels have the capacity to generate approximately 160 megawatt-hours (MWh) of electricity per year, sufficient to power 30 average Australian homes.⁵⁴



Adelaide Airport's grid-connected rooftop solar installation (Photo courtesy of Adelaide Airport)

Alice Springs Airport opened its solar power station in September 2010. The facility has 28 arrays of tracking solar panels capable of producing approximately 600 MWh of electricity per year, supplying about 28% of the airport's energy needs.⁵⁵



Solar tracking arrays at Alice Springs Airport

Airfield lighting

Airservices Australia is a commercial provider of airfield lighting for Australian airports and emphasises the environmental benefits of providing "...solar powered installations that can be used for runway edge, taxiway and emergency lighting; and lighting fixtures featuring LED technology to minimise energy use."⁵⁶

⁵³ Adelaide Airport Solar Install Completed (<http://www.hotfrog.com.au/Companies/Solaris-Technology/Adelaide-Airport-solar-install-completed-12138>).

⁵⁴ Adelaide Airport Solar Install Completed (<http://www.hotfrog.com.au/Companies/Solaris-Technology/Adelaide-Airport-solar-install-completed-12138>).

⁵⁵ Alice Springs Airport Solar Power Station (<http://www.alicespringsairport.com.au/property/solar-power-station>).

⁵⁶ Airfield Lighting — cost-effective, tailored airfield lighting solutions (http://www.airservicesaustralia.com/projectsservices/services/airsidesys/docs/9462_air_lighting.pdf).

Research

Adelaide Airport has formed a partnership with the University of Adelaide's Centre of Energy Technology (CET) to develop clean energy solutions for Adelaide Airport which will include research into renewable energy generation through wind and solar, innovative systems to reduce energy from heating, cooling and lighting, and alternative approaches to ground transportation.⁵⁷

Ground Transport Plans

Following amendments to the *Airports Act 1996* which came into force in December 2010, Australia's major airports are now required to produce a detailed Ground Transport Plan to better link and integrate the airport with off-airport land transport systems in order to maximise the efficient movement of people and freight to and from the airport.⁵⁸

Carbon footprint reporting

Several Australian airports have undertaken carbon footprint exercises consistent with the requirements of the *National Greenhouse and Energy Reporting Act 2007*. A standardised approach to this carbon reporting was coordinated through the Australian Airports Association.

Sydney Airport has compiled and published an overview inventory of its carbon footprint⁵⁷ as part of its carbon neutral strategy. Understanding the carbon footprint was the first step of the strategy; the next step is to pursue a range of initiatives to reduce the Airport's direct carbon emissions.⁵⁸

Figure 13: Sydney Airport Carbon Footprint 007

Source	CO ₂ (tonnes)	%
Electricity	90,961	94.2
Natural gas	4,599	4.8
Other fuels	780	0.8
Staff air travel	260	0.2
LPG	1	-
Total	96,601	100.0

Australian Airport Initiatives

- Reducing the airport carbon footprint by
 - designing and building 'greener' commercial buildings;
 - providing ground power and preconditioned air facilities to service aircraft;
 - decreasing the fuel consumption of ground-based vehicles, for example by reducing vehicle idling time and by increasing the use of electric vehicles.
- Generating electricity through solar installations.
- Conducting research into developing cleaner energy solutions for airports.
- Producing Ground Transport Plans to better link and integrate the airport with off-airport land transport systems.
- Preparing carbon footprint reports on airport emissions.

⁵⁷ Energy Experts Working on Smarter, Greener Airport (<http://www.adelaide.edu.au/adelaidean/issues/42481/news42487.html>).

⁵⁸ Airports Act 1996 Master Plan Amendments – Guidelines (http://www.infrastructure.gov.au/aviation/airport/planning/pdf/draft_strengthen_master_plan_guidelines_july_2011%20.pdf).

⁵⁹ Sydney Airport Master Plan 2009, Chapter 14, Table 14.5, page 142 (<http://www.sydneyairport.com.au/SACL/Master-Plan.html>).

⁶⁰ Sydney Airport Master Plan 2009, Fact Sheet 7: Aviation and Climate Change (<http://www.sydneyairport.com.au/SACL/DownloadDocument.aspx?DocumentID=116>).

Part 3

Measurement, Reporting and Verification

10. Monitoring and Reporting Emissions

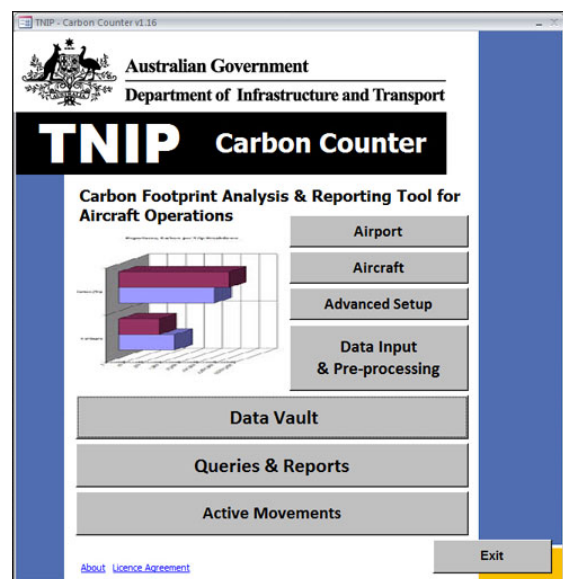
10.1 Introduction

Robust transparent carbon footprint reporting for aviation is essential to measuring aviation's progress towards achieving emissions targets. It is important to understand the CO₂ contribution of the separate elements in the aviation system. This will help to identify areas where new or additional actions can be taken to reduce the carbon footprint and to assess the effectiveness of new measures.

10.2 Development of a carbon footprint tool

In order to generate transparent carbon footprint reports and to underpin environmental analysis and assessment, the Australian Department of Infrastructure and Transport has developed *TNIP Carbon Counter*, a software tool for computing CO₂ emissions from aircraft operations. This tool builds on the internationally recognised ICAO Carbon Calculator⁶¹ and is available for download from the Department's website.⁶²

TNIP Carbon Counter rapidly sums carbon emissions on a flight-by-flight basis and aggregates the data at various levels across the Australian aviation network. The ability to disaggregate the total carbon footprint is important for understanding the drivers underpinning changes in carbon emissions and fuel efficiency. The program has a number of potential applications which includes producing carbon footprint reports for environmental reporting, informing on the carbon implications of proposed changes to aircraft operations, engaging the community about airport operations and proposed developments, analysing trends in fuel efficiency and computing carbon footprints for corporate travel.



61 ICAO Carbon Calculator (http://www2.icao.int/public/cfmapps/carbonoffset/carbon_calculator.cfm).

62 TNIP Carbon Counter (http://www.infrastructure.gov.au/aviation/environmental/transparent_noise/tnip_CC.aspx).

10.3 Annual carbon footprint reports

The 2010 ICAO Assembly encouraged ICAO Member States to “submit...annual reporting on international CO₂ emissions to ICAO.”⁶³ In response to this request the Australian Government will use the TNIP Carbon Counter to produce detailed annual reports tracking changes in Australia’s carbon footprint from aircraft operations. These reports will provide an ongoing record of performance.

10.4 Fuel sales reporting to ICAO

The ICAO Assembly Resolution requests Member States to support the work of ICAO on measuring progress through the reporting of annual data on traffic and fuel consumption.⁶⁴

The ICAO Secretariat, in conjunction with CAEP, has developed a Fuel Reporting Form for Member States to report annual fuel consumption. Australia’s international carriers, Qantas Group and Virgin Australia, have been working cooperatively with the Department of Infrastructure and Transport to report their fuel usage as requested by ICAO. In this case, the fuel usage reported by the airlines is for their operations worldwide and not only fuel uplifted in Australia. The Department will ensure that any confidential information on fuel use is reported in an aggregate manner which does not disclose details of commercial elements.

10.5 Reporting gross and net footprints

The carbon footprint information in this report relates to the gross footprint of the activities it relates to. In circumstances where some of the carbon in the fuel has already been accounted for (e.g. by the purchase of offsets) or is not fossil-based (e.g. a biofuel) it is useful to compute and report the net carbon footprint so that a transparent picture is presented of the amount of ‘unmanaged’ CO₂ that is emitted into the atmosphere. (Section 3.4 discusses the differences between gross and net fuel efficiency.)

While it is anticipated that Australia’s gross carbon footprint will continue to increase given the forecast growth in demand for air services, the net footprint may display quite different trend characteristics when carbon offsets are taken into account. Recognising that some form of carbon offsetting is likely to be necessary to achieve Carbon Neutral Growth or emissions reductions, the Department will monitor information on the quantum of offsets purchased in Australia in order to report both gross and net carbon footprints. This work will support the ICAO Assembly request to “collect information on the volume of carbon offsets purchased in relation to air transport.”⁶⁵

Similarly, when aviation biofuels come into regular use, full life-cycle emissions of producing the biofuel will need to be computed and taken into account in order to report the net amount of carbon (i.e. the fossil-based CO₂) that has been emitted into the environment.

10.6 National greenhouse gas reporting

The reporting discussed in the previous sections relates to aviation specific reporting which is, or will be, carried out by the Department of Infrastructure and Transport. The Australian Department of Climate Change and Energy Efficiency (DCCEE) has additional obligations on the monitoring and reporting of CO₂ which are discussed below. The two departments are collaborating to ensure that there is consistency between the different reporting regimes.

63 ICAO Assembly Resolution A37-19, para 9.

64 ICAO Assembly Resolution A37-19, para 24k.

65 ICAO Assembly Resolution A37-19, para 20.

National Greenhouse Accounts

Australia compiles national emissions data using the Australian Greenhouse Emissions Information System (AGEIS) and the National Carbon Accounting System (NCAS) and publishes the national accounts in the annual National Greenhouse Gas Inventory.⁶⁶ The data is used to meet Australia's reporting commitments under the UNFCCC and track progress against Australia's target under the Kyoto Protocol.

The National Greenhouse Gas Inventory separately reports total emissions from the domestic civil aviation sector and international bunker fuels calculated from aviation fuel sales data that are published in the *Australian Petroleum Statistics*.⁶⁷ It does not report disaggregated aviation emissions data on a state or route level.

National Greenhouse and Energy Reporting

The *National Greenhouse and Energy Reporting Act 2007* (the NGER Act) introduced a national framework for the reporting and dissemination of information on greenhouse gas emissions, energy production and energy consumption by corporations. The framework streamlines reporting at both national and state levels and sets up a register for underpinning the introduction of an emissions trading scheme and for meeting Australia's international reporting obligations. From 2009–10 increased reliance has been placed on data obtained under the NGER Act in the compilation of Australia's National Greenhouse Accounts.

The first annual reporting period under the NGER Act began on 1 July 2008 and encompassed corporations which exceeded a threshold of 125 kilotonnes of greenhouse gas emissions for the financial year 2008–09. The information published by DCCEE for 2010–11 shows that the Qantas Group, Virgin Australia, Regional Express and Tiger Airways emitted 4.36, 1.89, 0.96 and 0.18 million tonnes (Mt) of CO₂-e respectively for that period. These figures relate to the companies' total emissions and have not been broken down to show emissions solely from aircraft operations.

10.7 Airline Annual Reports

Airlines such as the Qantas Group and Virgin Australia report their annual aviation emissions in the companies' annual reports. For example, in its 2011 Annual Report the Qantas Group reported an annual CO₂ emissions total of 12.3 Mt CO₂-e for its entire network with an emissions efficiency of 99.1 kg CO₂-e per 100 Revenue Tonne Kilometre (RTK).⁶⁸ For the same period, Virgin Australia reported total annual CO₂ emissions of 3.0 Mt CO₂-e for all its aircraft with 99.8 g CO₂e per Revenue Passenger Kilometre (RPK).⁶⁹

66 Australia's National Greenhouse Accounts (<http://www.climatechange.gov.au/climate-change/emissions.aspx>).

67 Australian Petroleum Statistics (<http://www.ret.gov.au/resources/fuels/aps/pages/default.aspx>).

68 Qantas Annual Report 2011, p114 (<http://www.qantas.com.au/travel/airlines/investors-annual-reports/global/en>).

69 Virgin Australia Annual Report 2011, p138 (<http://www.virginaustralia.com/au/en/about-us/company-overview/investor-information/annual-reports/>).

Part 4

Future Directions

11. Future Measures

Despite the reduction in carbon emissions possible from continuing current efficiency improvements, the carbon footprint of the Australian aviation network is expected to grow at a rate of around 3% per year due to increasing demand for air travel. New 'step changing' measures will be needed if substantial progress is to be made in counteracting current trends in the growth of the aviation carbon footprint. Figure 8 provides estimates of the quantity of CO₂ that will need to be managed to achieve carbon neutral growth, compared to current trends.

At the present time there are several potential new measures that might further reduce Australia's aviation carbon footprint into the future:

- *Near term* — market-based measures
- *Medium term* — sustainable biofuels
- *Long term* — new aircraft or fuel technologies

Market-based measures are well understood economic instruments which are able to be introduced, subject to the necessary international agreements, in relation to international operations. There are already examples of national or regional MBMs being applied around the world including in the Australian domestic economy.

Development of alternative fuels for aviation is continuing and Section 11.2 provides details of Australian Government and industry initiatives to further research, production and commercialisation of aviation biofuels.

The aviation industry has long been at the forefront of the adoption of new technologies and it is expected that they will continue to play an important role in carbon footprint management in the future.

11.1 The near term – market-based measures

The Australian Government is taking action to manage the carbon footprint of Australian domestic aviation through the introduction of a domestic carbon price from 1 July 2012.

The scope for the introduction of market-based measures for international aviation is being negotiated through ICAO. At the 194th ICAO Council Session in November 2011, Australia proposed that key elements of a global agreement be developed for consideration by ICAO's 38th Assembly in 2013. The ICAO Secretary General has now presented to the Council a high level road map to accelerate the development of a global MBM framework by 2013. That roadmap provides scope for ICAO Member States to work collaboratively within ICAO to progress towards an effective global agreement. The principles which would guide such a scheme are provided in Section 6.3.

Domestic aviation

Under Australia's domestic carbon pricing scheme, domestic airlines will be required to fully account for all the CO₂ generated by their activities. If this is taken to mean that their activities are carbon neutral, then the net fuel efficiency of their domestic aircraft operations will be 0 L/RTK. This contribution by MBMs would lead to the fuel efficiency of the Australian aviation network being improved by approximately 44% (from 0.37 L/RTK to 0.21 L/RTK, see Table 2).

International aviation

ICAO is currently working to develop a global sectoral approach with clearly defined global emissions limitation goals, mechanisms to support achievements of the goals, and appropriate accountability arrangements for emissions reduction action. Australia has proposed that specific milestone achievements be identified for ICAO's 38th Assembly in 2013 which include agreement on a global goal for international aviation emissions for 2020, a work program to further develop goals from 2020 to 2050, and agreement on key elements of a global sectoral treaty.

11.2 The medium term – alternative fuels

The aviation industry is currently contributing towards the development of sustainable biofuels as an alternative to conventional jet fuel for economic and environmental reasons. IATA has set a target of using 10% alternative fuels by 2017.⁷⁰ A number of test flights worldwide have demonstrated that specific blends of biofuels and conventional jet fuel can safely power aircraft. On 1 July 2011, 50-50 blends of conventional jet kerosene with hydrotreated renewable jet (HRJ) fuels derived from natural plant oils and animal fats were officially certified for use in commercial flights.⁷¹

While certification has opened the door to trialling of partly biofuel-powered regular scheduled flights,⁷² there is still great uncertainty about the timing and availability of commercial supplies of aviation biofuels for widespread use throughout the aviation network. Complex issues surround the sustainable production of biofuel feedstocks. These include constraints imposed by factors such as competition for water, impacts on food production, price increases for fertilisers, depletion of arable land, loss of biodiversity and deforestation.

In Australia, the development of sustainable aviation biofuels is progressing on several fronts. The Australian Government committed \$20 million in the 2011–12 Budget towards the establishment of the Australian Biofuels Research Institute (ABRI) to examine the economics of developing biofuels in Australia.

The Australian Government has also released the *Strategic Framework for Alternative Transport Fuels* in December 2011 that establishes a long term approach to a market led adoption of alternative fuels in Australia.⁷³ This strategy constitutes part of the Government's Energy White Paper to improve Australia's energy and transport fuel security. In September 2011, Australia's Department of Resources, Energy and Tourism signed a Memorandum of Understanding (MOU) with the US Federal Aviation Administration (FAA) to exchange information and expertise on projects of mutual interest in relation to the development of sustainable aviation biofuels. The inaugural meeting of the Australian Initiative for Sustainable Aviation Fuels (AISAF), a joint Department of Resources, Energy and Tourism and aviation industry stakeholder funded

70 IATA, *A Global Approach to Reducing Aviation Emissions*, p5 (http://www.iata.org/SiteCollectionDocuments/Documents/Global_Approach_Reducing_Emissions_251109web.pdf).

71 ASTM certifies aviation biofuels from plant oils, animal fat (<http://www.flightglobal.com/news/articles/astm-certifies-aviation-biofuels-from-plant-oils-animal-359086/>).

72 Lufthansa launches first scheduled flights using biofuel (<http://presse.lufthansa.com/en/news-releases/singleview/archive/2011/july/15/article/1980.html>).

73 *Strategic Framework for Alternative Transport Fuels* (http://www.ret.gov.au/resources/fuels/alternative_transport_fuels/strategy/Pages/AlternativeTransportFuelsStrategy.aspx).

mechanism, was held in August 2012 to establish the work program for cooperation between the US and Australia under the MOU in areas including new feedstock development, fuel technologies and fuel testing and certification.

The Government has announced that it will help fund a dedicated study into the sustainable production and commercialisation of aviation biofuels in Australia. The \$500,000 Emerging Renewables Program grant will see Qantas partner with Shell Australia to undertake a feasibility study into the long-term viability of biofuel feedstock and the production of low carbon alternative aviation fuels in Australia. The study will also investigate opportunities to use existing refining plant and fuel distribution infrastructure for aviation biofuel production. A business case is also being developed to build a commercial sugarcane-to-bio-aviation fuel refinery in Mackay, Queensland, funded by the Queensland State Government.⁷⁴

Other Industry initiatives in Australia include a road map study on the establishment of a sustainable bioderived aviation fuels industry in Australia and New Zealand. This study was carried out by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) under direction from the Australasian grouping of the Sustainable Aviation Fuel Users Group (SAFUG).⁷⁵ The Sustainable Aviation Fuel Road Map, which was released in May 2011, identified several challenges and opportunities for the development of sustainable aviation biofuels in the Australasian region. In particular, the report concluded that the Australasian region has sufficient biomass resources to achieve a 5% bioderived jet fuel share by 2020 and a 50% share by 2050.⁷⁶ The uptake trajectory for this scenario is illustrated in Figure 8 in Section 4.3.

Potential contribution by biofuels

Assuming the uptake trajectory of sustainable biofuels in Australia's international aviation sector is feasible starting from 2015, as described in the Road Map mentioned previously, Australia's projected international carbon emissions for a 'business as usual' case as shown by the blue line in Figure 14 is reduced to the dashed green line in the same figure.⁷⁷

Figure 14 shows that if it were possible to develop the industry's road map scenario for the uptake of bio-derived jet fuel in Australia, then savings of up to 14.5 Mt CO₂ in 2050 could be achieved. Under the road map scenario, Australia would be able to meet a carbon neutral growth objective from 2020 out to 2026 without the need to purchase carbon offsets. From then onwards, carbon offsets would need to be purchased to maintain carbon neutral growth. If 50% of fuel is sourced from sustainable biofuels in 2050 then 2.5 Mt CO₂ will need to be managed via additional action such as market-based measures (rather than 17 Mt CO₂ in the absence of biofuels).

Figure 14 also shows that if the uptake of biofuels is much slower, say at 10% or 30% of market share by 2050, then the amount of Australia's international carbon emissions that will need to be accounted for by the application of market-based measures in 2050 to achieve carbon neutral growth will be in the order of 14.1 or 8.3 Mt CO₂ respectively.

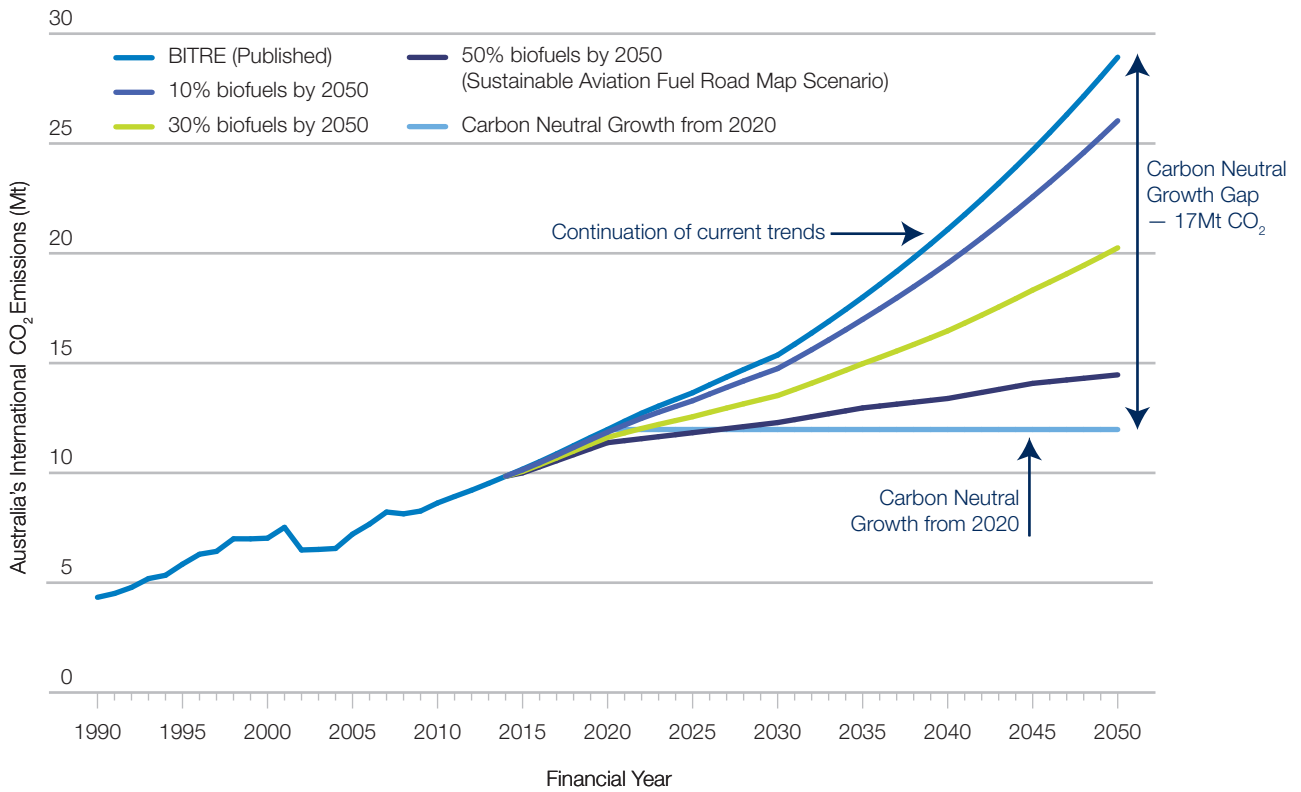
74 *Mackay bio-aviation fuel facility one step closer* (<http://statements.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=80189>).

75 Sustainable Aviation Fuel Users Group (<http://www.safug.org/>).

76 *Flight Path to Sustainable Aviation*, CSIRO, May 2011, Figure 17, p41 (<http://www.csiro.au/resources/sustainable-aviation-fuel-report.html>).

77 This analysis assumes that biofuels have a zero carbon emissions rating.

Figure 14: Potential biofuel impacts on Australia’s projected international aviation carbon emissions to 2050



12. The way ahead

12.1 Range of scenarios for Australia’s international aviation carbon emissions

In Section 4.3, two scenarios were presented for managing Australia’s international aviation carbon emissions and three examples of the potential impacts of biofuels on Australia’s emissions trajectories were presented in Section 11.2. These scenarios have been combined into a single figure below (Figure 15) to enable comparisons to be made.

Figure 15: Scenarios for Australia’s projected international aviation carbon emissions to 2050

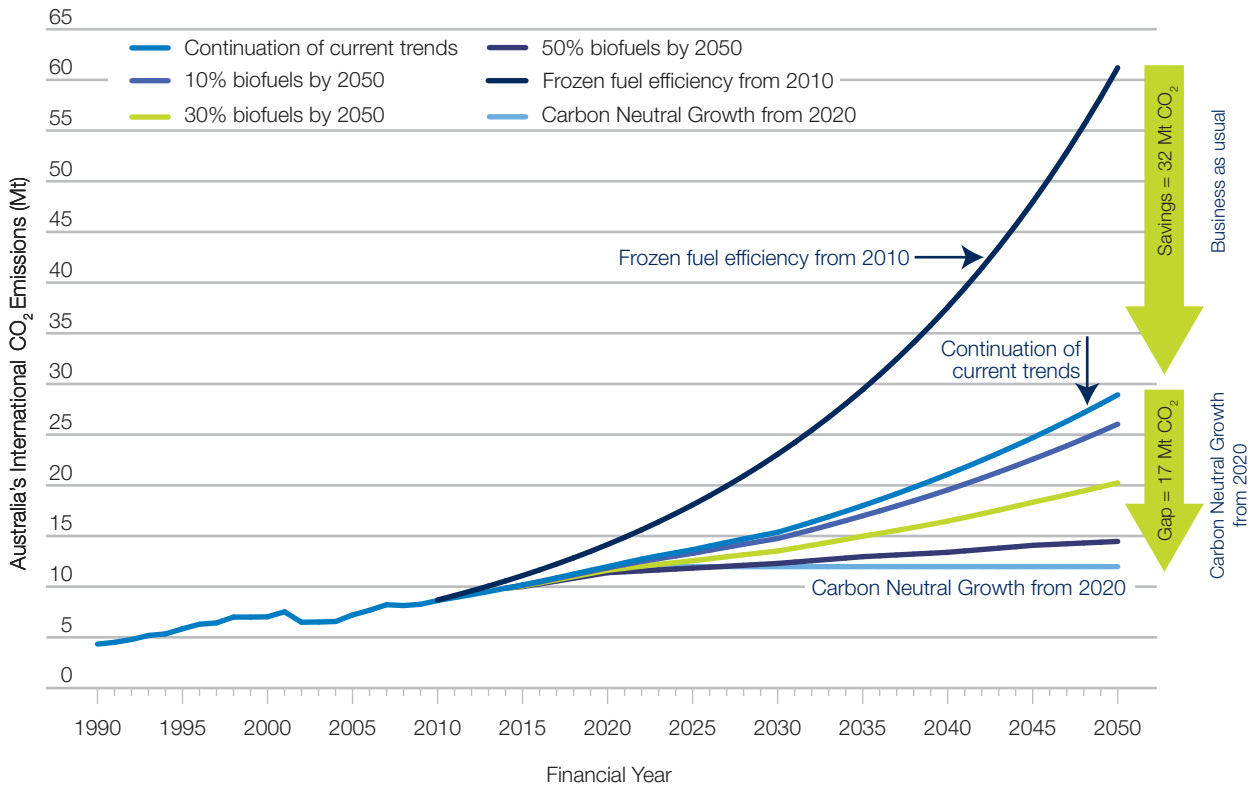


Figure 15 shows that some key scenarios for Australia’s international aviation carbon emissions are:

- **Continuing historic trends**

This case estimates Australia’s net international aviation carbon emissions by taking into account historical trends and ongoing measures to reduce carbon emissions and to improve the overall system efficiency. This scenario represents an annual fuel efficiency improvement of 1.8% per annum over the four decades between 2010 and 2050.

- **Intermediate scenarios with contributions from biofuels**

Figure 15 shows three examples of Australia’s international aviation emissions curves which incorporate 10%, 30% and 50% sustainable biofuels in Australia’s total share of fuel uplifted for international aviation. These emissions projections all correspond to an improvement in the net fuel efficiency compared to the historical trend case, but they still result in an increasing carbon footprint. They represent annual improvements in the average net fuel efficiency of 2.1%, 2.7% and 3.5% respectively between 2010 and 2050.

- **Carbon neutral growth from 2020**

Figure 15 shows that if Australia were to cap its international carbon emissions at the 2020 level of 12 Mt CO₂, then a saving of 17 Mt CO₂ from the historical trend case would be required in 2050. If half of Australia’s international aviation fuel were sourced from sustainable biofuels in 2050 and if these were zero rated for carbon emissions as described in ICAO’s Guidance Material for preparing State Action Plans, then the amount of CO₂ required to be ‘managed’ in 2050 in order to maintain carbon emissions at 2020 levels would drop to 2.5 Mt. Market-based measures or other additional action could be used to bridge this gap.

12.2 Conclusion

International aviation activity has increased strongly over the past five decades. Aviation is critical for driving growth in international business, trade and social connections. This will continue to be important in the future. The Australian Government supports this growth and recognises that action needs to be taken to ensure the aviation industry's growth is sustainable and its contribution towards global climate change is minimised.

The aviation industry has made significant generational improvements in aircraft and system efficiency over recent decades and will continue to improve in the future. The Australian Government supports these improvements through the application of improved air traffic management technology and enhanced operational procedure to optimise the efficiency of aircraft operations to and from Australia and in Australian airspace. Australia also provides an economic regulatory framework that supports an open, commercial aviation sector that is efficient, modern and environmentally responsible.

The Australian Government strongly supports the development of a multilateral approach to the management of emissions from international aviation, including consideration of market-based measures. Australia is actively participating within ICAO to achieve a global sectoral agreement that addresses international aviation emissions and looks forward to substantial progress leading up to the 38th ICAO Assembly in 2013.

Alternative fuels also represent an opportunity to achieve significant long term reductions in greenhouse gas emissions from aviation. Following some successful trials, the Australian Government is supporting industry efforts to further research, develop and commercialise these fuels.

The Government is committed to working in partnership with industry to implement the initiatives summarised in this document and to minimise the aviation industry's carbon footprint and contribution towards global climate change.

This document provides an overview of the policy approach and actions the Australian Government and industry are taking to address greenhouse gas emissions from aviation. It will be important to regularly update the document to monitor and report on progress. As part of a regular three year review of this document, the scenarios will be reassessed and new trajectories may be included. The revision of scenarios will enable Australia to consider the impact of any targets agreed at future ICAO Assemblies or arising from progress of work under the United Nations Framework Convention on Climate Change, as well as reflect changes to national emission reduction targets.