CANADA'S ACTION PLAN

to Reduce Greenhouse Gas Emissions from Aviation

2013 ANNUAL REPORT

Government of Canada
Gouvernement du Canada

Canada

TP 15285
Catalogue No.: T40-3/2013E-PDF
ISSN 2292-3683

An electronic version of this publication is available at www.tc.gc.ca/aviation-emissions/.

CANADA'S ACTION PLAN
TO REDUCE GREENHOUSE GAS EMISSIONS FROM AVIATION
2013 ANNUAL REPORT

CONTENTS

EXECUTIVE SUMMARY

This is the second Annual Report under *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* (the Action Plan).

In 2013, good progress was made towards implementing the Action Plan, including a number of noteworthy achievements related to fleet renewal, improved air traffic management (ATM) and international coordination. Canadian air carriers have collected the necessary data to track fuel efficiency improvements achieved in 2013. The results show that Canadian air carriers continue to improve their annual fuel efficiency. The combined fuel consumption rate in 2013 was 36.83 litres per 100 Revenue Tonne-Kilometres (RTK). The fuel consumption rate for international activity was 33.52 litres per 100 RTK, and for domestic activity was 44.58 litres per 100 RTK. Compared with 2012, Canadian air carriers improved fuel efficiency by 0.9 percent, which represents a 1.2 percent average annual improvement, from a 2005 baseline or a cumulative annual improvement of 8.9 percent from 2005 to 2013.

Section 5.0 of the Action Plan identifies three key measures that are expected to have the greatest impact on greenhouse gas emissions: fleet renewals and upgrades; more efficient air operations; and improved capabilities in ATM. This Annual Report highlights the advances made on all three fronts in 2013, including Canadian air carriers replacing older aircraft with more efficient aircraft and Canada making greater use of performance-based navigation and advanced surveillance technologies.

Section 6.0 of the Action Plan highlights progress on a second set of measures that the Canadian aviation industry expects to produce beneficial environmental results in the future. These measures include: aviation environmental research and development; alternative fuels; airport ground operations and infrastructure use; regulatory measures; and international coordination.

Finally, this Annual Report provides a preview of some important 2014 milestones, including: NAV CANADA's Performance-Based Navigation (PBN) Operations Plan; the Canadian Performance-Based Aviation Action Team to help implement PBN operations in Canadian airspace; the renewal of the Green Aviation Research & Development Network for five more years with $24 million for research; additional reductions in carbon dioxide emissions from the ongoing implementation of the Windsor-Toronto-Montreal Airspace and Services Review; and increased collaborations with BioFuelNet Canada.

BACKGROUND

On June 4, 2012, the Government of Canada and the Canadian aviation industry released *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* (the Action Plan) and submitted it to the International Civil Aviation Organization (ICAO). Developed by a joint industry-government Working Group on Aviation Emissions, the Action Plan:

- Builds on the success of previous collaborations between the Government of Canada and Canada's aviation stakeholders. This includes the world's first voluntary agreement to reduce greenhouse gas emissions from aviation, which was signed in 2005 between Transport Canada and the Air Transport Association of Canada on behalf of its member carriers.
- Commits to annual reporting to summarize and track progress towards meeting the fuel efficiency goal and other Action Plan activities. This is the second Annual Report published under the Action Plan.
- Describes ongoing and planned activities to address greenhouse gas emissions from Canada's domestic and international aviation activities. These measures could contribute to reductions in Canada's domestic emissions and ICAO's global aspirational goals.

The Action Plan set a target to improve fuel efficiency of Canada's air carriers by 2 percent per year until 2020, from a 2005 baseline of 40.43 litres of fuel per 100 Revenue Tonne-Kilometres.

To support this goal, the Action Plan identifies three key measures that are expected to have the greatest impact in reducing greenhouse gas emissions:

- Fleet Renewals and Upgrades;
- More Efficient Air Operations; and
- Improved Capabilities in Air Traffic Management.

The Action Plan also highlights a second set of measures expected to have beneficial environmental results. These results are not expressed in quantitative terms due to their nature or current stage of development. These include:

- Aviation Environmental Research and Development;
- Alternative Fuels;
- Airport Ground Operations and Infrastructure Use;
- Regulatory Measures; and
- International Coordination.

Highlights for 2013

Canada has made good progress in implementing the Action Plan. Working Group members took advantage of opportunities to advance collaboratively a number of Action Plan measures. Several milestones were reached in 2013, including the following noteworthy achievements:

Fleet Renewals and Upgrades

- National Airlines Council of Canada member airlines removed 12 aircraft from service and introduced 23 aircraft into service.
- WestJet signed a letter of intent to purchase 65 Boeing 737 MAX aircraft worth US$6.3 billion. This aircraft will have CFM International LEAP-1B engines which are expected to reduce fuel burn and carbon dioxide (CO_2) emissions by 14 percent as compared with the most fuel-efficient single-aisle aircraft currently available. Deliveries are scheduled to begin in 2017.
- Air Canada finalized its order for the purchase of 61 Boeing 737 MAX aircraft worth US$6.5 billion which will enter into service over the next decade. Deliveries are scheduled to begin in 2017.

Performance-Based Navigation and Surveillance

Transport Canada approved performance-based navigation advisory circulars that allow for the use of new procedures and navigation specifications that will lead to more efficient routes. Transport Canada also authorized a new NAV CANADA automatic dependent surveillance-broadcast (ADS-B) exemption. This allows NAV CANADA to provide Air Traffic Management (ATM) services to all aircraft that transmit acceptable ADS-B data and will result in safer and more efficient air operations.

Air Traffic Management Working Group

Formed in 2013, members of this Working Group represent the Greater Toronto Airports Authority (GTAA), NAV CANADA, Airlines and the GTAA Central De-icing Facility. It aims to improve performance and reduce emissions associated with aircraft movements from gate-to-gate.

International Coordination

Canada has continued its active engagement at the International Civil Aviation Organization, including participating in its Committee on Aviation and Environmental Protection to develop the new CO_2 standard for aeroplanes and the new particulate matter standard for aircraft engines.

Improved Air Traffic Management in Targeted Corridors with Area Navigation

Military Airspace

One of the many prerequisites for optimized airspace design and route enhancements in southern Ontario involved the re-design of military airspace on the NAV CANADA/United States (US) Federal Aviation Administration (FAA) boundary that the US Air Force and its allies use for training. NAV CANADA, the FAA and the Department of Defense worked to identify the US Air Force and National Guard training objectives as well as international commercial air traffic efficiency objectives near these areas.

Through collaboration, NAV CANADA was able to develop a new military airspace structure that increased the efficiency for commercial traffic through safely reduced track miles while increasing the training opportunities for the military. This is one example of how area navigation (RNAV) can improve the system for all stakeholders through multi-disciplinary collaboration.

The Toronto Flight Information Region

The airspace corridor in the southern half of the Flight Information Region (FIR) is the busiest in Canada. Here, more than 3,000 flights a day transition between the FAA and NAV CANADA on their way between US cities, Canadian cities and international destinations. Because of the concentration of traffic, most aircraft in this area operate on specified routes to maintain an organized traffic flow. These routes were anchored on a limited number of ground based navigational aids (NAVAIDS) that, by their nature, impose additional conflictions and traffic restrictions.

By working with customers and stakeholders, the resulting RNAV design reduces fuel burn and emissions for arrivals, departures as well as for overflights operating through the Toronto FIR.

Results for 2013

The Air Transport Association of Canada (ATAC) and the National Airlines Council of Canada (NACC) have collected the data required to report on the fuel efficiency improvements achieved in 2013.[1] Although progress towards the Action Plan's target is measured in terms of litres of fuel used per Revenue Tonne-Kilometre (RTK), the air operator associations have provided additional data (see Appendix A: Glossary of Key Terms and Acronyms for definitions) to calculate the industry's main activity measures. Other key aviation activity measurements include:

- Revenue Passenger-Kilometres (RPK);
- Passenger Revenue Tonne-Kilometres (Passenger RTK);
- Cargo Revenue Tonne-Kilometres (Cargo RTK);
- Total Revenue Tonne-Kilometres (Total RTK).

Table 1 illustrates the combined results for ATAC and NACC air carriers for calendar years 2005 to 2013. It shows trends in fuel consumption and its conversion to greenhouse gas emissions, expressed in carbon dioxide equivalent (CO_2e); as well as ratios of litres of fuel and grams of CO_2e per RPK and total RTK.

Table 1 also shows the following results from the reporting carriers in 2013 (in slightly rounded figures):

- The combined fuel consumption rate was 36.83 litres per 100 RTK, which is an average annual improvement between 2005 and 2013 of 1.2 percent.
- Revenue service was 150.92 billion RPK and 2.05 billion Cargo RTK.
- Combined revenue service was 17.14 billion RTK (i.e., 15.09 billion RTK for passengers plus 2.05 billion for cargo).

1 It should be noted that the number of air carriers that provide data under the Action Plan could change from year to year. As a result, the statistics presented in this report may not be entirely comparable with those in subsequent annual reports.

TABLE 1 Annual Results of Operations, 2005-2013

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fuel use (million litres)	4,887	5,186	5,543	5,575	5,077	5,659	6,089	6,256	6,314
Greenhouse gas emissions (millions of tonnes of CO_2e)	12.496	13.259	14.172	14.255	12.981	14.468	15.568	15.995	16.144
Traffic (billions)									
Revenue passenger-kilometres (RPK)	105.22	112.98	124.15	125.55	117.62	128.77	141.27	148.74	150.92
Passenger revenue-tonne-kilometres (pass. RTK)*	10.52	11.30	12.42	12.55	11.76	12.88	14.13	14.87	15.09
Cargo revenue-tonne-kilometres (cargo RTK)	1.57	1.53	1.82	1.57	1.38	2.01	1.98	1.96	2.05
Total revenue-tonne-kilometres (RTK)	12.09	12.83	14.23	14.13	13.14	14.88	16.11	16.83	17.14
Fuel consumption rates									
Litres/RPK	0.0464	0.0459	0.0446	0.0444	0.0426	0.0425	0.0421	0.0415	0.0408
Litres/Total RTK	0.4043	0.4043	0.3895	0.3947	0.3863	0.3802	0.3780	0.3716	0.3683
Emission rates									
CO_2e grams/RPK	118.76	117.36	114.15	113.54	109.02	108.66	107.55	106.06	104.34
CO_2e grams/Total RTK	1,034	1,034	996	1,009	988	972	966	950	942

*Note that Passenger RTK are calculated by multiplying RPK by 100 kg (or 0.1 tonnes), which is the industry's conventional assumption of the average weight per passenger, including baggage.

See Appendix D: Additional Figures Illustrating Key Trends for Figures 5, 6, 7, 8, 9, 11, 14 and 15 that illustrate trends presented in Table 1.

Canadian air carriers report aviation activity data for both domestic and international activities. International includes flight segments that begin or end outside of Canada, whereas domestic activity includes flight segments within Canada.

Table 2 provides data on international versus domestic aviation activity for 2013.

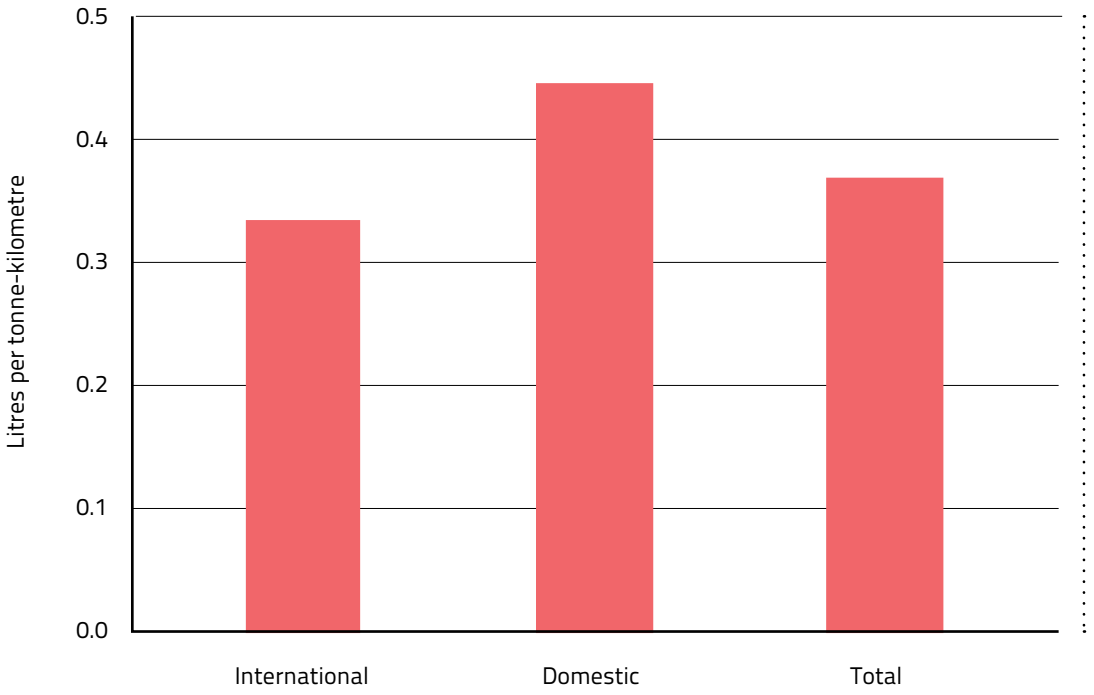
- Separately, the fuel consumption rate for international activity was 33.52 litres per 100 RTK, and 44.58 litres per 100 RTK for domestic activity. (Also illustrated in Figure 1).
- Total fuel consumed amounted to 6.31 billion litres (63.7 percent for international activity and 36.3 percent for domestic activity).
- Total greenhouse gas emissions amounted to an estimated 16.14 megatonnes (Mt) (10.29 Mt for international activity and 5.85 Mt for domestic).

TABLE 2 International vs. Domestic Aviation Activity, 2013

	International	Domestic	Total
Fuel use (million litres)	4,025	2,289	6,314
Greenhouse gas emissions (millions of tonnes of CO_2e)	10.29	5.85	16.14
Traffic (billions)			
Revenue passenger-kilometres (RPK)	103.9	47.0	150.9
Passenger revenue-tonne-kilometres (pass. RTK)	10.4	4.7	15.1
Cargo revenue-tonne-kilometres (cargo RTK)	1.6	0.4	2.1
Total revenue-tonne-kilometres (RTK)	12.0	5.1	17.1
Fuel consumption rates			
Litres/Total RTK	0.3352	0.4458	0.3683
Emission rates			
CO_2e grams/Total RTK	857	1,140	942

See Appendix D: Additional Figures Illustrating Key Trends for Figures 4, 9, 12 and 13 that illustrate trends presented in Table 2.

FIGURE 1 Fuel Consumption Rates-International and Domestic, 2013



The main Action Plan target indicator is the ratio of fuel consumption to total traffic (litres/total RTK), aiming to achieve improvements of at least 2 percent per year until 2020 from a 2005 baseline.

Table 3 shows progress towards reaching the Action Plan target, illustrating the change in the measures and rates between 2012 and 2013, and between 2005 and 2013. Fuel efficiency in 2013 improved by 0.9 percent over 2012, and the cumulative annual improvement between 2005 and 2013 was 8.9 percent, or an annual average of 1.2 percent.

TABLE 3 Absolute and Proportional Changes Over Time, 2005-2013

	Change 2012-2013		Change 2005-2013		
	Absolute	**Proportional**	**Absolute**	**Proportional**	**Annual rate**
Fuel use (million litres)	58	0.9%	1,427	29.2%	3.3%
Greenhouse gas emissions (millions of tonnes of CO_2e)	0.15	0.9%	3.65	29.2%	3.3%
Traffic (billions)					
Revenue passenger-kilometres (RPK)	2.2	1.5%	45.7	43.4%	4.6%
Passenger revenue-tonne-kilometres (pass. RTK)	0.2	1.5%	4.6	43.4%	4.6%
Cargo revenue-tonne-kilometres (cargo RTK)	0.1	4.8%	0.5	31.0%	3.4%
Total revenue-tonne-kilometres (RTK)	0.3	1.8%	5.1	41.8%	4.5%
Fuel consumption rates					
Litres/RPK	-0.001	-1.6%	-0.006	-12.1%	-1.6%
Litres/Total RTK	-0.003	-0.9%	-0.036	-8.9%	-1.2%
Emission rates					
CO_2e grams/RPK	-1.7	-1.6%	-14.4	-12.1%	-1.6%
CO_2e grams/Total RTK	-8.5	-0.9%	-92.0	-8.9%	-1.2%

Fleet Renewal

Air Canada and WestJet are upgrading their fleets with Boeing 737 MAX aircraft, which is expected to yield significant fuel and maintenance cost savings. Compared to today's aircraft, the 737 MAX improves fuel efficiency and reduces CO_2 emissions by 14 percent, while reducing the operational noise footprint by 40 percent.

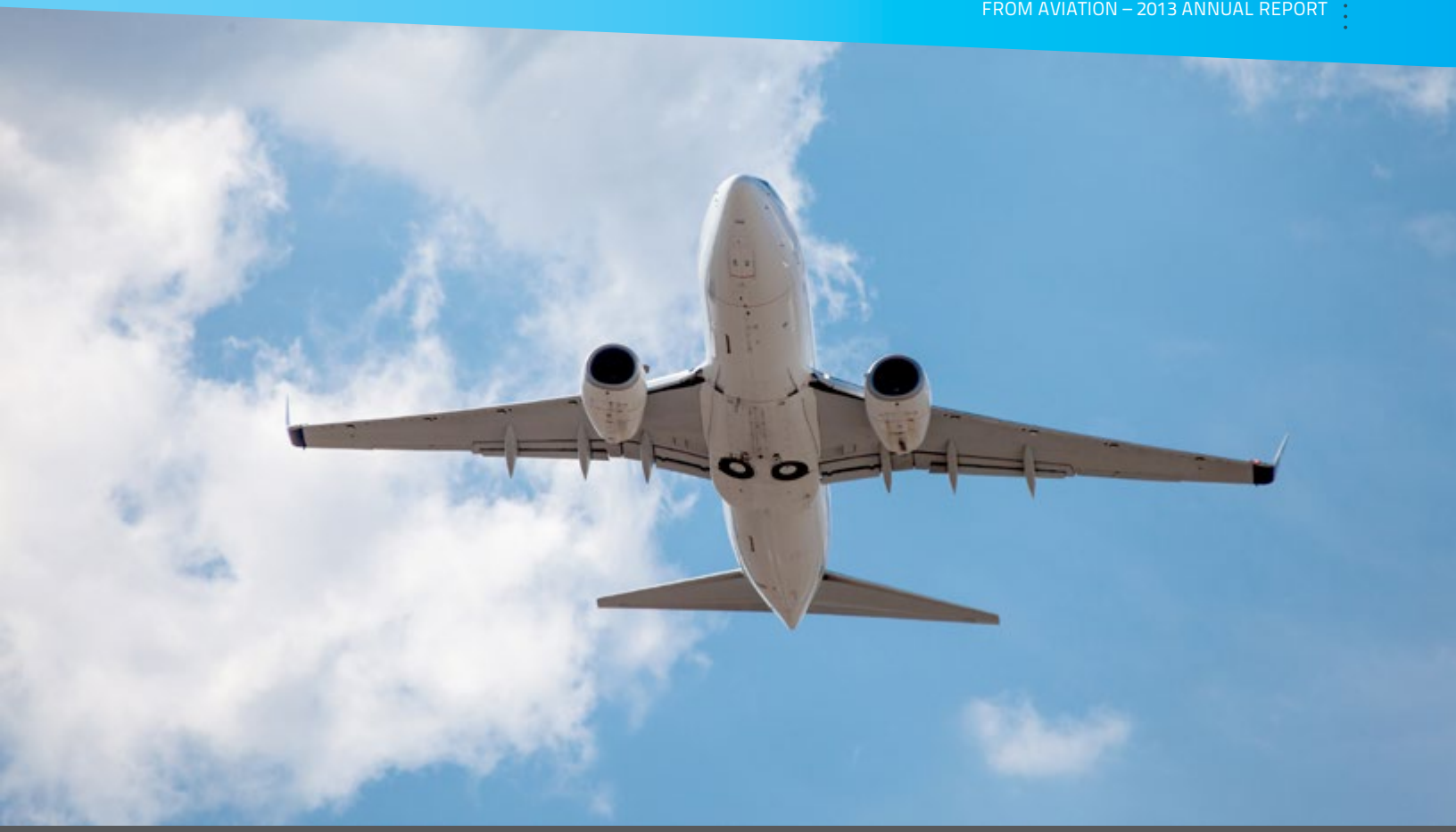
The 737 MAX incorporates the latest technology LEAP-1B engines from CFM International with other advancements including Advanced Technology winglets and should deliver high efficiency, reliability and passenger comfort. These aircraft will enter into Air Canada and WestJet service over the next decade, beginning in 2017.

The figures presented in Tables 1, 2 and 3 allow for the following summary of trends:

- In 2013, reported RPK rose by 1.5 percent, a minor change when compared to the increases in 2011 (9.7 percent) and 2012 (5.3 percent) when passenger traffic was rebounding strongly from effects of the international economic recession. Between 2005 and 2013, RPK grew by 43.4 percent.
- While changes in NACC and ATAC carrier reporting make it difficult to compare reported trends in cargo, the figures suggest there was an increase in total RTK of 1.8 percent from 2012 to 2013, and an increase of 41.8 percent between 2005 and 2013.
- A total of 6.31 billion litres of fuel was used in 2013, 0.9 percent greater than in 2012.
- Greenhouse gas emissions from 2012 to 2013 also increased by 0.9 percent, to 16.14 Mt of CO_2e.
- Greenhouse gas emissions per RTK improved by the same proportions as those for litres per RTK in 2013 compared to 2012 and 2005 (0.9 percent and 8.9 percent, respectively).

Figure 2 shows the target trajectory from 2005 to 2020 of a 2 percent annual improvement in fuel efficiency and the progress made between 2005 and 2013. It also adds an indicative trajectory that would be required to meet the 2020 goal from the actual 2013 level.

FIGURE 2 **Target Trajectory, 2005 – 2020**



Performance-Based Navigation

Performance-Based Navigation (PBN) is a broad range of technologies that enable aircraft to fly any desired flight path using onboard equipment and procedures. It reduces the need to fly exclusively to and from individual sensor-based navigational aids on the ground. This increases the flexibility of point-to-point flights and will enable more efficient operations in the air and on the ground, reducing fuel burn and associated greenhouse gas emissions.

Transport Canada and NAV CANADA have formed the Canadian Performance-based Aviation Action Team (CPAAT) to help implement performance-based operations in Canadian airspace that include all aspects of Communications, Navigation, Surveillance/Air Traffic Management. These operations will aim to meet the short-, medium- and long-term timeline goals of Transport Canada and NAV CANADA identified in their documents such as the PBN Concept of Operations, the Air Navigation System Plan, and the Operations Business Plan. The CPAAT will provide a multi-disciplinary forum for the regulator, service provider, users and manufacturers.

In 2013, many changes set the stage for the implementation of PBN in 2014 and in the years to follow. Transport Canada's approval of new design criteria allowed NAV CANADA to begin stakeholder consultations at four of Canada's busiest airports that should result in more efficient approach and landing paths. In particular, stakeholder consultations will be required to address noise and other community concerns associated with PBN implementation.

FIGURE 3 Impact of Fuel Efficiency Improvement since 2005 on Greenhouse Gas Emissions

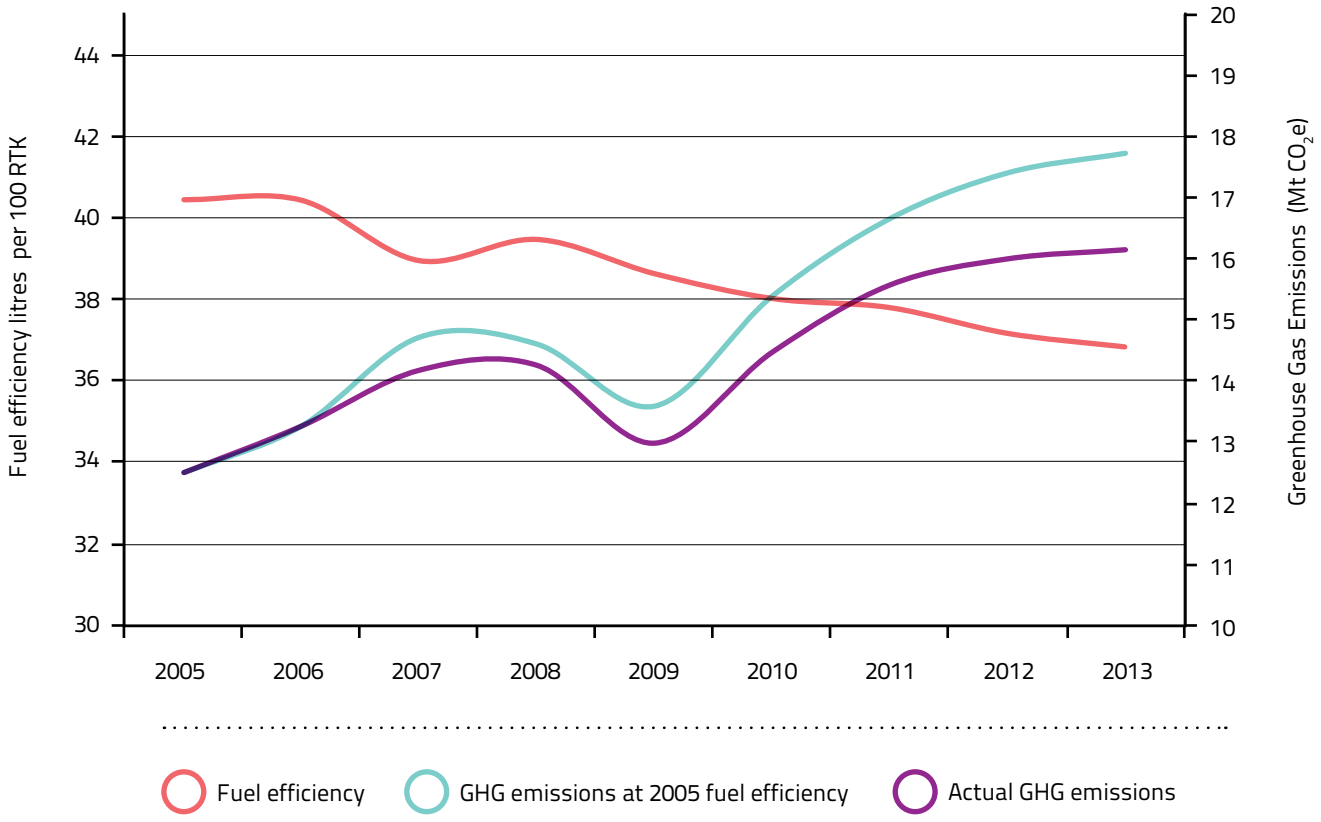


Figure 3 provides an illustration of how much greater greenhouse gas emissions would have been between 2005 and 2013 if fuel efficiency had remained at 2005 levels of 40.43 litres of fuel per 100 RTK. Total greenhouse gas emissions in 2013 would have reached 17.72 Mt at the 2005 rate, whereas actual 2013 emissions were 8.9 percent lower, at 16.14 Mt.

Reporting on Section 5.0 Measures

Section 5.0 of *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* identifies measures that represent the greatest opportunities to reduce greenhouse gas emissions and help improve average annual fuel efficiency by 2 percent between 2005 and 2020. The following table summarizes the results achieved and the status of each measure.

Summary Table of Section 5.0 Measures

Measure	Results	Status
5.1 Fleet Renewals and Upgrades		
Canadian air carriers expect to achieve an annual fuel efficiency improvement of 0.7 percent for both domestic and international flights between 2005 and 2020 through further fleet changes.	During 2013, NACC member airlines made the following changes to their aircraft fleets: ▪ Jazz Aviation removed 8 CRJ100 Canadair Regional Jets from service and introduced 6 Q400 Bombardier aircraft. ▪ WestJet introduced 5 Boeing 737-800 NG aircraft. The launch of Encore introduced 8 Q400 Bombardier aircraft into service. ▪ Air Canada introduced 4 Boeing 777-300 aircraft into service and removed 1 Boeing 767-300 aircraft from service. ▪ Air Transat removed 3 Airbus A310 aircraft from service. In August 2013, WestJet entered into a letter of intent to purchase 65 737 MAX aircraft from Boeing. The order includes: ▪ 40 737 MAX 8 and 25 737 MAX 7 aircraft - an investment of approximately US$6.3 billion. The deliveries are scheduled to take place between 2017 and 2027. ▪ 50 additional aircraft and 15 existing 737 NG deliveries that have been converted to MAX type. The 737 MAX aircraft will be equipped with CFM International LEAP-1B engines, which should reduce fuel burn and CO_2 emissions by 14 percent as compared with the most fuel-efficient single-aisle aircraft currently available.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
	In 2013, Air Canada finalized its purchase order for 61 Boeing 737 MAX aircraft, the manufacturer's newest narrow-body aircraft - an investment of approximately US$6.5 billion. This completes the first phase of the carrier's narrow-body fleet renewal plan. The aircraft will enter into service over the next decade with deliveries scheduled to begin in 2017 and completed in 2021. The carrier expects the new aircraft to yield a 10 percent reduction in costs per seat as a result of lower fuel and maintenance expenses. ATAC air carriers that operate highly efficient aircraft such as B737-800 and Bombardier Q400 continue to use and/or grow their fleets with these types of aircraft. Operators of B737-200 aircraft have begun to replace these classic versions with B737-300/400/500 series aircraft with more efficient CFM56 engines. Cargo air carriers continue to upgrade from narrow body B727 to larger, more fuel efficient aircraft with high bypass ratio engines such as B757 and B767 aircraft.	
The Canadian Business Aviation Association (CBAA) will also encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through fleet renewal.	To increase its outreach efforts, in 2013 the CBAA launched "CBAA Matters!", an online forum for its members to increase awareness and provide feedback on activities of interest to Canadian business aviation operators, including Canada's Action Plan. The CBAA continues to encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through fleet renewal and has added this topic and other greenhouse gas emissions reduction topics to CBAA Matters! as a way to give the issues greater visibility to operators.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
5.2 More Efficient Air Operations		
Canadian air carriers expect to achieve an average annual fuel efficiency improvement of 0.2 percent for combined domestic and international flights between 2005 and 2020 through improved operations.	All ATAC and NACC carrier members continued to re-emphasize the use of fuel saving operating procedures. Carriers continue to look for additional opportunities to reduce fuel burn. For example, Air Transat: ▪ Introduced a paperless cockpit with electronic flight bags on all of their aircraft. This has resulted in a weight reduction of 27 kg (60 lbs) per aircraft and associated fuel savings. ▪ Began using reduced landing flap as standard operational procedure, which saves fuel during approach and landing. ▪ Reconfigured all aircraft cabins with new, lighter seats which resulted in a weight saving of approximately 1-2 tonnes per aircraft and associated fuel savings.	
The CBAA will encourage its members to continue to adopt operational improvements to reduce emissions.	The CBAA continues to encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through operational improvements. It has added this topic and other greenhouse gas emissions reduction topics to CBAA Matters! as a way to give the issues greater visibility to operators.	
Transport Canada will continue to work through ICAO to help provide guidance, and encourage technological and operational improvements, including updating ICAO Circular 303.	Transport Canada participated in updating ICAO Circular 303 into a new ICAO manual, which was completed in 2012 and will become available online in 2014.	
NACC, ATAC and CBAA will encourage their members to continue to take advantage of the opportunities presented in the new ICAO manual.	The input for the updated manual was built upon NACC and ATAC carriers' policies and procedures. The final draft was circulated to NACC, ATAC and CBAA who will promote it to their members once it becomes available online.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
5.3 Improved Capabilities in Air Traffic Management		
Performance – based Navigation (PBN) - Building on existing PBN activities, the Action Plan identified that the average annual fuel efficiency could improve by 1 to 2 percent between 2005 and 2020 through further implementation of PBN. The benefits resulting from PBN will depend on collaboration between Transport Canada and the Canadian aviation industry, particularly NAV CANADA.		
Approval by Transport Canada for use of the United States (US) Federal Aviation Administration (FAA) Order 8260.54A and 8260.52 instrument procedure.	Transport Canada approved the US FAA Orders 8260.54A in December 2011. Transport Canada approved the use of the US FAA Order 8260.58 (which consolidates 8260.54A and 8260.52) in October, 2013.	
Approval of guidance by Transport Canada for Operations Specifications in support of the use of the US FAA Order 8260.52 criteria.	Final publication of the Advisory Circular for use of procedures based on the US FAA Order 8260.52 was completed on March 31, 2013. Additional Advisory Circulars for new PBN navigation specification were also published: Required Navigation Performance Authorization Required Approach in March, 2013; Radius-to-fix legs in September, 2013 and Required Navigation Performance 1 (RNP 1) in October, 2013. NACC carriers continued to work on Canadian Required Navigation Approach Authorization Required (RNP AR) approval in 2013.	
The Canadian Aviation Regulation Advisory Council (CARAC) to identify short-, medium-, and long-term opportunities for adopting PBN.	The CARAC PBN Working Group identified short- and medium-term solutions in its Final Report, which was completed October 2, 2013, and presented to CARAC at the end of October, 2013. Discussions within Transport Canada's Civil Aviation are underway on proceeding with these solutions. The Working Group will transition to a standing working group that will address: ▪ long-term solutions identified by the Working Group; and ▪ NAV CANADA's Concept of Operations for the implementation of PBN in Canada.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
Transport Canada, NAV CANADA, and Canada's aviation industry to jointly develop and put in place an ICAO State PBN Implementation Plan.	To facilitate the ICAO State PBN Implementation Plan, Transport Canada committed to develop a PBN policy statement by spring 2012. This statement will be developed in consultation with Transport Canada and NAV CANADA experts and completed by summer 2014.	
Surveillance – Increased surveillance capability and coverage will present opportunities for more efficient air operations. The Action Plan includes a NAV CANADA commitment to continue to use technologies to increase surveillance capability and coverage, both airborne and on the ground, which will result in more efficient air operations.	NAV CANADA has identified both short- and medium-term opportunities to improve surveillance. The best short-term opportunity is to broaden the current air traffic participation rates in existing Automatic Dependent Surveillance-Broadcast (ADS-B) coverage volumes. Transport Canada authorized a new NAV CANADA ADS-B exemption that removes the requirement for NAV CANADA customers to have the ADS-B Operations Specification before providing surveillance services. This exemption enables NAV CANADA to provide surveillance services to all of the aircraft that transmit ADS-B data. This is almost 90 percent of our existing traffic in the affected area versus the current close to 50 percent that have the exemption. Medium- and longer-term opportunities could result from: ▪ applying space-based ADS-B; ▪ expanding existing ground-based ADS-B service volume; and ▪ expanding ADS-B surveillance application from high-level en route to low-level en route and terminal use.	
Improved Air Traffic Management in Targeted Corridors (new measure) – In 2007, NAV CANADA launched the Windsor-Toronto-Montreal (WTM) Airspace and Services Review, which aimed to enhance the efficiency of aircraft operations by optimizing airspace design, particularly for instrument flight rules and visual flight rules aircraft within the WTM corridor, while maintaining safety.	NAV CANADA implemented changes to the Toronto Flight Information Region (FIR) infrastructure in 2012 that focused on improving the efficiency of the airspace by harnessing the potential of area navigation (RNAV). Throughout 2013, the Toronto FIR continued to work with customers and stakeholders to bring similar enhancements to the remainder of the FIR. The final phases of this project required significant changes to routes that cross the boundary between Canada and the US. The flexibility of RNAV permits routes to be designed safely in the most efficient manner, reducing fuel burn and greenhouse emissions for arrivals, departures as well as overflights operating through the Toronto FIR.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

Reporting on Section 6.0 Measures

The *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* contains other measures with expected results not expressed in quantitative terms due to the nature of the activity or their current stage of implementation. Such measures will be essential to achieving the long-term aspirational goals.

Summary Table of Section 6.0 Measures

Measure	Results	Status
6.1 Aviation Environmental Research and Development		
Significant research efforts are underway to minimize or reduce aviation's environmental impacts and to inform the development of future regulations. This research provides valuable information on how best to address these environmental impacts. This research is being directed primarily through four areas.		
The Green Aviation Research & Development Network (GARDN) will continue to undertake research and development of technologies that will help reduce greenhouse gas emissions.	GARDN has selected and financially supported 17 projects, totalling almost $35 million in research (over half of the projects deal specifically with emissions reductions). The projects have developed over 35 technologies from 270 researchers who have produced more than 50 publications, developed 12 potential licences or patents and trained 51 students in Canada. GARDN has signed agreements with the Air Transport Action Group (ATAG) and is the Canadian representative for the Civil Aviation sector in the Canada-China Science and Technology Agreement.	

Measure	Results	Status
Canada will continue its support of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) to advance research in such areas as emissions; operations; alternative fuels; tools; system-level and policy assessment; and noise.	The PARTNER Center of Excellence (COE) held its final advisory board meeting in the fall of 2013. In September 2013, the US FAA announced a new 10-year, $40 million dollar COE called the Aviation Sustainability Center (ASCENT). This new COE will focus on alternative aviation jet fuels as well as aircraft noise and other environmental issues. Transport Canada will sponsor ASCENT and maintain an active role on the Advisory Board reviewing research projects and progress. Transport Canada continued to provide direct support to five projects under PARTNER: 1. Health Impacts of Aviation-Related Air Pollutants (Project 11); 2. Emissions Atmospheric Impacts (Project 12); 3. Investigation of Aviation Emissions Air Quality Impacts (Project 16); 4. Metrics for an Aviation CO_2 Standard (Project 30); and 5. Non-volatile Particulate Matter – SAE E31 Aerospace Recommended Practice research issues (Project 37).	
The National Research Council (NRC) will continue to work on a number of projects that provide scientific support to inform regulatory decisions in Canada and will continue its program on developing and evaluating alternative fuels.	The NRC has conducted a number of critical safety and emissions tests on aviation biofuels. With financial support from the Government of Canada's Clean Transportation Initiative and GARDN in 2012, the NRC conducted the world's first test flight of a 100 percent, unblended, renewable jet fuel that met petroleum jet fuel specifications. In conducting this test, the NRC was also able to obtain valuable in-flight emissions data. The NRC participated on a number of international sampling campaigns in 2013 to measure non-volatile particulate matter (nvPM), or black carbon emissions from aircraft engines. One campaign has the validation of the North American Mobile Reference Sampling System as its objective.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
	The NRC, with support from Transport Canada, is collaborating with an international team, the SAE E-31 Aircraft Exhaust Emissions Measurement Committee, to develop a recommended practice, which will lead to a new certification requirement for nvPM emissions from gas turbine engines. The draft Aerospace Recommended Practice is expected to be completed by early 2015.	
Transport Canada and the Canadian Airport Council (CAC) will continue to support and participate in the US Transportation Research Board's Airport Cooperative Research Program (ACRP) in a number of key environmental research areas.	Transport Canada and the CAC continue to support and participate in ACRP and to share relevant information with Canadian airports. In 2013, ACRP released a number of items of interest to Canadian airports including: ▪ Report 84: Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans; and, ▪ Report 86: Environmental Optimization of Aircraft Departures: Fuel Burn, Emissions, and Noise.	
6.2 Alternative Fuels		
The Government of Canada and the Canadian aviation industry will work together to advance research and demonstration efforts related to alternative fuels for aviation.		
The Government of Canada will continue to support research, development, and demonstration of alternative fuels for aviation through ongoing federal research and development efforts.	Since 2010, Sustainable Development Technology Canada (SDTC) has provided over $9 million to two ongoing alternative aviation fuel projects that are in the demonstration phase: ▪ $2.5 million to Agrisoma Biosciences Inc. for a Brassica carinata-based biofuel project; and ▪ $6.7 million to MARA Renewables Corporation for an algae-based biofuel project. In 2013, there were no new alternative jet fuel projects funded under the SDTC, the Program of Energy Research and Development, or the ecoEnergy Innovation Initiative.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
Canada will pursue opportunities to collaborate with its key trading partners, particularly the US, on alternative aviation fuel research and development and certification, and explore issues such as commercial production. For example, the ongoing Canada-US Clean Energy Dialogue includes next generation biofuels as a priority research and development area.	Transport Canada maintains a dialogue with the US FAA to exchange information on biofuels development. Transport Canada and the Canadian aviation industry engage with the US "Commercial Aviation Alternative Fuels Initiative," which provides information on how to assess the "sustainability" of aviation biofuels. Transport Canada has actively supported the US FAA in the establishment of a new COE dedicated to the advancement of alternative jet fuel research.	
The Government of Canada and the Canadian aviation industry will discuss the potential for, benefits of, and barriers to alternative aviation fuel production and use in Canada.	Government of Canada and Canadian aviation industry officials continue discussions on potential next steps.	
6.3 Airport Ground Operations and Infrastructure Use		
The Action Plan commits to reducing greenhouse gas emissions from airport ground operations and infrastructure use, primarily through the three initiatives.		
Air carriers and airports continue to work together to reduce emissions from Auxiliary Power Units (APU) and Ground Support Equipment (GSE).	In 2013, the APU/GSE Subgroup continued to share information on current emission reduction initiatives and developed a list of potential projects the group could undertake over the coming years. A list of existing equipment, such as APUs, GSE, and existing pre-conditioned air (PCA) equipment at gates was developed for the 2013 calendar year. A number of emission reduction initiatives are advancing at Canadian airports. Examples include: ▪ Deploying PCA BoomAir at Montreal airport. ▪ Jazz Aviation and Air Canada tracking GSE with GPS at Toronto, Montreal and Halifax airports.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
The Canadian aviation industry (airports, air operators, and NAV CANADA) will continue to work together to reduce airport aircraft ground emissions through improved taxiing and queuing procedures. The Canadian aviation industry will also work to reduce taxi times associated with de-icing procedures.	Multilateration systems make it possible to see all airport ground movement. Initially adopted for safety reasons, these systems can promote efficiencies and reduce emissions. Such systems were introduced in Montreal in 2012 and Toronto in 2013. Full implementation will occur in Calgary in 2014 and in Vancouver in 2015. The ability to monitor taxi times helps manage and reduce aircraft operating times and emissions. A cost-sharing agreement between NAV CANADA and the Toronto Airport uses a program called EXCDS to produce taxi times. Toronto and Montreal Airports are using this tool to develop average baselines for taxi times and it may be used at the Calgary airport as well. Initial implementation of Airport Collaborative Decision Making has been aimed at Ground Delay Program Enhancements at Toronto and Montreal airports. A new Air Traffic Management Working Group (core members are the Greater Toronto Airports Authority (GTAA), NAV CANADA, Airlines and the GTAA Central De-icing Facility) will begin meeting in Toronto in 2014. Its mandate is to extend the existing Airline/NAV CANADA working partnership on greenhouse gas reduction activities to aircraft movements from gate-to-gate. This will improve performance and reduce emissions by: balancing and improving runway use, and arrival and departure flows (holding and taxi times).	
CAC and Transport Canada will continue to refine and improve the data quality of the Airport Greenhouse Gas Emission Inventories and will explore opportunities to adopt emission reduction strategies.	Transport Canada recently collected Scope 1 and 2 (i.e., emissions directly associated with the airport activity) emissions data from all 26 National Airport System airports using the Airport Carbon and Emissions Reporting Tool. Transport Canada continues to work with Canadian airports to develop air quality reports using the Transport Canada Mobile Air Quality Laboratory. Joint studies recently took place at Regina International Airport, Edmonton International Airport and are currently in progress at Kelowna International Airport.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
6.4 Regulatory Measures		
Transport Canada is actively participating at ICAO on the development of the CO_2 standard.	While the schedule for completing the new international standard was revised due to its complexity, development is on-track for the 2016 timeline.	
Transport Canada is actively participating at ICAO on the development of the nvPM standard.	The completion of the new international standard is on-track for 2016.	
6.5 International Coordination		
Transport Canada continues to participate in ICAO's work to address greenhouse gas emissions.	In 2013, Canada actively participated in the High-level Group on Climate Change and in the 38th Assembly of ICAO, which adopted a Resolution on Climate Change. Canada continues to actively participate in ICAO's Committee on Aviation and Environmental Protection (CAEP), to develop the new CO_2 standard for aeroplanes and the new particulate matter standard for aircraft engines. Canada is also a member of CAEP's Market-based Measure Technical Task Force that is assessing two specific technical elements of market-based measures for aviation. Transport Canada and NAV CANADA are supporting ICAO efforts to estimate environmental benefits associated with the ICAO Aviation System Block Upgrades initiative. In particular, this includes anything related to ground-based and space-based ADS-B. NAV CANADA has significant experience in both using ADS-B and estimating the associated environmental benefits.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

Measure	Results	Status
	Transport Canada, as the Task Group lead, and the CAC are also supporting ICAO's CAEP Working Group 2 – Operations. Transport Canada will lead the update to the Airport Planning Manual, Part 2. The update will include adding eco-friendly airport planning information as well as best practices in land-use planning and management. Once completed, the manual will provide ICAO Member States with guidance and recommendations on airport planning. The update is scheduled for completion at the end of 2015.	
As the Canadian member of the International Coordinating Council of Aerospace Industries Associations (ICCAIA), the Aerospace Industries Association of Canada (AIAC) will strive to lead Canadian aerospace manufacturers in working directly with its international counterparts and through the ICAO CAEP process in developing and producing aircraft and engines that meet or exceed ICAO required improvements.	AIAC member companies continue to provide subject matter experts to advise ICAO's CAEP; and AIAC provides the link to the international community through its membership in ICCAIA. The AIAC also plays a key leadership role by chairing and facilitating the work of GARDN, which includes international coordination. Since it was formed, GARDN has signed agreements with ATAG, the Advisory Council for Aeronautics Research in Europe, and Canadian Composites Manufacturing R&D Inc. AIAC is also the Canadian representative for the Civil Aviation sector in the context of the Canada-China Science and Technology Agreement.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

CONCLUSIONS

Summary of Results

Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation set a target of an average annual improvement in fuel efficiency (measured in litres of fuel per RTK) of at least 2 percent per year until 2020 from a 2005 baseline of 40.43 litres of fuel per 100 RTK.

Aviation activity and associated fuel use data for 2013 provided by members of ATAC and NACC, demonstrate continued progress towards meeting this ambitious target.

Since 2010, the demand for aviation services has continued to grow. Combined revenue passenger and cargo operations increased by 1.8 percent in 2013, compared with 2012. Canadian air carriers used 6.31 billion litres of fuel, a 0.9 percent increase compared with 2012. Consequently, total greenhouse gas emissions also increased by 0.9 percent to 16.14 Mt in 2013, compared with 2012.

Despite the increased demand for aviation services in 2013, the overall rate of fuel consumption (i.e., litres per RTK) declined by 0.9 percent, compared with 2012. The combined domestic and international fuel consumption rate reported for 2013 was 36.83 litres per 100 RTK (combining both passenger and cargo traffic). This translates to an average reduction in fuel consumption per RTK of 1.2 percent per year between 2005 and 2013, and a cumulative improvement of 8.9 percent.

2014 Look Ahead

While Canada made progress in many areas in 2013, important milestones were also advanced in 2014. These milestones will be addressed in more detail in the 2014 Annual Report, which is scheduled to be released by December 31, 2015. The 2014 Annual Report will include information about:

- Updates on NACC carrier fleet renewal and upgrade plans. For example, in 2014:
  - WestJet will sell 10 of their oldest 737-700NG aircraft, 5 each in 2014 and 2015 and will replace them with new 737-800 aircraft.
  - Air Canada will continue its narrow-body fleet renewal plan and could expand its order to as many as 109 Boeing 737 MAX aircraft as it replaces 87 older Airbus and up to 45 Embraer aircraft.
- The 2014 release of the approved NAV CANADA PBN Operations Plan. This Plan will establish PBN high level strategic goals in which implementation will be linked to ATM and customer adoption of new technologies subdivided into short-term (2014 to 2016), near-term (2017 to 2021) and long-term (2022+) segments.
- The Canadian Performance-Based Aviation Action Team. This multidisciplinary forum for the regulator, service provider, operators and manufacturers, will begin work to help implement PBN operations in Canadian airspace.
- The continued implementation of PBN in Canada, including;
  - The first RNP AR approaches which should be published in Calgary in 2015;

- Approval of Operations Specification (Ops Spec) applications to allow operators to conduct the approaches and realize associated fuel savings, including approval of Air Canada's Ops Spec application in June 2014.

- The ongoing implementation of the Windsor-Toronto-Montreal Airspace and Services Review, which is forecast to achieve an additional reduction of 100,000 tonnes CO_2e by 2020.
- Cooperation with the US FAA that will create a PBN route structure using RNAV Standard Instrument Departure, RNAV Standard Terminal Arrival Route, and 'Q' and 'T' routes that will take effect in 2014/2015. The new route structure will permit the deletion of the 'Jet' airway infrastructure in Southern Ontario in favour of RNAV Q Routes. The flexibility of RNAV allows routes to be designed in the most efficient manner, without being constrained to the locations of ground based navigational aids.
- The new GARDN II program, which will focus on three key words: quiet, clean and sustainable. GARDN will also pursue its participation in other Canadian environmental collaboration initiatives, as well as in the activities of international organizations.
- Transport Canada's efforts to expand collaborations with BioFuelNet Canada on aviation biofuels.
- Canada's continued participation at ICAO, including at a workshop in Mexico in April 2014 on 'Action Plans to Address Emissions from Aviation' where Canada will present on its Action Plan.
- Canada's participation in the new 10-year, $40 million COE called ASCENT that will focus on alternative aviation jet fuels, noise and environmental issues.
- The NAV CANADA led initiative, titled ENGAGE II, will be conducted in partnership with Air France and in conjunction with the United Kingdom's air navigation service provider. This initiative is expected to successfully demonstrate the viability and safety of varying aircraft speeds (Mach) and variable altitudes for flights transiting the unsurveilled airspace over the North Atlantic. The fuel and emissions savings per flight could average between one and two per cent, which translates to a reduction of 200 to 400 litres of fuel and 525 to 1,050 kilograms of greenhouse gas emissions. With close to 400,000 flights crossing the North Atlantic each year, the potential economic and environmental benefits are substantial.

Appendix A: Glossary of Key Terms and Acronyms

Key Aviation Activity Measurements

Revenue Passenger-Kilometres (RPK): is a measure of traffic showing revenue-paying passengers carried, multiplied by distance flown.

Passenger Revenue Tonne-Kilometres (Passenger RTK): is the total tonnes of revenue-paying passengers carried, estimated by converting RPK into weight using the industry's convention of 100 kg (220 lbs) per passenger, multiplied by distance flown.

Cargo Revenue Tonne-Kilometres (Cargo RTK): is the total tonnes of revenue-generating cargo (freight and mail) multiplied by distance flown (reflects actual cargo carried).

Total Revenue Tonne-Kilometres (Total RTK): is the total tonnes of passengers, freight, and mail carried (revenue load) multiplied by distance flown.

Acronyms

ACRP: Airport Cooperative Research Program

ADS-B: Automatic Dependent Surveillance-Broadcast

AIAC: Aerospace Industries Association of Canada

APU: Auxiliary power unit

ASCENT: Aviation Sustainability Centre

ATAC: Air Transport Association of Canada

ATAG: Air Transport Action Group

ATM: Air Traffic Management

CAC: Canadian Airports Council

CAEP: Committee on Aviation and Environmental Protection

CARAC: Canadian Aviation Regulation Advisory Council

CBAA: Canadian Business Aviation Association

CO_2: Carbon dioxide

CO_2e: Carbon dioxide equivalent

COE: Center of Excellence

CPAAT: Canadian Performance Based Aviation Action Team

FAA: Federal Aviation Administration

FIR: Flight Information Region

GARDN: Green Aviation Research & Development Network

GSE: Ground support equipment

GTAA: Greater Toronto Airports Authority

ICAO: International Civil Aviation Organization

ICCAIA : International Coordinating Council of Aerospace Industries Associations

Mt: Megatonnes

NRC: National Research Council

nvPM: Non-volatile particulate matter

PARTNER: Partnership for AiR Transportation Noise and Emissions Reduction

PBN: Performance-based navigation

PCA: Pre-conditioned air

RNAV: Area Navigation

RNP: Required Navigation Performance

RNP AR: RNP Authorization Required

RPK: Revenue Passenger-Kilometres

RTK: Revenue Tonne-Kilometres

SDTC: Sustainable Development Technology Canada

WTM: Windsor-Toronto-Montreal

Appendix B: Calculations and Caveats

The following factors and formulas were applied in preparation of the aggregated report from ATAC and NACC. Note that industry statistics are still maintained in imperial units, including miles and tons, which are converted to International System (SI) units (kilometres and tonnes) for the present report. The emissions factors for all calendar years are the latest factors used by Environment Canada in Canada's National Greenhouse Gas Inventory since 2009.

Aviation Jet Fuel emission factors:
2534 grams CO_2 per litre
2557 grams CO_2e per litre

Conversion miles to kilometres:
1 m = 1.609344 km

Conversion tons to tonnes:
1 ton = 0.907185 tonnes

Formulae for CO_2 equivalents:
CO_2e (grams)/RPK = (Fuel Used x 2557) / (RPM x 1.609344)

CO_2e (grams)/Cargo RTK = (Fuel Used x 2557) / (Cargo RTM x 1.609344 x 0.907185)

CO_2e (grams)/Total RTK = (Fuel Used x 2557) / {(RPM x 1.609344 x 0.907185) + (Cargo RTM x 1.609344 x 0.907185)}

Reports by ATAC and NACC members have been revised from time to time, notably of activity statistics. The consolidated statistics presented in this report include all the latest figures reported by ATAC and NACC carriers, including all such revisions. It should be noted that the statistics are not entirely comparable between years.

The reported annual emission statistics do not account for 100 percent of Canadian aviation operations, and therefore will not be directly comparable to Environment Canada's annual National Greenhouse Gas Emissions Inventory. *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation*, and therefore this report, did not cover private aviation, military and other government operations, or foreign carriers' operations in Canada.

There has been some variability in reporting from year to year, particularly from including more carriers. Coverage in 2013 was slightly improved compared to 2012. Adding carriers does not substantially affect the industry-wide ratios and longer-term trends computed for fuel use and emissions per unit of traffic.

Appendix C: List of Signatories and Air Operator Member Companies Reporting

The members of the Working Group on Aviation Emissions, which developed the Action Plan, are:

- Aerospace Industries Association of Canada;
- Air Transport Association of Canada;
- Canadian Airports Council;
- Canadian Business Aviation Association;
- National Airlines Council of Canada;
- NAV CANADA; and
- Transport Canada.

All four members of NACC contributed 2013 data for this annual report, including:

- Air Canada;[2]
- Air Transat;
- Jazz Aviation LP; and
- WestJet.[3]

The ATAC member carriers who contributed 2013 data for this annual report were:

- Air Georgian;
- Air North;
- Bearskin;
- Canadian North;
- Cargojet;
- EVAS Air;
- First Air;
- Flair;
- Harbour Air;
- Kelowna Flightcraft;
- Nolinor;
- North Cariboo Air;
- Porter Airlines; and
- Sunwing.

2 Air Canada reporting includes data from Rouge and Sky Regional

3 WestJet reporting includes data from Encore

Appendix D: Additional Figures Illustrating Key Trends

FIGURE 4 Fuel Use — International and Domestic, 2013

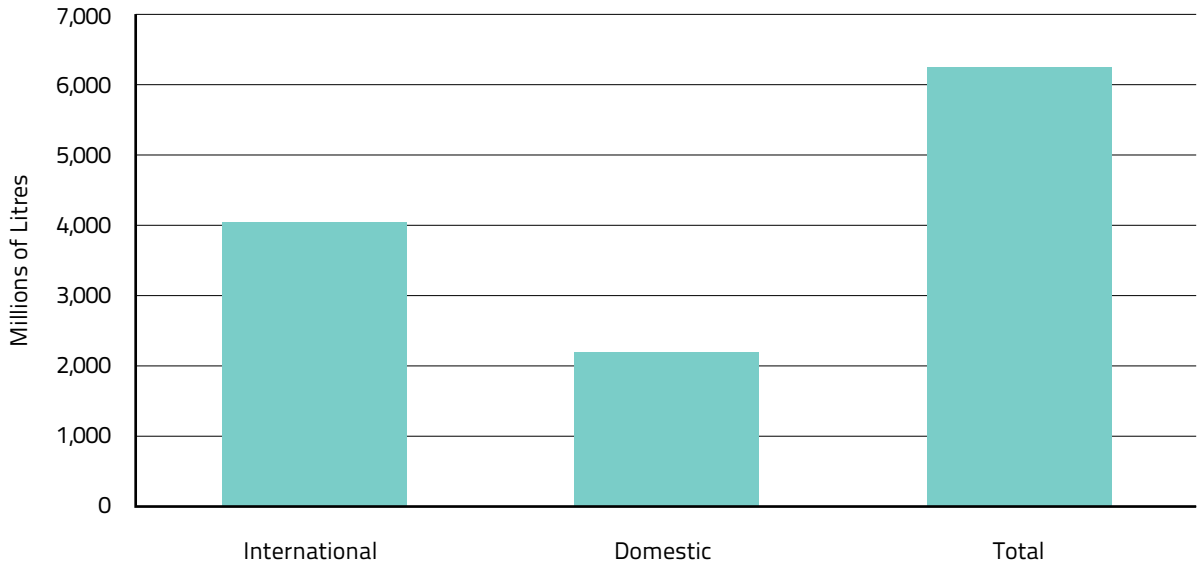


FIGURE 5 Fuel Use, 2005-2013

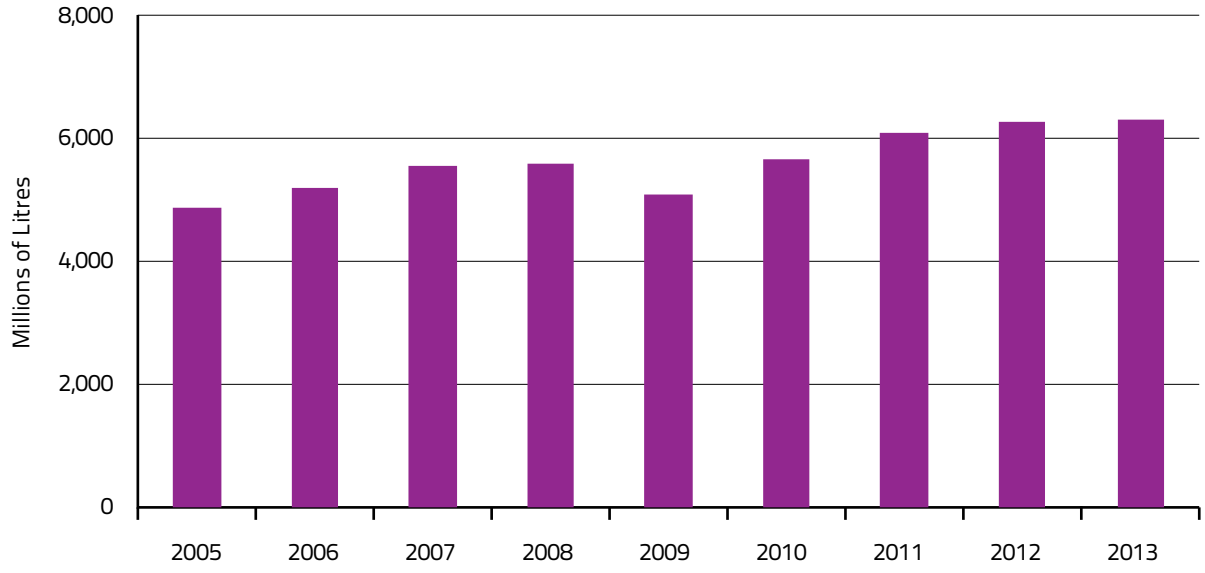


FIGURE 6 Revenue Passenger Kilometres, 2005-2013

FIGURE 7 Cargo Revenue Tonne-Kilometres, 2005-2013

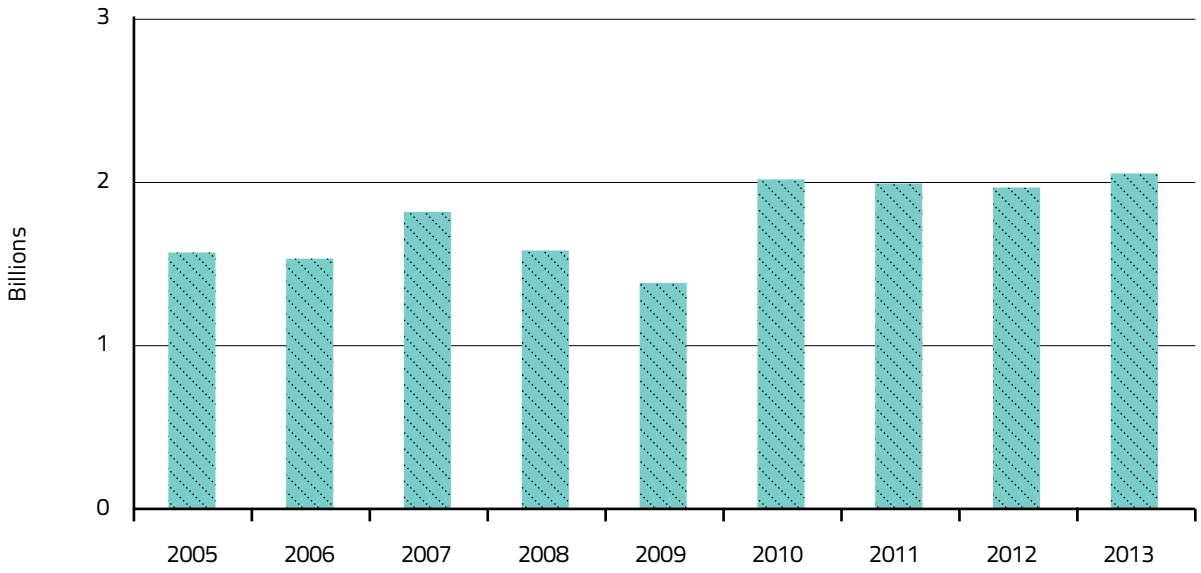


FIGURE 8 Total Passenger and Cargo Tonne-Kilometres, 2005 -2013

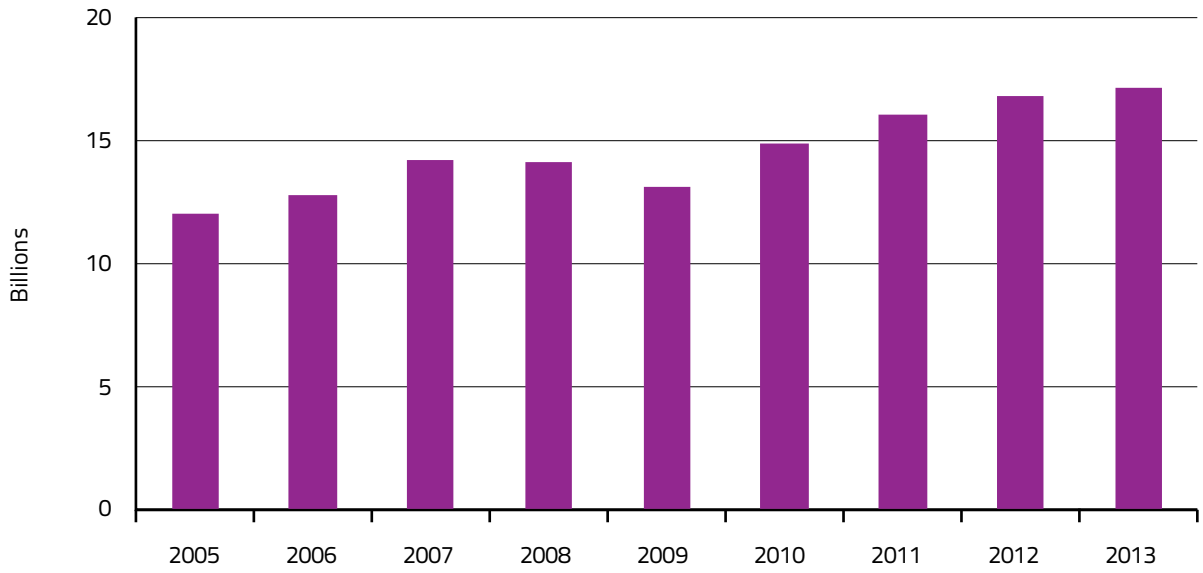


FIGURE 9 Total Passenger and Cargo Tonne-Kilometres — International and Domestic, 2013

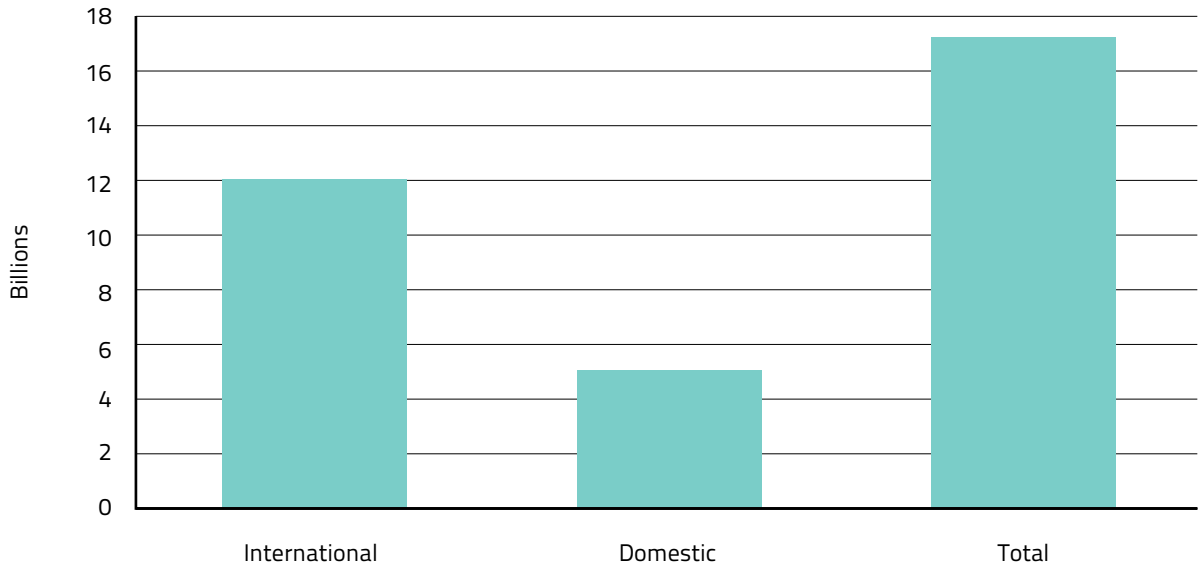


FIGURE 10 Fuel Consumption Rate — Passengers, 2005-2013

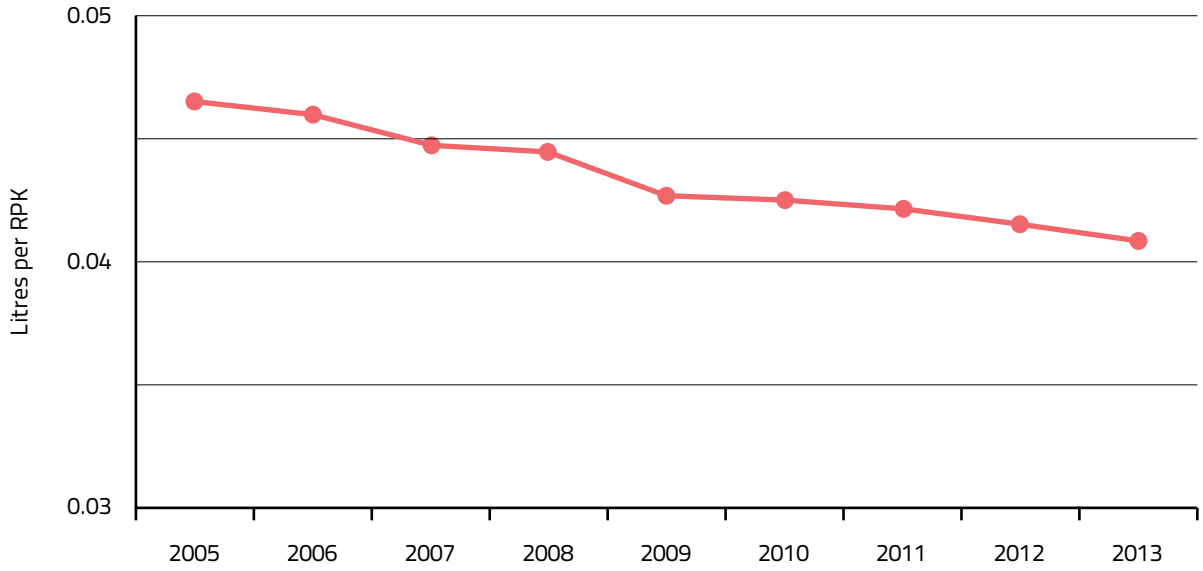


FIGURE 11 Fuel Consumption Rate — Combined Passengers and Cargo, 2005-2013

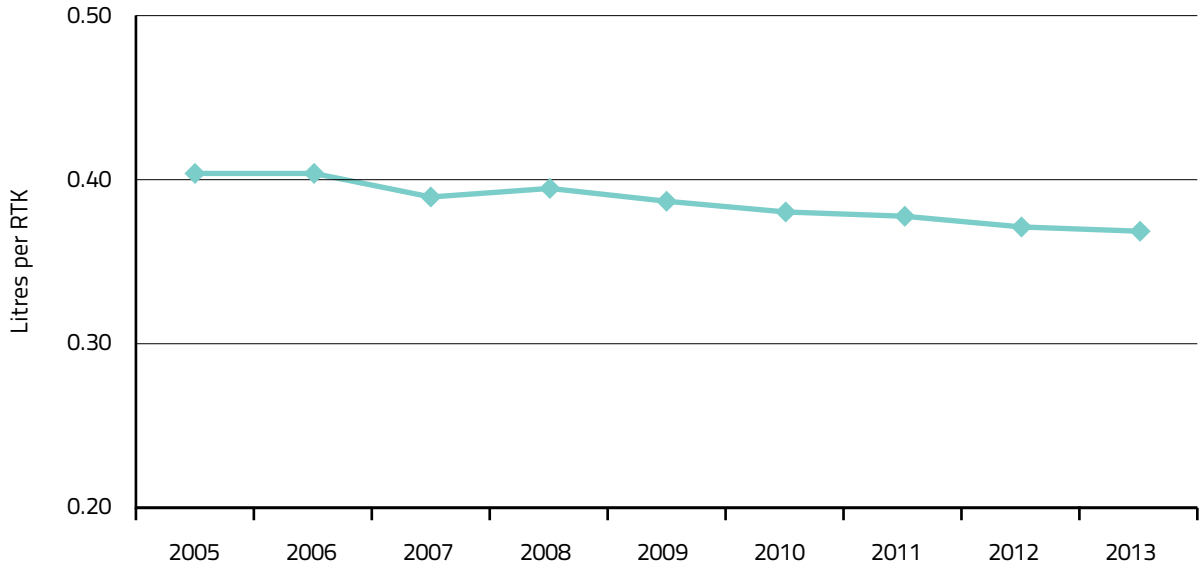


FIGURE 12 Greenhouse Gas Emissions — International and Domestic, 2013

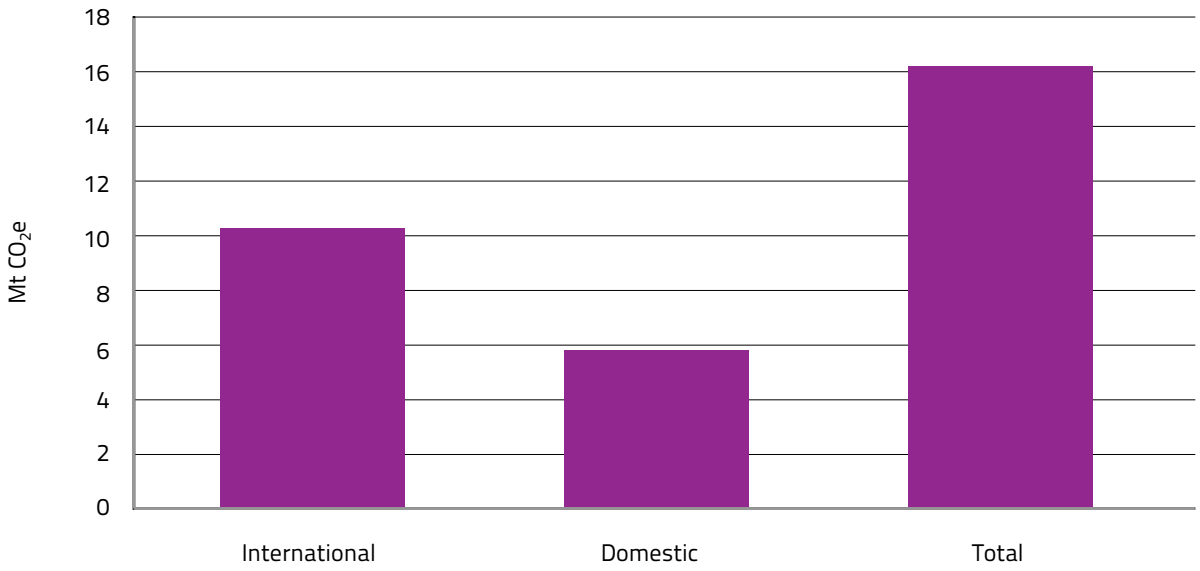


FIGURE 13 Greenhouse Gas Emission Rates — International and Domestic, 2013

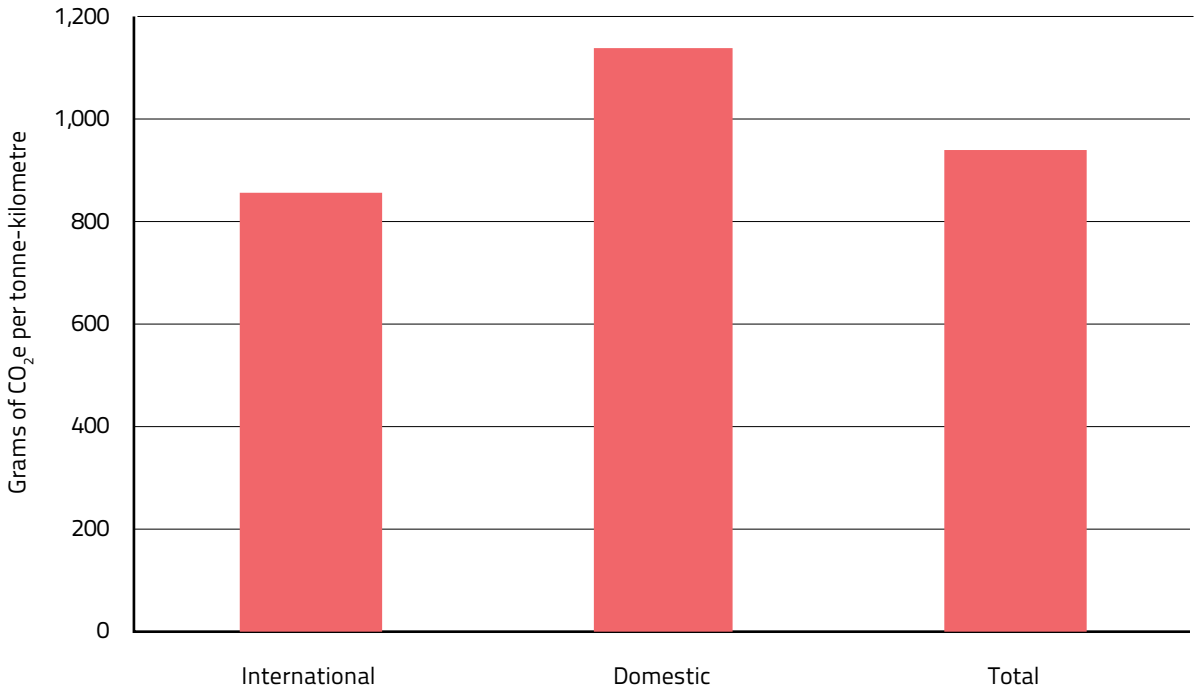


FIGURE 14 Greenhouse Gas Emission Rate — Passengers, 2005-2013

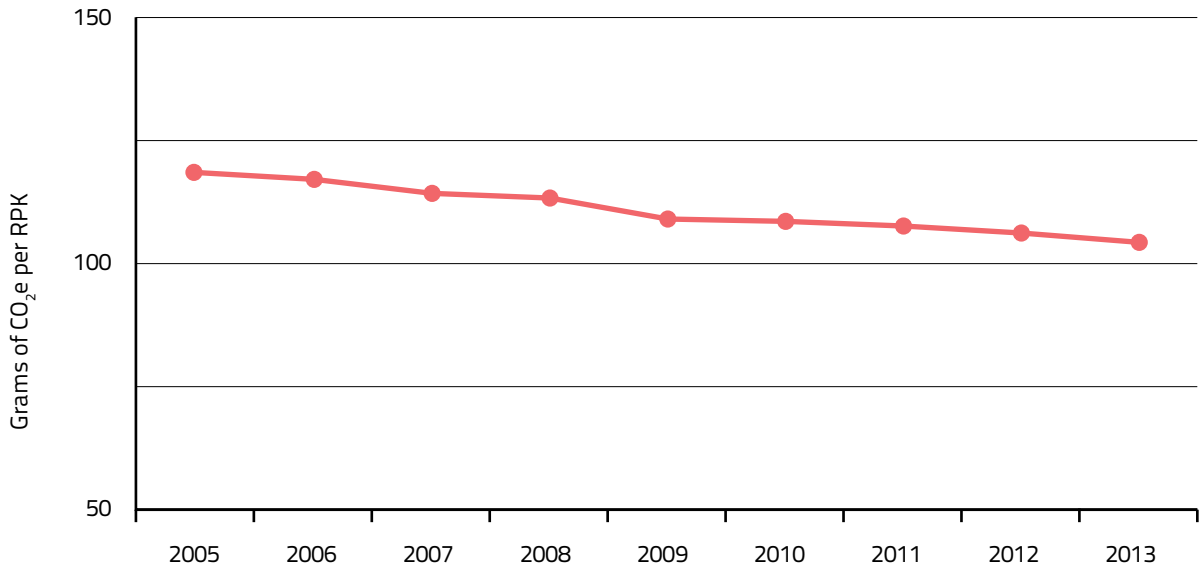


FIGURE 15 Greenhouse Gas Emission Rate — Combined Passenger and Cargo, 2005-2013