CANADA'S ACTION PLAN

to Reduce Greenhouse Gas Emissions from Aviation

2014 ANNUAL REPORT

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EXECUTIVE SUMMARY

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

In 2014, good progress was made towards implementing the Action Plan, including a number of noteworthy achievements related to fleet renewal, improved air traffic management (ATM), international coordination and research and development. Canadian air carriers have collected the necessary data to track fuel efficiency improvements achieved in 2014. The results show that Canadian air carriers continue to improve their annual fuel efficiency. The combined fuel consumption rate in 2014 was 35.74 litres per 100 Revenue Tonne-Kilometres (RTK). The fuel consumption rate for international activity was 32.81 litres per 100 RTK, and for domestic activity was 42.61 litres per 100 RTK. Compared with 2013, Canadian air carriers improved fuel efficiency by 3.0 percent, which represents a 1.4 percent average annual improvement, from a 2005 baseline or a cumulative improvement of 11.6 percent from 2005 to 2014.

Section 5.0 of the Action Plan identifies 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 2014, including Canadian air carriers replacing older aircraft with more efficient aircraft and Canada making greater use of improved air traffic management technologies, including 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 2015 milestones, including: development of a comprehensive Canadian Performance-Based Navigation (PBN) State Plan; continued progress towards deployment of space-based Automatic Dependent Surveillance-Broadcast (ADS-B) technologies; and completion of a review of the Action Plan by the Working Group on Aviation Emissions.

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 third 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 measures that are expected to have the greatest impact in reducing greenhouse gas emissions:

- Fleet Renewals and Upgrades;

- More Efficient Air Operations;

- Improved Capabilities in Air Traffic Management;

- Aviation Environmental Research and Development;

- Alternative Fuels;

- Airport Ground Operations and Infrastructure Use;

- Regulatory Measures; and

- International Coordination.

Highlights for 2014

Canada has made good progress towards 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 2014, including the following noteworthy achievements:

Fleet Renewals and Upgrades

Canadian airlines continue to upgrade their overall fleet operating efficiencies by replacing older generation aircraft with new and more efficient aircraft and engine types. For example, older generation jet equipment has been replaced with the latest technology turbo-jet and turbo-prop aircraft. Such changes are having a positive impact on operating efficiency for both all-passenger and all-cargo type operations.

Air Traffic Management

NAV CANADA released its PBN Operations Plan. The plan established PBN high level strategic goals in which implementation will be linked to ATM and customer adoption of new technologies subdivided into short term (2014-2016), near term (2017-2021) and long term (2022+) segments. The implementation of the PBN plan will be led by the Canadian Performance-based Aviation Action Team (CPAAT) and will include a range of agencies, each with leadership roles in specific projects.

International Coordination

Canada has continued its active engagement at the International Civil Aviation Organization (ICAO). This included participating in the Environmental Advisory Group and its work to develop a market-based measure as well as in the Committee on Aviation and Environmental Protection (CAEP) on work to develop a new CO_2 standard for aeroplanes and a new particulate matter standard for aircraft engines and in CAEP's task forces on alternative fuels and market-based measures. Additionally, Transport Canada has continued active participation on the CAEP Airports and Operations Working Group supporting the work of this group including taking a leadership role on the update to the Airport Planning Manual Part 2.

Research and Development

A number of advances were made with respect to aviation environmental research and development. These include: the five-year renewal of the Green Aviation Research & Development Network; the launch of a new ten-year U.S. FAA Center of Excellence on alternative aviation jet fuel known as the Aviation Sustainability Center (ASCENT), of which Canada is a key supporting partner; and the creation of an Aviation Task Force within BioFuelNet Canada.

The Green Aviation Research & Development Network

The Green Aviation Research & Development Network (GARDN) was established to promote aerospace technologies for the protection of the environment.

Established in 2009, GARDN supported 17 projects totalling $42 million in research; with over half of the projects dealing specifically with emissions reductions. The projects developed over 35 technologies, 10 of which have been advanced to commercialization. These projects were supported by 270 researchers and have resulted in more than 50 scientific publications.

The original GARDN mandate concluded in March 31, 2014. Owing to its successes, GARDN was renewed for an additional 5 years for a total of $24 million in research (funded equally by the federal government and participating aerospace companies). The focus of the new GARDN program is "quiet, clean and sustainable". In 2014, GARDN II announced the launch of seven R&D projects, representing nearly $14 million in funding, including: Greening the Aerospace Supply Chain; Flight Management Performance Optimization II, and Next Generation Combustor for Small Turbine Engines.

Results for 2014

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 2014.[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 2014. 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 2014 (in slightly rounded figures):

- The combined fuel consumption rate was 35.74 litres per 100 RTK, which is an average annual improvement between 2005 and 2014 of 1.4 percent.
- Revenue service was 16.16 billion passenger RTK and 2.25 billion cargo RTK.
- Combined revenue service was 18.41 billion RTK

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, 2005-2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fuel use (million litres)	4,887	5,186	5,543	5,575	5,098	5,659	6,089	6,256	6,314	6,579
Greenhouse gas emissions (megatonnes of CO_2e)	12.619	13.390	14.312	14.396	13.164	14.611	15.721	16.153	16.303	16.987
Traffic (billions)										
Revenue passenger-kilometres (RPK)	105.22	112.98	124.15	125.55	117.62	128.77	141.27	148.74	150.92	161.62
Passenger revenue-tonne-kilometres (pass. RTK) *	10.52	11.30	12.42	12.55	11.76	12.88	14.13	14.87	15.09	16.16
Cargo revenue-tonne-kilometres (cargo RTK)	1.57	1.53	1.82	1.57	1.38	2.01	1.98	1.96	2.05	2.25
Total revenue-tonne-kilometres (RTK)	12.09	12.83	14.23	14.13	13.14	14.88	16.11	16.83	17.14	18.41
Fuel consumption rates										
Litres/RPK	0.0464	0.0459	0.0446	0.0444	0.0433	0.0439	0.0431	0.0421	0.0418	0.0407
Litres/Total RTK	0.4043	0.4043	0.3895	0.3947	0.3879	0.3802	0.3780	0.3716	0.3683	0.3574
Emission rates:										
CO_2e grams/RPK	119.93	118.52	115.28	114.66	111.92	113.47	111.28	108.59	108.03	105.11
CO_2e grams/Total RTK	1,044	1,044	1,006	1,019	1,002	982	976	960	951	923

* 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.

** The CO_2 emission factor and global warming potentials for CH_4 and N_2O were updated in 2013. These changes are documented in Environment Canada's National Inventory Report 1990-2013. All GHG emissions included in this report have been calculated based on these updated factors and potentials.

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 activities include 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 2014.

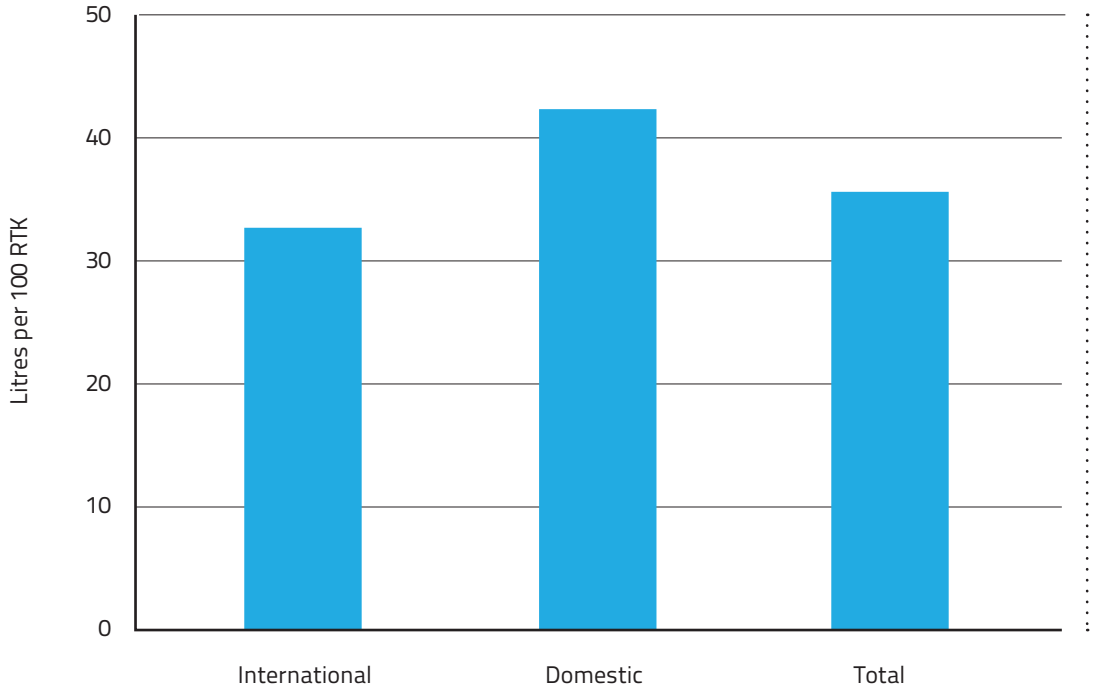
- Separately, the fuel consumption rate for international activity was 32.81 litres per 100 RTK, and 42.61 litres per 100 RTK for domestic activity. (Also illustrated in Figure 1).
- Total fuel consumed amounted to 6.58 billion litres (64.4 percent for international activity and 35.6 percent for domestic activity).
- Total greenhouse gas emissions amounted to an estimated 16.99 megatonnes (Mt) (10.93 Mt for international activity and 6.05 Mt for domestic).

TABLE 2 International vs. Domestic Aviation Activity, 2014

	International	Domestic	Total
Fuel use (million litres)	4,235	2,344	6,579
Greenhouse gas emissions (megatonnes of CO_2e)	10.93	6.05	16.99
Traffic (billions)			
Revenue passenger-kilometres (RPK)	112.1	49.5	161.6
Passenger revenue-tonne-kilometres (pass. RTK)	11.2	5.0	16.2
Cargo revenue-tonne-kilometres (cargo RTK)	1.7	0.6	2.2
Total revenue-tonne-kilometres (RTK)	12.9	5.5	18.4
Fuel consumption rates			
Litres/Total RTK	0.3281	0.4261	0.3574
Emission rates:			
CO_2e grams/Total RTK	847	1100	923

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, 2014



The main Action Plan target indicator is the ratio of fuel consumption to total traffic (litres/total RTK), aiming at improvements of 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 2013 and 2014, and between 2005 and 2014. Fuel efficiency in 2014 improved by 3.0 percent over 2013, and the cumulative improvement between 2005 and 2014 was 11.6 percent, or an annual average of 1.4 percent.

TABLE 3 Absolute and Proportional Changes Over Time, 2005-2014

	Change 2013-2014		Change 2005-2014		
	Absolute	**Proportional**	**Absolute**	**Proportional**	**Annual rate**
Fuel use (million litres)	264	4.2%	1,692	34.6%	3.4%
Greenhouse gas emissions (megatonnes of CO_2e)	0.68	4.2%	4.37	34.6%	3.4%
Traffic (billions)					
Revenue passenger-kilometres (RPK)	10.7	7.1%	56.4	53.6%	4.9%
Passenger revenue-tonne-kilometres (pass. RTK)	1.1	7.1%	5.6	53.6%	4.9%
Cargo revenue-tonne-kilometres (cargo RTK)	0.2	9.5%	0.7	43.4%	4.1%
Total revenue-tonne-kilometres (RTK)	1.3	7.4%	6.3	52.3%	4.8%
Fuel consumption rates					
Litres/RPK	-0.001	-2.7%	-0.006	-12.4%	-1.5%
Litres/Total RTK	-0.011	-3.0%	-0.047	-11.6%	-1.4%
Emission rates					
CO_2e grams/RPK	-2.9	-2.7%	-14.8	-12.4%	-1.5%
CO_2e grams/Total RTK	-28.2	-3.0%	-121.1	-11.6%	-1.4%

The Aviation Sustainability Center

Transport Canada was a co-sponsor of the Partnership for AiR Transportation Noise and Emissions Reduction Centre of Excellence, commonly known as PARTNER, for 10 years (2003-2013) with the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA). Over this period, PARTNER completed aviation environmental research projects worth over $108 million. The knowledge and capability gained from this research provided critical information to government, industry and community decision-makers. It also provided aviation research opportunities for York University and Bombardier.

In September 2013, the FAA awarded $40 million over 10 years to a new Center of Excellence (COE) for Alternative Jet Fuels and the Environment entitled the Aviation Sustainability Center (ASCENT). ASCENT is co-led by Washington State University and the Massachusetts Institute of Technology (MIT) on behalf of the FAA and contributing sponsors.

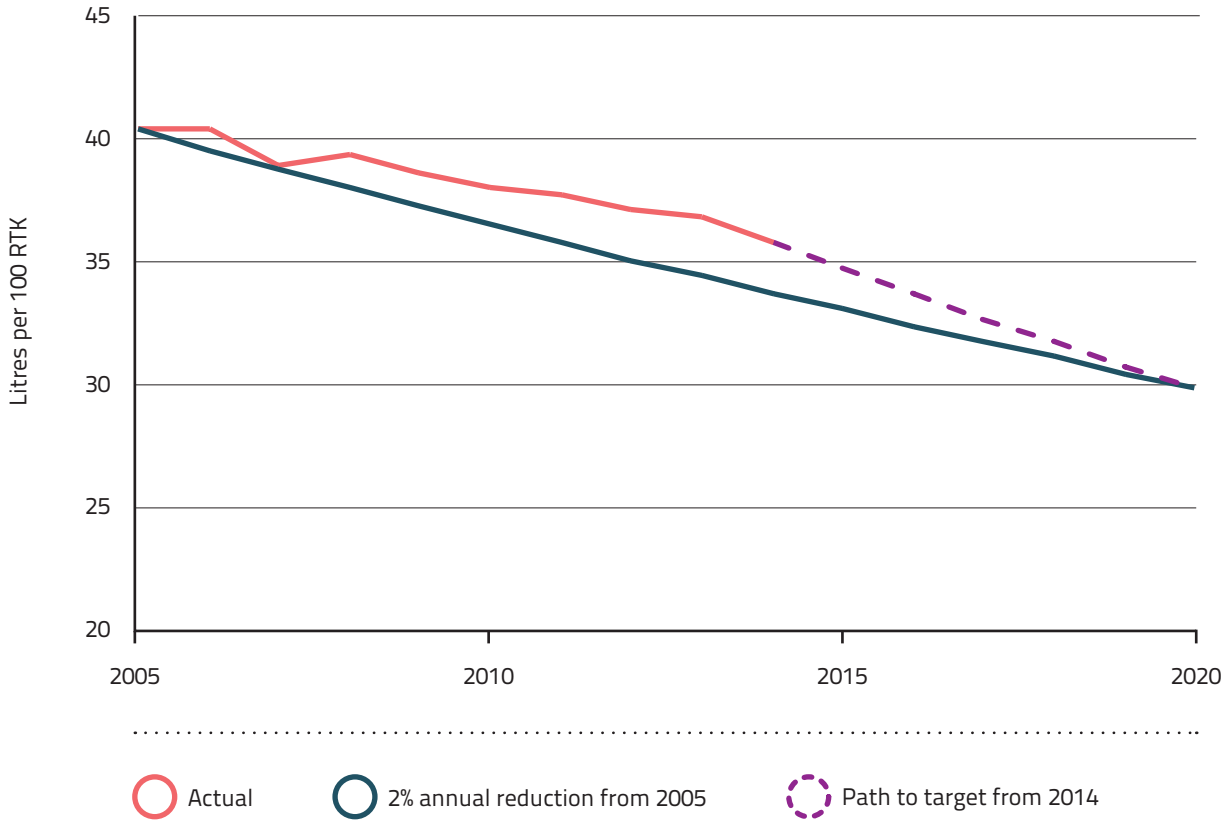
This new COE will replace PARTNER with a renewed focus on environmental goals for noise, air quality, climate change and energy. Some of the areas of study will include new aircraft technologies and sustainable alternative aviation jet fuels.

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

- In 2014, reported RPK rose by 7.1 percent (partially attributed to additional carriers reporting). Between 2005 and 2014, RPK grew by 53.6 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 7.4 percent from 2013 to 2014, and an increase of 52.3 percent between 2005 and 2014.
- A total of 6.58 billion litres of fuel was used in 2014, 4.2 percent greater than in 2013.
- Fuel efficiency in 2014 improved by 3.0 percent over 2013, and the cumulative improvement between 2005 and 2014 was 11.6 percent, or an annual average of 1.4 percent.
- While fuel efficiency improved, greenhouse gas emissions from 2013 to 2014 also increased by 4.2 percent, to 16.99 Mt of CO_2e due to increased traffic.
- Greenhouse gas emissions per RTK improved by the same proportions as those for litres per RTK in 2014 compared to 2013 and 2005 (3.0 percent and 11.6 percent, respectively).

Figure 2 shows the target trajectory from 2005 to 2020 of reductions of 2 percent annual improvement in fuel efficiency and the progress made between 2005 and 2014. It adds an indicative trajectory required that would be required to meet the 2020 goal from the actual 2014 level. Canadian carriers expect to achieve greater emissions reduction as they take delivery of new, more efficient aircraft closer to 2020.

FIGURE 2 Target Trajectory, 2005 – 2020



International Coordination and Cooperation on Air Traffic Management

Canada continues to supports international coordination and cooperation efforts to reduce greenhouse gas emissions from aviation through a number of air traffic management initiatives.

For example, ENGAGE, an efficiency initiative led by NAV CANADA in partnership with other international aviation stakeholders, seeks to demonstrate the viability and safety of aircraft at varying speeds and altitude while transiting the unsurveilled airspace over the North Atlantic (NAT) Ocean. ENGAGE was undertaken as part of the Atlantic Interoperability Initiative to Reduce Emissions Program. Over 200 flight trials were conducted with partners and the achieved fuel and emissions savings per trial averaged one to two percent, which translates to a reduction of 200 to 400 litres of fuel and 525 to 1,050 kilograms of greenhouse gas emissions, depending on aircraft type and the direction of the flight. With close to 400,000 flights crossing the North Atlantic each year, the potential economic and environmental benefits are substantial. ENGAGE is paving the way for significant changes to operations in the NAT.

NAV CANADA also works with its partners to effectively manage NAT airspace using surveillance technologies, including Aireon's Global ATS surveillance enabled by space based ADS-B. As over 90 percent of aircraft operating on the NAT are already equipped for this service, NAV CANADA has slated the North Atlantic for the first deployment of space-based ADS-B service in early 2018. This will enable longitudinal separation standards on the NAT to be reduced from 80 nautical miles to 15 nautical miles resulting in more aircraft being allowed to climb to their optimum cruising altitudes and assigned their preferred route. Following implementation in the North Atlantic space-based ADS-B service will expand to enable global coverage. Separation standards will be reduced, and radar-like surveillance will be available worldwide.

These initiatives will benefit both Canadian and international operators entering Canadian airspace by facilitating improved efficiency and fuel savings. With foreign carriers accounting for over 90 percent of traffic on the NAT, Canada is supporting efforts to reduce global aviation emissions.

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

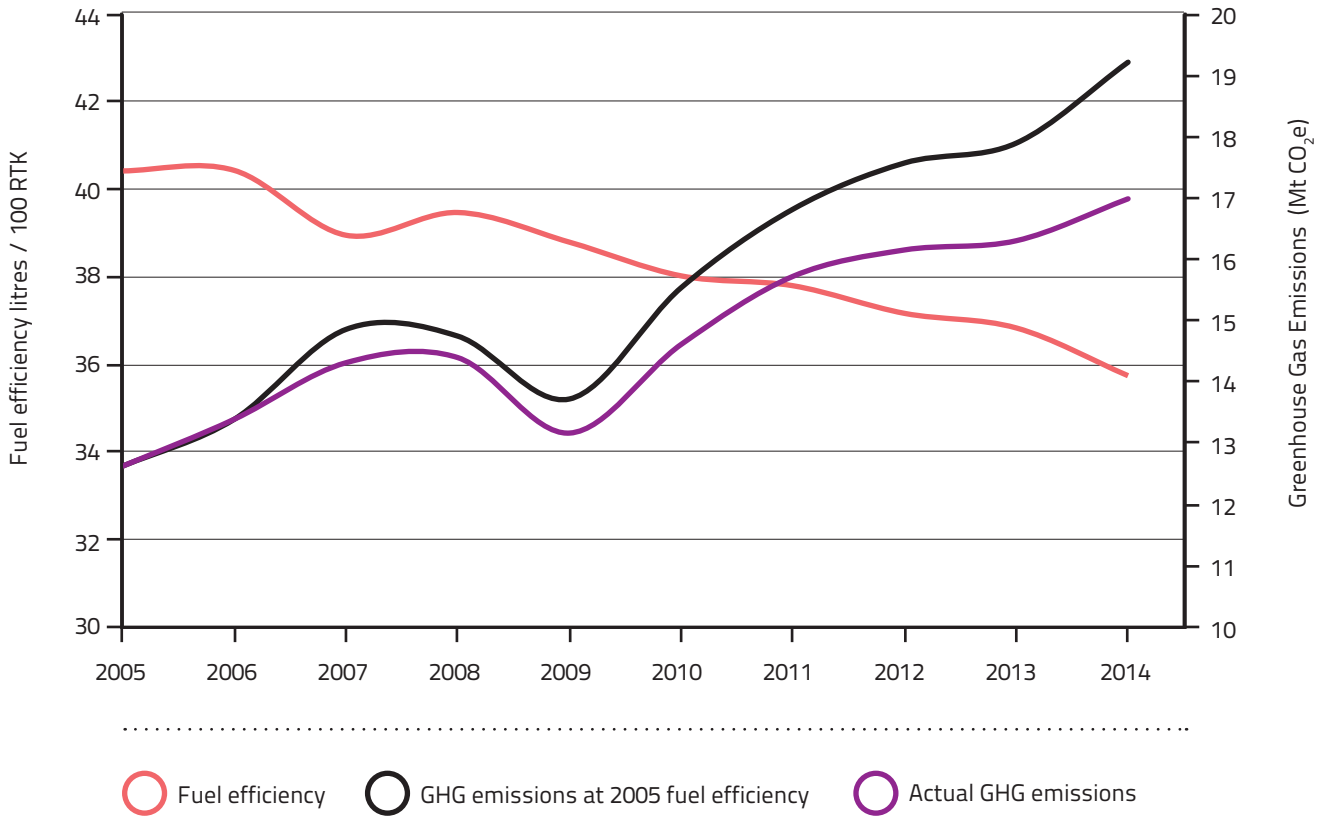


Figure 3 provides an illustration of how much greater greenhouse gas emissions would have been between 2005 and 2014 if fuel efficiency had remained at 2005 levels of 40.43 litres of fuel per 100 RTK. Total greenhouse gas emissions in 2014 would have reached 19.22 Mt at the 2005 rate, whereas actual 2014 emissions were 11.6 percent lower, at 16.99 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 2014, NACC member airlines made the following changes to their aircraft fleets: ▪ WestJet introduced 7 Boeing 737-800 NG aircraft and removed 5 Boeing 737-700 NG aircraft from service. ▪ Air Canada introduced 1 Boeing 777-300 aircraft and 6 Boeing 787-8 aircraft into service. ▪ Air Transat introduced 4 Boeing 737-800 aircraft into service. ▪ Encore introduced 7 Bombardier Q400 into service. ▪ Rouge introduced 6 Boeing 767-300 aircraft into service, which were transferred from Air Canada. In 2014, ATAC all-passenger air carriers continued to add highly efficient aircraft such as B737-800 and Bombardier Q400/ATR 42-500 aircraft to their fleets while replacing older less efficient fleet types. Operators of B737-200 aircraft have replaced many of these classic versions with B737-300/400/500 series aircraft with more efficient CFM56 engines. ATAC all-cargo air carriers continued their transformation to much more efficient cargo operations as they upgrade from narrow body B727 to larger, more fuel efficient aircraft with high bypass ratio engines such as B757, B767 and DC-10-30.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
The Canadian Business Aviation Association (CBAA) will also encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through fleet renewal.	The CBAA continued to build on its greenhouse gas reduction outreach efforts through "CBAA Matters!", launched in 2013. This online forum increases awareness CBAA members and provides a space for feedback on activities of interest to Canadian business aviation operators, including Canada's Action Plan. The CBAA will continue to encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through fleet renewal.	
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. The 6 Boeing 767-300 transferred to Rouge from Air Canada were retrofitted with blended winglets which will provide significant fuel savings.	
The CBAA will encourage its members to continue to adopt operational improvements to reduce emissions.	The CBAA continued to encourage its members to take advantage of opportunities to reduce greenhouse gas emissions through operational improvements. CBAA Matters! will continue to give these 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: Doc 10013 Operation Opportunities to Minimize Fuel Use and Reduce Emissions. Work on this document was completed in 2012 and became available for sale 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. NACC, ATAC and CBAA promoted the ICAO manual to its members when it came online in 2014.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

Measure	Results	Status
5.3 Improved Capabilities in Air Traffic Management		
Performance-based Navigation (PBN) - Shifting from sensor-based to performance-based navigation will enable more efficient enroute and airport operations for equipped aircraft, reducing fuel burned and associated GHG emissions. The benefits resulting from PBN will depend on collaboration between Transport Canada and the Canadian aviation industry, particularly NAV CANADA.	NAV CANADA's Collaborative Initiatives for Emissions Reduction (CIFER) Report documents achievable annual fuel savings for all air traffic management measures (including PBN) averaging over 500 million litres per year from 2012 to 2014 for all operators using Canadian airspace. It is estimated that 180 million litres of these annual benefits are attributable to Canadian operators. Many of the initiatives described in the CIFER Report have been enabling benefits for many years.	
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 2014.	

Measure	Results	Status
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 in 2014. Discussions within Transport Canada are underway on proceeding with these solutions. In 2014, the Working Group transitioned to the Canadian Performance-based Aviation Action Team (CPAAT), 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.	
Transport Canada, NAV CANADA, and Canada's aviation industry to jointly develop and put in place an ICAO State PBN Implementation Plan.	Transport Canada, NAV CANADA and the Canadian aviation industry are working together to implement an ICAO State PBN plan for Canada in 2015. The implementation of the PBN plan will be led by CPAAT and will include a range of agencies, each with leadership roles in specific projects. Opportunities for ongoing consultation and involvement will be provided throughout the implementation.	
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.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

Measure	Results	Status
	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. A NAV CANADA led initiative, ENGAGE, successfully demonstrated, through over 200 flight trials, the viability and safety of new procedures using variable aircraft speeds (Mach) and variable altitudes for flights transiting unsurveilled airspace over the North Atlantic. The fuel and emissions savings per flight trial averaged one to 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, depending on the aircraft type and the direction of flight. In 2014, the results of the ENGAGE trials were reviewed and endorsed by several international groups.	
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.	The implementation of the Windsor-Toronto-Montreal Airspace and Services Review continued in 2014. In cooperation with the FAA, a PBN route structure using RNAV Standard Instrument Departure, RNAV Standard Terminal Arrival Route, and 'Q' and 'T' routes was implemented. The new route structure permitted 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. This ongoing implementation of the Windsor-Toronto-Montreal Airspace and Services Review is forecasted to achieve a reduction of 100,000 tonnes CO_2e by 2020.	

 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 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.	Established in 2009, GARDN I supported 17 projects totalling $42 million in research; with over half of the projects dealing specifically with emissions reductions. The projects developed over 35 technologies, 10 of which have been advanced to commercialization. These projects were supported by 270 researchers and have resulted in more than 50 scientific publications. The original GARDN mandate concluded in March 31, 2014. Owing to its successes, GARDN was renewed for an additional 5 years for a total of $24 million in research (funded equally by the federal government and participating aerospace companies). The focus of the new GARDN program is "quiet, clean and sustainable". GARDN II has announced the launch of nine R&D projects, representing nearly $14 million in funding.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
	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.	
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 COE called the Aviation Sustainability Center (ASCENT). Launched in 2014, ASCENT focuses on alternative aviation jet fuels as well as aircraft noise and other environmental issues. Transport Canada continues to sponsor ASCENT and maintain an active role on the Advisory Board reviewing research projects and progress with particular focus on the following: ▪ ASCENT 1 - Alternative Jet Fuel Supply Chain Analysis ▪ ASCENT 2A & B - Ambient Conditions Corrections for Non-Volatile PM Emissions Measurements & Examination of Engine to Engine PM Emissions Variability Using an ARP Reference Sampling and Measurement System ▪ ASCENT 13 - Microphysical Modeling & Analysis of Aviation Exhaust Observations ▪ ASCENT 14 - CO_2 Standard ▪ Investigation of Aviation Emissions Air Quality Impacts (Project 16); ▪ ASCENT 18 - Health Impacts Quantification for Aviation Air Quality Tools; and ▪ ASCENT 24B - PM Emissions Database Compilation, Analysis and Predictive Assessment.	

Measure	Results	Status
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 alternative fuels. With financial support from the Government of Canada's Clean Transportation Initiatives, the NRC has: ▪ Conducted research with NASA and the German Aerospace Centre (DLR), to study the effects of biojet fuels at altitude. The study, called ACCESS II, confirmed that biojet burns cleaner and, although still under investigation, that contrail ice particle number densities vary directly with exhaust soot concentrations. ▪ Worked with Transport Canada, Environment Canada and the US FAA to develop capabilities to conduct the required testing to transition to unleaded aviation gasoline. In 2014, a Canadian stakeholder consultation was conducted as well as extensive consultations with the US FAA. ▪ Contributed to the development of a sampling and measurement methodology and an Aerospace Recommended Practice document for the certification requirement for the new ICAO nvPM standard for aircraft engines.	
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 2014, ACRP released a number of items of interest to Canadian airports including: ▪ Report 133: Best Practices Guidebook for Preparing Lead Emission Inventories from Piston-Powered Aircraft with the Emission Inventory Analysis Tool; and, ▪ Synthesis 63: Overview of Airport Fuelling Operations.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
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.	In 2014, Transport Canada and the Canadian aviation industry liaised with Canada's BioFuelNet to encourage the development of an Aviation Task Force within the network. Since 2010, Sustainable Development Technology Canada (SDTC) has provided over $12 million to two ongoing alternative aviation fuel projects that are in the demonstration phase: ▪ $3.3 million to Agrisoma Biosciences Inc. for a Brassica carinata-based biofuel project; and ▪ $9.6 million to MARA Renewables Corporation for an algae-based biofuel project. In 2014, there were no new alternative jet fuel projects funded under the SDTC, the Program of Energy Research and Development, or the ecoEnergy Innovation Initiative.	
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 engaged with the US "Commercial Aviation Alternative Fuels Initiative". Transport Canada also participates in the ICAO Alternative Fuels Task Force, which is developing information on how to assess the "sustainability" of aviation biofuels. Transport Canada has actively supported the US FAA in the establishment of the new ASCENT Center of Excellence and collaborated with NASA on alternative aviation fuel research.	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
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.	In 2014, the Government of Canada funded a $200,000, two-year research project into the feasibility, cost, and environmental impact of a biojet fuel supply chain 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 2014, the APU/GSE Subgroup continued to share information on current emission reduction initiatives and maintained a list of potential projects the group could undertake over the coming years. In 2014, a study on best practices pertaining to APU and GSE use was undertaken, which looked at examples from airports, airlines and service providers in Canada and abroad. A number of emission reduction initiatives are advancing at Canadian airports. Examples include: ▪ Continued deployment of BoomAir at Montreal airport; ▪ Jazz Aviation and Air Canada continued tracking of GSE with GPS at the Toronto Pearson International Airport, the Montréal–Pierre Elliott Trudeau International Airport, and the Halifax Stanfield International Airport, and in 2014, expanded to the Calgary International Airport and the Vancouver International Airport.	

 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, in Toronto in 2013 and Calgary in 2014. Full implementation will occur 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, Montreal and Calgary Airports have the capability to use EXCDS to develop average baselines for taxi times. 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) began 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).	

 COMPLETE  IN PROGRESS  BEHIND SCHEDULE

Measure	Results	Status
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 continues to work with Canadian airports to develop air quality reports using the Transport Canada Mobile Air Quality Laboratory. A joint study was completed at the Kelowna International Airport in 2014 and the Air Quality Laboratory is now currently located at the Victoria International Airport.	
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 CO_2 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 mass and number standard.	The completion of the new international mass standard is on-track for 2016. A number standard is scheduled for completion by 2019.	
6.5 International Coordination		
Transport Canada continues to participate in ICAO's work to address greenhouse gas emissions.	Canada is participating in the Environmental Advisory Group of the ICAO Council, tasked with developing the design of a global market-based measure to address greenhouse gas emissions from international civil aviation for consideration at the 39th ICAO assembly in 2016. 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 mass and number standard for aircraft engines. Canada is also a member of CAEP's Global Market-based measure technical Task Force that is assessing two specific technical elements of market-based measures for aviation and providing quantitative analysis supporting the work of the Environmental Advisory Group. Canada is also participating in the CAEP Alternative Fuels Task Force.	

COMPLETE IN PROGRESS BEHIND SCHEDULE

Measure	Results	Status
	Transport Canada and NAV CANADA are supporting efforts under ICAO's Global Air Navigation Plan and Aviation System Block Upgrades (ASBU), as well as NAV CANADA's PBN Operations Plan, through planned upgrades through to 2017 on: ▪ Communications; ▪ Navigation; ▪ Surveillance; and ▪ Air Traffic Management. These upgrades maximize the benefits for operators of aircraft that are best equipped to take advantage of the PBN procedures, while recognizing the needs for airspace access to operators not eligible for these procedures. Canada is actively participating in ICAO's CAEP Working Group 2 – Operations and is leading the Group's work to update 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 in 2016.	
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 2014 provided by members of ATAC and NACC, demonstrate continued progress towards this extremely ambitious target.

Since 2010, the demand for aviation services has continued to grow. Combined revenue passenger and cargo operations increased by 7.4 percent in 2014, compared with 2013. Canadian air carriers used 6.58 billion litres of fuel, a 4.2 percent increase compared with 2013. Consequently, total greenhouse gas emissions also increased by 4.2 percent to 16.99 Mt in 2014, compared with 2013.

In 2014, the overall rate of fuel consumption (i.e., litres per RTK) declined by 3.0 percent, compared with 2013. The combined domestic and international fuel consumption rate reported for 2014 was 35.74 litres per 100 RTK (combining both passenger and cargo traffic). This translates to an average reduction in fuel consumption per RTK of 1.4 percent per year between 2005 and 2014, and a cumulative improvement of 11.6 percent.

2015 Look Ahead

While Canada made progress in many areas in 2014, important milestones were also advanced in 2015. These milestones will be addressed in more detail in the 2015 Annual Report, which is scheduled to be released by December 31, 2016. The 2015 Annual Report will include information about:

- A comprehensive Canadian PBN State Plan will be drafted at the Canadian Performance-based Aviation Action Team (CPAAT). This document will include Canada's vision for performance-based communication, navigation, surveillance and Air Traffic Management. The Canadian PBN State Plan will be presented to ICAO and published on the Transport Canada website.
- NAV CANADA will continue to use technologies that increase surveillance capability including Global ATS surveillance enabled by space based ADS-B. As over 90 percent of aircraft operating on the North Atlantic are already equipped for this service, NAV CANADA has slated the North Atlantic for the first deployment of space-based ADS-B service in early 2018.
- A review of the Action Plan goals in accordance with section 7.3 of the Action Plan and in line with ICAO guidance (see Appendix E). The results of the review will be shared with ICAO by the end of 2015 and any recommended updates will be reflected in the 2015 Annual Report.

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

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

NACC: National Airlines Association of Canada

NRC: National Research Council

nvPM: Non-volatile particulate matter

PARTNER: Partnership for AiR Transportation Noise and Emissions Reduction

PBN: Performance-based navigation

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:
2560 grams CO_2 per litre
2582 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 2582) / (RPM x 1.609344)

CO_2e (grams)/Cargo RTK = (Fuel Used x 2582) / (Cargo RTM x 1.609344 x 0.907185)

CO_2e (grams)/Total RTK = (Fuel Used x 2582) / {(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 2014 was slightly improved compared to 2013. 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 2014 data for this annual report, including:

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

The ATAC member carriers who contributed 2014 data for this annual report were:

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

2 Air Canada reporting includes data from Rouge

3 WestJet reporting includes data from Encore

Appendix D: Additional Figures Illustrating Key Trends

FIGURE 4 Fuel Use — International and Domestic, 2014

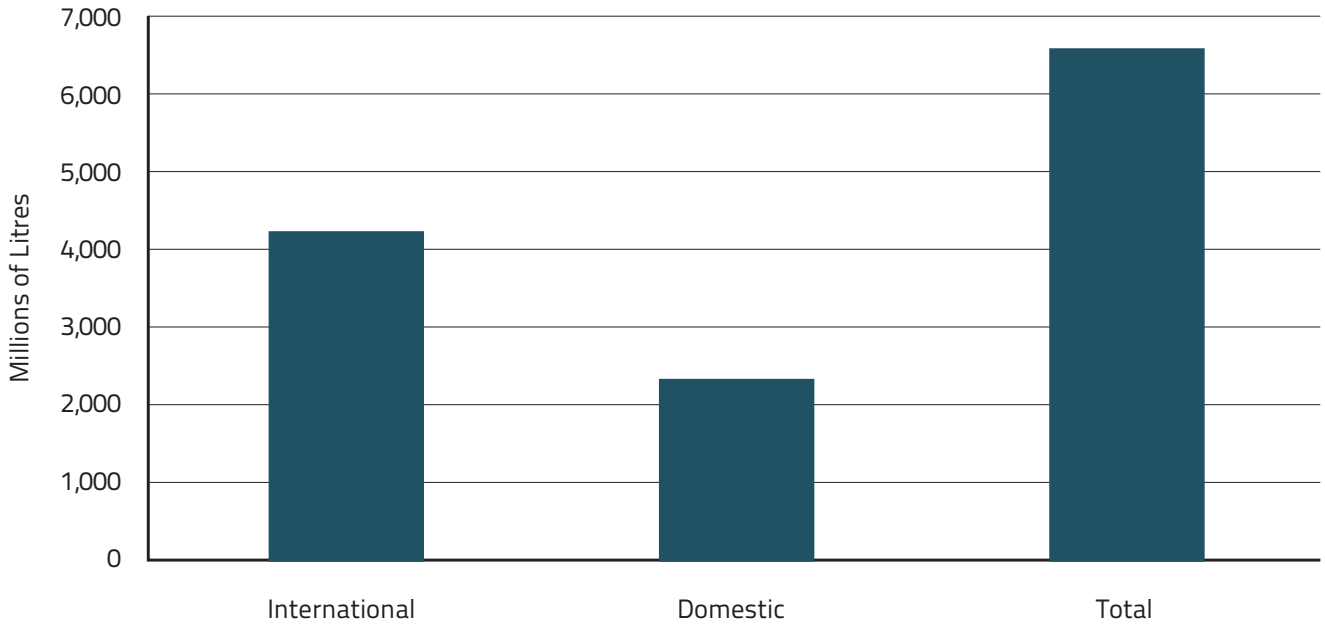


FIGURE 5 Fuel Use, 2005-2014

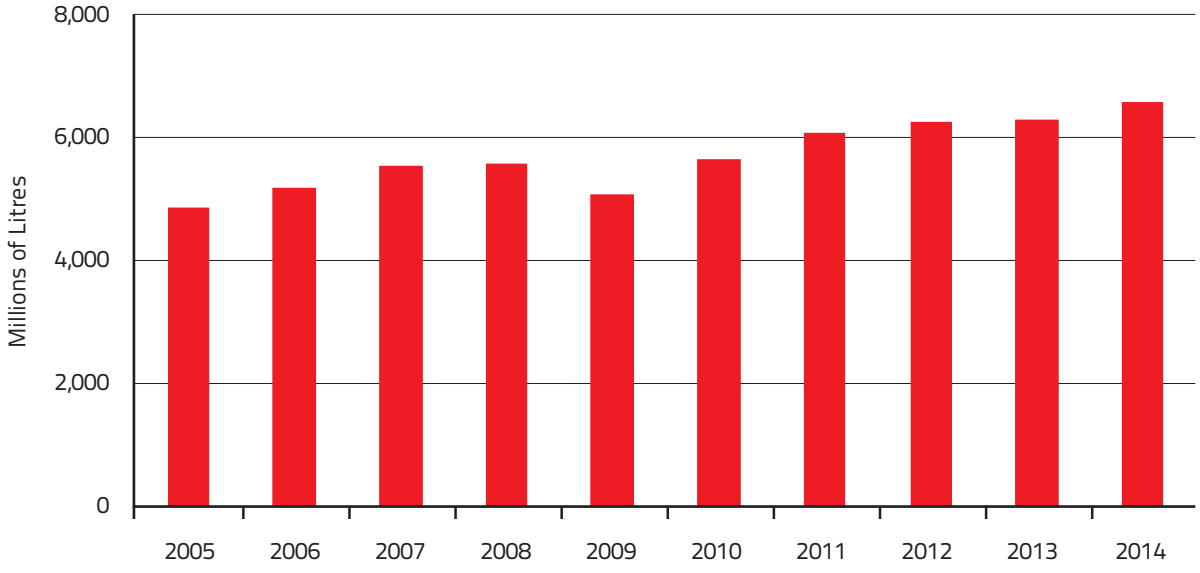


FIGURE 6 Revenue Passenger Kilometres, 2005-2014

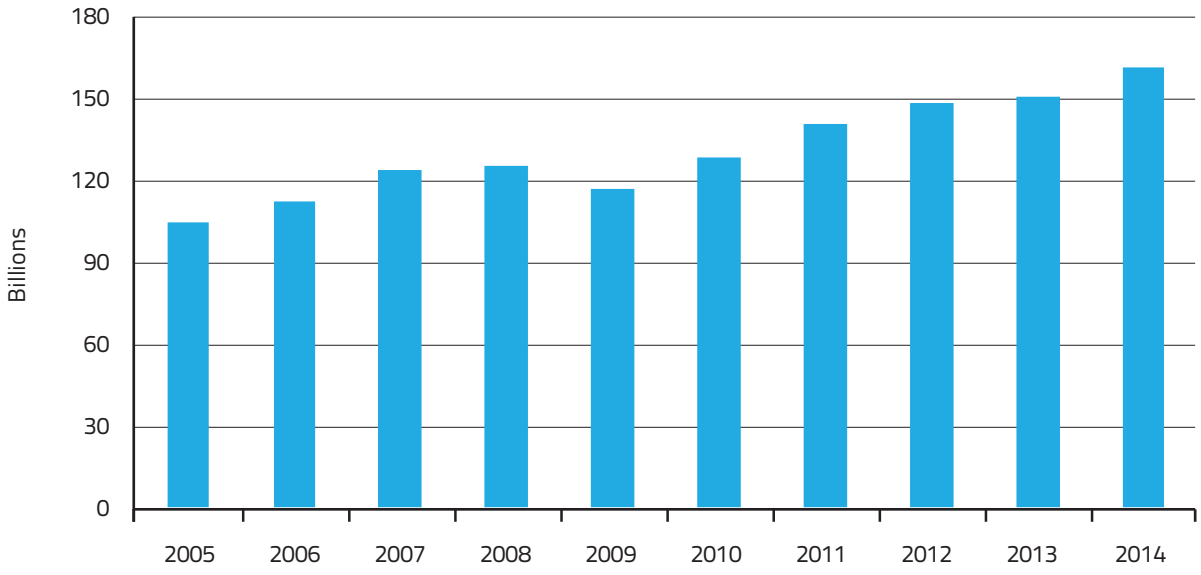


FIGURE 7 Cargo Revenue Tonne-Kilometres, 2005-2014

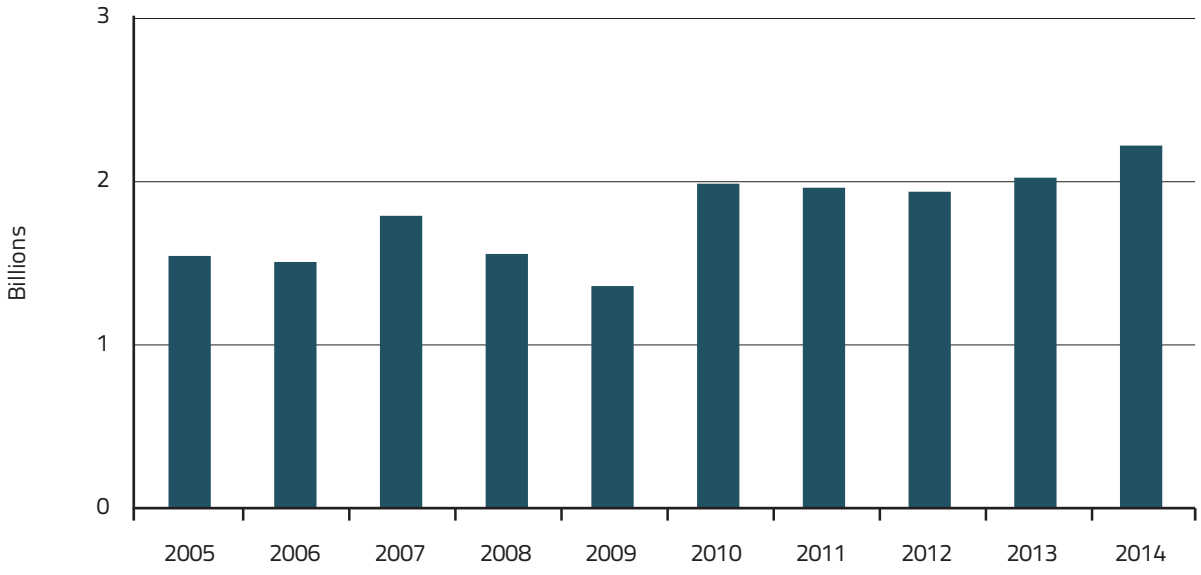


FIGURE 8 Total Passenger and Cargo Tonne-Kilometres, 2005 -2014

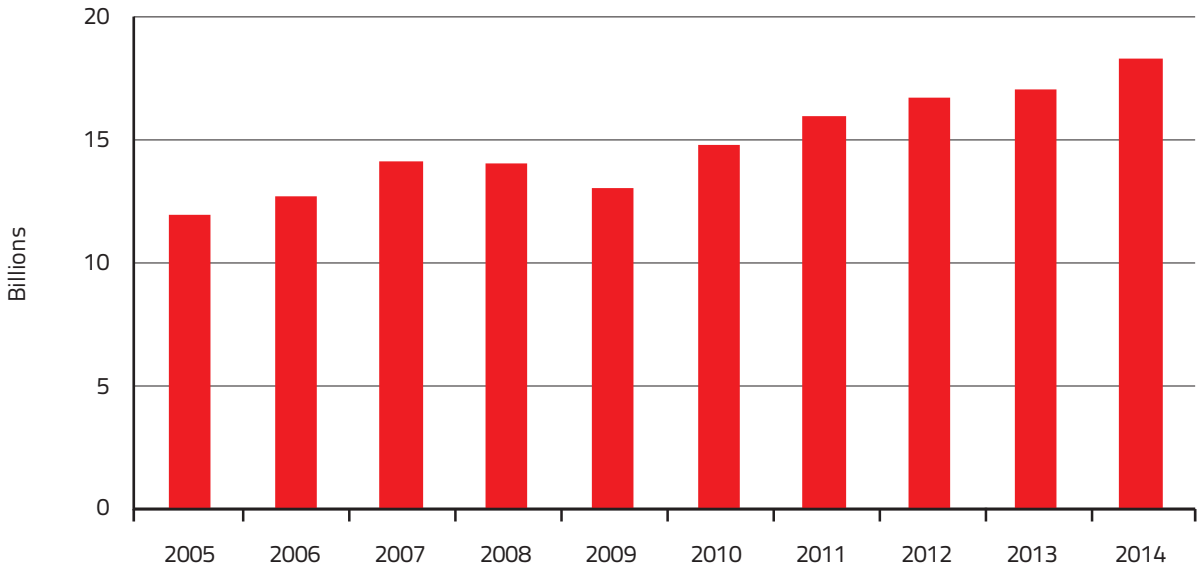


FIGURE 9 Total Passenger and Cargo Tonne-Kilometres — International and Domestic, 2014

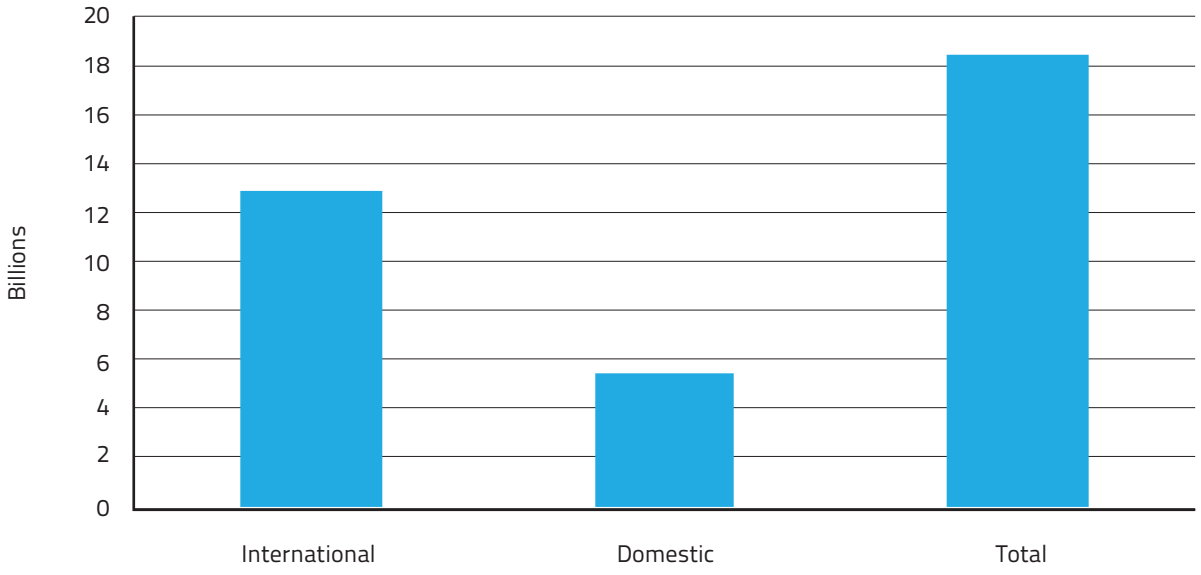


FIGURE 10 Fuel Consumption Rate — Passengers, 2005-2014

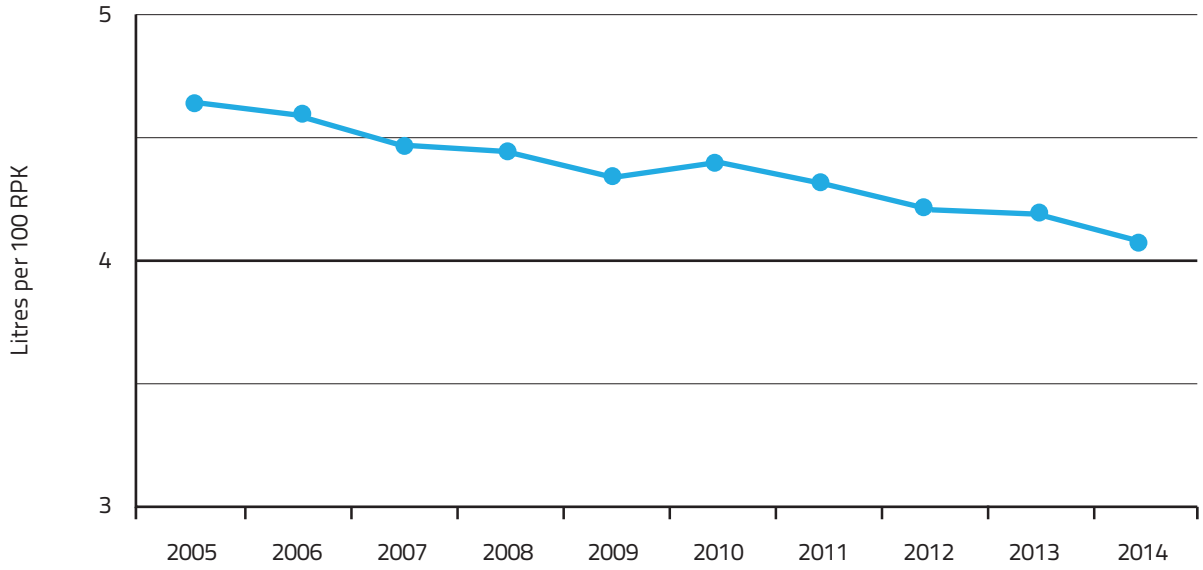


FIGURE 11 Fuel Consumption Rate — Combined Passengers and Cargo, 2005-2014

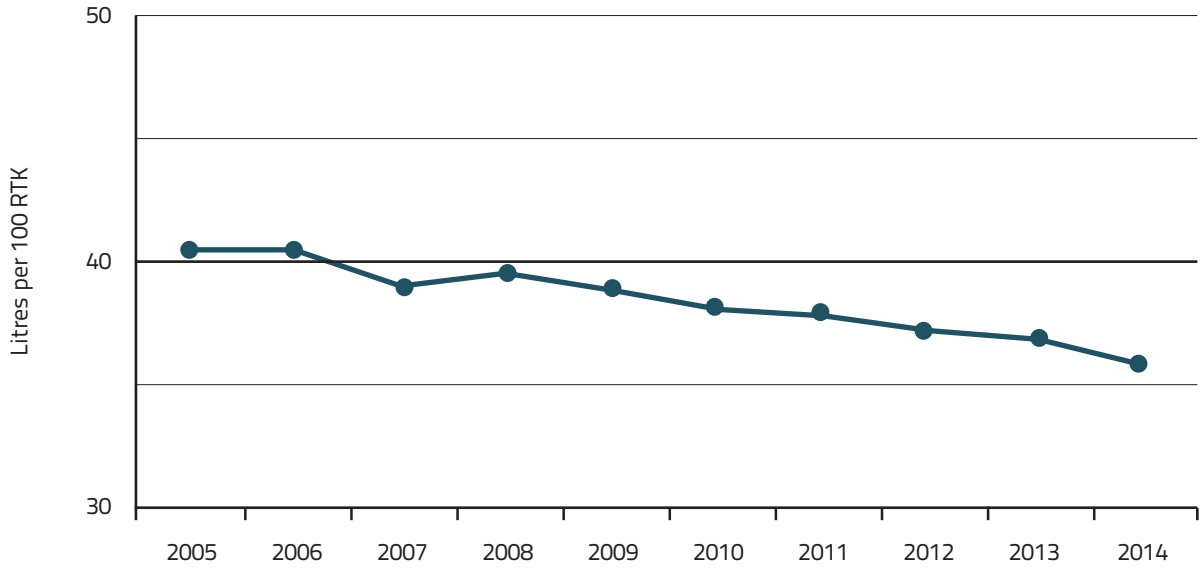


FIGURE 12 Greenhouse Gas Emissions — International and Domestic, 2014

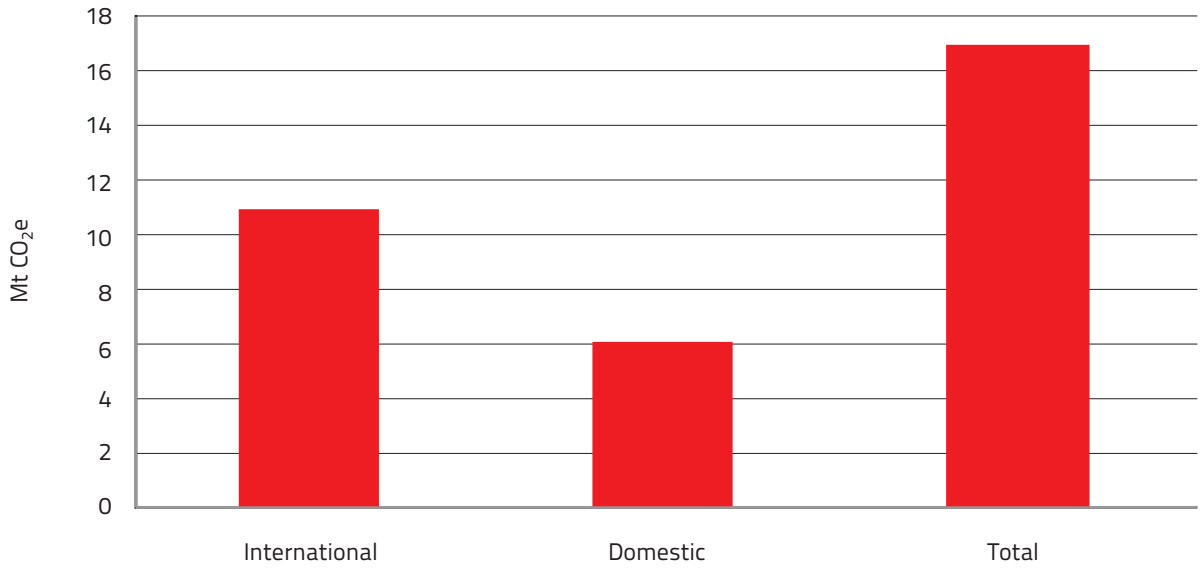


FIGURE 13 Greenhouse Gas Emission Rates — International and Domestic, 2014

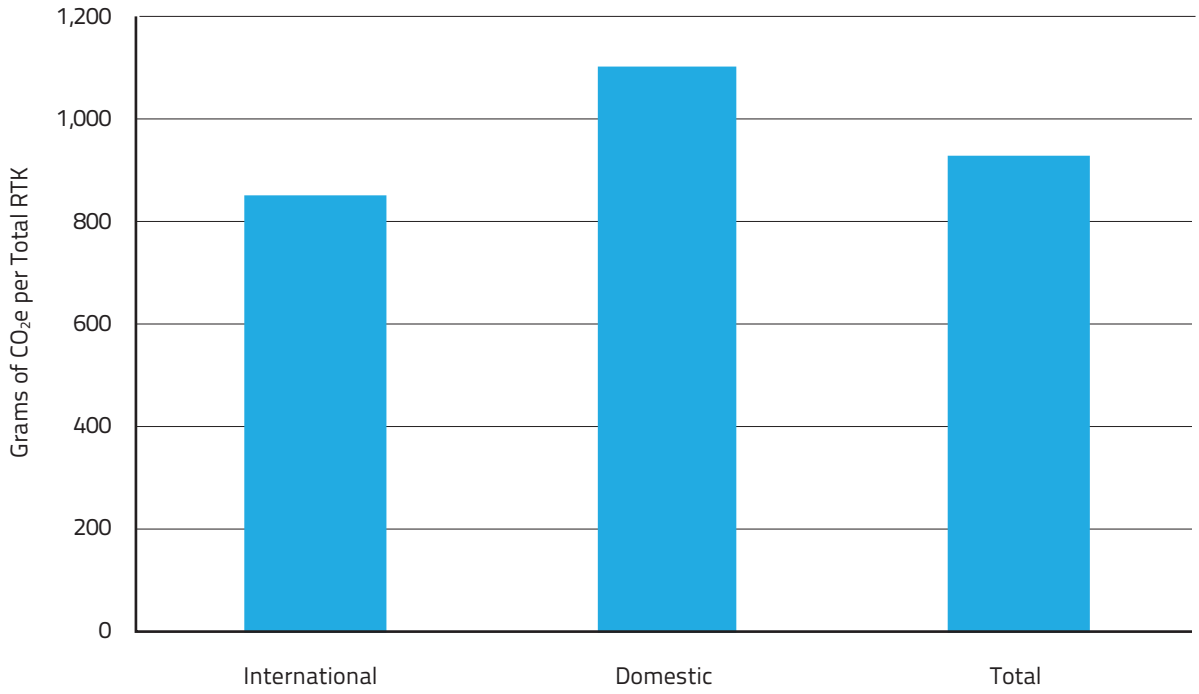


FIGURE 14 Greenhouse Gas Emission Rate — Passengers, 2005-2014

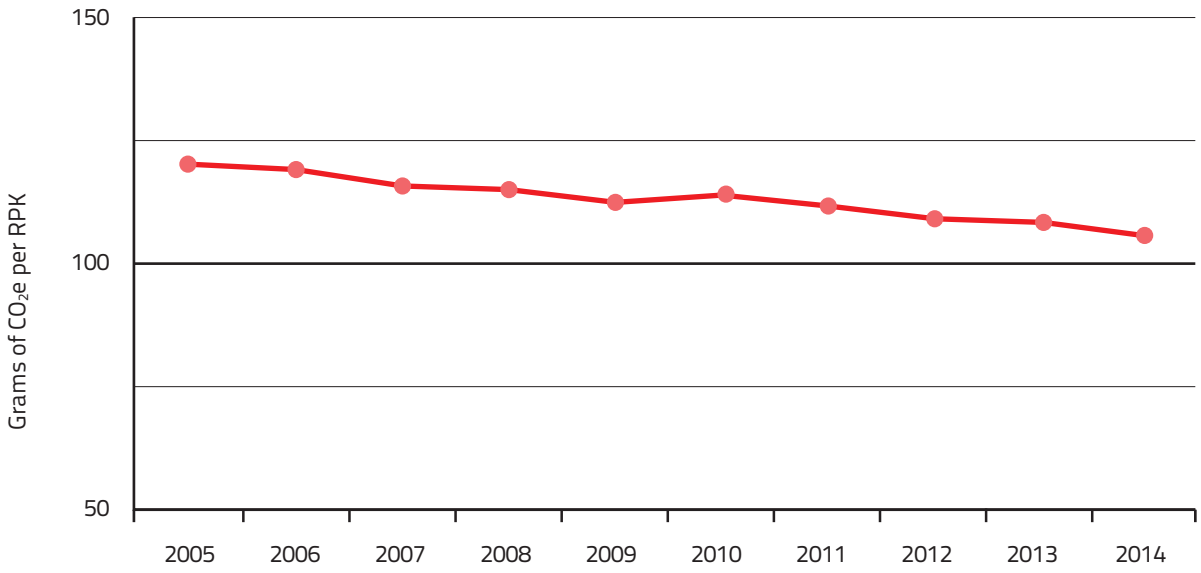
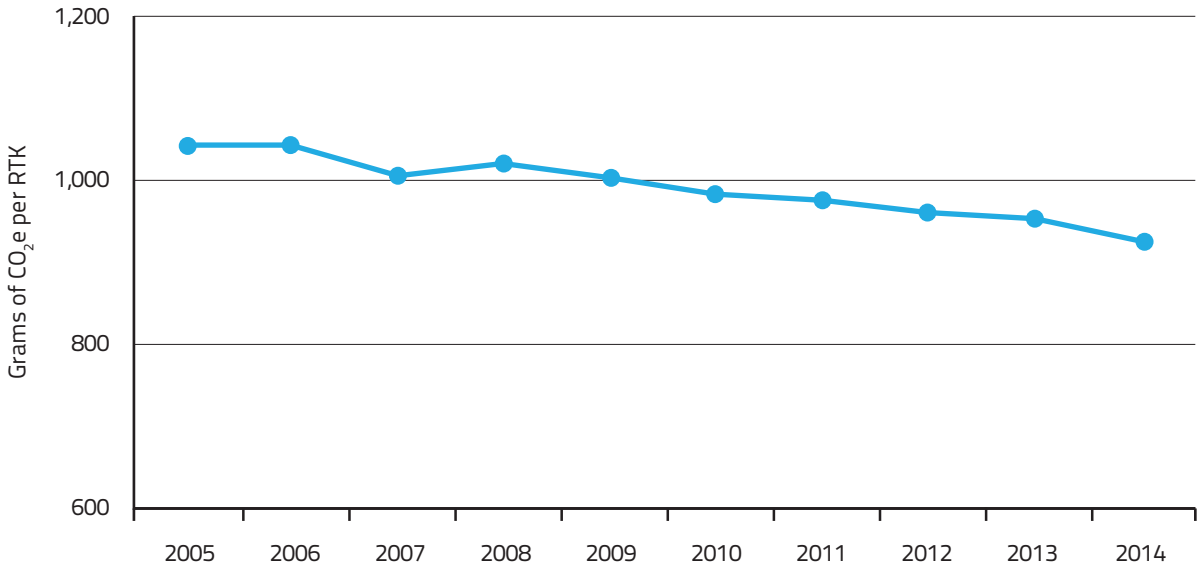


FIGURE 15 Greenhouse Gas Emission Rate — Combined Passenger and Cargo, 2005-2014



Appendix E – Addendum to Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation

2015 Update

Introduction

At its October 2010 General Assembly, the International Civil Aviation Organization (ICAO) adopted an assembly resolution on climate change (A37-19), which established several voluntary goals, including an average annual fuel efficiency improvement of 2 percent until 2020. To track progress towards these goals, the resolution encouraged Member States to submit national action plans detailing specific measures to address greenhouse gas emissions from their aviation activities by June 2012.

At the same time, work was underway to develop a successor to the 2005 Memorandum of Understanding (MOU) between Transport Canada and Canadian air carriers, which established a goal to improve fuel efficiency by 1.1 percent per year from 1990 to 2012. Through this agreement, Canadian air carriers improved fuel efficiency by 31.6 percent from 1990-2011, or an annual average of 1.8 percent.

Canada's Action Plan

In 2010, a Working Group on Aviation Emissions was created, including representatives from all areas of the aviation industry: air carriers; airports; business aviation; navigation; and aerospace manufacturing. Together this group developed *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation*, which was released in 2012.

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 (L/100 RTK).

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

- Fleet Renewals and Upgrades;
- More Efficient Air Operations;
- Improved Capabilities in Air Traffic Management;
- Aviation Environmental Research and Development;
- Alternative Fuels;
- Airport Ground Operations and Infrastructure Use;
- Regulatory Measures; and
- International Coordination.

Purpose of Review

The Action Plan commits the Canadian aviation sector to report annually on progress towards achievement of the fuel efficiency target. In addition to this annual reporting, the Canadian aviation sector committed to a review pursuant to section 7.3 (Review) of the Action Plan and its associated activities which states that "*the Working Group will conduct a review of the Action Plan in three years to assess progress towards environmental goals and commitments, and update the Action Plan"*. This is in line with ICAO guidance which states that updates to Action Plans should be submitted every three years.

Review Process

In 2014, a subgroup to the working group was struck including representatives from the National Airlines Council of Canada, the Air Transport Association of Canada, the Aerospace Industries Association of Canada, the Canadian Airports Council, NAV CANADA and Transport Canada. This subgroup undertook a review of the Action Plan goals and measures.

More specifically, the group reviewed the commitments in the Action Plan and the 2012 and 2013 Annual Reports to assess elements that are successful, elements that should be improved, and elements that are no longer valid.

Review Findings

Progress to date

The review found that Canada has made good progress towards implementing the Action Plan. In 2014, fuel efficiency reported by Canadian air carriers improved by an annual average of 1.4 percent compared to 2005, which represents a cumulative improvement of 11.6 percent from 2005 to 2014 (see Table 1 in the 2014 Annual Report). In addition, a number of key activities have been advanced, including for example:

- Canadian air carriers continued to renew and upgrade their fleets with highly efficient aircraft. For example, in 2013, Westjet and Air Canada committed to acquire 126 Boeing 737 MAX aircraft, representing 12.8 billion dollars in investment towards efficient operations and emissions reductions;
- Air Canada and Porter Airlines both carried out biofuel powered flights in 2012;
- In 2012, the National Research Council (NRC) conducted the world's first 100 percent biofuel test flight through an initiative funded by Transport Canada and the Green Aviation Research and Development Network (GARDN);
- An Aviation Task Force was created in 2014 as part of BioFuelNet Canada, a national network of academic researchers, industry and government established in 2012 to harness the opportunities and overcome the barriers to sustainable biofuels production;
- Key changes to Performance Based Navigation (PBN) and surveillance were introduced that will result in safer and more efficient operations, including changes to the

Windsor-Toronto-Montreal air corridor that allow aircraft to fly in a more precise, efficient and predictable manner;

- NAV CANADA continued to participate in Aireon LLC's plan to deploy a global space-based ADS-B surveillance network, anticipated for 2018, which will provide fuel savings opportunities to both domestic and international air carriers around the globe;
- Canada continued its active engagement at ICAO, including participation in the Environmental Advisory Group and its work to develop a market-based measure and in the Committee on Aviation and Environmental Protection's (CAEP) work on the development of the new carbon dioxide (CO_2) standard for airplanes, a non-volatile particulate matter (nvPM) standard for aircraft engines; and the development of alternative fuels for aviation, and;
- The Airport Carbon and Emissions Reporting Tool (ACERT), that allows airports to identify energy saving initiatives, was released by Transport Canada and made available to more than 1,600 airports worldwide at no cost on Airports Council International's website.

Further details and additional information on progress are included in Annual Reports, available at: https://www.tc.gc.ca/aviation-emissions

Challenges

In the context of continuing to improve the fuel efficiency of aviation activity, Canada faces a number of unique challenges. Canada's population is spread across a large landmass, making air transportation an essential service for moving both people and goods. Canada has long been committed to reducing the impact of the transportation system on the environment, with Canadian air carriers having taken early action to improve fuel efficiency resulting in significant gains since 1990. This means that Canada now has a young fleet of aircraft with fewer opportunities for further efficiency improvements than countries with older fleets.

Despite these challenges, Canada set a target to improve fuel efficiency by an annual average of 2 percent from a 2005 baseline of 40.43 L/100 RTK. This target reflected ICAO's global aspirational goals and set an ambitious bar for Canada to strive towards as it would result in a 2020 efficiency level of 29.86 L/100 RTK.

Research on the aviation sector's mitigation potential has since progressed, with findings from the 2013 CAEP analysis revealing that, under the most ambitious scenarios, annual average efficiency improvements of 1.4 percent to 2050 could be achievable.

Canada's Action Plan estimated that further implementation of PBN could improve average fuel efficiency by 1-2 percent annually, while efficiency gains from fleet renewal and improved air operations were estimated at 0.9 percent annually. Analysis undertaken as part of the review of Canada's Action Plan suggests that estimating efficiency gains from any one measure in isolation from other measures could be difficult and misleading. Experience has demonstrated that it is not possible to accurately apportion fuel efficiency gains to any one measure, as they are interconnected initiatives working together. To do so would result in a significant risk of double-counting.

Moreover, it should be recognized that Air Traffic Management (ATM) initiatives implemented in Canada benefit both Canadian and international airlines operating in our airspace. Additionally, two thirds of the fuel burned by Canadian airlines is on international routes and therefore largely outside of the area in which Canadian preferences and procedures have effect. These factors make quantification and attribution of efficiency gains even more challenging.

Canada's Continuing Commitment

Parties to the Action Plan will continue to strive towards the 2 percent goal as an aspirational target, as it inspires future work and innovation in the aviation sector. At the same time, Canada also recognizes the Air Transport Action Group (ATAG) target of 1.5 percent to 2020 set in 2009 as an ambitious industry accepted goal. This goal is more in line with Canada's operational realities, but would nevertheless be challenging to attain. As such, moving forward Canada's progress will be benchmarked against both the 2 percent aspirational goal and the 1.5 percent target set by ATAG. This benchmarking will begin in the 2015 Annual Report.

Canada will continue to advance key measures outlined in Canada's Action Plan. These measures have been summarized and updated in Annex 1. The Working Group on Aviation Emissions will continue to oversee the implementation of the Action Plan and will also serve a more strategic function by sharing information amongst parties and bringing key issues to the table for discussion. Furthermore, the subgroups under the Working Group have been streamlined to focus on the following three key areas:

- Air Traffic Management (includes PBN and Surveillance);
- Airport Ground Operations (includes Auxiliary Power Units / Ground Support Equipment and Taxi Operations); and
- Alternative Fuels.

These subgroups will continue to meet regularly to identify and advance emission reduction opportunities.

Through these efforts, Canada will continue to improve the efficiency of the Canadian aviation sector as well as contribute to airspace initiatives enabling fuel savings opportunities that benefit domestic and international carriers operating in Canadian airspace.

Conclusion

Canada is committed to contributing positively to global efforts to address greenhouse gas emissions from aviation activity. Transport Canada and its partners in the Canadian aviation industry will continue to report annually on progress made under Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation. The next review of the Action Plan is planned for 2018, which will be released with the 2017 Annual Report.

Annex 1 – Summary of Action Plan Measures

Section 5.0 Measures

Measure	Overview
5.1 Fleet Renewals and Upgrades	Canadian airlines expect to achieve average annual fuel efficiency improvements on domestic and international flights to 2020 through further fleet changes. Business aviation operators will be encouraged to take advantage of opportunities to reduce emissions through fleet renewal.
5.2 More Efficient Air Operations	Canadian airlines expect to achieve average annual fuel efficiency improvements for domestic and international flights to 2020 through improved operations. Business aviation operators will be encouraged to adopt operational improvements to reduce emissions. Canadian operators will continue to take advantage of opportunities identified ICAO guidance on minimizing fuel use and reducing emissions.
5.3 Improved Capabilities in Air Traffic Management (ATM)	NAV CANADA, in partnership with Transport Canada, Canadian air carriers, global ANSPs and other industry participants remains committed to taking advantage of opportunities to improve ATM through further implementation of Performance Based Navigation (PBN), such as RNP AR and RNAV, new ATM technologies and procedures, as well as surveillance technologies, such as ADS-B and multilateration. The Canadian Performance-based Aviation Action Team (CPAAT) will lead the implementation of Canada's PBN Implementation Plan and will provide opportunities for ongoing consultation and involvement throughout implementation. More specifically NAV CANADA will: ▪ implement RNP AR procedures at numerous airports beginning in 2015, continue to expand the use of Area Navigation and implement broader access to ADS-B surveillance; all of which will improve flight path efficiencies, reduce fuel consumption and reduce GHG emissions. ▪ enable international navigation improvements through work at ICAO and through initiatives such as Aireon LLC's plan to provide global surveillance capabilities through the deployment of space-based ADS-B, anticipated for 2018

Measure	Overview
	▪ report annually on achievable fuel savings and emission reductions from joint efforts with domestic and international carriers operating in Canadian airspace s and industry partners through the annual Collaborative Initiatives for Emissions Reduction (CIFER) Report. In addition, Transport Canada will continue to issue or update advisory circulars to provide guidance or approve new procedures or specifications, such as those related to RNP and ADS-B. Transport Canada is working to amend the Foreign Air Operator Certification to allow foreign operators to gain approvals for RNP AR. This would enable an increase in the number of aircraft eligible to perform RNP AR runway approaches. While ADS-B is not being mandated in the near term, consideration could be given to airspace or route mandates for a geographic area or operational time period should equipage rates be insufficient to enable full system surveillance benefits.

Section 6.0 Measures

Measure	Overview
6.1 Aviation Environmental Research and Development	The Government of Canada and the Canadian aviation industry will continue to support research and development initiatives to minimize or reduce aviation environmental impacts. Research will continue through a number of key organizations and programs, including: ▪ Green Aviation Research & Development Network (GARDN II) ▪ FAA Aviation Sustainability Centre (ASCENT) ▪ National Research Council of Canada (NRC) ▪ United States Transportation Research Board's Airport Cooperative Research Program (ACRP). Research findings and key indicators such as technology readiness levels will be shared with interested parties.
6.2 Alternative Fuels	The Government of Canada and the Canadian aviation industry will continue to work collaboratively to advance efforts related to alternative aviation fuel production and use in Canada and will take advantage of opportunities to collaborate with key trading partners. The Government of Canada will continue to support research, development and demonstration of alternative fuels for aviation through initiatives such as the ICAO CAEP Alternative Fuels Task Force, Sustainable Development Technology Canada; BioFuelNet, ASCENT and the Commercial Aviation Alternative Fuels Initiative (CAAFI).
6.3 Airport Ground Operations and Infrastructure Use	The Canadian aviation industry will collaborate to reduce emissions at the gate and on the ground from taxi operations, auxiliary power units and ground support equipment. Partners will work together to improve the quantification of greenhouse gas emissions associated with ground operations. Canadian airports will refine and improve emissions inventories and will explore further opportunities for emissions reduction strategies.

Measure	Overview
6.5 Regulatory Measures	Transport Canada will continue to participate at CAEP on the finalizations of the new CO2 emissions standard for airplanes, targeted for 2016. Transport Canada will continue to help develop a new nvPM standard for aircraft engines, through CAEP, with Phase 1 targeted for 2016, and Phase 2 targeted for 2019. Once completed and adopted by ICAO, Transport Canada will adopt both standards domestically under the *Aeronautics Act*.
6.5 International Coordination	Transport Canada will continue to actively participate, through ICAO, on the development and implementation of global approaches and standards to address climate change, including system efficiencies and market-based measures, and the development of alternative fuels for aviation. Transport Canada will continue to engage the Canadian aviation industry as part of the international dialogue. NAV CANADA will continue to represent the air navigation interests of Canadian aviation stakeholders internationally through representation in ICAO groups and panels. As a member of the International Coordinating Council of Aerospace Industries Associations (ICCAIA), the Aerospace Industries Association of Canada (AIAC) will continue to lead Canadian aerospace manufacturers in working with international partners to develop and produce aircraft and engines that meet or exceed ICAO requirements for fuel efficiency and emissions.