

CANADA'S ACTION PLAN

TO REDUCE GREENHOUSE GAS EMISSIONS FROM AVIATION



2018 ANNUAL REPORT



Government
of Canada

Gouvernement
du Canada

Canada



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EXECUTIVE SUMMARY

Aviation is vital to Canada's transportation network. It is essential to Canada's domestic and international trade, as well as for connecting Canadians within the country and to the rest of the world. Canada's air industry also serves remote communities where it is often the only way to move people and basic commodities.

The Canadian aviation industry has had a strong climate action strategy in place since 2005. The approach to reduce greenhouse gas (GHG) emissions, which continues under Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation (the Action Plan), is centered on adopting new technology, making operational improvements and investing in infrastructure. It also focuses on research and development to support the future use of sustainable aviation fuel, which is needed to help meet the sector's long-term environmental goals. These activities also contribute to seven of the 17 United Nations Sustainable Development Goals. Furthermore, industry also has a strong engagement presence with the federal government as Canada develops and implements effective market-based measures and a clean fuel standard under the Pan-Canadian Framework on Clean Growth and Climate Change.

This is the seventh Annual Report under the Action Plan. To date, good progress has been made on the Plan's implementation, which has led to Canadian air carriers improving their fuel intensity by 3.3 percent in 2018. Since 2008, there has been an average annual improvement rate of 2 percent, which exceeds the Action Plan's target of 1.5 percent. Without these efficiency improvements, the sector would have emitted an additional 19.3 megatonnes (Mt) CO₂e from 2008–2018.

While the sector continues to demonstrate meaningful fuel efficiency gains, within the last year alone, demand for Canadian air transport grew by 8.5 percent. To meet the demand, air carriers used 5 percent more fuel, which consequentially increased GHG emissions by the same amount. In total, Canadian air carriers emitted 22 Mt of CO₂e, with approximately two thirds being generated from international flights. The emissions from domestic flights represent roughly 1 percent of Canada's total emissions.

In addition to reporting on annual fuel use and efficiency, this document also identifies and describes a series of measures taken to address GHG emissions across the aviation sector. These measures include:

- fleet renewals and upgrades;
- more efficient air operations;
- improved air traffic management capabilities;
- aviation environmental research and development;
- alternative fuels;
- airport ground operations and infrastructure use;
- regulatory measures; and
- international coordination.

Finally, this report also provides a preview of important milestones achieved in 2019, including the fleet renewal and upgrades of National Air Council of Canada (NACC) and Air Transport Association of Canada (ATAC) carriers, progress under the Government of Canada's Sky's the Limit Challenge and the drafting of the offsetting phase of CORSIA.

SKY'S THE LIMIT CHALLENGE:

In August 2018, the Government of Canada announced the launch of the Sky's the Limit Challenge. This \$14 million challenge consists of two distinct prize competitions. In the Green Aviation Fuels Innovation Competition, the grand prize will be awarded for the greenest and most cost-effective biojet fuel in Canada. In the Cross-Canada Flight Competition, the prize will be awarded to the first producer of enough made-in-Canada biojet to fuel a cross-Canada commercial flight. The prize winners will be announced by the end of March 2021. Partners in the initiative include Air Canada, WestJet and GARDN.

For more information, visit:

<https://impact.canada.ca/en/challenges/green-aviation>





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 GHG emissions from aviation, which was signed in 2005 between Transport Canada and the Air Transport Association of Canada (ATAC) on behalf of its member carriers.
- Describes ongoing and planned initiatives to address GHG emissions from Canada's domestic and international aviation activities.
- Sets an aspirational goal to achieve a 2 percent annual average fuel efficiency improvement between 2005 and 2020. This is aligned with the goal set by ICAO.
- Commits to annual reporting on fuel efficiency performance and other Action Plan activities.

The Working Group on Aviation Emissions also committed to review the Action Plan, including the aspirational goal and on-going and planned activities, every three years. As a result of the 2015 review, the parties agreed to adopt a global industry-recognized¹ fuel efficiency target of a 1.5 percent annual average improvement between 2008 and 2020. The 2008 baseline fuel efficiency is 39.5 litres of fuel per 100 Revenue Tonne-Kilometres (L/100 RTK). Since this decision, Canada's progress has been benchmarked against both the 1.5 percent target and the 2 percent aspirational goal. For more information regarding the 2015 review, refer to Appendix E of the 2014 Annual Report.

In 2016, the Government of Canada, in collaboration with the provinces and territories, released the Pan-Canadian Framework on Clean Growth and Climate Change (PCF). Many of the transportation-specific actions identified in the framework, such as using cleaner fuels, investing in transportation infrastructure and improving efficiency align closely with measures under the Action Plan. Additionally, industry engages regularly with the government as Canada develops and implements market-based measures and a clean fuel standard under the PCF.

¹ This target was established by the Air Transport Action Group (ATAG), which is an independent coalition that represents all sectors of the air transport industry, working to promote aviation's sustainable growth.

AIR TRAFFIC MANAGEMENT— MODERNIZING CANADIAN AIRSPACE:

NAV CANADA is working with industry partners to help reduce GHG emissions from aviation through efforts to modernize the design of Canada's airspace and international flight paths by implementing new technologies. For instance, Required Navigation Performance (RNP) is a technology being implemented that combines highly accurate satellite-based positioning with an aircraft's modern flight management system to enable it to fly a precise, pre-programmed three-dimensional approach path, reducing fuel use and GHG emissions. With more and more aircraft becoming RNP-equipped, NAV CANADA plans to continue to publish RNP arrival procedures for Canadian airports over the next few years. By the end of 2018, procedures were published for Ottawa, Halifax, Edmonton, Winnipeg, St. John's, Regina, Brandon, Saskatoon, Vancouver and Kelowna.





SUSTAINABLE DEVELOPMENT GOALS

In September 2015, Canada and 192 other United Nations member states adopted the 2030 Agenda for Sustainable Development. The 2030 Agenda is a 15-year global framework centered on an ambitious set of 17 Sustainable Development Goals (SDGs), 169 targets and over 230 indicators. The 2030 Agenda is a global framework of action for people, planet, prosperity, peace, and partnership. It integrates social, economic, and environmental dimensions of sustainable development, as well as peace, governance and justice elements.

Canada is committed to implementing the 2030 Agenda and its SDGs. On July 17th, 2018, Canada presented its first **Voluntary National Review report** at the United Nations High Level Political Forum in New York, which highlights

Canada's progress and plan to achieve the 2030 Agenda for Sustainable Development at home and abroad.

Through actions taken under Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, the Government of Canada and the Canadian aviation industry contribute to seven of the 17 SDGs.





RESULTS FOR 2018

This section outlines the results for 2018, including airline traffic, fuel use, fuel efficiency and GHG emissions reductions.²

TRAFFIC AND FUEL USE:

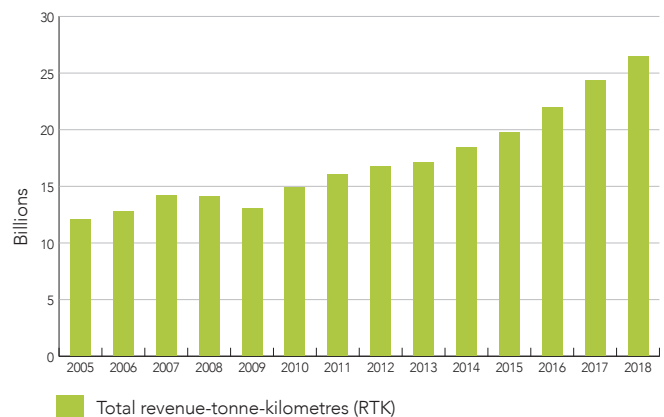
The demand for air travel has continued to grow. In 2018, revenue service for Canadian airlines was 26.5 billion total RTK (total tonnes of passenger³ and freight multiplied by kilometres flown). This metric, often referred to as airline “traffic”, increased by 8.5 percent in 2018 compared to 2017. To meet this demand, fuel use increased by 5 percent, to a total of 8.5 billion litres. The following chart shows the annual traffic in total RTK between 2005 and 2018.

AIR CANADA ECO-AIRLINE AWARD:

In February, Air Canada was named 2018 Eco-Airline of the Year by airline industry publication Air Transport World, who cited the airline’s commitment to emissions reductions through supporting the development of alternative fuels and its numerous green programs and partnerships, such as the Canada’s Biojet Supply Chain Initiative.

CHART 1

Annual Traffic: Combined International and Domestic Operations, 2005–2018



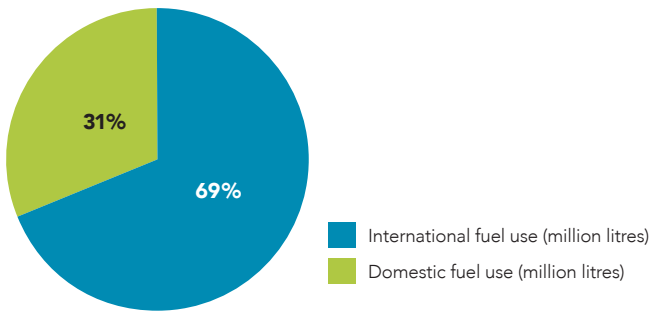
This report also distinguishes between results for domestic and international operations. Similar to the Intergovernmental Panel on Climate Change’s definition of international and domestic activities, the Action Plan defines international activity as flight segments that begin or end outside of Canada, whereas domestic activity includes flight segments within Canada.

² It should be noted that the number of air carriers that provide data under the Action Plan have changed from year to year. As a result, the statistics presented in this report may not be entirely comparable with those in other years.

³ The industry conventional assumption is that the average weight per passenger is 100kg or 0.1 tonnes.

In regard to the 8.5 billion litres of fuel consumed in 2018, 69 percent was consumed for international activity and 31 percent was from domestic activity. The following chart illustrates the difference in scale between international and domestic fuel consumption.

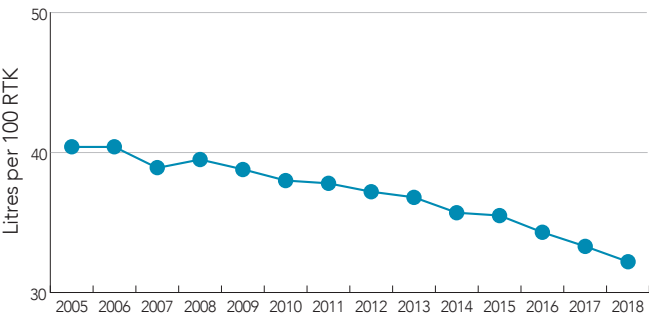
CHART 2
Airline Fuel Use: International versus Domestic, 2018



EFFICIENCY IMPROVEMENTS AND PROGRESS TOWARDS THE ACTION PLAN TARGET:

Fuel efficiency is commonly measured as fuel intensity. Fuel intensity is the amount of fuel used to move 1 tonne a distance of 100 kilometres. In 2018, fuel intensity for combined domestic and international flights was 32.2 litres per 100 RTK. This is a 3.3 percent improvement from 2017. The trend since 2005 has been decreasing, as shown in Chart 3.

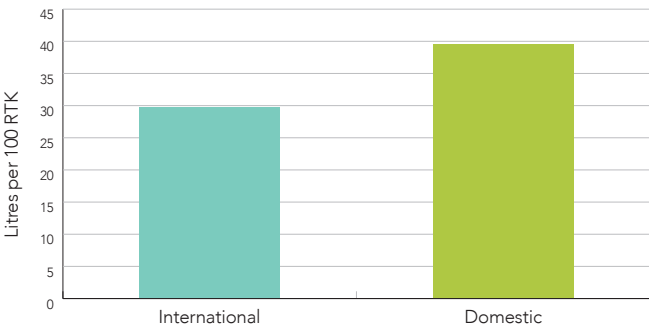
CHART 3
Fuel Intensity: Combined Passengers and Cargo, 2005–2018



Separately, as shown in Chart 4, the fuel intensity of international operations was 29.8 litres per 100 RTK, and 39.5 litres per 100 RTK for domestic operations. There are many factors that contribute to this difference, including

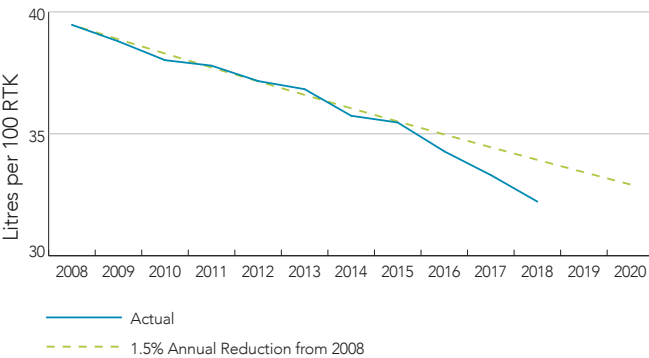
type and size of aircraft, distance flown, cruising altitude, and speed amongst others. For more information regarding international vs. domestic fuel intensity, see Table 2 in Appendix A.

CHART 4
Fuel Intensity: International and Domestic, 2018



With regard to the Action Plan’s target (1.5 percent annual average fuel efficiency improvement between 2008 and 2020), carriers have so far averaged 2 percent. Cumulatively, this represents a fuel intensity rate decrease of 18.4 percent. Chart 5 plots a comparison of the 1.5 percent target against the achieved fuel intensity rate between 2008 and 2018.

CHART 5
Comparison of Achieved Fuel Intensity against the Target, 2008–2020



In relation to the Action Plan’s 2 percent aspirational goal, Canadian airlines have averaged an annual improvement of 1.7 percent, since 2005. For more results related to the progress against the goal, see Appendix B.

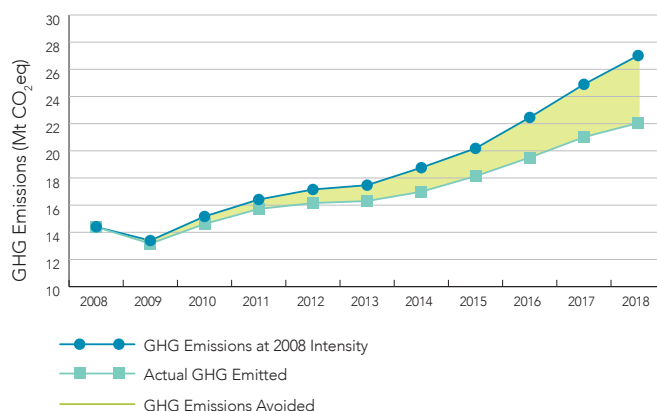
IMPACT ON GHG EMISSIONS:

While the sector continues to improve its fuel efficiency, the demand for air transportation continues to grow. This resulted in a 5 percent increase in fuel consumption in 2018. Consequently, the amount of the GHG emissions also increased by 5 percent, to 22 Mt of CO₂e. The domestic portion, roughly one third of emissions, account for approximately 1 percent of Canada's total emissions.⁴

The 18.4 percent fuel efficiency improvement over the 2008–2018 timeframe has enabled the sector to emit 19.3 Mt fewer emissions over that same period of time. For example, if carriers had continued to operate at 2008 intensity levels, they would have emitted 27 Mt of CO₂e in 2018. This is 5 Mt more than actual emission. The shaded area in Chart 6 shows the emissions that were avoided as a result of these improvements.

4 National Inventory Report 1990–2017: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada.
<http://www.publications.gc.ca/site/eng/9.506002/publication.html>

CHART 6
GHG Emissions Avoided Since 2008





REPORTING ON ACTION PLAN MEASURES


The Action Plan identifies the following measures that represent the greatest opportunities to reduce GHG emissions and help improve fuel efficiency:

- fleet renewals and upgrades;
- more efficient air operations;
- improved air traffic management capabilities;
- aviation environmental research and development;
- alternative fuels;
- airport ground operations and infrastructure use;
- regulatory measures; and
- international coordination.


The following table outlines activities under each measure and highlights the results achieved in 2018.




SUMMARY TABLE OF 2018 ACTIVITIES AND RESULTS

 Complete
  In Progress
  Behind Schedule

ACTIVITIES	RESULTS	STATUS
FLEET RENEWALS AND UPGRADES		
Canadian air carriers expect to achieve annual fuel efficiency improvements on domestic and international flights through to 2020 through further fleet changes.	<p>In 2018, NACC member airlines continued to add more efficient aircraft to their fleets. The following changes were made:</p> <ul style="list-style-type: none"> • Air Canada introduced five Boeing 787-9 aircraft and sixteen Boeing 737 MAX 8 aircraft into service*. Air Canada removed four Boeing 767-300ER aircraft and six Embraer E190 aircraft from service. The new larger version of the Boeing 787 Dreamliner can carry 75 percent more cargo by weight than the Boeing 767s. • WestJet introduced seven Boeing 737 MAX 8 aircraft into service* and removed two Boeing 737-700 NG aircraft from service. Encore introduced four Bombardier Q400 aircraft into service. 	


* In March 2019, the Boeing 737 MAX 8 aircraft was grounded, until further notice, by Transport Canada as a precautionary safety measure.




ACTIVITIES	RESULTS	STATUS
	<ul style="list-style-type: none"> • Air Transat introduced three Airbus A330-200 and two Airbus A321neo aircraft into service. They also removed three Airbus A320-200 from service. • Rouge introduced one Boeing 767-300ER, two Airbus A319-100 and one Airbus 321-200 aircraft into service. • Jazz removed one Bombardier DH8-100 and one Bombardier DH8-300 aircraft from service. <p>ATAC all-passenger air carriers continued to add highly efficient aircraft such as Boeing 737-800, Boeing 737 MAX 8 and Bombardier Q400/ATR 42-500 and 700 aircraft to their fleets while replacing older less efficient fleet types such as Boeing 737-200 and Hawker Siddeley 748. Operators of Boeing 737-200 aircraft have replaced almost all of these classic versions with Boeing 737-300/400/500 series aircraft with their more efficient CFM56 engines. The remaining Boeing 737-200 aircraft are currently being retained as they are combi freighter/passenger aircraft equipped for operation on gravel runways and there is no direct replacement type of aircraft available. Further efficiencies have been achieved with the utilization of combi variants of the 737-400, ATR 42-300 and Dash 8-300/100 combi's.</p> <p>ATAC all-cargo air carriers continued their transformation, at a more advanced pace. In order to improve efficiencies in cargo operations, operators have upgraded from Boeing 727 aircraft to larger, more fuel-efficient aircraft with high bypass ratio engines such as Boeing 757-200F and Boeing 767-300F</p> <p>By replacing Boeing 737-800 with the next generation Boeing 737 MAX 8 aircraft, Canadian air carriers are expected to experience a 19 percent increase in range and a 16 percent lower fuel burn. In addition, the MAX aircraft have decreased drag with modifications to the tail cones, engine aerodynamics and split tip winglets. The new LEAP engines produce 20 percent lower carbon emissions and 50 percent lower nitrogen oxide emissions.</p>	
<p>Business aviation operators will be encouraged to take advantage of opportunities to reduce emissions through fleet renewal.</p>	<p>The Canadian Business Aviation Association (CBAA) continued to build on its GHG reduction outreach efforts through its online forum and other member fora. The online forum increases awareness 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 GHG emissions through fleet renewal.</p>	



ACTIVITIES	RESULTS	STATUS
MORE EFFICIENT AIR OPERATIONS		
Canadian air carriers expect to achieve average annual fuel efficiency improvements for domestic and international flights to 2020 through improved operations.	<p>All ATAC and NACC members continued to re-emphasize the use of fuel saving operating procedures. Carriers continue to look for additional opportunities to reduce fuel burn by reviewing operating procedures and weight saving programs.</p> <p>The use of combi aircraft provide the opportunity to carry reduced passenger loads with cargo in the cabin of the aircraft. This segregation has increased operational efficiency.</p>	
Business aviation operators will be encouraged to adopt operational improvement to reduce emissions.	The CBAA continued to encourage its members to take advantage of opportunities to reduce GHG emissions through operational improvements. The CBAA Forum will continue to give these issues greater visibility to operators.	
Canadian operators will continue to take advantage of the opportunities identified in ICAO guidance on minimizing fuel use and reducing emissions.	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.	




ACTIVITIES	RESULTS	STATUS
IMPROVED CAPABILITIES IN AIR TRAFFIC MANAGEMENT		
<p>NAV CANADA, in partnership with Transport Canada, Canadian air carriers, global Air Navigation Service Providers and other industry participants remains committed to taking advantage of opportunities to improve air traffic management (ATM) through further implementation of Performance Based Navigation (PBN), such as Public Required Navigation Performance -Authorization Required (RNP AR), new ATM technologies and procedures, as well as surveillance technologies, such as Automatic Dependent Surveillance-Broadcast (ADS-B) and multilateration.</p> <p>More specifically NAV CANADA will:</p>	<p>The Canadian Performance-based Aviation Action Team (CPAAT) is leading the implementation of Canada's PBN Implementation Plan and will provide opportunities for ongoing consultation and involvement throughout implementation.</p>	
<ul style="list-style-type: none"> Implement RNP AR procedures at numerous airports, 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. 	<p>RNP AR approaches allow aircraft to land using satellite-based navigation in place of ground-based navigation systems, the benefits of which include reduced flying time and GHG emissions.</p> <p>In 2018, NAV CANADA continued the implementation and publishing of new public RNP AR approaches at Regina, Saskatoon, Brandon, Deer Lake and Quebec City, bringing the total number of airports with RNP AR to 12. RNP AR project work was also initiated at Thunder Bay, London, Kitchener/Waterloo, Kamloops, Penticton and Toronto Island airports for planned publication in 2019.</p> <p>Through the use of RNP AR procedures approximately 2 million litres of aviation fuel have been saved. This results in a reduction of approximately 5 million kilograms of CO₂ emissions, which is over double the reduction from 2017.</p>	

ACTIVITIES	RESULTS	STATUS
	<p>In November 2018, NAV CANADA became the first Air Navigation Service provider to adopt the new ICAO separation standard, established on RNP AR at the Calgary International Airport. The new standard safely enables arriving aircraft in Calgary to simultaneously conduct RNP AR approaches and improves the integration of these procedures, increasing the usage of quieter, continuous descent approaches. Through the increased use of RNP AR approaches using the new standard, NAV CANADA is estimating an additional reduction of approximately 2,500 tonnes of GHG emissions in the first year alone.</p> <p>In conjunction with implementing RNP AR approaches, NAV CANADA conducted reviews of the airspace surrounding Regina, Saskatoon, Quebec City, Deer Lake and Brandon Airports, identifying and modernizing standard departure and arrival procedures, with a focus on PBN. Improvements and efficiencies that benefited NAV CANADA and customers were identified, and were implemented concurrently with the publication of RNP AR projects.</p> <p>Transport Canada, NAV CANADA and other key stakeholders (including customers, airport authorities, noise consultation, procedure design and operational Air Traffic Control) continue to work through a collaborative process to make the necessary regulatory and procedural changes to take even greater advantage of these approaches. The work underway includes new approvals and separation standards, which are required to allow the use of these types of procedures in a close parallel runway environment, such as at Calgary and Vancouver international airports.</p>	
<ul style="list-style-type: none"> • 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. 	<p>In 2018, under the Aireon initiative, three additional ADS-B payloads on Iridium Next satellites were successfully launched and deployed. As a result, NAV CANADA estimates GHG emissions savings to be approximately 300,000 tonnes, from North Atlantic routes alone.</p>	
<ul style="list-style-type: none"> • Report annually on achievable fuel savings and emission reductions from joint efforts with domestic and international carriers operating in Canadian airspace and industry partners through the annual Corporate Social Responsibility Report. 	<p>NAV CANADA's 2018 Corporate Social Responsibility Report is available on the NAV CANADA website.</p>	


ACTIVITIES	RESULTS	STATUS
<p>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.</p>	<p>Transport Canada issued an advisory circular (AC 700-041 Required Communications Performance 240 and Required Surveillance Performance 180) for the North Atlantic, which was updated in 2018.</p> <p>Transport Canada's PBN State Plan outlines the actions that have and will be undertaken to develop and implement policy to ensure smooth transition to ADS-B and monitor future changes in the technology in Canada.</p>	
AVIATION ENVIRONMENTAL RESEARCH AND DEVELOPMENT		
<p>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 the following key organizations and programs.</p>		
<ul style="list-style-type: none"> Green Aviation Research & Development Network (GARDN) 	<p>Established in 2009 and renewed in 2014, GARDN has supported 37 projects (32 completed and 5 in progress) representing over \$70 M of Canadian aviation environmental research (jointly funded by the federal government and participating aerospace companies). These projects embrace three research thrusts, CLEAN, QUIET and a SUSTAINABLE Canadian air transport.</p> <p>Over half of the aforementioned projects deal specifically with emissions reductions. Five projects focus on bio-derived jet fuel applications for Canada.</p>	
<ul style="list-style-type: none"> FAA Aviation Sustainability Centre (ASCENT) 	<p>ASCENT, also known as the Center of Excellence for Alternative Jet Fuels and Environment, works to create science-based solutions to the aviation industry's biggest challenges. In 2018, Transport Canada continued to sponsor ASCENT and maintain an active role on the Advisory Committee reviewing research projects and progress with particular focus on the following:</p> <ul style="list-style-type: none"> ASCENT 1 – Alternative Jet Fuel Supply Chain Analysis; ASCENT 21 – Improving Climate Policy Analysis Tools; ASCENT 24 – Emissions Data Analysis for CLEEN, ACCESS and Other Recent Tests, and Project; ASCENT 31A – Alternative Jet Fuels Test and Evaluation; 	

ACTIVITIES	RESULTS	STATUS
	<ul style="list-style-type: none"> • ASCENT 33 – Alternative Fuels Test Database Library; • ASCENT 36 – Parametric Uncertainty Assessment for the Aviation Environmental Design Tool (AEDT); • ASCENT 45 – Takeoff/Climb Analysis to Support AEDT APM Development; • ASCENT 46 – Surface Analysis to Support AEDT APM Development; and • ASCENT 48 – Analysis to Support the Development of an Engine non-volatile Particulate Matter (nvPM) Emissions Standard. 	
<ul style="list-style-type: none"> • National Research Council of Canada (NRC) 	<p>With financial support from the Government of Canada's Clean Transportation Initiatives, the NRC has:</p> <ul style="list-style-type: none"> • Participated in ND-MAX, an international sampling campaign at Ramstein Air Force base in Germany with NASA and DLR (German Aerospace) to measure emissions from alternative jet fuels, both in-flight and on-wing (ground). Analysis on-going. • Contributed significantly to an improved assessment of the uncertainties associated with the measurement of nvPM mass and number emissions. • Contributed to the development and documentation of a system loss methodology for the sampling and measurement of nvPM mass and number emissions from aircraft engines. • Continued to support OEMs with their certification efforts with respect to their nvPM emissions data. • Continued to work with Transport Canada, Environment and Climate Change Canada (ECCC) and the US FAA to develop capabilities to conduct the required testing to transition to unleaded aviation gasoline. • Conducted extensive ground and flight testing of experimental fuel using the Harvard test aircraft in support of the FAA's Piston Aviation Fuel Initiative program. • Used the previously developed Testbed for Aviation Piston Engine Research (TAPER) for the simulated altitude testing of potential candidate unleaded aviation gasoline formulations. 	
<ul style="list-style-type: none"> • US Transportation Research Board's Airport Cooperative Research Program (ACRP) 	<p>Transport Canada and the Canadian Airports Council continue to support and participate in ACRP and share relevant information with Canadian airports.</p>	


ACTIVITIES	RESULTS	STATUS
ALTERNATIVE FUELS		
<p>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.</p>	<p>GARDN has funded five projects on bio-derived jet fuel applications for Canada, two under GARDN I and three under GARDN II (described below):</p> <ul style="list-style-type: none"> • WG-22 project: Civil Aviation Alternate Fuel Contrail and Emission Research (CAAF CER). The objective of this project was to enhance the T33 emissions instrumentation by the addition of a CPC3776 ultra-fine aerosol sensor and denuder to differentiate between volatile and non-volatile particulates and then undertake jet emissions and contrail measurement flights. It was found that both the contrail ice particle number and particle emissions reduced in proportion to the percentage of HEFA used in the biofuel blend. The NRC Laboratory Technical Report was publicly released in 2018. • NEC-21 project: An assessment of likely technology maturation pathways used to produce biojet from forest residues. The assessment concluded that biocrudes produced through thermochemical liquefaction technologies, including fast pyrolysis, catalytic pyrolysis and hydrothermal liquefaction can be successfully used to produce a significant volume of biojet fuel. In addition, through a life cycle analysis, the assessment demonstrated that significant emission reductions were possible. • WG-21 project: Canada's Biojet Supply Chain Initiative (CBSCI): The primary objective of the project was to demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system using existing delivery infrastructure to directly support carbon neutral growth of the Canadian aviation sector beyond 2020. The project also aimed to validate the Canadian biojet supply chain elements (e.g. quantitative feedstock availability, sustainability certification, biojet integration in the jet fuel supply system, quantify regulatory/fiscal options) to enable a feasibility assessment for private sector investment in commercial scale biojet production in Canada. The project included hands-on experience in the one-time delivery of blended biojet fuel from California's AltAir Fuels facility to Toronto Pearson International Airport's commingled fuel infrastructure. Biojet handling and integration with existing airport fueling infrastructure will help to develop best practices in Canada. For more information on the project, including the published reports, visit the CBSCI website. <p>In August 2018, the Government of Canada, with industry and research partners, announced the launch of a sustainable aviation fuels innovation competition entitled The Sky's the Limit Challenge. For more information, see text box on Page 2.</p> <p>Transport Canada maintains a dialogue with the US FAA to exchange information on biofuels development.</p>	



ACTIVITIES	RESULTS	STATUS
<p>The Government of Canada and the Canadian aviation industry will continue to support research, development and demonstration of alternative fuels for aviation through active participation in international fora such as the ICAO Committee on Aviation and Environmental Protection (CAEP) and its working groups and task forces, ASCENT and the Commercial Aviation Alternative Fuels Initiative (CAAFI).</p>	<p>In 2018, Transport Canada actively supported:</p> <ul style="list-style-type: none"> • The ICAO CAEP Alternative Fuels Tasks Force, including a Canadian expert from the University of Toronto with specific expertise in biofuel lifecycle assessment; • The ICAO CAEP Global Market-based Measures Task Force – alternative fuels subgroup; and • The US FAA through ASCENT Center of Excellence and collaborated with NASA on alternative aviation fuel research. <p>Transport Canada continues to liaise with other government departments through the ad-hoc aviation biofuels group to both share information on biojet development and discuss government-wide views on issues of common interest.</p>	

AIRPORT GROUND OPERATIONS AND INFRASTRUCTURE USE



<p>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.</p>	<p>Several emission reduction initiatives are advancing at Canadian airports. Examples include:</p> <ul style="list-style-type: none"> • Vancouver International Airport (YVR) upgraded six gates with pre-conditioned air (PCA) units, which maintain the temperature and air quality of parked aircraft by bringing external, filtered air into the cabin. With three additional gates equipped, 95 percent of YVR's gates now have both PCA and ground power units (GPU), up from 42 percent in 2012. YVR continues to actively work on electrical charging infrastructure to reach a 50 percent goal of ground handling fleet running on electric power by 2020. In 2018, 32 percent of the licensed Ground Support Equipment (GSE) operator fleet and 73 percent of baggage support equipment were electric. There are 40 common-use charging stalls to support the electrification goal. In 2017, YVR launched a passenger bussing initiative, transferring passengers by bus from aircraft to its international terminal. This was supported by the first fully electric COBUS in North America. In 2018 additional electric buses were added for a fleet total of eight. • Montréal-Trudeau airport (YUL) introduced a series of measures to reduce GHG emissions, including: <ul style="list-style-type: none"> » The acquisition of a fully electric COBUS, for passenger transport to and from remote aircraft stands; » The acquisition of four plug-in hybrid electric vehicles for Airport Patrol service contracts; 	
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ACTIVITIES	RESULTS	STATUS
	<p>» YUL has also installed charging stations for electric vehicles in public and employee parking lots as well as those for its service vehicles, increasing the number of stations to 46 in 2018; and</p> <p>» The conversion of more than 2,000 indirect lighting fixtures to LEDs in the terminal complex.</p> <p>Each year, YUL continues to upgrade its heating, ventilation and air-conditioning systems to optimize performance. In 2018, an ASHRAE Energy Audit I and II was conducted to target low-cost, fast-return measures. A new inclined carousel with advanced friction-drive technology was installed in the international arrivals area. This equipment consumes 2.5 times less energy than the one it replaced.</p> <ul style="list-style-type: none"> • In 2018, Toronto Pearson International Airport (YYZ) initiated a study & completed preliminary design work for upgrades to the electric chargers for GSE in the terminal baggage roads. Furthermore, YYZ completed LED lighting conversions at both terminals—installing a total of 6,000 LED tubes and 1,800 new fixtures. Together with a Terminal 1 heating, ventilation and air conditioning optimization project, these initiatives have significantly reduced the airport's GHG emissions. • Greater Moncton Romeo LeBlanc International Airport (YQM) has implemented a Carbon Management Plan, which includes: <ul style="list-style-type: none"> » carbon reduction initiatives to continually reduce emissions from the airport » monitoring fuel and energy consumption » awareness and training program for staff » control measures in place to minimize emissions » internal auditing program <p>In addition, carbon reduction initiatives currently underway include an LED retrofit of lighting in the Terminal Building, and a voltage optimization project to reduce energy consumption of key equipment.</p> • Quebec City Airport (YQB) has implemented a Carbon Management Plan and produced its first Sustainable Development Report, in accordance with the Global Reporting Initiative. In addition, measures concerning the reduction of energy consumption (e.g. heating, air conditioning, etc.) have been implemented in their new terminal, resulting in 54 percent GHG emission reductions in 2018, despite the doubling of the area. 	

ACTIVITIES	RESULTS	STATUS
	<ul style="list-style-type: none"> In 2018, Halifax Stanfield International Airport (YHZ) implemented a carbon management plan to reduce emissions. Initiatives included undertaking a 2-year program to replace existing incandescent airfield lighting fixtures with new LED technology that saw a total of 400 fixtures replaced in 2018 and 1,600 more to be switched in 2019. Other projects included upgrading lighting control in administrative offices with LED technology, occupancy sensors, and daylight harvesting; real-time electricity consumption monitoring; upgrading HVAC controls from pneumatic to digital for more precise control and optimization; and fine tuning of natural gas boilers for improved efficiency. <p>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, Calgary in 2014, and will be operational in Vancouver in 2019.</p> <p>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.</p> <p>The Greater Toronto Airports Authority Air Traffic Management Working Group has extended the Airline/NAV CANADA working partnership to aircraft movements from gate-to-gate. This has improved performance and reduced emissions by balancing and improving runway use, and arrival and departure flows (holding and taxi times). In 2016, the Visual Departure Separation, which allows for the reduction of the minimum separation standard of three miles, was implemented. Results have shown an estimated benefit of one additional flight per hour, when utilized in the north-south operation. The process continues on a full-time basis whenever appropriate conditions allow.</p>	
<p>Partners will work together to improve the quantification of GHG emissions associated with ground operations.</p>	<p>The Airport Ground Operations Subgroup, made up of industry and government representatives, reviewed and updated its workplan, which includes the following objectives:</p> <ul style="list-style-type: none"> To explore GHG emission reduction opportunities from airport ground operations and quantify the impacts from these opportunities where possible; and To establish a forum for research, information sharing, and discussion of emerging initiatives involving the reduction of GHG emissions within Canada's airport ground operations. 	

ACTIVITIES	RESULTS	STATUS
<p>Canadian airports will refine and improve emissions inventories and will explore further opportunities for emissions reduction strategies.</p>	<p>There are 14 Canadian airports participating in the Airport Carbon Accreditation (ACA) program under Airports Council International (ACI). Within this program, there are four levels of certification:</p> <ul style="list-style-type: none"> I. Mapping – footprint measurement; II. Reduction – carbon management towards a reduced carbon footprint; III. Optimization – third party engagement in carbon footprint reduction; and IV. Neutrality – carbon neutrality for direct emissions by offsetting. <p>Canadian airports have achieved the following levels of certification:</p> <p>Level I: Victoria, Kelowna, Edmonton, Regina, Winnipeg, Fredericton, and Charlottetown</p> <p>Level II: Quebec City and Halifax (2019)</p> <p>Level III: Montreal, Toronto, Vancouver, Moncton (2019) and Ottawa (2019)</p> <p>Participation in the ACA program is voluntary and is a step that a subset of Canadian airports have chosen to take to demonstrate their commitment to reducing emissions. However, it should be noted that a number of airports who are not participating in this program have also made strong commitments to reducing emissions through their environment programs.</p>	
REGULATORY MEASURES		
<p>Transport Canada will continue to participate in the development of the new international nvPM mass and number standard for aircraft engines, through the ICAO CAEP.</p>	<p>Canada continues to make significant contributions in the development of the ICAO nvPM international mass and number standard. This Phase II standard will be completed at ICAO in 2019.</p>	

ACTIVITIES	RESULTS	STATUS
<p>Transport Canada will adopt the nvPM standards (Phase I and II) domestically under the <i>Aeronautics Act</i>.</p> <p>Transport Canada will adopt the new CO2 emissions standard domestically under the <i>Aeronautics Act</i>.</p> <p>Transport Canada will also incorporate CORSIA into the <i>Aeronautics Act</i> for Canadian operators operating internationally.</p>	<p>The notice for proposed amendment (NPA) to the Canadian Aviation Regulations for Phase I of the nvPM standard has been prepared and will be published in 2019. Transport Canada will draft the NPA for Phase II of the nvPM standard once it has been adopted by ICAO in 2020.</p> <p>The CO2 standard requires an enabling regulation in the <i>Aeronautics Act</i> for the new Annex 16 Volume III. Work is underway on the amendment to the regulations.</p> <p>The MRV requirements of CORSIA were finalized in Canada Gazette in November 2018. Regulations covering the offsetting phase of CORSIA will be completed ahead of its start date of January 1, 2021.</p>	
INTERNATIONAL COORDINATION		
<p>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.</p>	<p>Canada supports CAEP's working groups and task forces with technical experts and provides significant leadership in a number of key areas.</p> <p>Canada continues to actively participate in CAEP to refine the nvPM mass and number standard for aircraft engines, as well as the technical requirements for CORSIA. Canada is also a member of the Advisory Group to Council on CORSIA that is providing guidance on the development of the scheme.</p> <p>On June 27, 2018, ICAO Council adopted the Standards and Recommended Practices (SARP) for CORSIA. The SARPs include the majority of the rules underpinning the system and their adoption is a key step in the process. Future decisions are still needed on the detailed requirements for emission units and sustainable aviation fuels. Canada will continue to actively participate in CAEP in support of CORSIA and in particular on the development of related CORSIA Eligible Fuels requirements under the Alternative Fuels Task Force.</p> <p>Canada co-leads ICAO CAEP Working Group 2 which deals with airports and operations. Several of the work items of this group deal with minimizing emissions that affect the global climate and local air quality.</p>	

ACTIVITIES	RESULTS	STATUS
<p>NAV CANADA will continue to support the air navigation interests of Canadian aviation stakeholders internationally through representation in ICAO groups and panels.</p>	<p>Transport Canada and NAV CANADA are supporting efforts under ICAO's Global Air Navigation Plan and Aviation System Block Upgrades, as well as NAV CANADA's PBN Operations Plan, through planned upgrades on:</p> <ul style="list-style-type: none"> • Communications; • Navigation; • Surveillance; and • Air traffic management. <p>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.</p>	
<p>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.</p>	<p>AIAC member companies continue to provide subject matter experts to advise CAEP; and AIAC provides the link to the international community through its membership in ICCAIA.</p> <p>The President and CEO of AIAC also plays a key leadership role by chairing and facilitating the work of GARDN.</p>	



CONCLUSIONS

SUMMARY OF RESULTS

Aviation activity and associated fuel use data for 2018 provided by members of ATAC and NACC, demonstrate continued progress towards the Action Plan's fuel efficiency target and aspirational goal.

Since 2010, the demand for aviation services has continued to grow. Combined revenue passenger and cargo operations increased by 8.5 percent in 2018, compared with 2017. Canadian air carriers used 8.5 billion litres of fuel, a 5 percent increase compared with 2017. Consequently, total GHG emissions also increased by 5 percent to 22.04 Mt in 2018.

In 2018, the fuel efficiency (i.e. litres per RTK) improved by 3.3 percent, compared with 2017. The combined domestic and international fuel efficiency rate reported for 2018 was 32.2 litres per 100 RTK (combining both passenger and cargo traffic). This translates to an annual average fuel efficiency improvement of 2 percent between 2008 and 2018, and a cumulative improvement of 18.4 percent.

In relation to the aspirational goal, Canadian air carriers improved their fuel efficiency by 1.7 percent with a cumulative improvement of 20.3 percent from 2005–2018.



LOOK AHEAD 2019

This section provides a snapshot of advancements being made under measures of the Action Plan in 2019. More detail will be provided in the 2019 Annual Report, which is scheduled to be released in fall 2020.

FLEET RENEWALS:

Updates on NACC and ATAC carrier fleet renewal plans:

- Air Canada will take delivery of six Boeing 737 Max 8, two Boeing 787-9 aircraft, four Airbus A330-300 and one Airbus A220-300 aircraft. Twelve additional 737 Max 8 deliveries were initially expected in 2019, but were postponed as they were conditional on the resolution of the 737 Max aircraft grounding.
- WestJet plans to take delivery of four new Boeing 737 Max 8 aircraft and will introduce three Boeing 787-9 aircraft into service. The 737 Max 8 deliveries will be conditional on the resolution of the 737 Max aircraft grounding.
- Rouge will take delivery of four Airbus A321-211 and six Airbus A320-214 aircraft.
- Sunwing will continue to add Boeing 737 MAX 8 aircraft to its fleet, conditional on the resolution of the 737 Max aircraft grounding.

AIR TRAFFIC MANAGEMENT:

Updates on the NAV CANADA PBN projects

- RNP AR and PBN airspace project work continues, with larger scale multi-airport projects in the Maritimes and Southern Ontario.
- Further implementations of the new ICAO separation standard, established on RNP AR, will be explored for possible deployments at other major airports in Canada.

RESEARCH AND DEVELOPMENT— ALTERNATIVE FUELS:

In May 2019, the Government of Canada announced the top four finalists for the Green Aviation Fuels Innovation Competition under the Sky's the Limit Challenge. Each finalist received up to \$2 million and have now entered an 18-month period to produce their fuel.

AIRPORT GROUND SUPPORT EQUIPMENT:

Vancouver International Airport will complete the installation of PCA and GPU units at bridged gates in 2019.

Toronto Pearson International Airport purchased two electric busses (COBUS) to its fleet in order to support the transfer of passengers by bus to and from aircraft at hardstands and its Infield Concourse.

Halifax Stanfield International Airport will continue with the 2-year program to replace existing incandescent airfield lighting fixtures with new LED technology and will replace 1,600 fixtures in 2019.

FEDERAL REGULATORY MEASURES:

The Government of Canada established a pan-Canadian approach to pricing carbon pollution in 2018, with a federal fuel charge and output-based pricing system coming

into effect in 2019. For provinces subject to the federal fuel charge, aviation fuel used in intra-provincial flights is included. The Government has committed to engage with stakeholders, provinces and territories, on an approach to pricing for inter-provincial flights.

The Government of Canada also held consultations with industry representatives in 2019 on the development of the federal Clean Fuel Standard (CFS). It is anticipated that the CFS will initially apply to liquid fuels used in Canada starting in 2022, with regulations planned to be published in Canada Gazette, Part I, in 2020.

DOMESTIC AND INTERNATIONAL COORDINATION:

In 2019, Transport Canada initiated drafting for the offsetting phase of CORSIA and worked with Canadian international operators to ensure they properly implement their operations under the MRV phase.





APPENDIX A:

DATA TABLES

TABLE 1:
Annual Results of Domestic and International Operations, 2005–2018

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fuel use (million litres)	4,887	5,186	5,543	5,575	5,098	5,659	6,089	6,256	6,314	6,579	7,023	7,555	8,137	8,542
GHG emissions (megatonnes of CO ₂ e)	12.619	13.390	14.312	14.396	13.164	14.611	15.721	16.153	16.303	16.987	18.132	19.506	21.010	22.057
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	175.66	193.98	212.06	230.03
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	17.57	19.40	21.21	23.00
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	2.24	2.64	3.22	3.51
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	19.80	22.04	24.43	26.51
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	0.0400	0.0389	0.0384	0.0371
Litres/Total RTK	0.4043	0.4043	0.3895	0.3947	0.3879	0.3802	0.3780	0.3716	0.3683	0.3574	0.3546	0.3428	0.3331	0.3222
Emission rates**														
CO ₂ e grams/RPK	118.52	115.28	114.66	111.92	113.47	111.28	108.59	108.03	105.11	103.22	100.55	99.08	95.89	95.89
CO ₂ e grams/Total RTK	1,044	1,006	1,019	1,002	982	976	960	951	923	916	885	860	832	832

* 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.

** All GHG emissions included in this report have been calculated based on Environment and Climate Change Canada's (ECCC) National Inventory Report 1990-2017.

TABLE 2:
International vs. Domestic Aviation Activity, 2018

	International	Domestic	Total
Fuel use (million litres)	5,900	2,637	8,537
GHG emissions (megatonnes of CO ₂ e)	15.23	6.81	22.04
Traffic (billions)			
Revenue passenger-kilometres (RPK)	170.5	59.4	230.0
Passenger revenue-tonne-kilometres (pass. RTK)	17.1	5.9	23.0
Cargo revenue-tonne-kilometres (cargo RTK)	2.8	0.7	3.5
Total revenue-tonne-kilometres (RTK)	19.8	6.7	26.5
Fuel consumption rates			
Litres/Total RTK	0.2975	0.3945	0.3220
Emission rates			
CO ₂ e grams/Total RTK	768	1,019	832

TABLE 3:
Absolute and Proportional Changes Over Time, 2008–2018

	Change 2017–2018		Change 2008–2018		
	Absolute	Proportional	Absolute	Proportional	Annual Rate
Fuel use (million litres)	406	5.0%	2,967	53.2%	4.4%
GHG emissions (megatonnes of CO ₂ e)	1.05	5.0%	7.7	53.2%	4.4%
Traffic (billions)					
Revenue passenger-kilometres (RPK)	18.0	8.5%	104.5	83.2%	6.2%
Passenger revenue-tonne-kilometres (pass. RTK)	1.8	8.5%	10.4	83.2%	6.2%
Cargo revenue-tonne-kilometres (cargo RTK)	0.3	8.9%	1.9	123.5%	8.4%
Total revenue-tonne-kilometres (RTK)	2.1	8.5%	12.4	87.7%	6.5%
Fuel consumption rates*					
Litres/RPK	-0.001	-3.2%	-0.0073	-16.4%	-1.77%
Litres/Total RTK	-0.011	-3.3%	-0.0725	-18.4%	-2.01%
Emission rates					
CO ₂ e grams/RPK	-3.2	-3.2%	-18.8	-16.4%	-1.77%
CO ₂ e grams/Total RTK	-28.1	-3.3%	-187.2	-18.4%	-2.01%

* Note that fuel consumption rates are calculated using the Compound Annual Growth Rate (CAGR) formula. For more information, refer to Appendix D.



APPENDIX B:

PROGRESS TOWARDS CANADA'S 2 PERCENT ASPIRATIONAL GOAL

In addition to reporting against the 1.5 percent annual average fuel efficiency target from a 2008 baseline, Canada continues to pursue and report against the 2012 aspirational goal to improve fuel efficiency by a 2 percent annual average, from a 2005 baseline of 40.4 L/100 RTK.

Table 4 provides the combined ATAC and NACC results for measuring progress towards the aspirational goal between 2005 and 2018.

TABLE 4:
Absolute and Proportional Changes Over Time, 2005–2018

	Absolute	Change 2005–2018	
		Proportional	Annual Rate
Fuel use (million litres)	3,655	74.8%	4.4%
GHG emissions (megatonnes of CO ₂ e)	9.44	74.8%	4.4%
Traffic (billions)			
Revenue passenger-kilometres (RPK)	124.8	118.6%	6.2%
Passenger revenue-tonne-kilometres (pass. RTK)	12.5	118.6%	6.2%
Cargo revenue-tonne-kilometres (cargo RTK)	1.9	124.1%	6.4%
Total revenue-tonne-kilometres (RTK)	14.4	119.3%	6.2%
Fuel consumption rates*			
Litres/RPK	-0.009	-20.0%	-1.71%
Litres/Total RTK	-0.082	-20.3%	-1.73%
Emission rates			
CO ₂ e grams/RPK	-24.0	-20.0%	-1.71%
CO ₂ e grams/Total RTK	-212.0	-20.3%	-1.73%

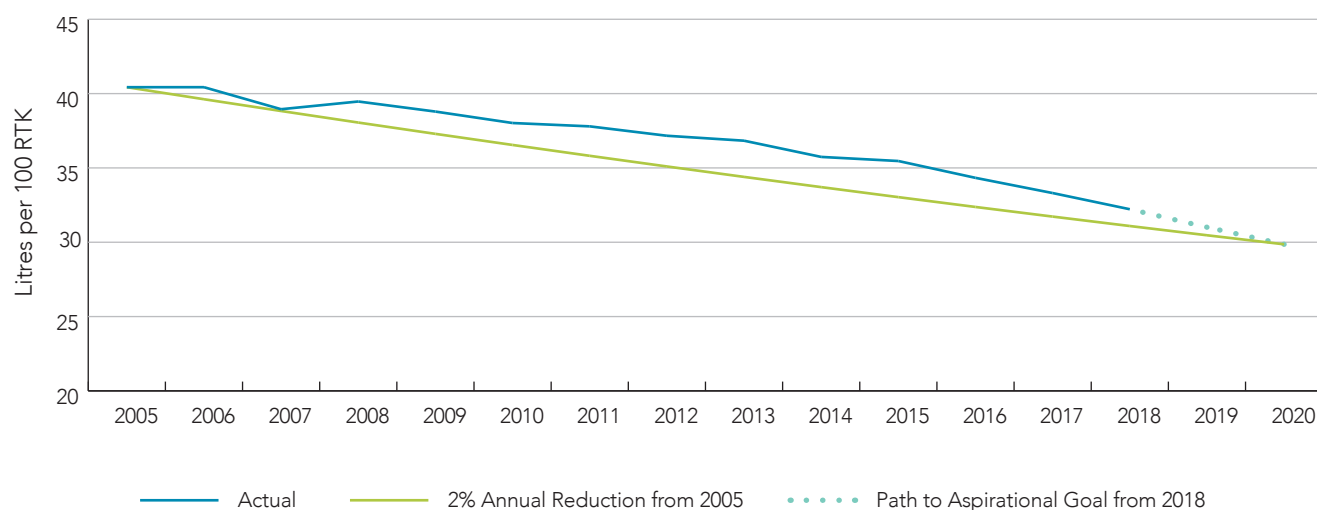
* Note that fuel consumption rates are calculated using the Compound Annual Growth Rate (CAGR) formula. For more information, refer to Appendix D.

The figures presented in Table 4 allow for the following summary of trends between 2005 and 2018:

- Fuel consumption and GHG emissions rose by 74.8 percent, an average of 4.4 percent per year;
- RPK grew by 118.6 percent;
- Total reported RTK increased by 119.3 percent; and
- The cumulative improvement in fuel efficiency (litres/RTK) was 20.3 percent, or an annual average of 1.7 percent.

Chart 7 shows the goal trajectory of the 2 percent aspirational goal and the fuel efficiency improvements made between 2005 and 2018. It also shows an indicative trajectory that would be required to meet the 2020 aspirational goal, given 2018 results.

CHART 7:
Aspirational Goal Trajectory, 2005–2020





APPENDIX C:

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

ACI: Airports Council International

ACRP: Airport Cooperative Research Program

ADS-B: Automatic Dependent Surveillance-Broadcast

AIAC: Aerospace Industries Association of Canada

ANSP: Air Navigation Service Providers

ASCENT: Aviation Sustainability Center

ATAC: Air Transport Association of Canada

ATAG: Air Transport Action Group

ATM: Air Traffic Management

CAEP: Committee on Aviation and
Environmental Protection

CBAA: Canadian Business Aviation Association

CO₂: Carbon Dioxide

CO₂e: Carbon Dioxide Equivalent

FAA: Federal Aviation Administration

GARDN: Green Aviation Research & Development Network

GSE: Ground Support Equipment

ICAO: International Civil Aviation Organization

ICCAIA: International Coordinating Council of Aerospace Industries Associations

Mt: Megatonnes

NACC: National Airlines Council of Canada

NRC: National Research Council

PBN: Performance-based Navigation

RNP: Required Navigation Performance

RNP AR: RNP Authorization Required

RPM: Revenue Passenger-Miles

RPK: Revenue Passenger-Kilometres

RTM: Revenue Ton-Miles

RTK: Revenue Tonne-Kilometres





APPENDIX D:

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 from ECCC's National Inventory Report 1990–2017.

AVIATION JET FUEL EMISSION FACTORS:

2560 grams CO₂ per litre

2582 grams CO₂e per litre

CONVERSION MILES TO KILOMETRES:

1 m = 1.609344 km

CONVERSION TONS TO TONNES:

1 ton = 0.907185 tonnes

FORMULA USED TO CALCULATE ANNUAL FUEL EFFICIENCY:

Compound Annual Growth Rate (CAGR) =
(ending value/beginning value)^(1/# of years) - 1

The fuel efficiency goals are expressed as cumulative annual reductions; therefore, the actual trends are calculated consistently as compound average annual growth rates.

FORMULAE FOR CO₂-EQUIVALENTS:

CO₂e (grams)/RPK = (Fuel Used × 2582) / (RPM × 1.609344)

CO₂e (grams)/Cargo RTK =
(Fuel Used × 2582) / (Cargo RTM × 1.609344 × 0.907185)

CO₂e (grams)/Total RTK =
(Fuel Used × 2582) / {(RPM × 1.609344 × 0.907185) +
(Cargo RTM × 1.609344 × 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 ECCC's

annual National Greenhouse Gas Emissions Inventory. Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, and therefore this report, does 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. However, coverage in 2018 was slightly less to that of 2017. The change in the number of carriers does not substantially affect the industry-wide ratios and longer-term trends computed for fuel use and emissions per unit of traffic.





APPENDIX E:

LIST OF SIGNATORIES AND AIR OPERATOR MEMBER COMPANIES REPORTING

Members of the Working Group on Aviation Emissions, which developed the Action Plan, include:

- [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 2018 data for this annual report⁵, including:

- Air Canada;⁶
- Air Transat;
- Jazz Aviation LP; and
- WestJet.⁷

⁵ Sky Service reporting was included as part of NACC's submission

⁶ Air Canada reporting includes data from Rouge

⁷ WestJet reporting includes data from Encore

The ATAC member carriers who contributed 2018 data for this annual report were:

- Air Georgian;
- Air North;
- Canadian North;
- Cargojet;
- Central Mountain Air;
- First Air;
- Flair Airlines;
- Harbour Air;
- KF Aerospace;
- Morningstar;
- Nolinor;
- North Cariboo Air;
- PAL Airlines;
- Porter Airlines; and
- Sunwing.



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