CANADA'S ACTION PLAN

TO REDUCE GREENHOUSE GAS EMISSIONS FROM AVIATION

2019 ANNUAL REPORT

Government of Canada
Gouvernement du Canada

Canada

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For questions regarding this report or Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, contact:
TC.AviationEmissions-Emissionsaviation.TC@tc.gc.ca

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EXECUTIVE SUMMARY

The Working Group on Aviation Emissions is pleased to present its eighth Annual Report under Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation (the Action Plan).

Aviation is vital to the movement of people and goods across Canada and abroad. Recognizing that flights rely on the use of fossil fuel and generate greenhouse gas (GHG) emissions, Canada's aviation sector, in partnership with the Government of Canada, has had a strong climate action strategy in place since 2005. Under this Action Plan, parties continue to voluntarily address these emissions by increasing efficiencies, adopting new green technologies, investing in infrastructure, and improving operations – these actions also contribute to six of the 17 United Nations Sustainable Development Goals. Furthermore, industry also has a strong engagement presence with the government as Canada develops and implements effective climate change policies and market-based measures, such as the Clean Fuel Standard (CFS) and the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

To date, good progress has been made on the Action Plan's implementation. Between 2008 and 2019 Canadian air carriers have improved their fuel efficiency at an annual average rate of 1.77 percent, which exceeds the Action Plan's target of 1.5 percent. Without these improvements, the sector would have emitted an additional 24.1 megatonnes (Mt) of carbon dioxide equivalent (CO_2e) over this time period.

In 2019, air carriers saw a slight decrease in fuel efficiency by 0.6 percent compared to 2018. This result is lower than those reported in recent years and is likely due to the grounding of the Boeing 737 MAX 8 aircraft and a reduction in reported cargo revenue-tonne-kilometers.

In addition to reporting on annual fuel use and efficiency, this document also describes measures taken under the Action Plan 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;
- sustainable aviation fuels;
- airport ground operations and infrastructure use;
- regulatory measures; and
- international coordination.

Finally, this report also provides a preview of important initiatives achieved in 2020. Despite the significant impact the COVID-19 pandemic has had on the aviation sector, in 2020 parties to the Action Plan continued to demonstrate their commitment to conducting activities and implementing measures to reduce emissions from aviation. This includes the fleet renewal and upgrades of National Airlines Council of Canada (NACC) and Air Transport Association of Canada (ATAC) carriers, advancements on NAV CANADA's Performance-Based Navigation projects, airport efficiency improvements, and the release of Canada's strengthened climate plan, A Healthy Environment and a Healthy Economy.

SKY'S THE LIMIT CHALLENGE

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. The finalists have been awarded up to $2 million each to help fund production and have entered an 18-month period where they will produce a 10-litre sample of their sustainable aviation fuel (SAF). In 2022, the team with the best sustainable aviation fuel will be awarded a $5-million Grand Prize to help commercialize their innovation.

The four finalists (in no particular order) are:

- Carbon Engineering Ltd for its SAF, made from air, water, and renewable electricity (British Columbia);
- Enerkem for its SAF made from forestry biomass and municipal solid waste through a hub and spoke approach (Quebec);
- FORGE Hydrocarbons Corp for its lipid-to-hydrocarbon SAF project (Alberta); and
- SAF+ Consortium for its SAF made from fuel gas-captured CO_2 and low-carbon hydrogen (Quebec).

INTRODUCTION

Canada's aviation industry is a major component of the country's transportation system and is a key driver of economic activity and trade, both domestically and internationally. Millions of Canadians rely on air transport to travel each year for business and pleasure. Air transport is also vital to northern and remote communities where it is often the only way to move people and basic commodities.

Like most types of transportation, air travel relies heavily on the use of fossil fuels, which generate greenhouse gas (GHG) emissions that contribute to climate change. In Canada, domestic aircraft operations account for 1 percent of the country's total annual GHG emissions. To minimize these emissions, Canada's air carriers have had a strong climate action strategy in place for over fifteen years. For example, in 2005 Transport Canada and the Air Transport Association of Canada (ATAC), on behalf of its member carriers, signed the world's first voluntary agreement to reduce GHG emissions from aviation.

Achieving significant efficiency improvements and emission reductions from aviation operations requires a full sector approach. As a result, in 2012, the Government of Canada and key stakeholders from across the Canadian aviation industry came together to release *Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation* (the Action Plan). This voluntary initiative builds on the foundation set by the 2005 agreement and brings the collective efforts of multiple organizations and their members, including the National Airlines Council of Canada (NACC), ATAC, the Canadian Airports Council (CAC), the Canadian Business Aviation Association (CBAA), the Aerospace Industries Association of Canada (AIAC), and NAV CANADA to increase efficiencies, improve operations and incorporate new technologies to minimize GHG emissions from aviation.

The Action Plan (2012–2020):

- Set a 1.5 percent annual average fuel efficiency improvement target by 2020;
- Set a 2 percent annual average fuel efficiency improvement aspirational goal by 2020;
- Identified key measures to improve efficiencies and minimize GHG emissions;
- Formed the basis for Canada's response to the International Civil Aviation Organization's (ICAO) request[1] for Member States to develop action plans to address GHG emissions from aviation;
- Established an Air Emissions Working Group to oversee the implementation of the Action Plan (See Appendix E for the list of Working Group organizations); and
- Committed to publish annual reports to demonstrate progress towards the fuel efficiency targets and emission reduction measures.

This is the eighth Annual Report under the Action Plan. As in past years, Transport Canada worked collaboratively with industry partners to collect and aggregate the quantitative data used to calculate the sector's fuel efficiency. Parties also provided updates and described actions being taken across the sector to support near- and long-term GHG emission reductions. This report was reviewed and approved by members of the Air Emissions Working Group and is published on Transport Canada's website.

When reviewing this report, it is important to consider the impact major world events have had on the 2019 results. The first is the grounding of the Boeing 737 MAX 8, which occurred following the tragic Ethiopian Airlines incident that claimed the lives of 157 people, including 20 Canadians. Along with grounding the aircraft, Canada also created strict safety measures that expanded on those recommended by the U.S. Federal Aviation Administration (FAA). These measures impacted airline operations and fleet fuel efficiency because less-efficient aircraft were relied on to maintain schedules and take on more routes.

The second major event is the COVID-19 global public health pandemic. In 2020 and 2021, when this report was being developed, Canada's aviation industry experienced unprecedented disruption and challenges as a result of the pandemic. Passenger air travel dropped by as much as 90 percent as governments recommended a halt to all non-essential travel. This led to an economic crisis rippling across the sector, which included mass lay-offs. This disruption caused significant capacity challenges regarding the production, collection and reporting of information under the Action Plan. As a result, fewer industry partners were able to contribute towards this voluntary initiative[2], which slightly impacts the ability to conduct longitudinal analysis on the data for this year. Despite these challenges, parties to the Action Plan were determined to continue publicly demonstrating their environmental performance metrics and communicating their commitment to reducing emissions.

1 Assembly Resolution a-37 "Invites those States that choose to prepare their action plans to submit them to ICAO as soon as possible preferably by the end of June 2012 in order that ICAO can compile the information in relation to achieving the global aspirational goals, and the action plans should include information on the basket of measures considered by States, reflecting their respective national capacities and circumstances, and information on any specific assistance needs."

2 Although the number of air carriers that voluntarily provide data under the Action Plan fluctuate from year to year, the 2019 reporting year in particular saw a reduction in participation, due to COVID-19 circumstances. This includes Georgian Air (airline) which ceased operations, and WestJet, which did not provide its cargo data due to capacity issues.

AIR TRAFFIC MANAGEMENT—RECOGNITION FOR BEING A WORLD LEADER IN USING ATM TO REDUCE AVIATION'S ENVIRONMENTAL FOOTPRINT

NAV CANADA was the recipient of the 2019 Air Traffic Management (ATM) ATC Award and was a World ATM Congress Maverick award finalist for Sustainability, in reducing the impact on the environment and making significant contributions to improving the environmental footprint of aviation through ATM. Both awards were recognition for being the world's first Air Navigation Service Provider to implement the new ICAO standard, "Established on RNP-AR," (EoR), which is now operational at Calgary International Airport. The new standard significantly increases the usage of RNP AR approaches at parallel runway airports, and at Calgary in the first 12 months of operation, over 35,000 RNP AR approaches (from Canadian and international air carriers) were flown, saving 4.1 million kgs of GHG emissions.

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. 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 6 of the 17 SDGs.

RESULTS FOR 2019

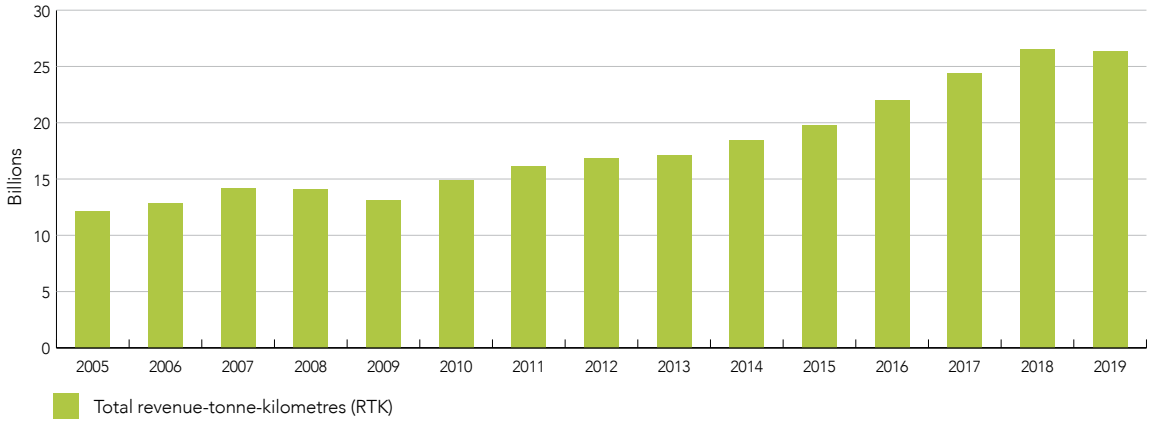
This section outlines the results for 2019, including airline traffic, fuel use, fuel efficiency and GHG emissions reductions.

TRAFFIC AND FUEL USE

Following nine years of continual increases in annual traffic, passenger traffic hardly changed in 2019 compared to 2018, while demand for cargo transport declined slightly from its 2018 peak. In 2019, combined revenue service for Canadian airlines was 26.3 billion total Revenue Tonne-Kilometres (RTK)[3]. This is a decrease by 0.8 percent in 2019 compared to 2018. Fuel use decreased by 0.1 percent in 2019 compared to 2018, to a total of 8.53 billion litres. The following chart shows the annual traffic in total RTK between 2005 and 2019.

CHART 1

Annual Traffic – Combined International and Domestic Operations, 2005–2019



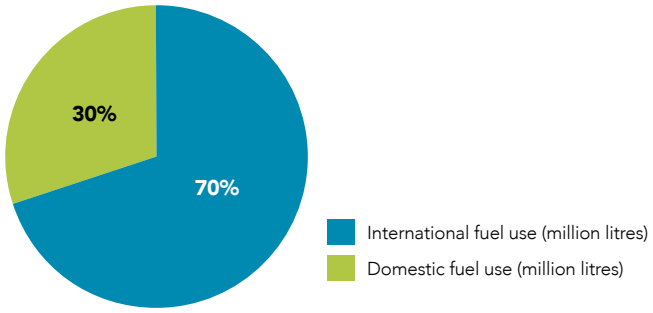
3 RTK is calculated as the total tonnes of passenger and freight multiplied by kilometres flown. The industry conventional assumption is that the average weight per passenger is 100kg or 0.1 tonnes.

This report compares results for both domestic and international operations of Canadian operators. 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.

In regard to the 8.53 billion litres of fuel consumed in 2019, 70 percent was consumed for international activity and 30 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, 2019



BioPortYVR PROJECT

Sustainable aviation fuel (SAF) is a key element to help the aviation industry achieve deep long-term emission reductions. The Vancouver International Airport is working with a team experienced in SAF development and airport sustainability (The Green Aviation Research and Development Network (GARDN), SkyNRG and Waterfall Group) to establish Canada's first SAF supply chain at the Vancouver International Airport.

BioPortYVR partners completed a feasibility study to determine the elements required to introduce an ongoing supply of SAF at Vancouver International Airport. The study found that YVR is a highly suitable location from which to concentrate activities to encourage SAF production and use. The BioPortYVR initiative is working to identify and establish next steps to enable SAF uptake.

HARBOUR AIR AND MAGNIX TEST FLIGHT OF WORLD'S FIRST COMMERCIAL ELECTRIC PLANE

In December 2019, Harbour Air, North America's largest seaplane airline and magniX, an aircraft electric motor manufacturer, demonstrated a successful flight of the world's first all-electric commercial aircraft. The successful flight of the ePlane, a six-passenger DHC-2 de Havilland Beaver magnified by a 750-horsepower (560 kW) magni500 propulsion system, took place on the Fraser River at Harbour Air Seaplanes terminal in Richmond, BC.

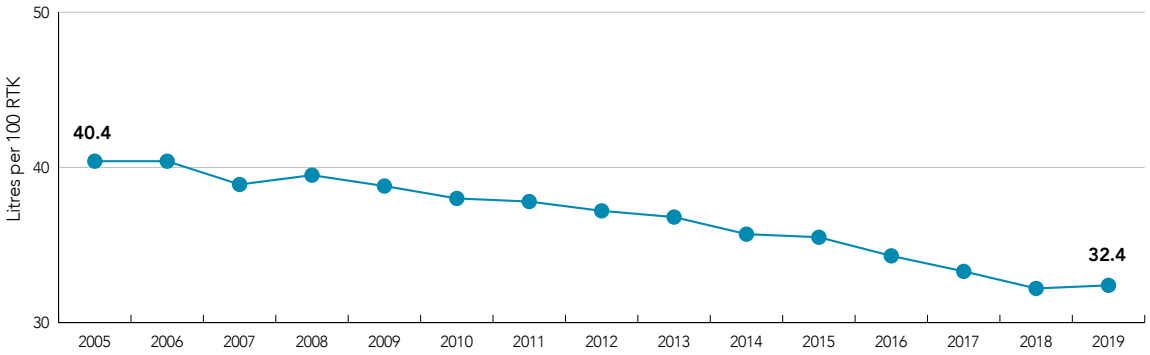
Harbour Air and magniX will work with Transport Canada to certify the installation of the electric propulsion unit and the battery system, with the aim of transforming Harbour Air's seaplanes into an all-electric commercial fleet.

EFFICIENCY IMPROVEMENTS AND PROGRESS TOWARDS THE ACTION PLAN TARGET

Fuel efficiency is commonly measured by calculating the amount of fuel used to move 1 tonne a distance of 100 kilometres. In 2019, fuel efficiency for combined domestic and international flights was 32.4 litres per 100 RTK compared to 32.2 in 2018. This is a decrease in fuel efficiency by 0.6 percent, largely due to a reduction in reported cargo RTK and the grounding of the Boeing 737 MAX 8 aircraft. The following table demonstrates the steady trend of fuel efficiency increases between 2008 and 2018, with the slight decrease in 2019.

CHART 3

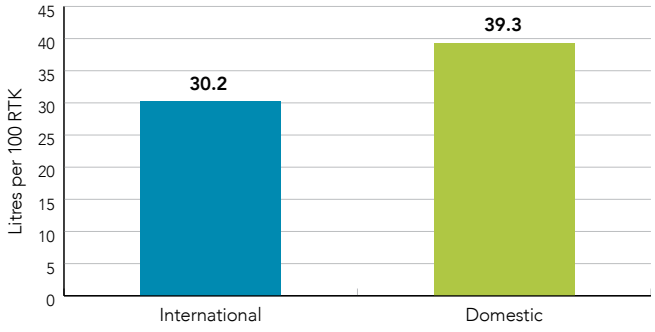
Fuel Efficiency – Combined Passengers and Cargo, 2005–2019



Separately, as shown in Chart 4, the fuel efficiency of international operations was 30.2 litres per 100 RTK, and 39.3 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. As an example, all things being equal, longer international flights tend to be more efficient than short domestic flights due to the greater time spent at cruising altitude, which is when the aircraft operates most efficiently. For more information regarding international vs. domestic fuel efficiency, see Table 2 in Appendix A.

CHART 4

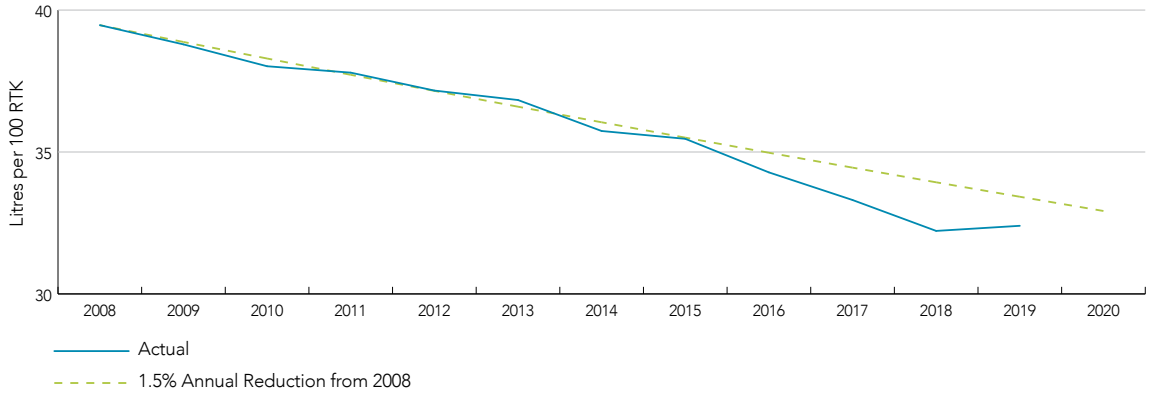
Fuel Efficiency – International and Domestic, 2019



Regarding the Action Plan's target (1.5 percent annual average fuel efficiency improvement between 2008 and 2020), carriers have so far averaged 1.77 percent. Cumulatively, this represents a fuel efficiency increase of 17.8 percent. Chart 5 shows a comparison of the 1.5 percent target against the achieved fuel efficiency between 2008 and 2019.

CHART 5

Comparison of Achieved Fuel Efficiency against the Target, 2008–2020



In relation to the Action Plan's 2 percent aspirational goal, Canadian airlines have averaged an annual improvement of 1.56 percent, since 2005. For more results related to the progress against the goal, see Appendix B.

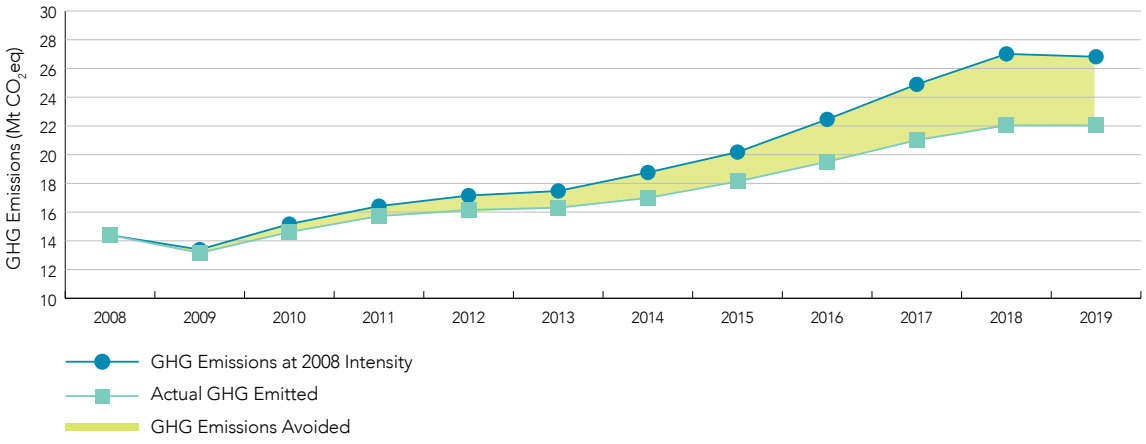
IMPACT ON GHG EMISSIONS

As a result of the 0.1 percent decrease in fuel use in 2019, the amount of GHG emissions decreased by the same percentage to 22.03 Mt of CO_2e. The domestic portion of these emissions account for approximately 1 percent of Canada's total emissions.[4]

The 17.8 percent fuel efficiency improvement over the 2008–2019 timeframe has enabled the sector to emit 24.1 Mt fewer emissions over that same period of time. For example, if carriers had continued to operate at 2008 efficiency levels, they would have emitted 26.8 Mt of CO_2e in 2019. This is nearly 5 Mt more than actual 2019 emissions. The shaded area in Chart 6 shows the emissions that were avoided as a result of these improvements over time.

CHART 6

GHG Emissions Avoided Since 2008



4 National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada. http://www.publications.gc.ca/site/eng/9.506002/publication.html

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;
- sustainable aviation 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 2019.

SUMMARY TABLE OF 2019 ACTIVITIES AND RESULTS

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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 as a result of further fleet changes.	In 2019, NACC member airlines continued to add more efficient aircraft to their fleets. The following changes were made: Air Canada took delivery of six Boeing 737 MAX 8s[5], two Boeing 787-9s, and one Airbus A220-300. It retired five Airbus A320-211s, five Embraer E190s and one Boeing 767-375 ER.	

5 On January 18, 2021, Transport Canada issued an Airworthiness Directive for the Boeing 737 MAX 8, which outlines the required modifications to be made to the aircraft prior to a return to service in Canadian airspace. It addresses Transport Canada's outstanding safety concerns and concludes the department's review of the aircraft. As a final step in the process, Transport Canada lifted the Notice to Airmen (NOTAM) which prohibits the commercial operation of the aircraft in Canadian airspace on January 20, 2021. This allowed for the return to service of the aircraft in Canada.

ACTIVITIES	RESULTS	STATUS
	Air Transat added two Airbus A321neos into service and retired the majority of their A310 fleet. According to Airbus, the A321neoLR improves fuel consumption by 40 percent per trip and nearly 30 percent less consumption per passenger compared to the Airbus A310. The A321neoLR is also the greenest aircraft in its class and generates 50 percent less noise in the cabin and communities, produces about 5,000 fewer tonnes of CO_2 a year and lowers nitrogen oxide emissions by 50 percent when compared to older models of aircraft in the Airbus 320 family. Air Transat will retire its last two A310s in early 2020 and plans to operate a fleet of at least 15 A321neoLRs in the coming years. Jazz retired one Bombardier Dash 8-100 and one Bombardier Dash 8-300. The airline added seven Bombardier CRJ200s and five Bombardier CRJ900s. WestJet added two Boeing 737 MAX 8s and three Boeing 787-9s. It retired two Boeing 700NGs. 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. 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 aircraft. ATAC all-cargo air carriers continued their transformation, at a more advanced pace. To improve efficiencies in cargo operations, operators have upgraded to more fuel-efficient aircraft such as Boeing 757-200F, Boeing 767-300F, and ATR 42 and ATR 72 freighters. By replacing Boeing 737-800 with the next generation Boeing 737 MAX 8 aircraft, Canadian air carriers are expecting 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.	
Business aviation operators will be encouraged to take advantage of opportunities to reduce emissions through fleet renewal.	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.	

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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.	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. Examples of air operation improvements include: • Low-drag approaches: In some cases, pilots were encouraged to configure the aircraft for landing using less flaps whenever safe to do so. This results in a reduction of drag and consequently in a reduction of the power required to maintain the plane at the approach speed. • Minimum bleed operations: A change in the operational procedures has been introduced by Bombardier on the DH8-400 fleet to allow the pilots to modify the setting of the air conditioning/pressurization system during climb and cruise phases provided a certain set of operational conditions are met. This results in reduction of fuel consumption during these phases of flight. • Light-weight catering trolleys: Old, heavier carts are being replaced by lighter ones through attrition. • 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.	
The CBAA continued to encourage its members to take advantage of opportunities to reduce GHG emissions through operational improvements.	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. The CBAA has created an Environmental Microsite where business aviation's efforts towards achieving social and corporate sustainability goals are promoted and documented.	

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ACTIVITIES	RESULTS	STATUS
IMPROVED CAPABILITIES IN AIR TRAFFIC MANAGEMENT		
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. More specifically NAV CANADA will:	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. The CPAAT facilitates the implementation of performance-based operations in Canadian airspace, including aspects of Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM). CPAAT is focused on improving operational efficiencies through the reduction of track miles flown, as well as opportunities to reduce aviation environmental impacts of emissions and noise exposure.	
• 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.	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. In Canada, RNP AR approaches continue to be implemented in very close consultation and collaboration with major Canadian airline operators. To date there are over 50 RNP AR public approach procedures published at 19 airports located throughout every province in the country. During 2019, NAV CANADA continued the implementation and publishing of new public RNP AR approaches at Thunder Bay, London, Kitchener/Waterloo, Kamloops, Penticton, and Toronto Island Airports. In addition, RNP AR project work was also initiated at Terrace, Comox, Prince George, Moncton, Charlottetown, Fredericton, Sydney, and Saint John airports and was published in 2019. At Calgary International Airport, the new Established on RNP AR (EoR) separation standard has been operational for 12 months. During this time, there were over 35,000 RNP AR approaches flown, averaging approximately 100 approaches per day with a reduction of over 250,000 nautical miles of power-on, low altitude flight over the city of Calgary. This amounts to a reduction of over 4.1 million kgs of CO_2 emissions. EoR is becoming the "new normal" internationally for parallel runway airports and will become the cornerstone for other major parallel-runway airports in Canada. Through the use of RNP AR procedures, approximately 2.5 million litres of aviation fuel have been saved. This results in a reduction of approximately 6.3 million kilograms of CO_2 emissions which is 26 percent more than what was saved in 2018.	

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ACTIVITIES	RESULTS	STATUS
	In conjunction with implementing RNP AR approaches, NAV CANADA conducted reviews of the airspace surrounding Toronto Island and Thunder Bay 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. 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 RNP AR approaches. The work underway continues with seeking 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 Vancouver and Calgary International Airports.	
• 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.	The Aireon Iridium NEXT space-based ADS-B constellation was completed in January 2019 with 100 percent coverage of the globe with 66 on-orbit satellites and 9 additional on-orbit spares. In March 2019, NAV CANADA began operational trials of space-based ADS-B based separation over the North Atlantic under their respective jurisdictions, with an estimated 10 percent increase (March 2019 – March 2020) in flights receiving optimum flight profile. As a result, aircraft being cleared to operate at these more fuel-efficient flight levels saw a reduction of GHG emissions of 1,480 kg of CO_2 equivalent per 3-hour flight across the North Atlantic ocean.	
• 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.	NAV CANADA's 2019 Corporate Social Responsibility Report is available on the NAV CANADA website.	
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.	NAV CANADA has entered collaboration with Transport Canada to move forward on the establishment of performance requirements and regulatory changes to support the implementation of an ADS-B Mandate in Canadian Domestic Airspace (CDA).	

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ACTIVITIES	RESULTS	STATUS
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 the Green Aviation Research & Development Network (GARDN) and the following entities:	Established in 2009 and renewed in 2014, GARDN is a network of over 65 members and has supported over 35 projects representing over $70 million of Canadian aviation environmental research (jointly funded by the Government of Canada and participating aerospace companies). These projects embrace three research thrusts of Canadian air transport: CLEAN, QUIET and SUSTAINABLE. Transport Canada participates in the GARDN Scientific Committee. Over half of the aforementioned projects deal specifically with emissions reductions. Five projects focus on bio-derived jet fuel applications for Canada. For example, GARDN supported the launch of BioPortYVR, an industry-led project to increase the supply of sustainable aviation fuel in Canada.	
• FAA (Federal Aviation Administration) Aviation Sustainability Centre (ASCENT)	ASCENT, also known as the Center of Excellence for Alternative Jet Fuels and Environment, works to create science-based solutions for the aviation industry's biggest challenges. In 2019, Transport Canada continued to sponsor ASCENT and maintains an active role on the Advisory Committee reviewing research projects and progress with particular focus on the following: • ASCENT 1 – Alternative Jet Fuel Supply Chain Analysis; • ASCENT 21 – Improving Climate Policy Analysis Tools; • ASCENT 31A – Alternative Jet Fuels Test and Evaluation; • 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.	
• National Research Council of Canada (NRC)	With financial support from the Government of Canada's Clean Transportation Initiatives, the NRC has: • Continued analysis of ground testing instrument inter-comparison data from ND-MAX, an international sampling campaign with NASA and DLR (German Aerospace) to measure emissions from alternative jet fuels. Manuscript for publication being prepared. • Participated in DICE-II, an international campaign to investigate nano-aerosol instrument characteristics on non-volatile particulate matter (nvPM) emissions from an aircraft engine. This included a world-first demonstration of the on-site calibration of an nvPM mass concentration instrument using the CPMA-Electrometer Reference Mass System (CERMS) approach developed at NRC.	

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ACTIVITIES	RESULTS	STATUS
	• Continued to support Original Equipment Manufacturers (OEMs) with their certification efforts with respect to their nvPM emissions data. • Conducted high altitude flight research comparing contrail optical thickness and emissions for Jet A1 and selected unblended bio-jet fuels. • 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.	
• US Transportation Research Board's Airport Cooperative Research Program (ACRP)	Transport Canada and the Canadian Airports Council (CAC) continue to support and participate in ACRP and share relevant information with Canadian airports.	
SUSTAINABLE AVIATION FUELS		
The Government of Canada and the Canadian aviation industry will continue to work collaboratively to advance efforts related to sustainable aviation fuel production and use in Canada and will take advantage of opportunities to collaborate with key trading partners.	GARDN has funded five projects on bio-derived jet fuel applications for Canada, two under GARDN I and three under GARDN II. The following GARDN II project took place in 2019 and is described below: • 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 biojet fuel. A lifecycle assessment that examined these technology pathways indicated up to 74 percent GHG emission reductions compared to fossil jet fuel were possible, with further possible reductions from feed-stocks used that avoided slash burning practice. The research team published a report[6] and a related research article[7] in 2019 from this project. 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, after launching the competition in August 2018. The finalists have been awarded up to $2 million each to help fund production and have entered an 18-month period where they will produce a 10 litre test sample of their sustainable aviation fuel. Transport Canada maintains a dialogue with the US FAA to exchange information on biofuels development.	

6 van Dyk, S., Ebadian, M., Su, J., Larock, F., Zhang, Y., Monnier, J., … Saddler, J. N. (2019). *Assessment of likely Technology Maturation Pathways for biojet production from forest residues (ATM Project).* Retrieved from Vancouver, University of British Columbia: http://task39.sites.olt.ubc.ca/files/2019/11/GARDN-NEC-21-ATM-project-final-report-public-release.pdf

7 van Dyk, S., Su, J., Ebadian, M., O'Connor, D., Lakeman, M., & Saddler, J. (2019). Potential yields and emission reductions of biojet fuels produced via hydrotreatment of biocrudes produced through direct thermochemical liquefaction. *Biotechnology for biofuels*, 12(1), 281. doi:10.1186/s13068-019-1625-2

ACTIVITIES	RESULTS	STATUS
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).	In 2019, Transport Canada actively supported: • The ICAO CAEP Alternative Fuels Task Force, which has transitioned into the permanent CAEP Fuels Task Group beginning in the CAEP 12 cycle in 2019; • The participation of a Canadian expert from the University of Toronto with specific expertise in biofuels, techno-economic assessment, and lifecycle assessment in the CAEP Fuels Task Group; • The ICAO CAEP Global Market-based Measures Task Force, which has transitioned into the permanent CAEP Working Group IV beginning in the CAEP 12 cycle in 2019; and • The US FAA through the ASCENT Center of Excellence and collaborated with NASA on alternative aviation fuel research. Transport Canada continues to liaise with other government departments through the ad-hoc aviation biofuels group to both share information on biojet development and collaborate on issues of common interest.	
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.	Several emission reduction initiatives are advancing at Canadian airports. Examples include: • Vancouver International Airport (YVR) is working to reduce its operational emissions and support its airline and business partners to reduce their impact. In 2019, YVR completed a multi-year bridge upgrade project, with all bridged gates equipped with ground power units (GPU) and pre-conditioned air (PCA) units, up from 42 percent in 2012. YVR continues to actively work on expanding electrical charging infrastructure. In 2019, 53 percent of the licensed Ground Support Equipment (GSE) operator fleet and 74 percent of baggage support equipment were electric. YVR has installed 50 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 2019 additional electric buses were added for a fleet total of eleven. In 2019, BioPort YVR was launched – an industry-led project aimed at establishing Canada's first Sustainable Aviation Fuel (SAF) supply chain in British Columbia, with YVR as its supply hub.	

ACTIVITIES	RESULTS	STATUS
	• Calgary International Airport (YYC) equipped all of their bridges with gate power, allowing operators to connect aircraft to electrical power rather than using diesel or gas powered ground or auxiliary power units. In 2019, YYC also installed several new electric GSE charging stations that are available to all ramp users. This upgrade took place in conjunction with a major investment in the baggage handling systems at YYC. The baggage handling system is now 80 percent more energy efficient that the previous one, greatly reducing associated emissions. Ground navigational procedures at YYC have also been optimized in partnership with airlines and NAV CANADA to reduce the taxi times and associated emissions. A major contributor to this was the opening, in late 2019, of a new centralized de-icing facility, which adds greater efficiency and lowers the emissions profile associated with de-icing activities. • In 2019, Montréal-Trudeau International Airport (YUL) conducted a re-commissioning project on the airport's 70 main ventilation systems which ended up saving 4 percent of YUL's overall energy consumption. YUL's maintenance team have also optimized the heating equipment in order to bring additional energy savings. YUL also installed ESPAR heaters on 50 heavy vehicles which will reduce their fuel consumption by 70 percent during waiting periods on the airport apron. Additional charging stations for electric vehicles were also installed, thus increasing the number of stations to 56. Finally, the airport authority joined the EV100 initiative. Launched in 2017 by the international non-governmental organization the Climate Group, the EV100 initiative aims to increase the use of electric vehicles by 2030. • Toronto Pearson International Airport (YYZ) has worked with key carriers and other partners to implement Airport Collaborative Decision Making (A-CDM), to see tangible benefits in terms of YYZ's environmental impact. By better coordinating various aspects of ground operations, it can, for example, shorten taxi times and eliminate unnecessary idling as aircraft wait to access gates or the de-icing facility. This translates into lower fuel consumption and reduced GHG emissions, helping all partners make tangible progress towards shared sustainability goals. Ten years ago, Toronto Pearson committed to a 20 percent reduction in GHG emissions (from a 2006 baseline) by 2020. As of the 2019 year-end, the airport well exceeded that target, having shrunk their carbon footprint by nearly half. Toronto Pearson procured its first two electric shuttle buses for passengers in 2019 and expects to add three more as existing gas vehicles are retired.	

ACTIVITIES	RESULTS	STATUS
	• Halifax Stanfield International Airport (YHZ) continued to implement its carbon management plan and completed a two-year program that replaced 2000 existing incandescent airfield lighting fixtures with new LED fixtures. YHZ also completed another phase of its chiller replacement program with a more efficient refrigeration system, which has assisted in reducing energy consumption and GHG emissions. 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, Toronto in 2013, Calgary in 2014, and Vancouver in 2019. 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.	
Canadian airports will refine and improve emissions inventories and will explore further opportunities for emissions reduction strategies.	There are 16 Canadian airports participating in the Airport Carbon Accreditation (ACA) program under Airports Council International (ACI). Within this program, there are four levels of certification: • 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. Canadian airports have achieved the following levels of certification: • Level I: Kelowna, Edmonton, Regina, Winnipeg, Fredericton, Charlottetown, St. John's, and Saskatoon • Level II: Halifax and Victoria • Level III: Montreal, Toronto, Vancouver, Moncton, Ottawa, and Quebec City 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 reduce their emissions through their own independent environment programs.	

Complete | In Progress | Behind Schedule

ACTIVITIES	RESULTS	STATUS
REGULATORY MEASURES		
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.	Canada continues to make significant contributions in the development of the ICAO nvPM international mass and number standard. This Phase II standard was completed in 2019, and recommended to ICAO Council for adoption in 2020.	
Transport Canada will adopt the nvPM standards (Phase I and II) domestically under the *Aeronautics Act*. Transport Canada will adopt the new CO_2 emissions standard domestically under the *Aeronautics Act*. Transport Canada will also incorporate CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) into the *Aeronautics Act* for Canadian operators operating internationally.	The notice for proposed amendment (NPA) to the Canadian Aviation Regulations for Phase I of the nvPM standard was published; the new standard became effective in Canada on June 1, 2019. Transport Canada will draft the NPA for Phase II of the nvPM standard once it has been adopted by ICAO in 2020. The CO_2 standard requires an enabling regulation in the *Aeronautics Act* for the new Annex 16 Volume III. Text was drafted for the amendment to the regulations. The MRV requirements of CORSIA were finalized in Canada Gazette in November 2018 and came into force on January 1, 2019. Regulations covering the offsetting phase of CORSIA will be completed ahead of its start date of January 1, 2021. 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 Clean Fuel Regulations will initially apply to liquid fuels used in Canada starting in 2022.	
INTERNATIONAL COORDINATION		
Through ICAO, Transport Canada will continue to actively participate 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 sustainable aviation fuels. Transport Canada will continue to engage the Canadian aviation industry as part of the international dialogue.	Canada co-leads ICAO CAEP Working Group 4 which deals with technical issues relating to the implementation of CORSIA. Canada also continues to actively participate in the development of related CORSIA Eligible Fuels requirements under the Fuels Task Group. Canada continues to co-lead 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. The group has had a particular focus on climate risk assessment, adaptation and resilience and published an information document on climate resistant airports.	

ACTIVITIES	RESULTS	STATUS
NAV CANADA will continue to support the air navigation interests of Canadian aviation stakeholders internationally through representation in ICAO groups and panels.	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: • Communications; • Navigation; • Surveillance; and • Air Traffic Management. These upgrades maximize the benefits for operators of aircraft that are best equipped to take advantage of PBN procedures, while recognizing the needs for airspace access to operators not eligible for these procedures. In 2019, NAV CANADA began drafting a new Communications, Navigation and Surveillance (CNS) Operations plan. The plan was drafted through a collaborative effort between NAV CANADA and major industry stakeholders and provides a roadmap for prioritizing, developing and deploying key CNS technologies over the next five years. The CNS Ops Plan will be published in spring 2020. NAV CANADA also strives to maintain a prominent and influential role in the development of ICAO Standards and Recommended Practices (SARPs), as well as Procedures for Air Navigation (PANS) and performance standard development through appropriate resource and budgetary allocation to facilitate consistent participation on ICAO Panels and to assist with ICAO initiated programs.	
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.	• 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. • The President and CEO of AIAC also plays a key leadership role by chairing and facilitating the work of GARDN.	

LOOK AHEAD 2020

This section provides a snapshot of advancements being made under measures of the Action Plan in 2020. Given the unprecedented disruption and challenges faced by Canada's aviation industry in 2020, as a result of the COVID-19 pandemic, the 2020 Annual Report may not follow the same format as previous reports.

Passenger flights were down by 90 percent in 2020. This is expected to have a significant impact on the data and continuity of reporting against the Action Plan's target and aspirational goal. With that said, the aviation sector and the Government of Canada are committed to reducing emissions from aviation, and even during the pandemic continued to advance measures and activities such as the ones described below.

FLEET RENEWALS

Updates on NACC and ATAC carrier fleet renewal plans:

- Air Canada expects to take delivery of 14 Airbus A220-300 aircraft.
- WestJet ordered additional Boeing 737 MAX 8 aircraft and will add three Boeing 787-9s. The airline will divest four Boeing 767 aircraft.
- Rouge took delivery of four Airbus A321-211s and six Airbus A320-214 aircraft.
- Jazz introduced two Bombardier CRJ 200s and eight Bombardier CRJ 900s. The airline retired five Bombardier DH8-100, four Bombardier DH8-300, four Bombardier CRJ 200s, and one Bombardier Q400.
- Sunwing expects to take delivery of additional Boeing 737 MAX 8 aircraft.

AIRCRAFT MANUFACTURING

On June 30, 2020, Bombardier became the first business jet manufacturer to release an Environmental Product Declaration (EPD). The EDP embeds environmental considerations (third party verified in accordance with international standards) from design to end-of-life for its flagship Global 7500 aircraft.

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, Alberta and Southern Ontario.
- Further implementations of the new ICAO separation standard, established on RNP AR (EoR), will be explored for possible deployments at other major parallel runway airports in Canada.
- Through the Canadian Performance-based Aviation Action Team (CPAAT), NAV CANADA, Transport Canada and Industry Stakeholders will begin exploring the adoption of RNP AR Departure procedures.

SUSTAINABLE AVIATION FUEL

Air Transat signed an offtake agreement to purchase a significant portion of synthetic jet fuel from future production by the SAF+ Consortium. SAF+ Consortium (one of the four finalists of the Sky's the Limit Challenge) is finalizing the fabrication of a pilot plant in Montreal East to make kerosene from CO_2. The process consists of capturing CO_2 produced from large industrial emitters and converting it to synthetic jet fuel by using a process called Fisher Tropsch (FT). It is estimated that SAF+ kerosene will have an 80 percent lower carbon footprint than conventional jet fuel. Construction of a pilot plant is due for completion in 2021.

AIRPORT EFFICIENCY IMPROVEMENTS

Vancouver International Airport will consider implementing an APU Shutdown Procedure to encourage the use of low-carbon electricity while aircraft are parked at gates.

Toronto Pearson International Airport anticipates replacing over 1,500 lighting fixtures with LED lights. Additionally, Toronto Pearson will be installing its first solar panel array on the property to pilot the use of the technology on the airport property moving forward.

Calgary International Airport will be reviewing whether airfield and authority maintenance vehicles can be replaced with low-emission options, such as hybrid or electric vehicles.

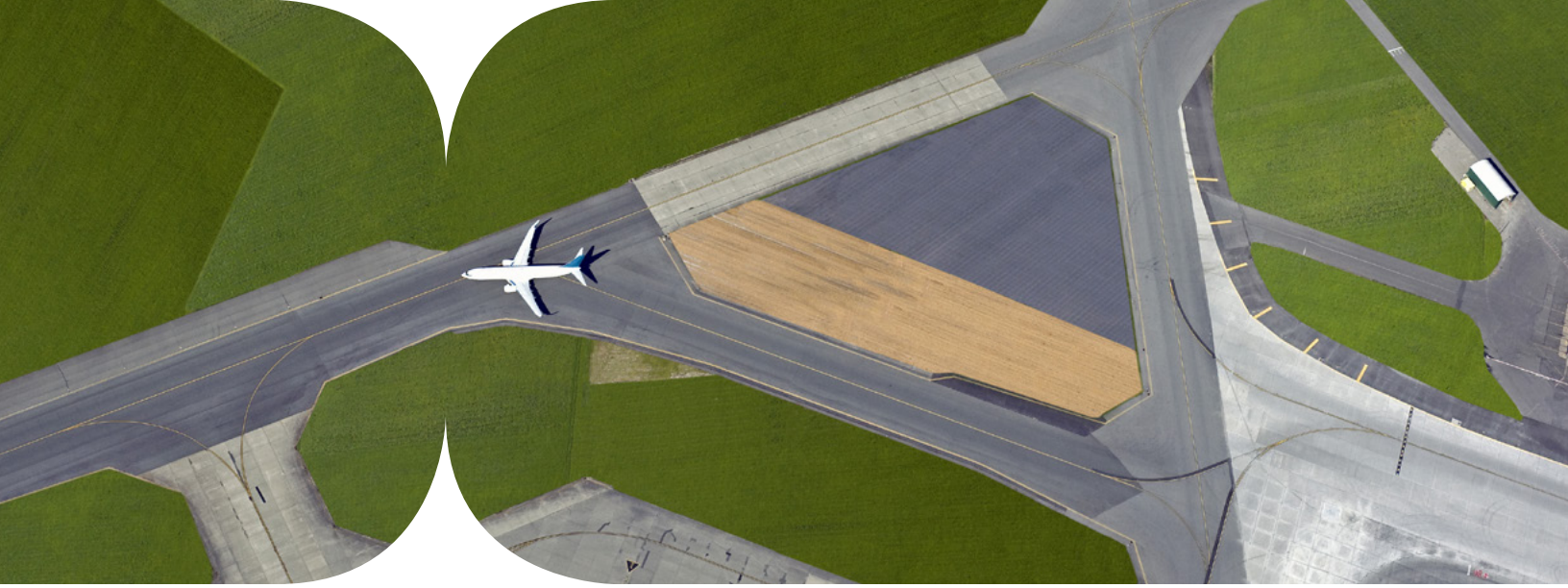
FEDERAL MEASURES

In December 2020, the Government of Canada announced its Strengthened Climate Plan, A Healthy Environment and a Healthy Economy (SCP). This plan sets out the Government of Canada's approach to meet and exceed Canada's 2030 GHG reduction target, while also driving Canada's economic recovery. The Government of Canada understands that meeting Canada's long-term climate objectives will require large transformation of Canada's transportation system, including the aviation sector, out to 2050. This includes supporting the transition to more sustainable alternatives and investing in research & development and infrastructure. The plan proposes to work with aviation stakeholders to accelerate technology development and pilot deployments, as well as the implementation of commercially-ready solutions. The Government will also make strategic investments to strengthen Canada's green aviation leadership position and secure the footprint and supply chains of this export-oriented, research and development intensive industry. Engagement with key stakeholders to explore these opportunities will take place in 2021.

As part of the SCP, the Government of Canada also announced that it will be investing $3 billion over 5 years through the Strategic Innovation Fund's new Net Zero Accelerator to rapidly expedite decarbonization projects with large emitters, scale-up clean technology, and accelerate Canada's industrial transformation across all sectors.

DOMESTIC AND INTERNATIONAL COORDINATION

In 2020, Transport Canada will publish the regulatory amendments covering the offsetting phase of CORSIA ahead of its start on January 1, 2021. Transport Canada will also perform Order of Magnitude checks on 2019 emissions and submit consolidated data to ICAO.



APPENDIX A: DATA TABLES

TABLE 1

Annual Results of Domestic and International Operations, 2005–2019

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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	8,532
GHG 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	18.132	19.506	21.010	22.057	22.030
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	230.39
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	23.04
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	3.27
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	26.31
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	0.0370
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	0.3243
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	103.22	100.55	99.08	95.89	9.62
CO_2e grams/Total RTK	1,044	1,044	1,006	1,019	1,002	982	976	960	951	923	916	885	860	832	837

* 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 the emissions factors used in Environment and Climate Change Canada's (ECCC) National Inventory Report 1990–2018.

TABLE 2

International vs. Domestic Aviation Activity, 2019

	International	Domestic	Total
Fuel use (million litres)	5,998	2,535	8,532
GHG emissions (megatonnes of CO_2e)	15.49	6.54	22.03
Traffic (billions)			
Revenue passenger-kilometres (RPK)	173.1	57.2	230.4
Passenger revenue-tonne-kilometres (pass. RTK)	17.3	5.7	23
Cargo revenue-tonne-kilometres (cargo RTK)	2.6	0.7	3.3
Total revenue-tonne-kilometres (RTK)	19.9	6.5	26.3
Fuel consumption rates			
Litres/Total RTK	0.3019	0.3927	0.3242
Emission rates			
CO_2e grams/Total RTK	779	1,014	837

TABLE 3

Absolute and Proportional Changes Over Time, 2008–2019

	Change 2018–2019		Change 2008–2019		
	Absolute	Proportional	Absolute	Proportional	Annual Rate
Fuel use (million litres)	-10	-0.1%	2,957	53.0%	3.9%
GHG emissions (megatonnes of CO_2e)	-0.03	-0.1%	7.6	53.0%	3.9%
Traffic (billions)					
Revenue passenger-kilometres (RPK)	0.4	0.2%	104.8	83.5%	5.7%
Passenger revenue-tonne-kilometres (pass. RTK)	0.0	0.2%	10.5	83.5%	5.7%
Cargo revenue-tonne-kilometres (cargo RTK)	-0.2	-6.7%	1.7	108.4%	6.9%
Total revenue-tonne-kilometres (RTK)	-0.2	-0.8%	12.2	86.3%	5.8%
Fuel consumption rates*					
Litres/RPK	-0.0001	-0.3%	-0.0074	-16.6%	-1.64%
Litres/Total RTK	0.002	0.6%	-0.0704	-17.8%	-1.77%
Emission rates					
CO_2e grams/RPK	-0.3	-0.3%	-19.0	-16.6%	-1.64%
CO_2e grams/Total RTK	5.3	0.6%	-181.8	-17.8%	-1.77%

* 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 THE ACTION PLAN'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 2019.

TABLE 4

Absolute and Proportional Changes Over Time, 2005–2019

	Change 2005–2019		
	Absolute	**Proportional**	**Annual Rate**
Fuel use (million litres)	3,645	74.6%	4.1%
GHG emissions (megatonnes of CO_2e)	9.41	74.6%	4.1%
Traffic (billions)			
Revenue passenger-kilometres (RPK)	125.2	119.0%	5.8%
Passenger revenue-tonne-kilometres (pass. RTK)	12.5	119.0%	5.8%
Cargo revenue-tonne-kilometres (cargo RTK)	1.7	109.0%	5.4%
Total revenue-tonne-kilometres (RTK)	14.2	117.7%	5.7%
Fuel consumption rates*			
Litres/RPK	-0.009	-20.3%	-1.60%
Litres/Total RTK	-0.080	-19.8%	-1.56%
Emission rates			
CO_2e grams/RPK	-24.3	-20.3%	-1.60%
CO_2e grams/Total RTK	-206.7	-19.8%	-1.56%

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

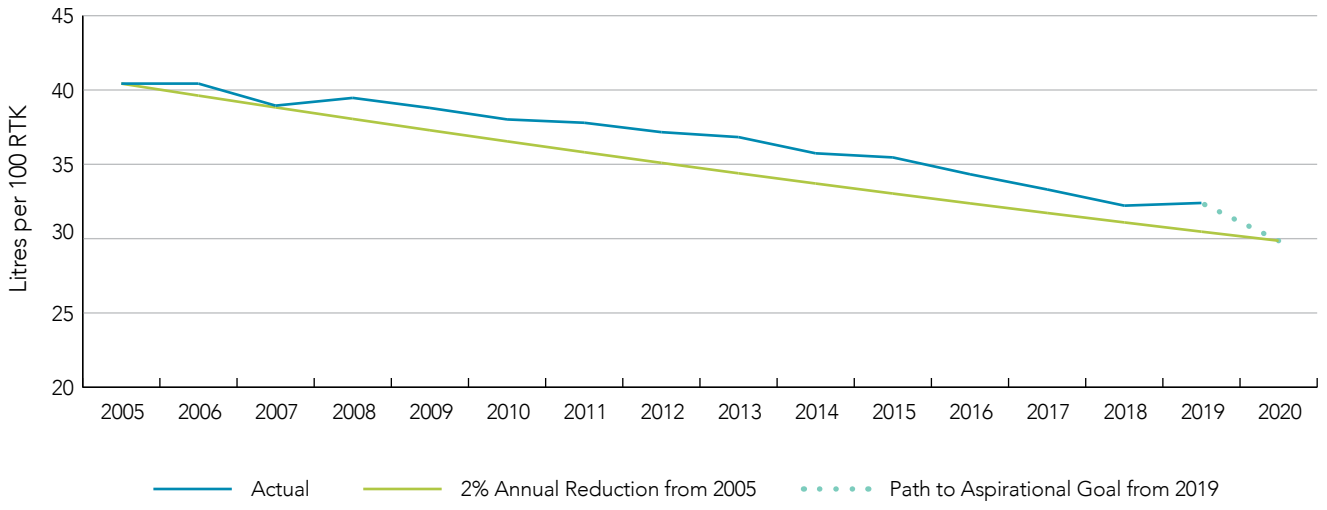
The figures presented in Table 4 allow for the following summary of trends between 2005 and 2019:

- Fuel consumption and GHG emissions rose by 74.6 percent, an average of 4.1 percent per year;
- Total reported RTK increased by 119 percent; and
- The cumulative improvement in fuel efficiency (litres/RTK) between 2005 and 2019 was 19.8 percent, or an annual average of 1.56 percent.

Chart 7 shows the goal trajectory of the 2 percent aspirational goal and the fuel efficiency improvements made between 2005 and 2019. It also shows an indicative trajectory that would be required to meet the 2020 aspirational goal, given 2019 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

ACA: Airport Carbon Accreditation

A-CDM: Airport Collaborative Decision Making

ACI: Airports Council International

ACRP: Airport Cooperative Research Program

ADS-B: Automatic Dependent Surveillance-Broadcast

AIAC: Aerospace Industries Association of Canada

ASCENT: Aviation Sustainability Center

ATAC: Air Transport Association of Canada

ATAG: Air Transport Action Group

ATM: Air Traffic Management

CAAFI: Commercial Aviation Alternative Fuels Initiative

CAEP: Committee on Aviation and Environmental Protection

CAC: Canadian Airports Council

CBAA: Canadian Business Aviation Association

CFS: Clean Fuel Standard

CO_2: Carbon Dioxide

CO_2e: Carbon Dioxide Equivalent

CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation

CPAAT: Canadian Performance-based Aviation Action Team

ECCC: Environment and Climate Change Canada

EDP: Environmental Product Declaration

EoR: Established on RNP AR

FAA: Federal Aviation Administration

GARDN: Green Aviation Research & Development Network

GHG: Greenhouse Gas

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

NPA: Notice for Proposed Amendment

NRC: National Research Council

OEM: Original Equipment Manufacturer

PBN: Performance-based Navigation

RNP: Required Navigation Performance

RNP AR: RNP Authorization Required

RPM: Revenue Passenger-Miles

RPK: Revenue Passenger-Kilometres

RTM: Revenue Tonne-Miles

RTK: Revenue Tonne-Kilometres

SAF: Sustainable Aviation Fuel

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 1990–2018.

AVIATION JET FUEL EMISSION FACTORS

2,560 grams CO_2 per litre

2,582 grams CO_2e per litre

CONVERSION MILES TO KILOMETRES

1 mi = 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 CO_2-EQUIVALENTS

CO_2e (grams)/RPK = (Fuel Used x 2,582) / (RPM x 1.609344)

CO_2e (grams)/Cargo RTK = (Fuel Used x 2,582) / (Cargo RTM x 1.609344 x 0.907185)

CO_2e (grams)/Total RTK = (Fuel Used x 2,582) / {(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 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 2019 was slightly less to that of 2018. 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 2019 data for this annual report, including:

- Air Canada (including Air Canada Rouge and Sky Regional);
- Air Transat;
- Jazz Aviation; and
- WestJet.

The ATAC member carriers who contributed 2019 data for this annual report were:

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