AVIATION ACTION PLAN

To Reduce Greenhouse Gas Emissions from Aviation

ANNUAL REPORT 2020 & 2021

Government of Canada
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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 ninth Annual Report under Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation (the Action Plan). Aviation represents a major part of Canada's transportation system and plays a crucial role facilitating the movement of people and goods both within the country and across borders. The sector is also a contributor to greenhouse gas (GHG) emissions, as flight operations to date have largely relied on the use of fossil fuel. 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 seventeen 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 Regulations (CFR) and the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The report highlights that there has been significant progress to date on the on the Action Plan's implementation.

The report is structured to cover a two-year period for 2020 and 2021, as the global pandemic had far-reaching impacts on the sector in these years. Emissions decreased by 61 percent between 2019 and 2020, followed by an additional 1 percent in 2021 due to lower activity levels resulting from the COVID-19 pandemic starting in early 2020. The impact of the pandemic also led to a decrease in operational efficiency, as carriers were forced to adapt to an array of challenges. Despite these impacts, parties of the action plan have emphasized the need to reduce greenhouse gas emissions, and have demonstrated an ongoing commitment to conducting activities and implementing measures in pursuit of this objective including:

- fleet renewals and upgrades;
- more efficient aviation 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.

INTRODUCTION

Aviation in Canada is of vital economic importance and facilitates economic activity and trade on both a domestic and international basis. Canadians and visitors to the country rely on aviation, as it is the most capable mode of transport to cover Canada's vast distance. Aircraft service is also vital to northern and remote communities, where it is often the only way to move people and goods. While there are significant benefits to aviation, fossil fuel use in the sector results in Greenhouse Gas Emissions (GHGs). In Canada, domestic aircraft operations account for 1 percent of the country's total annual GHG emissions. To minimize these emissions, Canada's carriers have had a strong climate action strategy in place for over fifteen years. 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.

In 2012, the Government of Canada and key stakeholders from across the Canadian aviation industry came together and jointly put forward 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 leverages the efforts of multiple organizations and their members, including the National Airlines Council of Canada (NACC), Air Transport Association of Canada (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 the sector.

The Action Plan was extended in August 2022 to cover an additional two years[1]. The Action Plan (2012–2022):

- Set a 1.5 percent annual average fuel efficiency improvement target;
- Set a 2 percent annual average fuel efficiency improvement aspirational goal;
- 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 for Member States to develop action plans to address GHG emissions from aviation;
- Established an Aviation 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.

1 The Extension Letter for the Action Plan is published online https://tc.canada.ca/en/corporate-services/policies/canada-s-action-plan-reduce-greenhouse-gas-emissions-aviation/extension-letter-canada-s-action-plan-reduce-greenhouse-gas-emissions-aviation

This is the ninth Annual Report under the Action Plan and provides data on the overall progress towards the targets outlined above. 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 Aviation Emissions Working Group and is published on Transport Canada's website.

The global COVID-19 pandemic took place in the years covered by this report, which led to unprecedented disruptions to aviation in both 2020 and 2021, impacting the efficient operation of flights. The results of this report highlight some of the challenges faced by the sector, as they relate to the sector's environmental performance, despite being outside of the sector's control. In interpreting the results, the context of the pandemic should be taken into consideration. Over the course of the pandemic, parties to the Action Plan have sought to continue reporting their environmental performance metrics and communicating their commitment to reducing emissions in pursuit of a green recovery. The transition to lower emissions in the sector following the pandemic requires a concerted effort and cooperation from all parties. The use of Sustainable Aviation Fuel (SAF) is expected to lead to the greatest GHG reductions in the coming years; its increased use and further improvements to the sector's environmental performance will be enabled by a wide range of activities highlighted in this report.

RESULTS FOR 2020 and 2021

Impact of Global COVID-19 Pandemic

Starting in 2020, as the global pandemic situation worsened, increased restrictions and measures were put in place to control the transmission of the virus, as governments enacted a halt to all non-essential travel. While there were several months of relatively normal operations in 2020, this was followed by a near shut down in activity, putting significant pressure on carriers throughout 2020 and 2021, thereby requiring cooperation between all parties to adapt to the crisis. Although the sector was adversely impacted by the pandemic, in 2020 and 2021 there was a continued emphasis on strengthening the sector and laying a foundation for a post-pandemic green recovery. The following sections outline the results for 2020 and 2021, including airline traffic, fuel use, fuel efficiency and GHG emissions reductions.[2]

Traffic and Fuel Use

Airlines' traffic is often measured as RTK (Revenue Tonne Kilometers)[3]. Carriers reporting traffic under the annual report cover at least 90 percent of total RTK activity by major operators in Canada in both 2020 and 2021[4]. As a result of the pandemic, there was a significant reduction in overall activity across the sector in both 2020 and 2021. The combined revenue service including passengers and cargo was 8.2 billion RTK in 2020 and 8.3 billion RTK in 2021, which is drastically lower than the 26.3 billion total RTK reported in 2019. This represents a 68 percent decline from 2019 to 2021.

Passenger traffic was 74 percent lower in 2020 compared to 2019. This reduction in passengers continued into 2021 as traffic was 78 percent lower compared to 2019. The additional reduction was in part due to the fact that the pandemic was in an earlier stage at the start of 2020, while the virus and the associated restrictions were in place for the whole of 2021.

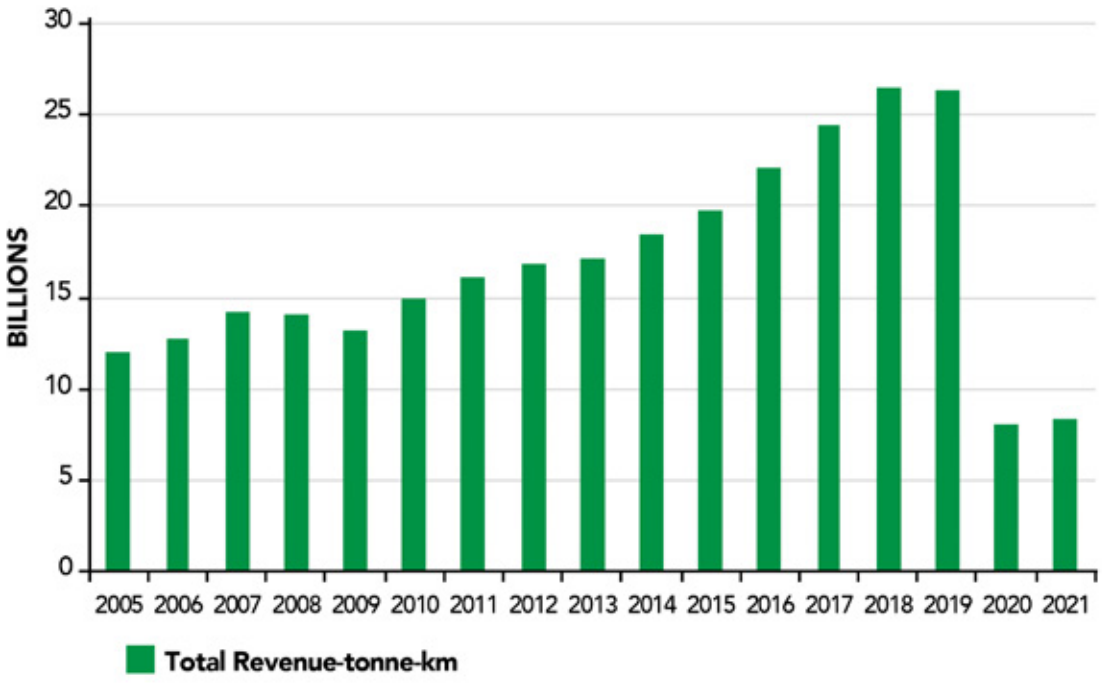
2 It should be noted that the number of aviation carriers that provide data under the Action Plan have changed from year to year. As a result, the statistics presented in this report may not be entirely comparable with those in other years.

3 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. It is important to note that RTK may not be fully applicable to all market segments, such as business aviation whose operations are not fully analogous to other commercial carriers.

4 Based on Statistics Canada data for level I and II carriers available through the Quarterly Civil Aviation Survey. May not be comparable with previous years' reports.

Cargo traffic was also impacted and was 33 percent lower in 2020 compared to 2019. In 2021 cargo traffic was less impacted by the pandemic and was significantly higher in 2021 compared to 2020, rebounding to 98 percent of 2019 values. Chart 1 shows annual traffic in total RTK between 2005 and 2021, including both passengers and cargo. More information on the passenger and cargo data is available in Table 1 in Appendix A of the report.

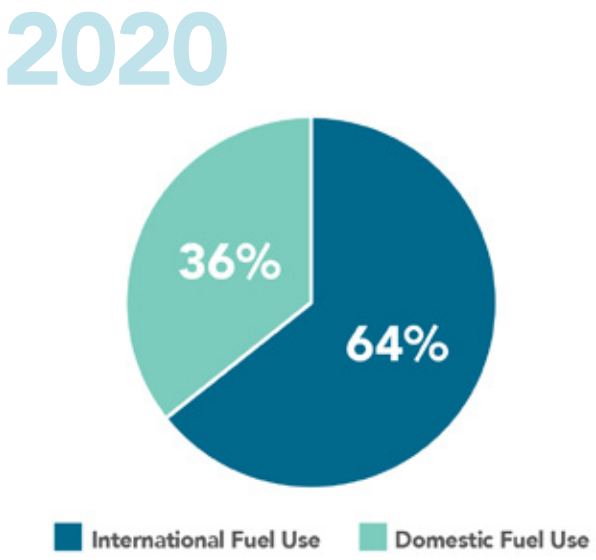
Chart 1 | Annual Traffic – Combined International and Domestic Operations, 2005-2021

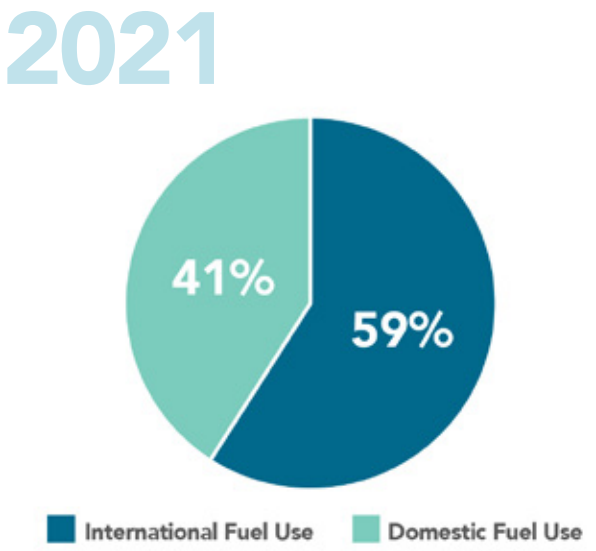


This report distinguishes between results for domestic and international operations. Following the Intergovernmental Panel on Climate Change's definition of international and domestic activities, the Action Plan classifies international activity as flight segments that begin in Canada or end outside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

International and domestic fuel use were also impacted by the pandemic, in part due to significant international travel restrictions in place. This resulted in domestic flights accounting for a greater share of airlines' total fuel use compared to 2019. This is illustrated in Chart 2, of the 3.2 million litres of total fuel consumed in 2021, of which 41 percent was consumed for domestic activity and 59 percent was consumed for international activity.

Chart 2 | Airline Fuel Use – International versus Domestic





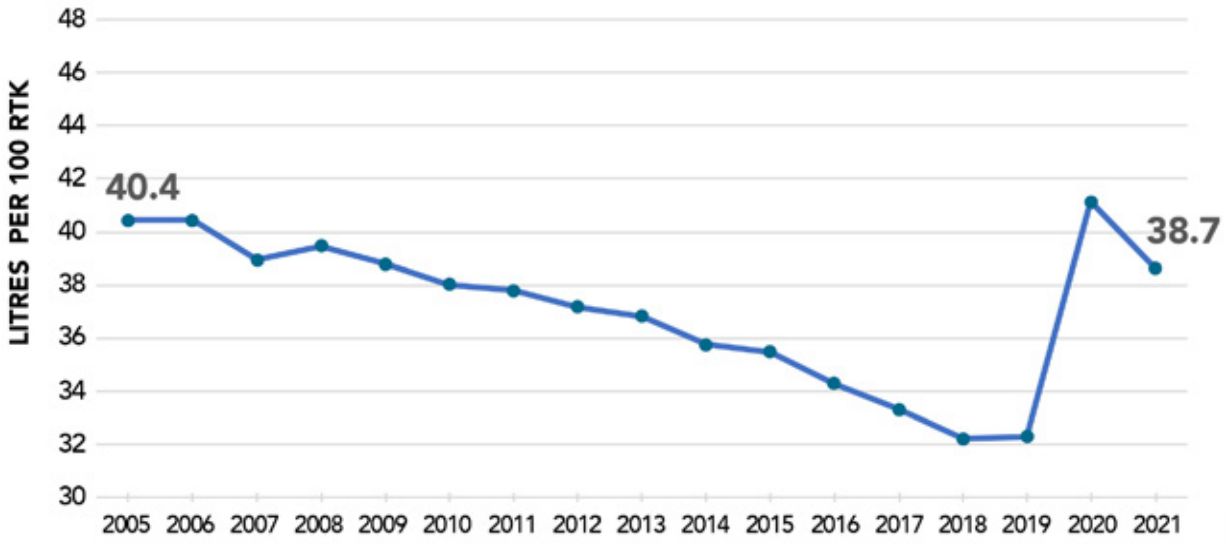
REQUIRED NAVIGATION PERFORMANCE – AUTHORIZATION REQUIRED (RNP-AR) TORONTO PEARSON AIRPORT PROJECT:

Together with NAV CANADA, the Greater Toronto Airports Authority (GTAA) introduced a new arrival procedure for aircraft. The procedure shortens flight times, reduces fuel burn - and by extension GHG emissions - and uses quieter continuous descent operations. It is estimated it will reduce greenhouse gas emissions by 178 million kilograms CO_2 over the next 10 years.

Efficiency Improvements and Progress Towards the Action Plan Target

Fuel efficiency in an operational context is commonly measured by calculating the amount of fuel used to move 1 tonne over a distance of 100 kilometres. In 2020 and 2021, fuel efficiency for combined domestic and international flights were 0.41 litres per 100 RTK and 0.39 litres per 100 RTK respectively, compared to 0.32 litres per 100 RTK in 2019. This indicates a worsening in fuel efficiency in terms of passengers and goods movement; however, the results for 2021 are indicative of early progress in returning to a pre-pandemic fuel efficiency improvement trend as overall fuel efficiency improved 6 percent between 2020 and 2021, even as the pandemic persisted.

Chart 3 | Fuel Efficiency – Combined Passengers and Cargo, 2005–2021



As shown in Chart 4, in 2021, the fuel efficiency of international operations was 37.2 litres per 100 RTK and 41.0 litres per RTK for domestic operations. In general, all things being equal, longer international flights tend to be more efficient and burn less fuel per kilometer travelled compared to shorter domestic flights. This is due to the greater time spent at cruising altitude, which is when the aircraft operates most efficiently. There are many factors contributing to the observed differences in domestic and international fuel efficiency including type and size of aircraft, capacity utilization, distance flown, cruising altitude, and speed. For more information regarding international vs. domestic fuel efficiency, see Table 2 in Appendix A.

Chart 4 | Fuel Efficiency – International and Domestic, 2020 and 2021

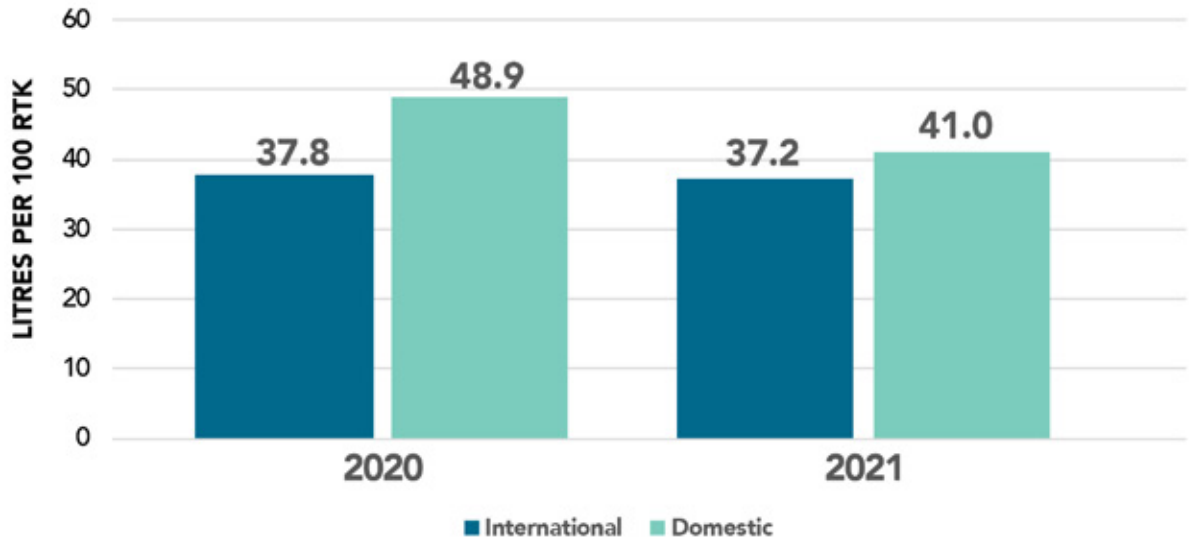
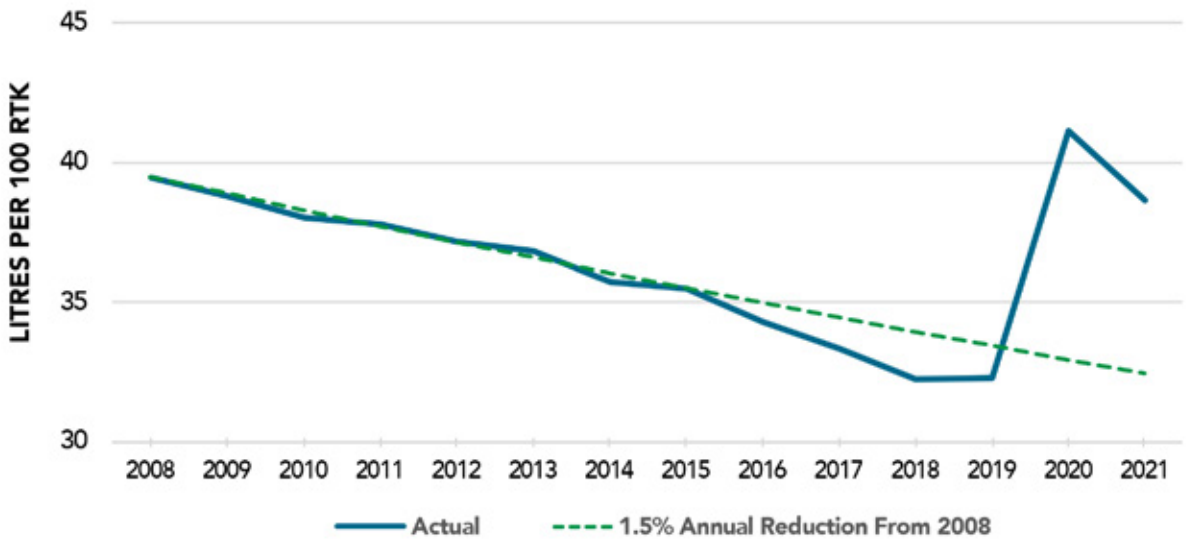


Chart 5 demonstrates the steady trend of fuel efficiency improvements between 2008 and 2019 against the 1.5 percent target. Between 2008 and 2019 there was an annual improvement in efficiency of 1.8 percent achieved. In 2020 and 2021 the pandemic led to a significant worsening in fuel efficiency due in large part to the unforeseen disruption to operating conditions leading to a reduction in aircraft utilization. The annual improvement in fuel efficiency from 2008 to 2021 was 0.2%, as such the sector may not be on track to meet the overall target by 2022 as a direct result of the outsized impact the pandemic had on fuel efficiency in 2021 and 2020. Nevertheless, the sector has continued to make progress implementing fuel savings improvements, which are expected to enable a return to the prior trend of fuel efficiency improvements.

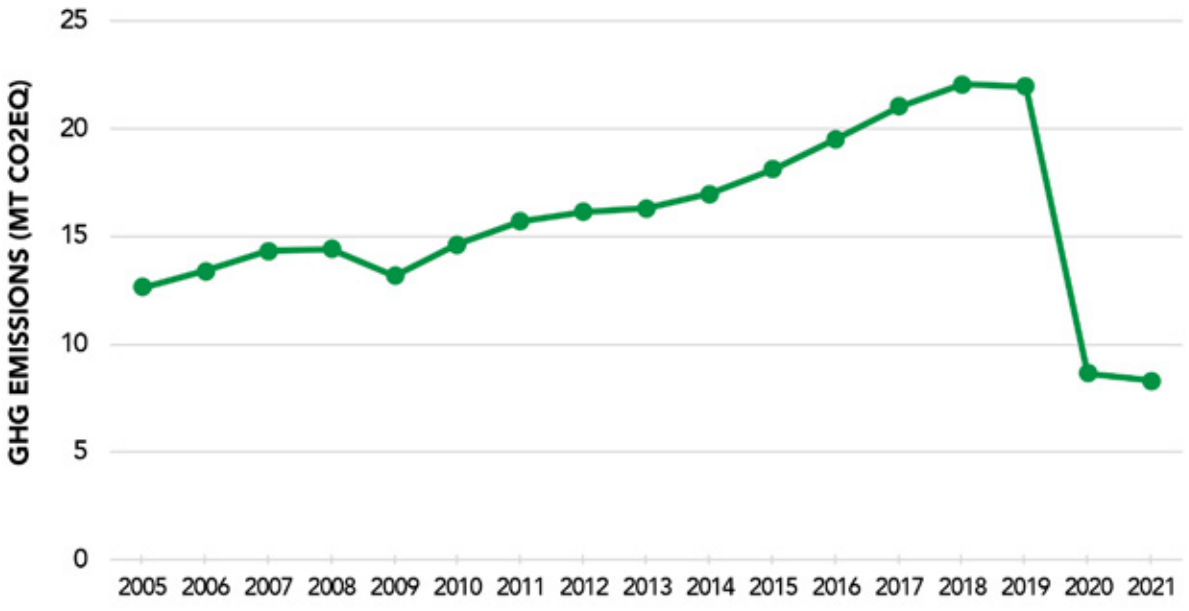
Chart 5 | Comparison of Achieved Fuel Efficiency against the Target, 2008–2021



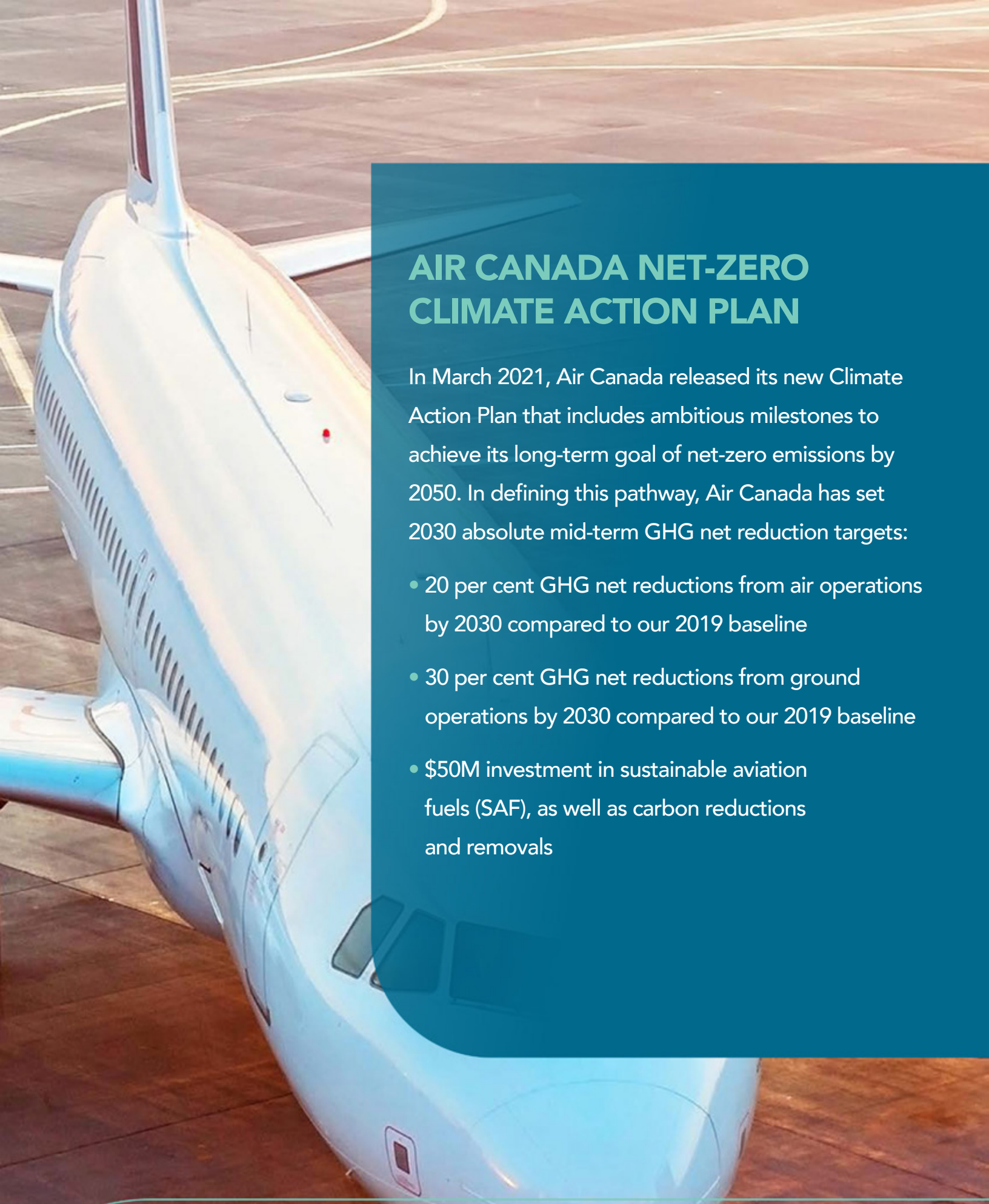
Greenhouse Gas Emissions

While previous reductions had been achieved through efficiency gains, the emissions reductions in 2020 and 2021 were driven primarily by lower activity levels. The domestic portion of Canada's aviation GHG emissions account for approximately 1 percent of Canada's total emissions in 2020 and 2021.[5] In general, the fuel efficiency improvements achieved to date have led to a significant reduction in greenhouse gas emissions. From 2008-2021 if carriers had continued to operate at 2008 efficiency levels, this would have resulted in 24 Mt more emissions over the same period. Despite fuel efficiency improvements made to date, emissions have generally continued to rise because of activity growth in the sector, reaching their highest level in 2018. Due to the reduced activity levels resulting from the pandemic, emissions decreased by 61 percent from 2019 levels in 2020 and by an additional percent in 2021. Chart 6 provides the overall trend in greenhouse gas emissions from 2005-2021.

Chart 6 | GHG Emissions, 2005-2021



5 National Inventory Report 1990-2021: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada.



AIR CANADA NET-ZERO CLIMATE ACTION PLAN

In March 2021, Air Canada released its new Climate Action Plan that includes ambitious milestones to achieve its long-term goal of net-zero emissions by 2050. In defining this pathway, Air Canada has set 2030 absolute mid-term GHG net reduction targets:

- 20 per cent GHG net reductions from air operations by 2030 compared to our 2019 baseline
- 30 per cent GHG net reductions from ground operations by 2030 compared to our 2019 baseline
- $50M investment in sustainable aviation fuels (SAF), as well as carbon reductions and removals

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 2020 and 2021:

FLEET RENEWALS AND UPGRADES

ACTIVITY	RESULTS
Canadian air carriers expect to achieve annual fuel efficiency improvements on domestic and international flights through to 2021 through further fleet changes.	In 2020, Air Transat retired all their Airbus A310 from the fleet and had 7 A321neo LR aircrafts. According to Airbus, the A321neo LR improves fuel consumption by 15% per trip and about 40% less consumption per passenger compared to the Airbus A310. In 2023, Air Transat operates a fleet of 15 A321neo. 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 737-700 NGs. Air Canada took delivery of seven Boeing 737 MAX 8s, twenty-six Airbus A220-300s and three Airbus A330-343s. It retired two Airbus A319-112s, ten Airbus A319-114s, nineteen Airbus A320-211s, two Boeing B767-316ERs, five Boeing B767-333ERs, three Boeing B767-33AERs, one Boeing B767-35HER, two Boeing B767-36NERs, four Boeing B767-375ERs, one Boeing B777-333ER and fourteen Embraer E190s. ATAC all-passenger air carriers continued to add more efficient aircraft such as Boeing 737-600/700/800, Boeing 737 MAX 8, and Bombardier/De Havilland Canada Dash 8-400, ATR 42-500 and 700, and Embraer E2 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 few 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 with equivalent payloads. 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. B777F aircraft have been ordered to provide the additional capacity customers are now demanding due to the explosive growth of online shopping.

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.

MORE EFFICIENT AVIATION OPERATIONS

ACTIVITY	RESULTS
Canadian carriers expect to achieve average annual fuel efficiency improvements for domestic and international flights to 2021 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 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 DHC-8-400 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 a 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 provides the opportunity to carry reduced passenger loads with cargo in the cabin of the aircraft. This segregation has increased operational efficiency. **Air Canada** • Optimization of aircraft configuration change events during initial climb to minimize distance and drag, reducing departure fuel and GHG emissions. • Implementation of a performance-based program for fuel planning management that uses statistical data and methods instead of prescriptive amounts to assess the contingency fuel required for each flight. • Upgrade of aircraft avionics to enable the use of newly published approaches at specific airports that reduce distance, fuel burn and GHG emissions. • New livery used lightweight paint. Using lightweight paint helps to reduce weight to carry, and thus contributes to jet fuel savings. • Many initiatives were done to reduce weight in the aircraft, which results in less fuel burn on flights. These initiatives include retrofitting cabins, optimization of the Duty-free catalogue and EnRoute magazines, removal of newspaper, the optimization of crew luggage, and replacing heavier catering trolleys with lighter versions. • Upgrade of long-haul aircraft avionics to meet the North-Atlantic Performance-Based Communication and Surveillance (PBCS) criteria and benefit from optimized routings and reduced distances, resulting in a reduction in fuel burn and greenhouse gas emissions. • Year-over-year incremental efficiency in the approval and planning of alternate aerodromes, lowering the total fuel weight carried, which resulted in lower fuel burn and greenhouse gas emissions. • Through implementation of special procedures over high or complex terrain, significant reduction in flown distances on operations to and from airports in Mumbai, New Delhi, Dubai, Doha, Buenos Aires and Santiago, resulting in lower fuel burn and greenhouse gas emissions. • Modification of the statistical taxi time determination process to COVID-level traffic, lowering the total fuel weight carried, which resulted in lower fuel burn and greenhouse gas emissions.

	• Introduction of the freeflight concept in the Magadan Airspace (Russian continental), reducing flown distance, associated fuel burn and GHG emissions. • Optimization of the published schedule and arrival margins to better align the flight speed with fuel efficient speeds instead of constantly accelerating flights to meet a too tight target. This results in a direct reduction of fuel burn (and GHG emissions) on numerous flights. • Taking benefit of the significant flight volume drop during COVID, an aircraft selection process was put in place to select more efficient airplanes within a fleet for each operation, which results in jet fuel savings (and GHG reductions).
Business aviation operators will be encouraged to adopt operational improvement to reduce emissions.	The Canadian Business Aviation Association (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.

IMPROVED CAPABILITIES IN AIR TRAFFIC MANAGEMENT

ACTIVITY	RESULTS
NAV CANADA, in partnership with Transport Canada, Canadian 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.	The Canadian Performance-based Aviation Action Team (CPAAT) is leading 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. 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. As of 2020/2021 there were over 50 RNP AR public approach procedures published at airports located throughout every province in the country. During 2020/2021, NAV CANADA continued the implementation and publishing of new public RNP AR approaches at Comox (CYQQ), Terrace (CYXT), Grande Prairie (CYQU) Fort St. John (CYXJ) and Yellowknife (CYZF) airports. 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.

More specifically NAV CANADA will: • 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.	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 separation over the North Atlantic under their respective jurisdictions. The reduced separation standards enabled by space-based ADS-B were officially published November 2020 and are standard operating procedure in the Gander Oceanic Control Area (OCA).
• Report annually on achievable fuel savings and emission reductions from joint efforts with domestic and inter-national carriers operating in Canadian airspace and industry partners through the annual Corporate Social Responsibility Report.	NAV CANADA's 2020/2021 Corporate Social Responsibility highlights can be found 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 into collaborations 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).

AVIATION ENVIRONMENTAL RESEARCH AND DEVELOPMENT

ACTIVITY	RESULTS
The Government of Canada and the Canadian aviation industry supported research and development initiatives to minimize or reduce aviation environmental impacts. Research activities in this area were led by the Green Aviation Research & Development Network (GARDN), which ceased operations on July 18, 2021.	The Green Aviation Research and Development Network (GARDN) was an industry-led consortium of 40 public and private sector partners, including industry heavyweights like Bombardier Aerospace, Pratt & Whitney Canada, Esterline CMC Electronics and Bell Helicopter Textron Canada. GARDN's research program supported 17 projects related to emissions reduction, noise reduction, aircraft operations, airport operations, alternative fuels, life cycle management, and materials and manufacturing processes. The network's research program was refocused for its second phase around three main research thrusts: clean, quiet and sustainable air transportation systems. Over half of the projects dealt specifically with emissions reductions. Five projects focused 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. At its closing in 2021, GARDN comprised 52 members and partners that supported 34 collaborative R&D projects in green aviation valued at a total value of $70 million. GARDN's mission led to the publication of 420 peer-reviewed papers and the training of nearly 90 highly qualified students.
Innovation, Science and Economic Development Canada (ISED)	Budget 2021 included $2 billion in direct support for the recovery of the aerospace industry in recognition of the significant and long-lasting impacts of the pandemic on the sector, including: • Strategic Innovation Fund (SIF): $1.75 billion, over seven years, in targeted funding for aerospace projects that help to bolster innovation, strengthen competitiveness, and accelerate the industry's green transformation; and • Aerospace Regional Recovery Initiative (ARRI): $250 million, over three years, to be delivered by the Regional Development Agencies to support small and medium-sized enterprises strengthen the productivity and commercialization capacity of the aerospace supply chain, and green their operations and products. As part of the SIF aerospace investment target, in July 2021, the Government of Canada announced hundreds of millions of dollars in support of new innovation projects with a focus on sustainable aviation. ISED continues to work with the sector to support Canadian aerospace companies as they pursue innovative R&D projects.
FAA 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 environmental and energy challenges. In 2020 and 2021, 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 31 – Alternative Jet Fuels Test and Evaluation • ASCENT 33 – Alternative Fuels Test Database Library; • 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. • ASCENT 52 – Comparative Assessment of Electrification Strategies for Aviation • ASCENT 54 – Aviation Environmental Design Tool (AEDT) Evaluation and Development Support • ASCENT 69 – Transitioning a Research nvPM Mass Calibration Procedure to Operations • ASCENT 78 – Contrail Avoidance Decision Support and Evaluation

National Research Council of Canada (NRC)	In 2021, the NRC Aerospace Research Centre launched the Low-Emission Aviation Program (LEAP) to accelerate the transition to "net-zero" for Canada's aviation industry and strengthen Canada's position as a clean technology leader. The program has a focus on the following four pillars for R&D and technology innovation with strategic partners: Novel Aircraft Configurations (incl. novel materials), Electrical Propulsion Systems, Clean Fuel Technologies, and Batteries for airborne applications. With financial support from the Government of Canada's Clean Transportation Initiatives, the NRC has: • Participated as a leader of the ground testing portion of the field measurement campaign ECLIF3 (Emission and Climate Impact of Alternative Fuels). ECLIF3 is a pioneering study into the effects of Sustainable Aviation Fuel (SAF) on aircraft emissions, The research was conducted with Airbus, DLR, Rolls-Royce, Neste, and University of Manchester. Data analysis is ongoing and is anticipated to lead to publications and presentations. • Participated in AVIATOR, an international field measurement campaign focused on plume evolution from aircraft engines, studying the emissions at different spatial locations from the engine exit to residential areas in close proximity to airports. Data analysis is ongoing and is anticipated to lead to publications and presentations. • Participated in RAPTOR, to evaluate performance of non-volatile particulate matter (nvPM) instruments well beyond their normal one-year calibration interval, and to assess the potential for improving nvPM mass concentration measurements by measuring mass concentration on raw exhaust to reduce limit-of-detection issues. Data analysis is ongoing and is anticipated to lead to publications and presentations. • Produced numerous publications and presentations on results obtained from prior field measurement campaigns and laboratory research. • 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. A manuscript for publication is being prepared. • Participated in DICE-II, an international campaign to investigate nano aerosol instrument characteristics on 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. • 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 to share relevant information with Canadian airports.

ALTERNATIVE FUELS

ACTIVITY	RESULTS
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 partners.	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. In Fall of 2021, the final technical evaluation was underway for the four finalists' sustainable aviation fuel production proposals. In December 2020, the Government announced the creation of a Clean Fuels Fund to support the production and distribution of low-carbon and zero-emission fuels. In Budget 2021, the value of the fund was announced at $1.5B over five years starting in 2021-22. Transport Canada maintains a dialogue with the US FAA to exchange information on sustainable aviation fuel development and use.
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 2020 and 2021, Transport Canada actively supported:** • The ICAO CAEP Fuels Task Group; • 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 Working Group IV, which is maintaining the technical elements and implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA); and • The US FAA through the Aviation Sustainability Center (ASCENT) Center of Excellence. Transport Canada continues to liaise with other government departments through an ad-hoc sustainable aviation fuels group to share information on alternative jet fuel developments and collaborate on issues of common interest.

AIRPORT GROUND OPERATIONS AND INFRASTRUCTURE USE

ACTIVITY	RESULTS

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:**
	• Saint John Airport (YSJ) has implemented a Carbon Management Plan, which includes:
	  • carbon reduction initiatives
	  • monitoring fuel and energy consumption
	  • awareness and training program for staff
	  • internal auditing program
	In addition, carbon reduction initiatives currently underway include an LED retrofit of lighting in various buildings at the airport, new firehall doors, and running targeted employee awareness campaigns to reduce energy consumption.
	• Ft. McMurray (YMM)

YMM BY THE NUMBERS (2019-2020)

22% LESS
overall carbon footprint

44.3% LESS
glycol consumed for aircraft de-icing activities in the winter

12.8% LESS
natural gas consumed by airport restaurants for cooking and cleaning

25.6% LESS
diesel consumed by ground service equipment, power generators and other

16.2% LESS
electricity consumed to light and heat airport buildings and light the runway and taxiway

12% LESS
gasoline consumed by airport operated vehicles

• The Montréal-Trudeau International Airport (YUL) conducted in 2019 a recommissioning project on the airport's 70 main ventilation systems which ended up saving 4% of YUL's overall energy consumption. YUL's maintenance team has also optimized the heating equipment in order to bring additional energy savings. Aéroports de Montréal (ADM) also installed ESPAR equipment on 50 heavy vehicles which will reduce their fuel consumption by 70% during waiting periods on the airport apron. Additional charging stations for electric vehicles were installed thus increasing the number of stations to 56. Finally, the airport authority joined the EV 100 initiative, launched in 2017 by the international non-governmental organization the Climate Group, which aims to increase the use of electric vehicles in companies by 2030.

In 2020, 12 charging stations were installed at YUL for Air Canada's fleet of electric baggage tractors. This same year, an electricity load shedding strategy was implemented to reduce the power demand of ADM's buildings at YUL during the utility's winter peak hours.

ADM started buying renewable natural gas (RNG) in 2021 for YUL's boiler. RNG is expected to represent 25% of YUL natural gas procurement in 2023.

- Toronto Pearson International Airport (YYZ) has upgraded its electric vehicle charging stations (airside), to provide better, more reliable charging for new lithium-ion battery powered vehicles. It is anticipated that all replacements will be completed in 2023 as part of a multi-year strategic rollout. YYZ has additionally added 2 electric COBUS' to its fleet, and continues to provide ground power unit and auxiliary power unit options at all gates with either fixed or mobile stations. YYZ continues to work on implementation of Airport Collaborative Decision Making (A-CDM) processes to reduce taxi times, and associated fuel burn. Additionally, YYZ replaced over 1,800 apron, taxiway and runway lights with LED lights; providing better visibility for pilots, while reducing overall energy consumption as well.
- Québec City Airport from 2019-2021 has implemented:
  - Effective lighting with luminosity detector;
  - Readjustment of the air supply temperature
  - Detector of CO2
  - Geothermal plant
  - Avoid idle of the vehicle (procedure communicated to the employees)
- Halifax Stanfield International Airport (YHZ) has developed a new carbon management plan that serves as a roadmap to net zero 2050. An interim CO_2e reduction goal of 30% below 2019 levels by 2026 has also been established for Scope 1 and 2 emissions. Carbon reduction initiatives implemented included updating apron lighting and parking lot lighting with all LED fixtures, replacing over 2000 compact fluorescent and T8 bulbs in the air terminal building with LED bulbs, installing telematics and conducting an electric vehicle assessment of HIAA's fleet, and replacing runway sweepers with more fuel-efficient models.
- Saskatoon Airport (YXE) identified that, compared to old incandescent bulbs, LED lights are up to 80% more efficient. Unlike fluorescent lights, LED lights convert 95% of their energy into light and only 5% is wasted as heat; while still using far less power to provide a strong and consistent output at a lower wattage. Rehabilitation of runway 15/33 presented the opportunity to replace all runway lights and signage and install LEDs. Same upgrades were done around the main terminal. After this change, compared to 2015, the airport had a reduction of 14% from 2015 airfield electricity consumption and overall reduction of 8.2% in terminal electrical consumption.
- Vancouver International Airport (YVR) is implementing a Roadmap to Net Zero by 2030, with four pathways – energy efficiency and conservation, greening the fleet, renewable energy and closing the gap through the purchase of carbon removals. YVR has been carbon neutral since 2020.

Canadian airports will refine and improve emissions inventories and will explore further opportunities for emissions reduction strategies.

There are 23 Canadian airports participating in the Airport Carbon Accreditation (ACA) program under Airports Council International (ACI). Within this program, there are six levels of certification:

+ MAPPING
Footprint measurement

+ REDUCTION
Carbon management towards a reduced carbon footprint

+ OPTIMISATION
Third party engagement in carbon footprint reduction

+ NEUTRALITY
Carbon neutrality for direct emissions by offsetting

+ TRANSFORMATION
Transforming airport operations and those of its business partners to achieve absolute emissions reductions

+ TRANSITION
Compensation for residual emissions with reliable offsets

Canadian airports have achieved the following levels of certification:

Level 1:

Aéroport Trois-Rivières, Edmonton International Airport, Fredericton International Airport, London International Airport, Nanaimo Airport, Regina International Airport, Region of Waterloo International Airport, St. John's International Airport, Calgary International Airport, Thunder Bay International Airport, John C. Munro Hamilton International Airport, Winnipeg James Armstrong Richardson International Airport

Level 2:

Charlottetown Airport, Kelowna International Airport, Fort McMurray International Airport, Halifax Stanfield International Airport, Saskatoon International Airport, Victoria International Airport

Level 3:

Québec City Jean Lesage International Airport, Montréal-Pierre Elliott Trudeau International Airport

Level 3+:

Ottawa International Airport Authority

Level 4:

Toronto Pearson International Airport

Level 4+:

Vancouver International Airport

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.

REGULATORY MEASURES

ACTIVITY	RESULTS
Transport Canada will continue to participate in the development of new or more stringent international standards for aircraft and aircraft engines, through the ICAO CAEP.	Canada continues to make significant contributions in the updating and developing ICAO international standards through CAEP. Canada adopts these standards into its domestic regulations. In 2020 this included the new nvPM and CO_2 standards.

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 into the *Aeronautics Act* for Canadian operators operating internationally.	Following the adoption by ICAO Council of Phase II of the new nvPM mass and number standard in March 2020, Transport Canada drafted a notice for proposed amendment (NPA). The NPA to the Canadian Aviation Regulations for Phase II of the nvPM standard was published; the new standard became effective in Canada on September 24, 2021. Transport Canada published the NPA for the new CO_2 Standard in October 2020. The new standard became effective on December 9, 2020. The *Aeronautics Act* was amended to enable the new CO_2 standard in the new ICAO Annex 16 Volume III. The Monitoring, Verification and Reporting (MRV) requirements of CORSIA were finalized in the Canada Gazette in November 2018 and came into force on January 1st, 2019. Regulations covering the offsetting phase of CORSIA were published in the Canada Gazette II in December 2020 and came into effect on January 1st, 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. Because of their special circumstances, the federal fuel charge for aviation fuel used in Yukon and Nunavut is currently set at $0.00/L. The Government has committed to engage with stakeholders, provinces and territories, to explore a consistent national approach, including the challenges and opportunities, to pricing emissions from inter-provincial aviation. The Clean Fuel Regulations (CFR) were published in July 2022. The CFR applies to gasoline and diesel used in Canada, with reduction requirements starting in July 2023.

INTERNATIONAL COORDINATION

ACTIVITY	RESULTS
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.	Canada provides expertise to support ICAO work on emissions standards, operational measures, modeling and economic assessments, fuels, CORSIA, and the evaluation of certification schemes used for CORSIA. 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.
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 Transport Canada's Performance Based Navigation (PBN) State Plan for Canada, 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 2020, NAV CANADA published 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. 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 are continuing to provide subject matter experts to advise ICAO's CAEP in all areas of environmental regulation, including carbon emissions, emissions with impacts on local air quality such as NOx and non-volatile Particulate Matter (nvPM), noise and makes scientific contributions on cutting-edge areas of research such as contrail formation. AIAC provides the link to the international community through its membership in ICCAIA. • The ICAO General Assembly adopted a package of environmental measures, marking a significant milestone in environmental protection. Of particular importance was the adoption of a Long-Term Aspirational Goal (LTAG) for carbon reduction that aligns with the industry's own ambition to achieve Net Zero operations by 2050. ICCAIA provided technical contributions to the LTAG report across all areas of technology, operations, fuels and market impact assessment, with over 70 experts providing inputs. • AIAC Member company is also Vice-Chair of the ICCAIA Aircraft Noise and Emissions Committee providing valuable advice and ensuring a leadership role.

LOOK AHEAD 2022

This section provides a short overview of several expected updates to be included in the 2022 annual report. The 2022 report will aim to provide a comprehensive overview of the sector's initial progress towards a green recovery.

Fleet Renewals

Updates on NACC and ATAC carrier fleet renewal plans:

- Air Canada took delivery of nine Boeing 737 MAX 8s, two Boeing 767-300Fs, and five Airbus A220-300s. It retired five Boeing 767-3s.
- Air Transat received 5 A321 NEO LRs and operated a total of 31 aircraft compared to 23 in 2021.
- Rise Air took delivery of a Next Generation ATR 42-500.
- Air North has completed its regional fleet transition from HS-748 to ATR 42 aircraft.

Aircraft Manufacturing

- AIAC continued, through ICCAIA, 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.

Air Traffic Management

NAV CANADA Performance Based Navigation (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 and Emissions Offsetting

- Air Canada resumed its SAF program and purchased more than 500,000 US gal of neat SAF.
- The Canadian Council for Sustainable Aviation Fuels (C-SAF) is launched.
- AirSprint has set a target for all flights to be carbon neutral by 2025 with measures including carbon offsets and SAF use.

Airport Efficiency Improvements

- Toronto Pearson International Airport continued replacing its light fleet with green vehicles and continuing to reduce emissions across all 3 scopes.
- Saskatoon Airport has assessed the energy use of bridges and determined that the insulation via vapor barrier of these Bridges will help to reduce heat loss and therefore reduce electricity costs. In the year 2022 all bridges were insulated, and vapor barriers were added.

Federal Measures

- The Sky's The Limit Challenge Final Grand Prize Winner Enerkem was announced in March 2022.
- Approximately 60 projects were selected to receive funding under the Government of Canada's Clean Fuels Fund (CFF)[6]. The value of the fund was announced at $1.5B over five years starting in 2021-22. These projects represent a first tranche of the highest-ranking applications from the 2021 call for proposals and have a total combined value of more than $3.8 billion. They include production facilities, as well as feasibility and front-end engineering and design studies, spanning seven jurisdictions and covering five different fuel types. The federal government is undertaking negotiations to finalize the terms of funding for each project, and the total federal investment in these projects will be up to $800 million.
- A call for project proposals for the Biomass stream of the CFF was also launched in August 2022 and closed in November 2022. The department is in the process of finalizing project recommendations.
- The federal Clean Fuel Regulations (CFR) were published in July 2022. The CFR applies to gasoline and diesel used in Canada, with reduction requirements starting in July 2023.

Domestic And International Coordination

- In 2022, Transport Canada participated in the 41st Session of the ICAO Assembly where the ICAO Assembly considered the progress of the work on exploring the feasibility of a long term global aspirational goal for international aviation. Transport Canada continued to perform CORSIA Order of Magnitude checks on 2020 emissions and submit consolidated data to ICAO.

Aviation Environmental Research and Development

- In 2022, NRC conducted the first hybrid-electric aircraft flight in Canada. A 40 member team of NRC research engineers and technicians converted a Cessna 337 civil aircraft to hybrid electric power by replacing the aircraft's rear engine with a fully electric propulsion system, including an electric motor, battery and support systems. The knowledge and capabilities built are being used to support industry and regulators in developing aircraft electrification technologies and certification standards.
- NRC undertaking development of a facility renewal strategy to identify key required enhancements and realignments to NRC's existing world-class clean energy and aviation research infrastructure to better support joint technology development in the aviation sector.

6 Minister Wilkinson Announces up to $800 Million in Project Funding to Advance Canada's Clean Fuels Sector - Canada.ca

APPENDIX A:
DATA TABLES

Table 1 | Annual Results of Domestic and International Operations, 2005–2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fuel use (million litres)	4,887	5,186	5,543	5,575	5,098	5,659	6,089	6,256	6,314	6,579
GHG emissions (megatonnes CO_2e)	12.622	13.393	14.316	14.399	13.167	14.615	15.725	16.157	16.307	16.991
Traffic (billions)										
Revenue passenger-kilometres (RPK)	105.2	113.0	124.2	125.5	117.6	128.8	141.3	148.7	150.9	161.6
Passenger revenue-tonne-kilometres (pass. RTK)*	10.5	11.3	12.4	12.6	11.8	12.9	14.1	14.9	15.1	16.2
Cargo revenue-tonne-kilometres (cargo RTK)	1.6	1.5	1.8	1.6	1.4	2.0	2.0	2.0	2.1	2.2
Total revenue-tonne-kilometres (RTK)	12.1	12.8	14.2	14.1	13.1	14.9	16.1	16.8	17.1	18.4
Fuel consumption rates										
Litres/RPK	0.0464	0.0459	0.0446	0.0444	0.0433	0.0439	0.0431	0.0421	0.0418	0.0407
Litres/Total RTK	0.4043	0.4043	0.3895	0.3947	0.3879	0.3802	0.3780	0.3716	0.3683	0.3574
Emission rates**										
CO_2e grams/RPK	120	119	115	115	112	113	111	109	108	105
CO_2e grams/Total RTK	1,044	1,044	1,006	1,019	1,002	982	976	960	951	923

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

** 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 1990–2021

Annual Results of Domestic and International Operations, 2015–2021

	2015	2016	2017	2018	2019	2020	2021
Fuel use (million litres)	7,023	7,555	8,137	8,543	8,498	3,357	3,223
GHG emissions (megatonnes CO_2e)	18.137	19.511	21.015	22.063	21.947	8.670	8.323
Traffic (billions)							
Revenue passenger-kilometres (RPK)	175.7	194.0	212.1	230.0	230.4	59.7	51.2
Passenger revenue-tonne-kilometres (pass. RTK)*	17.6	19.4	21.2	23.0	23.0	5.97	5.12
Cargo revenue-tonne-kilometres (cargo RTK)	2.2	2.6	3.2	3.5	3.3	2.19	3.22
Total revenue-tonne-kilometres (RTK)	19.8	22.0	24.4	26.5	26.3	8.16	8.34
Fuel consumption rates							
Litres/RPK	0.0400	0.0389	0.0384	0.0371	0.0369	0.0562	0.0629
Litres/Total RTK	0.3546	0.3428	0.3331	0.3222	0.3229	0.4114	0.3865
Emission rates**							
CO_2e grams/RPK	103	101	99	96	95	145	163
CO_2e grams/Total RTK	916	885	860	832	834	1,062	998

* 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 1990–2021

Table 2 | International Vs. Domestic Aviation Activity

2020

	Combined ATAC & NACC		
	International	**Domestic**	**Total**
Fuel use (million litres)	2,159	1,198	3,357
Greenhouse gas emissions (millions of tonnes of CO_2e)	5.58	3.09	8.67
Traffic (billions)			
Revenue passenger-kilometres (RPK)	42.3	17.4	59.7
Passenger revenue-tonne-kilometres (pass. RTK)	4.2	1.7	6.0
Cargo revenue-tonne-kilometres (cargo RTK)	1.5	0.7	2.2
Total revenue-tonne-kilometres (RTK)	5.7	2.5	8.2
Fuel consumption rates			
Litres/RPK	37.8	48.9	41.1
Emission rates:			
CO_2e grams/Total RTK	977	1,262	1,062

2021

	Combined ATAC & NACC		
	International	**Domestic**	**Total**
Fuel use (million litres)	1,903	1,319	3,223
Greenhouse gas emissions (millions of tonnes of CO_2e)	4.92	3.41	8.32
Traffic (billions)			
Revenue passenger-kilometres (RPK)	26.7	24.5	51.2
Passenger revenue-tonne-kilometres (pass. RTK)	2.7	2.5	5.1
Cargo revenue-tonne-kilometres (cargo RTK)	2.5	0.8	3.2
Total revenue-tonne-kilometres (RTK)	5.1	3.2	8.3
Fuel consumption rates			
Litres/RPK	37.2	41.0	38.7
Emission rates:			
CO_2e grams/Total RTK	960	1,060	998

Table 3 | Absolute and Proportional Changes Over Time, 2008–2021

	Change 2019-2020		Change 2020-2021		Change 2008-2021		
	Absolute	Proportional	Absolute	Proportional	Absolute	Proportional	Annual rate
Fuel use (million litres)	-5,141	-60.5%	-134	-4.0%	-2,353	-42.2%	-4.1%
GHG emissions (megatonnes CO_2e)	-13.28	-60.5%	-0.35	-4.0%	-6	-42.2%	-4.1%
Traffic (billions)							
Revenue passenger-kilometres (RPK)	-170.7	-74.1%	-8.5	-14.2%	-74.3	-59.2%	-6.7%
Passenger revenue-tonne-kilometres (pass. RTK)	-17.1	-74.1%	-0.8	-14.2%	-7.4	-59.2%	-6.7%
Cargo revenue-tonne-kilometres (cargo RTK)	1.0	46.9%	-1.1	-33.3%	1.6	104.7%	5.7%
Total revenue-tonne-kilometres (RTK)	0.177	2.17%	-18.2	-69.0%	-5.8	-41.0%	-4.0%
Fuel consumption rates							
Litres/RPK	0.019	52.4%	0.007	11.9%	0.02	41.7%	2.7%
Litres/Total RTK	0.089	27.4%	-0.025	-6.0%	-0.01	-2.1%	-0.2%
Emission rates:							
CO_2e grams/RPK	50	52.4%	17	11.9%	48	41.7%	2.7%
CO_2e grams/Total RTK	229	27.4%	-64	-6.0%	-21	-2.1%	-0.2%

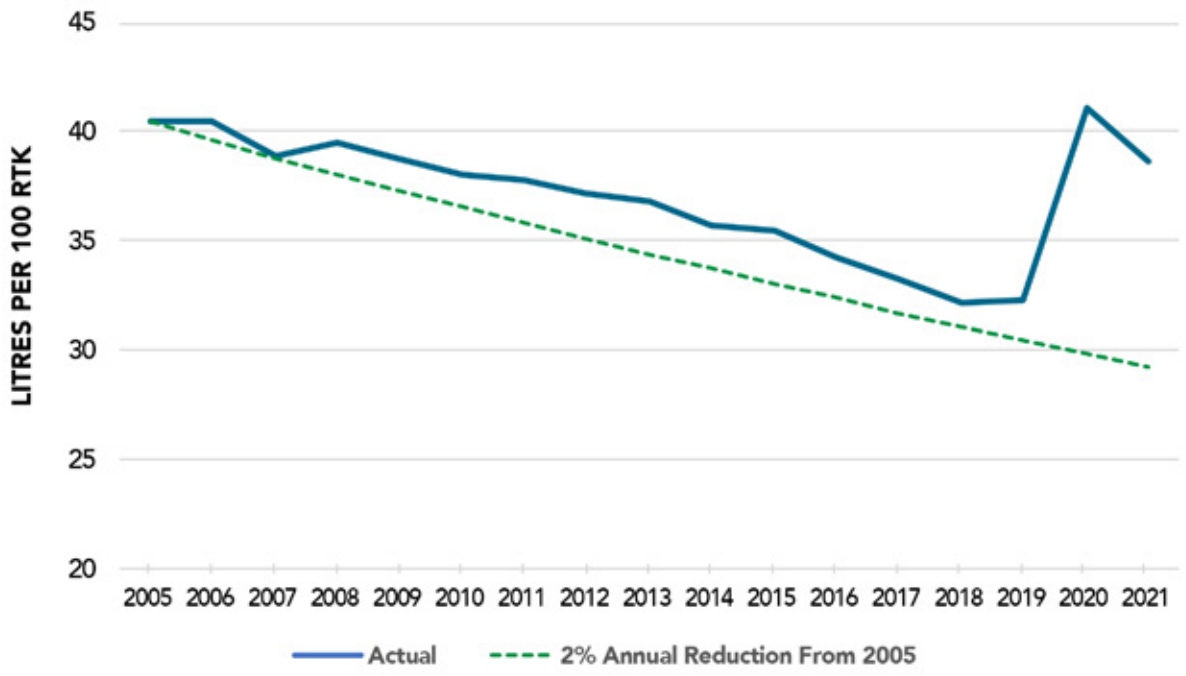
APPENDIX B:
PROGRESS TOWARDS THE ACTION PLAN'S 2 PERCENT ASPIRATIONAL GOAL

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 and Chart 7 illustrate the combined ATAC and NACC results for measuring progress towards the aspirational goal between 2005 and 2021. While the general trajectory of emissions was close to the 2 percent target leading up to 2019, due largely to the pandemic the aspirational goal for efficiency was not achieved in 2020 or 2021.

Table 4 | Absolute and Proportional Changes Over Time, 2005–2021

	Change 2005-2021		
	Absolute	**Proportional**	**Annual rate**
Fuel use (million litres)	-1,665	-34.1%	-2.6%
GHG emissions (megatonnes CO_2e)	-4.3	-34.1%	-2.6%
Traffic (billions)			
Revenue passenger-kilometres (RPK)	-54.0	-51.3%	-4.4%
Passenger revenue-tonne-kilometres (pass. RTK)	-5.4	-51.3%	-4.4%
Cargo revenue-tonne-kilometres (cargo RTK)	1.6	105.3%	4.6%
Total revenue-tonne-kilometres (RTK)	-3.8	-31.0%	-2.3%
Fuel consumption rates			
Litres/RPK	0.02	35.5%	1.9%
Litres/Total RTK	-0.018	-4.4%	-0.3%
Emission rates:			
CO_2e grams/RPK	43	35.5%	1.9%
CO_2e grams/Total RTK	-46	-4.4%	-0.3%

Chart 7 | Aspirational Goal Trajectory, 2005–2021



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

CFR: Clean Fuel Regulations

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

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 1990–2021.

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. Coverage in 2020 and 2021 was close to that of 2019 with some smaller changes in member reporting indicated in Appendix E. Changes 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 AVIATION 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 2020 and 2021 data for this annual report, including:

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

The ATAC member carriers who contributed 2020 and 2021 data for this annual report were:

- Air North;
- Canadian North/First Air;
- Cargojet;
- Central Mountain Air;
- Flair (included in 2021 data but not 2020);
- Harbour Air;
- KF Aerospace;
- Morningstar;
- Nolinor;
- North Cariboo Air;
- Perimeter Aviation (incorporating Bearskin Airlines);
- Porter; and
- Sunwing.