2011 Canadian Aviation Industry Report on Greenhouse Gas Emissions Reductions

December 2012 – amended August 2013*

* The amendment corrects a minor error in estimation of the rates of fuel consumption per revenue-tonne-kilometre for calendar years 2010 and 2011, reducing the estimates by 0.3% and 2.0% respectively (and therefore the rates of GHG emissions by those same proportions). All other estimates are unaffected.

Foreword

This is the sixth annual report prepared under the Voluntary Memorandum of Understanding (MOU) on the Reduction of Aviation Greenhouse Gas Emissions, signed in June 2005 between Transport Canada and the Air Transport Association of Canada (ATAC).[1]

Under the Terms and Conditions of the MOU, ATAC prepared and published annual reports for the first two calendar years, 2006 and 2007. [2,3] Subsequently, in 2008, the four largest passenger air carriers – Air Canada, Air Transat, Jazz Air LP, and WestJet – elected to leave ATAC, and formed a new trade association, the National Airlines Council of Canada (NACC).

While no longer covered by the MOU, those carriers affirmed their continuing support of the agreement and its goals, and assumed their responsibilities as set out in the agreement. For calendar year 2008, NACC prepared a report containing aggregated data for its four member carriers,[4] and ATAC provided a report on the activities in 2008 of six remaining member carriers. A Consolidated Report for the two associations was then prepared and published by Transport Canada.[5] For each of the two subsequent calendar years, 2009 and 2010, NACC again prepared a report covering its four members, ATAC provided a report on activities of its largest member carriers, and the consolidated report was prepared and published by Transport Canada.[6]

For the current volume, the same procedures have been followed by the two associations to report on activities in calendar year 2011.

Replacement of the MOU by Canada's new Action Plan

In March 2010, a joint-government industry Working Group on Aviation Emissions was established to develop a plan to address GHG emissions from the aviation sector. This collaboration builds on the success of existing efforts to address GHG emissions, including the 2005 voluntary agreement.

Beginning with the 2012 calendar year, the Memorandum of Understanding Between Transport Canada and the Air Transport Association of Canada (collectively the "Parties") will be concluded and replaced by Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation (Canada's Action Plan), which is available online at: http://www.tc.gc.ca/aviation-emissions/). Released on June 4, 2012, Canada's Action Plan sets an ambitious goal to reduce GHG emissions from both domestic and international aviation operations by improving fuel efficiency by an average rate of at least 2 percent per year until 2020, measured against a 2005 baseline. These efforts will contribute to Canada's broader target of reducing total GHG emissions by 17 percent from 2005 levels by 2020. Canada's Action Plan is also Canada's response to the International Civil Aviation Organization (ICAO) Assembly Resolution A37-19, which encouraged Member States to submit national action plans by June 2012 outlining their respective actions to address international aviation emissions.

As a result, this will be the final report produced under the 2005 voluntary agreement. All Parties agree that subsequent reports on the Canadian aviation industry's progress to reduce GHG emissions will be produced under the auspices of Canada's Action Plan.

Executive Summary

The purpose of this Report is to outline the efforts and achievements of Canada's aviation industry in greenhouse gas emissions reductions during 2011 under the voluntary Memorandum of Understanding established between the Air Transport Association of Canada and Transport Canada in 2005. That agreement's quantitative goal was to reduce the industry's greenhouse gas emissions rate per unit of output (primarily per revenue tonne-kilometre) by an average of 1.1 percent per year, with a cumulative reduction goal of 24 percent in 2012, compared to the 1990 baseline.

Information on activities during calendar year 2011, including relevant statistics describing operations and fuel use, have been reported by both ATAC and NACC, and consolidated in the present report.

Highlights of the report's findings are as follows:

- In 2011, aviation demand continued to rebound from the reductions in 2009 that accompanied the worldwide downturn in economic activity. After increasing by 9.5 percent from 2009 to 2010, passenger traffic rose by another 9.7 percent from 2010, to 141 billion revenue passenger-kilometre (RPK).

- Reported cargo traffic was 1.98 billion revenue tonne-kilometres (RTK) in 2011, a slight reduction from 2010, but over 40 percent greater than its extraordinarily low level in 2009 (though the trends are uncertain due to incomplete reporting).

- Total fuel consumption by the reporting air carriers in 2011 rose to 6.09 billion litres, an increase of 7.6 percent from 2010. Total greenhouse gas (GHG) emissions in 2011 were 15.6 megatonnes (Mt) of carbon dioxide equivalent (CO_2e), also a 7.6 percent increase over 2010.

- The key fuel consumption rate reported for 2011 was 0.378 litres per RTK, combining both passenger and cargo traffic, and the emissions rate was 966 grams CO_2e per RTK.

- The long-term annual average fuel efficiency improvement in litres per total RTK (combining passenger and cargo operations) was 1.8 percent between 1990 and 2011, surpassing the MOU-established target of 1.1 percent per year.

- Combined passenger and cargo RTK grew by 93 percent between 1990 and 2011. Total fuel consumption rose by 32 percent during the same period. Fuel intensity per RTK fell by 31.6 percent over the entire period, surpassing the long-term objective of the MOU of a cumulative improvement of 24 percent between 1990 and 2012.

- Without having taken action, total GHG emissions in 2011 would have reached 22.7 Mt at the 1990 fuel efficiency rate, whereas actual 2011 emissions were 32 percent lower, at 15.6 Mt.

1. Background

Aviation emissions goals of ICAO and IATA

In October 2010, the International Civil Aviation Organization (ICAO) adopted a new Assembly Resolution on climate change, Resolution A37-19. It set several voluntary goals for international aviation emissions, including:

- A global annual average fuel efficiency improvement of 2 percent until 2020;
- A medium-term aspirational goal of keeping the global net carbon emissions from international aviation from 2020 at the same level; and
- A global aspirational goal of 2 percent annual fuel efficiency improvements from 2021 to 2050.

To help ICAO track progress towards reaching these goals, the resolution encouraged Member States to submit action plans to ICAO by June 2012, detailing specific measures to address GHG emissions related to international aviation. Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation was approved and submitted to ICAO in June 2012, adopting the voluntary goals, including improving fuel efficiency by an average rate of at least 2 percent per year from 2005 to 2020.

ICAO's environmental activities are largely undertaken through the Committee on Aviation Environmental Protection (CAEP). Through CAEP, ICAO issued in 2004 a "Template and Guidance on Voluntary Measures", providing guidance to assist interested countries in establishing voluntary agreements to address emissions.[7] The guidance material lends support to ICAO's objective of harmonized efforts and underscores the importance of voluntary initiatives in addressing the problem of aviation emissions. The Template proposed that quantified goals be established for emissions reductions, expressed as fuel consumption per unit of aviation activity, suggesting that "the Partnership Goal is a specified percent annual improvement in fuel per revenue tonne-kilometre over a 12-year period from 1998-2010."[8]

In September 2009, the International Air Transport Association (IATA) announced its four-pillar Climate Change Strategy of technology investment, efficient infrastructure, effective operations and positive economic measures.[9] The Strategy also outlined the Association's commitment to three sequential targets:

- 1.5 percent average annual improvements in fuel efficiency to 2020,
- stabilizing emissions with carbon-neutral growth from 2020, and
- 50 percent absolute cut in emissions by 2050 compared to 2005.

Memorandum of Understanding (MOU) - Voluntary Agreement for the Reduction of Greenhouse Gas (GHG) Emissions

On June 29, 2005 ATAC and Transport Canada signed the first voluntary agreement in the world based on ICAO's Template. Canada's air service providers became the first air carriers to have reached a voluntary agreement with their government to reduce the growth of GHG emissions, including both domestic and international operations. Under the MOU, ATAC undertook to encourage its members to improve their fuel efficiency, with a quantitative goal to:

> "reduce collective ATAC member fleet greenhouse gas emissions on a per unit basis (through fuel efficiency improvements, e.g. reduction in litres of fuel/Revenue Tonne Kilometre) by an average of 1.1 percent per annum, reaching a cumulative improvement of 24 percent in 2012 compared to the 1990 base case scenario."

The MOU also addressed the principles governing the Agreement, the responsibilities of the parties, and provisions for its management and administration. A key provision was that ATAC would obtain the necessary data from its members, and report annually on progress, including statistics illustrating performance relative to the goal.

The association therefore accepted a more ambitious target than ICAO suggested at the time. At the time of the signing of the MOU, the 1.1 percent reduction target was consistent with the approach undertaken by IATA, of which some of the ATAC/NACC carriers are members. The IATA carriers had committed to achieving a fuel efficiency goal of 41.5 litres of fuel per 100 RTK by 2012. IATA goals were subsequently extended to 2020 and 2050, as noted above.

The first annual report under the MOU covered calendar year 2006, and was published by ATAC in February 2008. The subsequent report for 2007 was published in 2009. For the annual report covering 2008, ATAC and NACC provided reports on their respective members' activities which were consolidated by Transport Canada, approved by the MOU Management Committee on which both Associations are represented, and published early in 2010.[10] That procedure was repeated for the 2009 and 2010 reports published in October 2010 and March 2012 (see endnote 6), and has again been repeated for this report for calendar 2011.

Audit of the MOU

As part of the management procedures for the agreement, the MOU also called for their periodic audits, as follows:

> "In order to allow the Parties to have continued confidence in the reliability of the reports, a qualified auditor will be given access, each year or periodically but not more frequently than once a year, to audit the reports, processes and supporting documentation residing with ATAC pertaining to the Agreement. Transport Canada and ATAC will select the appropriate auditor capable of independently verifying the reports. Transport Canada will cover all audit costs."

The audit was undertaken during 2010. After examining the processes and reporting for the 2008 report, the independent auditor concluded that:

> "The data collection, modification, aggregation and normalization processes used by ATAC and NACC meet the requirements of the MOU in all material respects."

The auditor made some recommendations for improvement, to which ATAC and NACC provided a consolidated Management Response, attached as an Annex to the 2009 report.

2. Reporting of Activity and GHG Emissions

2.1 ATAC Reporting

Data from the ATAC air carriers is reported through the "ATAC GHG Emissions Reporting System", referred to as AGERS.

Annual Data Requested
Each year, ATAC requested the following data from its membership in order to populate the AGERS database:

- Litres of fuel burned;
- Available seat-kilometres or miles (ASK or ASM);
- Available tonne-kilometres or ton-miles (ATK or ATM) (cargo only);
- Revenue passenger-kilometres or -miles (RPK or RPM);
- Revenue tonne-kilometres or ton-miles (RTK or RTM) (cargo only);
- Total available tonne-kilometres or ton-miles (total ATK or total ATM) (total of passengers weight at 220 lbs each, including baggage);
- Total revenue tonne-kilometres or ton-miles (total RTK or total RTM) (total of passengers weight at 220 lbs each, including baggage).

AGERS Output
Once data are collected, de-identified and aggregated, the AGERS database produces the following:

- Current and annual air sector GHG total emission summary reports;
- Annual air sector GHG emissions intensity trend reports;
- Individual company emissions reports, on request by company affected;
- Air sector reports using aggregate data.

AGERS Units
The measurement units used by AGERS are industry-wide recognized and accepted, including:

- Litres of fuels/available tonne-kilometre (and ton-mile);
- Litres of fuel/revenue tonne-kilometre (and ton-mile);
- Litres of fuel/available seat-kilometre (and mile);
- Litres of fuel/revenue seat-kilometre (and mile);
- Greenhouse gas emissions in megatonnes CO_2-equivalent (abbreviated to CO_2e), combining emissions of Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) weighted by their radiative-forcing coefficients;
- grams CO_2e/passenger-kilometre;
- grams CO_2e/tonne-kilometre.

Carrier Participation

The information contained in the AGERS database relates to aircraft fuel use and does not include fuel used in ground equipment and facilities. It includes domestic, transborder and international operations.

The ATAC member carriers who contributed data to the AGERS database in 2011 were the same as those in 2010, namely:

- Air North
- Canadian North
- Cargojet
- First Air
- Flair
- Kelowna Flightcraft
- Porter Airlines
- Sunwing.

Inclusion of Porter Airlines and Kelowna Flightcraft for the first time in 2010 and again in 2011 means that statistics are more complete than in the previous years, improving the validity of the estimates of rates of fuel use and emissions. But it must be borne in mind that the number of carriers and extent of coverage of ATAC members' operations have varied over the period of the MOU, and the carrier reports have differed somewhat in the completeness of their activity statistics. Furthermore, to deal with incomplete activity records, the ratios of fuel use to activity have been adjusted to include only the carriers that reported the relevant activity. The statistics and rates in this report are the most reliable to date.

2.2 NACC Reporting

For the reporting of the statistics under the MOU, NACC adopted the reporting system of one of its member carriers, standardized to fulfill the reporting requirements under the MOU. The use of this system ensured that the other member carriers reported their data in a consistent and standardized manner. NACC contracted an independent third party to collect and maintain all carrier data.

The information has been compiled and reported in a consolidated manner in order to ensure that no carrier can be identified.

The GHG emissions reported in the NACC database pertain to aircraft fuel use and do not include fuel used in ground equipment or facilities. The reporting includes domestic, trans-border and international operations. All the members of NACC, that is, Air Canada, Air Transat, Jazz Air LP, and WestJet, contributed 2011 data.

This report revises data contained in earlier reports. A major revision was made by NACC to the statistics of cargo available ton-miles (ATM) for all the years reported, to correct a previous processing error which double-counted the estimate of passenger ATM. Consequently, all of the computed rates of emissions per tonne-kilometre are increased, but are more accurate.

The member carriers of NACC provided the following 2011 statistics:

- Cargo available ton-miles (ATM)
- Cargo revenue ton-miles (RTM)
- Available seat-miles (ASM)
- Revenue passenger-miles (RPM)
- Litres of fuel burned per year

Output

NACC aggregated the data provided by members and performed the necessary calculations to provide the following output statistics:

- Cargo revenue tonne-kilometres (RTK)
- Revenue passenger-kilometres (RPK)
- Total revenue tonne-kilometres (Total RTK) (100 kg per passenger)
- Litres of fuel burned per year
- Litres per 100 revenue tonne-kilometres (L/100 RTK)
- Litres per revenue tonne-kilometre (L/RTK)
- Cargo available tonne-kilometres (ATK)
- Passenger available tonne-kilometres (ATK) (100 kg per passenger)
- Total available tonne-kilometres
- Litres per 100 available tonne-kilometres (L/100 ATK)
- Tonnes of CO_2e emissions
- CO_2e emissions per revenue tonne-kilometre
- CO_2e emissions per available tonne-kilometre.

2.3 Calculations

The following factors and formulas were applied in Transport Canada's preparation of the consolidated industry Report. Note that industry statistics are customarily maintained in imperial units, including miles and tons, which are converted to International System (SI) units (kilometres and tonnes) for the present Report. Note also that the emissions factors for all calendar years are the latest factors used by Environment Canada in Canada's National Greenhouse Gas Inventory since 2009.[11]

Aviation Jet Fuel emission factors:

2534 grams CO_2 per litre
2557 grams CO_2e per litre

Conversion miles to kilometres:

1 m = 1.609344 km

Conversion tons to tonnes:

1 ton = 0.907185 tonnes

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

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

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

As with ATAC reporting, it is also the case that reports by NACC members have been revised from time to time, including the substantial revision noted above to cargo statistics in this year's report. The consolidated statistics presented in this report include all the latest figures reported by ATAC and NACC carriers, including all such revisions. It must borne in mind that the statistics are not entirely comparable between years; and that the information in this report supersedes that in the earlier annual reports under the MOU.

3. Results for 2011

The combined results for ATAC and NACC air carriers in 2011 are shown in Table 1, in comparison to each of the years from 2001, and also to 1990. The table includes the same elements and rates reported in the previous annual reports, though for brevity omits those in imperial units.

The reported annual emission statistics do not account for 100 percent of Canadian aviation operations, and therefore will not be directly comparable to the National Greenhouse Gas Emissions Inventory, issued annually by Environment Canada. The MOU, and therefore this report, did not cover private aviation, military and other government operations, nor operations in Canada of foreign carriers. Nor did it cover those carriers (mostly small) which are not members of either ATAC or NACC. Further, the extent of reporting of activities by members of the Associations has varied year to year. ATAC estimated in earlier annual reports that coverage by reporting members was in excess of 97 percent of domestic passenger and cargo traffic in 2001, in excess of 92 percent in 2002, then in excess of 95 percent in each of the years from 2003 to 2007. Reporting for 2011 is at least as complete as in those years. Since its formation in 2008, NACC has obtained more complete coverage of activities by its members, and has revised reports of cargo statistics back to 2001. It is clear that the reports cover most operations, and seems safe to conclude that inclusion of the remainder would not substantially affect the ratios and longer-term trends computed for fuel use and emissions per unit of traffic.

An important qualification must also be made to the comparisons to 1990: the figures for 1990 in Table 1 are not from the Associations, but were based on those officially reported by Statistics Canada in its publication entitled '*Aviation in Canada'* [12] (as compiled for this report by Transport Canada), which cover strictly only carriers of Levels I and II (i.e. transporting at least 50,000 passengers or 10,000 tonnes of cargo in that year). They were accepted as being essentially complete. However, since the major revision made this year by NACC to the statistics of Available Ton-Miles (ATM), it has become evident that the figures provided by the carriers to Statistics Canada also need revision. NACC has provided corrected statistics back to 2001, which are much lower than those reported by Statistics Canada. It has become clear from

the relative magnitudes of the 1990 and corrected 2011 figures that the 1990 ATM figure reported by Statistics Canada and used in earlier versions of this report was overstated. Unfortunately, no corrected estimate for 1990 is available from the carriers. Therefore an approximate correction was made for the present report: based on the corrected figures for 2001-2010 averaging only 40 percent of the previous values, the 1990 ATM figure has been reduced to the same proportion of the value published by Statistics Canada and used in the earlier annual reports in this series. This is clearly only a very rough approximation, which must be borne in mind when examining the trends in ATM reported below.

Table 1 shows trends in fuel consumption and its conversion to GHG emissions, expressed in CO_2e. Table 1 also provides the relevant traffic statistics namely:

- ASK, reflecting seating capacity multiplied by distance flown;
- RPK, showing actual passengers carried multiplied by distance flown. (The ratio between RPK and ASK is the passenger load factor, not shown in the table);
- passenger RTK, estimated by converting RPK into weight using the industry's convention of 100 kg (220 lbs) per passenger;
- cargo ATK and RTK, the former reflecting available carrying capacity, while the latter reflects actual cargo carried;
- passenger and cargo tonne-kilometres measures, combined to provide total ATK and total RTK, as overall industry output is measured.

The table also provides the ratios of fuel and GHG emissions to the main traffic measures: litres of fuel and grams of CO_2e per ASK, RPK, total ATK and total RTK.

According to Table 1, in 2011 the reporting carriers used (in slightly rounded figures) 6.09 billion litres of fuel, provided capacity of 171 billion ASK and 7.6 billion cargo ATK, and actually served 141 billion RPK and 2.0 billion cargo RTK. Total combined passenger and cargo capacity was therefore 24.7 billion ATK (i.e. 17.1 billion tonne-kilometres for passengers plus the 7.6 billion for cargo), and combined service was 16.1 billion RTK. Greenhouse gas emissions amounted to an estimated 15.6 million metric tonnes (megatonnes).

As shown in Table 2, comparisons to 2010 confirm that in 2011 the rebound continued in industry activity after the worldwide downturn in economic activity: reported RPK rose by another 9.7 percent, following the increase of 9.5 percent in the previous year. Between 2001 and 2011, RPK grew overall by 63 percent. The reported trends in cargo are somewhat unreliable, due to the changes noted above in reporting by both NACC and ATAC carriers. Estimated RTK is however dominated by passengers, and the revised figures suggest there was a substantial increase in RTK of 8.2 percent from 2010 to 2011, and an increase of 55 percent between 2001 and 2011.

Table 1: Annual Results of Operations 2001 to 2011 and comparison with 1990.

	1990	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fuel use (million litres)	4,616	4,829	4,634	4,584	4,566	4,887	5,186	5,543	5,575	5,077	5,659	6,089
GHG emissions (millions of tonnes of CO_2-equivalent)	11.801	12.346	11.846	11.719	11.673	12.495	13.258	14.171	14.254	12.980	14.467	15.566
Traffic (billions)												
Available seat-kilometres (ASK)	75.22	116.84	117.65	119.54	123.14	131.98	139.48	151.55	154.05	152.66	157.43	171.39
Revenue passenger-kilometres (RPK)	66.37	86.74	82.71	88.94	95.18	105.22	112.98	124.15	125.55	117.62	128.77	141.27
Passenger revenue-tonne-kilometres (pass. RTK) *	6.64	8.67	8.27	8.89	9.52	10.52	11.30	12.42	12.55	11.76	12.88	14.13
Cargo available tonne-kilometres (cargo ATK)	4.45	8.02	7.23	6.41	5.94	5.18	5.38	6.14	6.40	6.14	7.33	7.62
Cargo revenue-tonne-kilometres (cargo RTK)	1.72	1.71	1.74	1.49	1.54	1.57	1.53	1.82	1.57	1.38	2.01	1.98
Total available tonne-kilometres (ATK)	11.97	19.70	18.99	18.36	18.26	18.37	19.33	21.29	21.81	21.40	23.07	24.76
Total revenue-tonne-kilometres (RTK)	8.36	10.39	10.01	10.39	11.06	12.09	12.83	14.23	14.13	13.14	14.88	16.11
Fuel consumption rates												
Litres/ASK	0.0614	0.0413	0.0394	0.0383	0.0371	0.0370	0.0372	0.0366	0.0362	0.0333	0.0351	0.0347
Litres/RPK	0.0695	0.0557	0.0560	0.0515	0.0480	0.0464	0.0459	0.0446	0.0444	0.0432	0.0425	0.0421
Litres/Total ATK	0.3856	0.2451	0.2440	0.2496	0.2501	0.2660	0.2683	0.2603	0.2557	0.2382	0.2500	0.2508
Litres/Total RTK	0.5523	0.4649	0.4627	0.4414	0.4128	0.4043	0.4043	0.3895	0.3947	0.3863	0.3802	0.3780
Emission rates:												
CO_2e grams/ASK	156.89	105.67	100.69	98.04	94.79	94.68	95.05	93.51	92.53	85.02	89.64	88.64
CO_2e grams/RPK	177.81	142.33	143.23	131.77	122.64	118.75	117.35	114.14	113.53	110.36	108.65	107.54
CO_2e grams/Total ATK	986	627	624	638	639	680	686	666	654	609	639	641
CO_2e grams/Total RTK	1,412	1,188	1,183	1,128	1,055	1,034	1,034	996	1,009	988	972	966

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

Sources: Transport Canada/Statistics Canada for 1990, ATAC for years 2001-2007, ATAC and NACC for 2008-2011.
See text for qualifications to comparability among years.

The average passenger load factor also increased further to a new peak in 2011, to an average of 82.4 percent, from the previous peak of 81.8 percent in 2010.

The continued rebound in activity was accompanied by further increase in fuel use: after the extraordinary reduction in fuel use between 2008 and 2009, the total in 2011 was 6.09 billion litres, 7.6 percent greater than in 2010. Greenhouse gas emissions increased by the same proportion.

Fuel efficiency in 2011, as measured by the ratio of fuel consumption to total traffic, amounted to 0.378 litres per RTK, and emissions were 966 grams CO_2e per RTK.

Table 2: Changes 2001-2011 and 1990-2011

	Change 2010-2011	Change 2001-2011	Average annual change 2001-2011	Change 1990-2011	Average annual change 1990-2011
Fuel use (million litres)	7.6%	26.1%	2.3%	31.9%	1.3%
GHG emissions (millions of tonnes of CO_2-equivalent)	7.6%	26.1%	2.3%	31.9%	1.3%
Traffic (billions)					
Available seat-kilometres (ASK)	8.9%	46.7%	3.9%	127.9%	4.0%
Revenue passenger-kilometres (RPK)	9.7%	62.9%	5.0%	112.9%	3.7%
Passenger revenue-tonne-kilometres (pass. RTK))	9.7%	62.9%	5.0%	112.9%	3.7%
Cargo available tonne-kilometres (cargo ATK)	4.0%	-4.9%	-0.5%	71.3%	2.6%
Cargo revenue-tonne-kilometres (cargo RTK)	-1.2%	15.7%	1.5%	15.3%	0.7%
Total available tonne-kilometres (ATK)	7.3%	25.7%	2.3%	106.8%	3.5%
Total revenue-tonne-kilometres (RTK)	8.2%	55.1%	4.5%	92.8%	3.2%
Fuel consumption rates					
Litres/ASK	-1.1%	-16.1%	-1.7%	-43.5%	-2.7%
Litres/RPK	-1.0%	-24.4%	-2.8%	-39.5%	-2.4%
Litres/Total ATK	0.3%	2.3%	0.2%	-34.9%	-2.0%
Litres/Total RTK	-0.6%	-18.7%	-2.0%	-31.6%	-1.8%
Emission rates:					
CO_2e grams/ASK	-1.1%	-16.1%	-1.7%	-43.5%	-2.7%
CO_2e grams/RPK	-1.0%	-24.4%	-2.8%	-39.5%	-2.4%
CO_2e grams/Total ATK	0.3%	2.3%	0.2%	-34.9%	-2.0%
CO_2e grams/Total RTK	-0.6%	-18.7%	-2.0%	-31.6%	-1.8%

Table 2 and the following graphics illustrate the long-term trends in all of these quantities and ratios, and performance against the MOU target. Based on the information provided by ATAC and NACC, Table 2 shows the cumulative percentage change in each reported value from 2001 to 2011, followed by an annual average percentage change over the same period.

From Table 2, as well as from Figures 1 to 4 (on trends from 2001-2011 in fuel consumption and the main traffic measures) and Figures 5 to 8 (on main rates of fuel consumption and GHG emissions), the following observations can be drawn:

- The objective of the MOU is to encourage member airlines to achieve an average of 1.1 percent per annum fuel efficiency improvement, reaching a cumulative improvement of 24 percent in 2012 compared to the 1990 base case scenario,

expressed as reduction in litres of fuel per RTK. The performance in 2011 confirms that the industry has achieved continuous improvements in fuel efficiency and consequent reductions in emissions intensity of aviation operations, exceeding the goal of 1.1 percent.

- As illustrated in Figure 1, from 2001 to 2011, fuel use increased 26.1 percent, while Figures 2 to 4 show passenger capacity (ASK) rose by 47 percent and total capacity (ATK) by 26 percent.

- As presented in Figure 5, the fuel consumption rate and consequent GHG emission rate per RTK both fell by 18.7 percent between 2001 and 2011, an average annual improvement of 2.0 percent.

- Over the entire period from 1990 to 2011, passenger and cargo traffic grew by 107 percent, as expressed by total ATK, while fuel consumption rose by only 32 percent. Fuel consumption trends for combined passenger and cargo operations in 2001-2011 are illustrated in Figure 6.

- Consequently from 1990 to 2011 fuel use and emissions intensity per ATK fell by 35 percent, or an average of 2.0 percent per year.

- Over that entire period, the key indicator for the MOU of fuel intensity and GHG emissions per RTK fell by 31.6 percent, an average of 1.8 percent per year.

- Clearly those annual and cumulative reductions continue to surpass substantially the MOU goals of 1.1 percent annual reduction and 24 percent cumulative reduction between 1990 and 2012.

- It can also be noted that the fuel consumption rate per RTK in 2011 of 37.8 litres per 100 RTK also surpassed the IATA goal for 2012 of 41.5 litres per 100 RTK.

Figure 1: Fuel use (million litres) 2001-2011

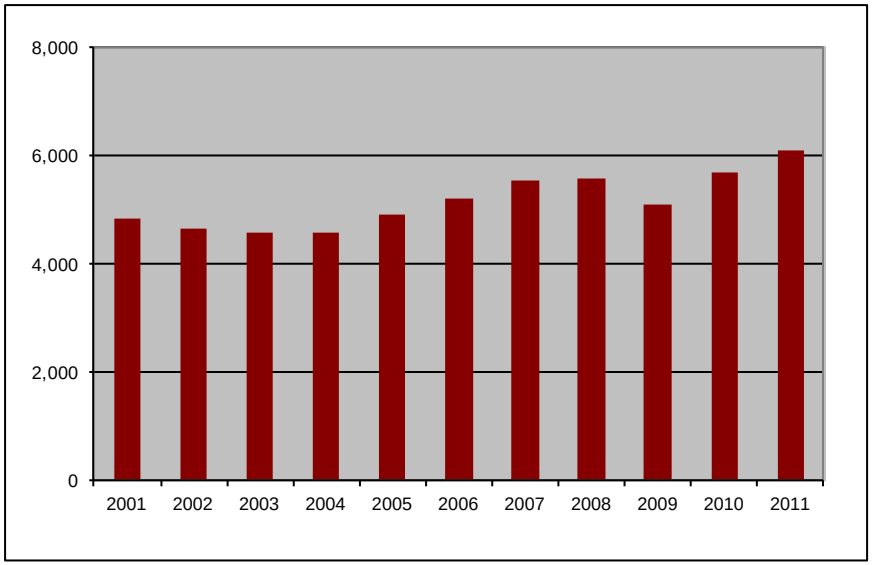


Figure 2: Passenger capacity and service, 2001-2011

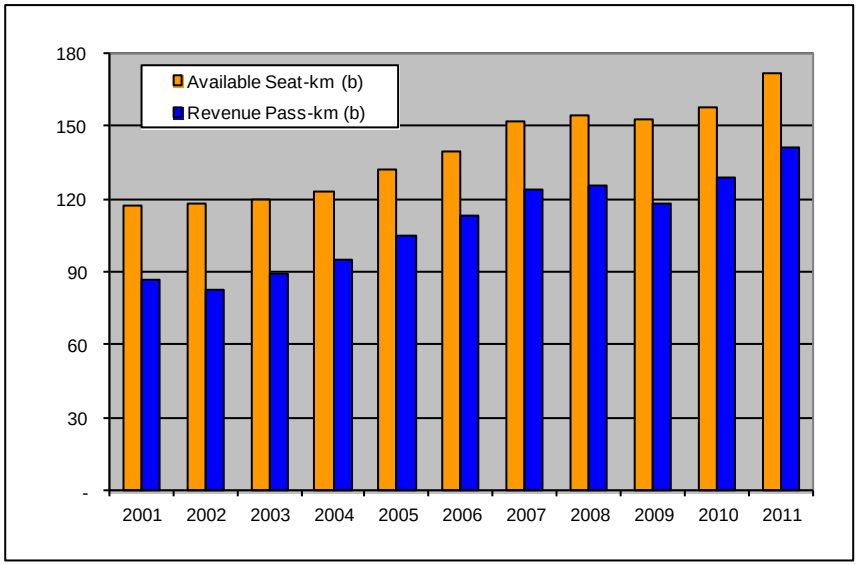


Figure 3: Cargo capacity and service, 2001-2011

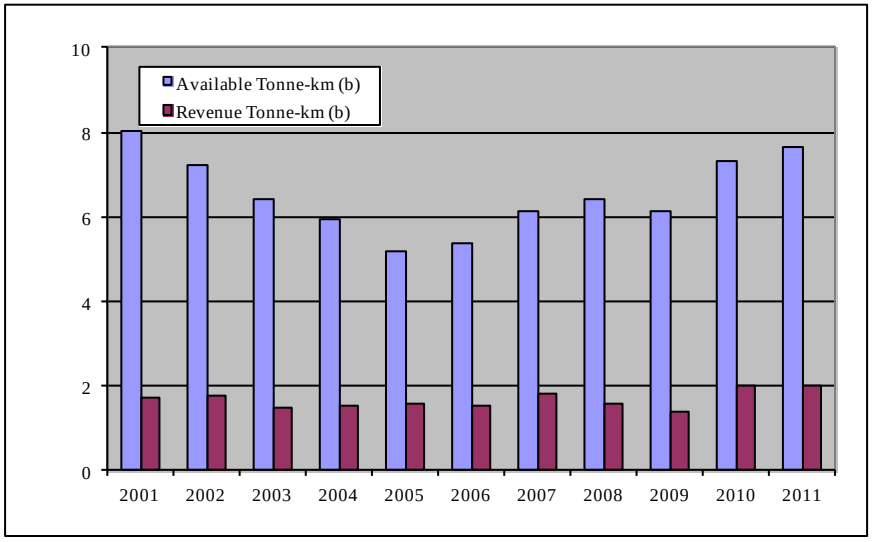


Figure 4: Total passenger plus cargo capacity and service, 2001-2011

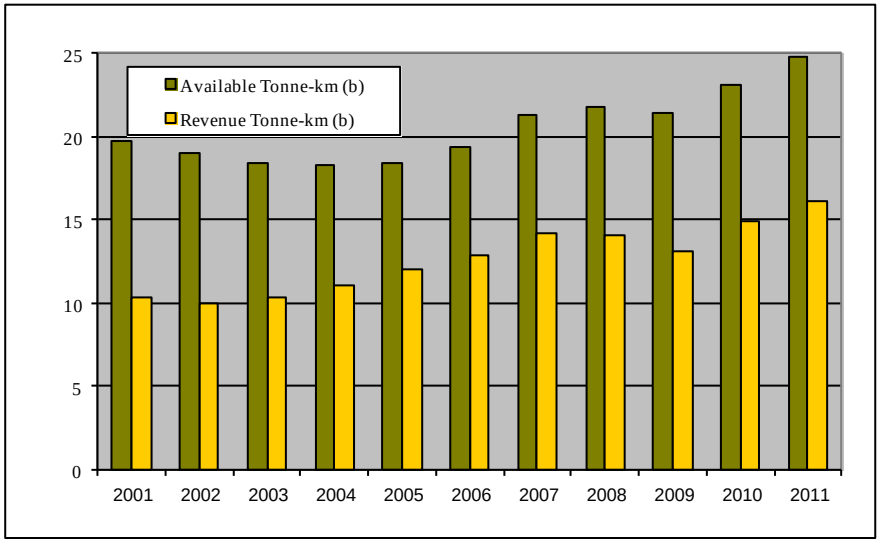


Figure 5: Fuel consumption rates – passengers 2001-2011

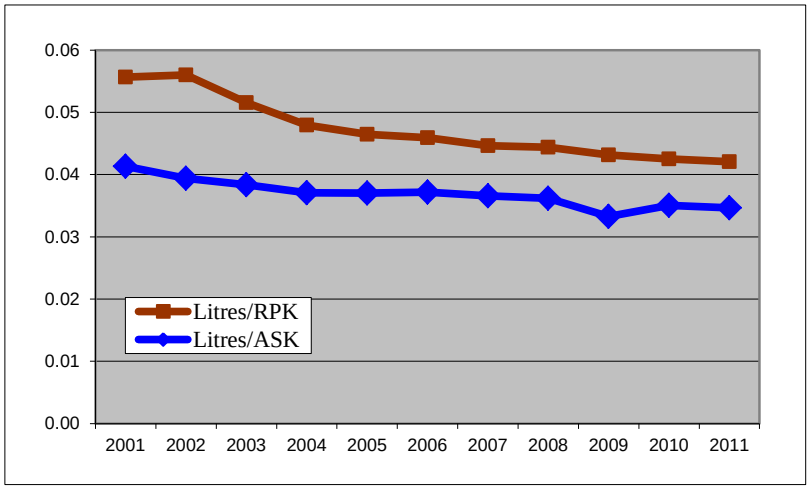


Figure 6: Fuel consumption rates – combined passengers and cargo , 2001-2011

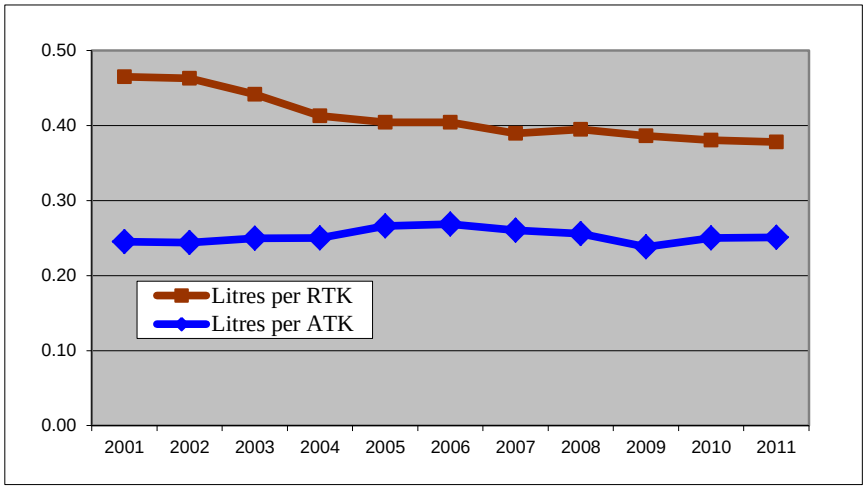


Figure 7: GHG emission rates – passengers 2001-2011

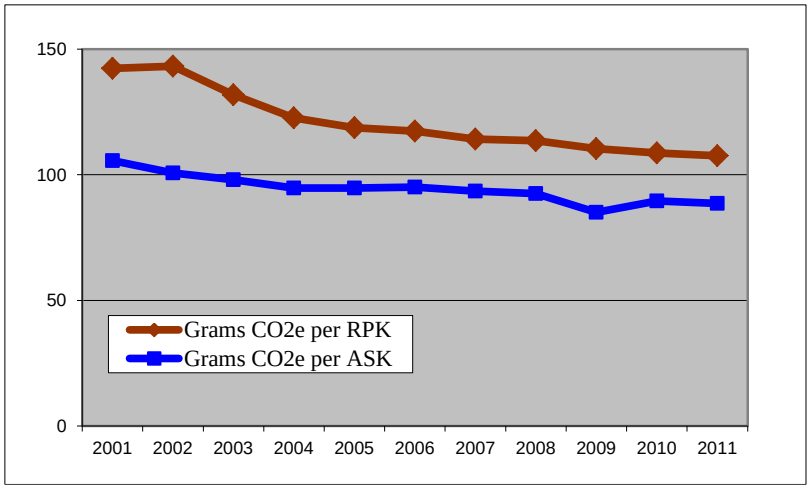
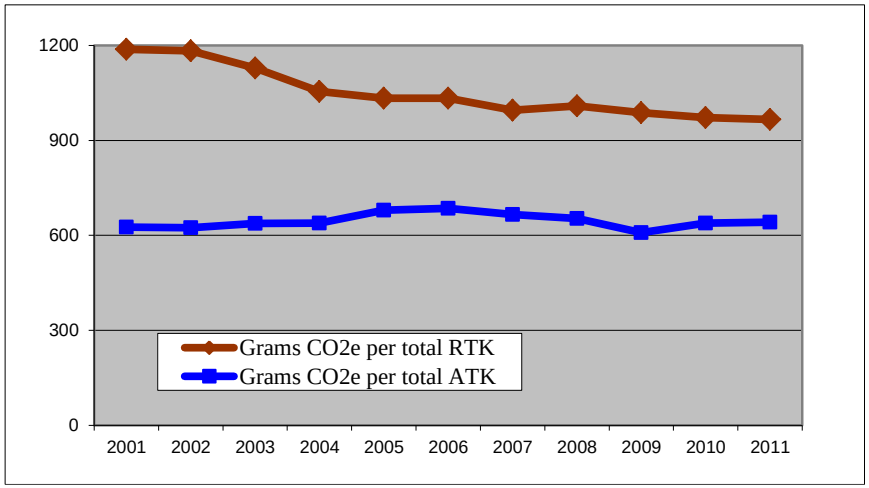
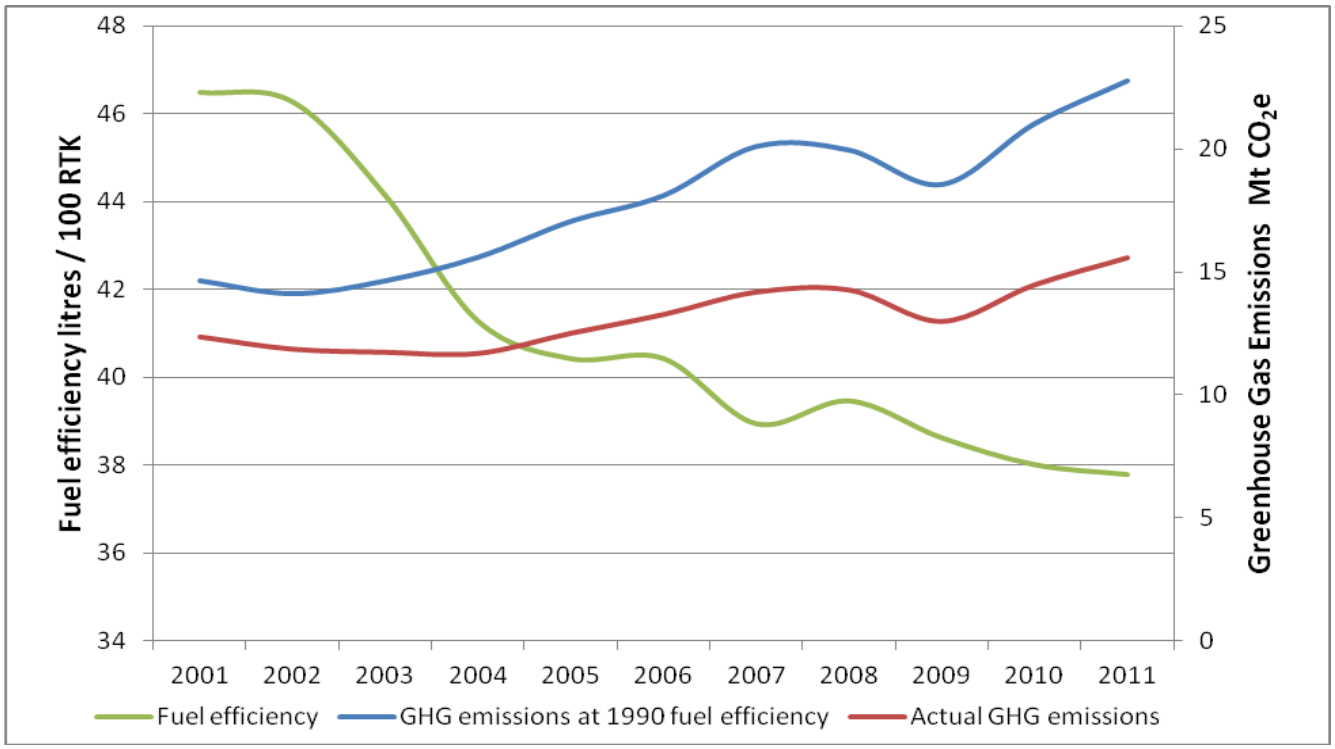


Figure 8: GHG emission rates – combined passengers and cargo , 2001-2011



Finally, figure 9 provides an illustration of how much greater GHG emissions would have been between 2001 and 2011 if fuel efficiency had remained at the 1990 level of 55 litres per 100 RTK (as shown in table 1). Total GHG in 2011 would have reached 22.7 Mt at the 1990 rate, whereas actual 2011 emissions were 32 percent lower, at 15.6 Mt.

Figure 9: Illustration of impact of fuel efficiency reduction since 1990 on GHG Emissions



4. Activities Supporting the MOU

4.1 ATAC Activities

Activities Undertaken by ATAC

In addition to initial development and subsequent maintenance and utilization of the ATAC Greenhouse Gas Emissions Reporting System (AGERS) database, ATAC continues to encourage its member companies to submit data for AGERS under the auspices of the MOU and Canada's Action Plan. This has taken place through regular emails and articles in @ATAC, ATAC's monthly email communication. Support has also been given directly to member companies and at the Annual General Meeting to assist members in the gathering and submission of the required data.

As a result of these efforts, ATAC has been able to capture data covering the vast majority of its members operating Canadian transport category aircraft in both passenger and cargo traffic markets. ATAC continues to promote participation in this system and in the objectives of the MOU and Canada's Action Plan, to its membership.

ATAC continues its active participation in ICAO meetings and conferences providing valuable input into discussions of the international emissions reductions initiatives.

Activities Undertaken by ATAC Members

In addition to the data collected and analyzed in the AGERS system, the MOU and Canada's Action Plan set out a plan for the reduction of GHGs from the aviation sector. Various methods for improving operational efficiencies and reducing emissions are encouraged to be utilized by ATAC member companies to the fullest extent possible.

ATAC members have instituted new procedures and training to limit fuel burn and make their operations more efficient and respectful of the environment.

ATAC members have taken very seriously the goals set out in the voluntary agreement, and have achieved better than projected efficiency improvements ever since the signing of the MOU in 2005.

ATAC members implemented operational changes, modifications and renewal of aircraft fleets that contributed to a reduction of the amount of fuel consumed and improvements in fuel efficiency in the aviation sector.

4.2 Activities by NACC and its Members

4.2.1 Activities Undertaken by the NACC

The NACC and its member carriers are committed to delivering environmentally responsible air travel and working to continually reduce the industry's environmental impact and aggressively curtail its emissions. To demonstrate to Canadians that the NACC airlines are committed to finding cost-effective

solutions for better environmental performance, the association has a standing Environment Subcommittee. Through this committee, the member carriers are working towards:

- developing a principled industry position on environmental issues;
- informing governments and the public on significant environmental improvements made by the airlines;
- demonstrating the airline industry's commitment to the environment.

The committee also ensures that its carriers have a forum to jointly address mutually applicable issues. One important issue was the commitment, support and participation of its member airlines with regard to the MOU. The NACC made available the resources to facilitate the generation of this report and ensured that all of its members participated in the data gathering. It also ensures that the Environmental Subcommittee has engaged in dialogue with Transport Canada and Environment Canada.

In 2009, the NACC launched its association web site, which outlines its commitment to reducing its environmental impact. In October 2011, the NACC released a report entitled *Improving Aviation Efficiency and Reducing Emissions: A NACC Framework*, as part of its continued efforts to improve aviation efficiency and its environmental impact. The report is found on the NACC web site.

The NACC has promoted its members' participation in the MOU and will continue to do so with Canada's Action Plan.

4.2.2 Activities Undertaken by NACC Members

Certain NACC members are also members of other industry associations such as the International Air Transportation Association (IATA), Airlines for America (A4A), and the Regional Airline Association (RAA). Participation in the environmental committees of these other industry associations allows respective NACC carriers to keep abreast of environmental issues internationally and in the United States of America. It also allows them to participate in international forums such as those for alternative fuels and in the ICAO Committee for Aviation Environmental Protection (CAEP) and its various working groups and task groups.

NACC members continue to invest in their respective fleet renewal programs, which will continue to introduce new, more efficient aircraft into their fleets. The carriers also continue to institute policies, procedures, programs and projects that impact their operations by either improving efficiency or reducing fuel burn and hence reducing CO_2 emissions. The ongoing benefits fall into the following categories:

- Aircraft modifications and maintenance
- Aircraft operation
- Cargo and baggage operations
- In flight/catering

A summary list of activities undertaken and previously reported in MOU reports is provided below. Because of the collective nature of the reporting, these activities are not attributed to specific airlines.

4.2.3 Aircraft Modifications and Maintenance

Various physical modifications were made that will have an effect on the overall carbon footprint of the operator and included:

- Ozone Scrubbers: One member company completed the installation of Ozone Scrubbers on an aircraft fleet, which eliminated flight level restrictions and allows the aircraft to fly at higher, more optimum altitudes, thus reducing fuel burn and providing ongoing benefits.

- Engine modification: One member company is currently installing EP (Enhanced Performance) kits on one of its engine types to improve fuel efficiency.

- Aircraft drag: As part of their regular aircraft maintenance programs, member companies inspect aircraft structures to identify and minimize aerodynamic drag to improve fuel efficiency. One company initiated a project to study the modification of NACA (National Advisory Committee for Aeronautics) fuel vents to reduce drag.

- Aircraft tires: Two member companies have installed lighter-weight tires on certain models of their aircraft, providing ongoing benefits.

- Engine washing: All member companies have instituted programs for the regular internal washing of engines to improve engine performance, resulting in better fuel efficiency characteristics of the engine. This can provide ongoing fuel efficiency benefits of up to 1.2 percent.

4.2.4 Aircraft Operation

Some NACC member companies made changes in the areas of training, flight planning/aircraft dispatch and aircraft operating procedures in order to reduce fuel consumption and therefore emissions. Implemented changes or processes continue to provide ongoing benefits. Some of these changes and ongoing activities include:

Training

- Presenting and explaining Cost Index (the optimization of time cost and fuel cost) in recurrent training classes.
- Development and implementation of a fuel conservation training program for pilots and key personnel involved in aircraft operations.
- Providing additional fuel guidance to dispatch personnel based on historical operations.

Flight Planning/Aircraft Dispatch

- Flight planning systems have been purchased, introduced or refined to increase efficiency and reduce fuel costs through improved calculations of taxi, holding and contingency fuel and optimization of flight profiles, aircraft speed and cost index.

- Continued focus on No Alternate IFR (Instrument Flight Rules) planning (NAIFR) as allowed by regulations, which reduces the amount of excess fuel carried, is an ongoing day-to-day activity.
- The refinement (removal and/or adjustment) of all fuel burn factors imbedded in the flight plan BURN calculation.
- The implementation of an additional descent profile on an aircraft fleet, which allows the flight planning system to select the optimum speed based on ambient conditions (weight/temp).
- Dispatch route optimization is an ongoing day-to-day activity.
- The development and implementation of Required Navigation Performance and Area Navigation (RNP RNAV) departures and approaches.
- Continuing work with Nav Canada on Airspace Redesign Projects.
- Implementation of Smart Operational Empty Weight Management (removing unnecessary equipment from the aircraft to reduce weight).
- Creating a Fuel Efficiency Key Performance Indicator in combination with Aircraft Performance Monitoring Program.
- Refinement and implementation of aircraft climb power settings, which enables the aircraft to climb faster to cruise altitude, reducing overall fuel consumption.
- The continual refinement of aircraft cruise speeds to optimize fuel burn.
- The optimization of aircraft descent speeds to minimize fuel consumption while accommodating air traffic control requirements.
- Improved loading procedures for cargo and passengers to improve Centre of Gravity (CG).
- The institution of a program that greatly improves the accuracy of determining aircraft weight and including actual weighing of aircraft as required during regular maintenance checks.
- Refining the calculation for determining the amount of alternate fuel carried for close-in alternate airports to ensure it reflects actual flight distance. This ensures aircraft do not carry fuel exceeding the regulatory requirement.
- The refinement of Cost Index to determine the most economical speed for each route/city pair is ongoing. This determines the most economical speed for operation of the aircraft, taking into account the cost of time versus the cost of fuel for each route operated.
- Initiatives to improve payload planning have been completed.
- Processes for conducting internal Fuel Audit to regularly examine all areas of the operation have been implemented to verify effectiveness of fuel saving policies and procedures.
- A process to provide more accurate taxi fuel to allow for improved flight planning has been implemented and updating of data is ongoing.
- Processes to more accurately determine the zero fuel weight for aircraft have been implemented and more accurately determine the true weight of the aircraft, including passengers and cargo, with a higher level of accuracy over previous methodology.
- A process has been implemented to optimize the location of the centre of gravity (CG), through a better distribution of passengers in the cabin whenever the load factor is below 90-95 percent. CG location has a direct influence on fuel burn during the climb and descent portions of the flight.
- A process has been implemented to reduce gate arrival delays. This will reduce the amount of time arriving aircraft are held off gate, thereby reducing fuel burn.
- The use of ground-based power and air conditioning wherever possible to reduce APU usage.

Aircraft Operating Procedures
All of the following aircraft operating procedures have been incorporated into various members' standard operating procedures.

- Employing single engine taxi-in and taxi-out procedures when conditions permit.
- Limiting APU usage on ground to 10 minutes on arrival and 20 minutes before departure at North American and European destinations.
- Reducing fuel consumption during the first 3000 feet of climb by using ICAO's NADP2 take-off climb procedure.
- Utilizing Econ climb profile, which reduces fuel burn by accelerating to en-route climb speed as soon as flap retraction is complete.
- Utilizing idle reverse and braking on landing rather than selecting maximum reverse thrust.
- Whenever possible, use of only one air conditioning pack during operation of the APU on the ground to reduce fuel burn.
- Introduction of a reduced APU operations procedure aimed at cutting fuel consumption and per-hour lease costs.
- Utilizing ground power units wherever possible to reduce APU usage.

4.2.5 Cargo and Baggage Operations

- One member completed the replacement of wooden skids with lighter composite skids. Previously it had switched from aluminum-constructed cargo containers to ultra light Kevlar containers. The member has also developed and instituted a program to maximize the number of bags per baggage container, thus reducing the number of baggage containers carried per flight. All of these activities provide ongoing benefits through weight reductions.

- Another member also initiated a project to switch from aluminum-constructed cargo containers to ultra light Kevlar containers.

- One member modified its loading procedures to optimize the use of bulk holds on its aircraft.

4.2.6 In-flight/Catering

NACC member companies continue to study and implement changes to their In-flight/catering services in order to reduce the overall weight of the aircraft, thus reducing fuel consumption and providing ongoing benefits. The following are some of the changes made or projects initiated by a least one member carrier:

- Optimizing the amount of potable water carried on their flights. Historical usage data per route was analyzed and now water carriage requirements are based on specific routes.
- Optimizing the carriage of service items on board the aircraft. Weight savings are achieved by reducing return catering, matching catering provisioning with actual requirements and eliminating/minimizing items such as headsets, amount of ice, magazines, newspapers and substituting lighter-weight products wherever possible.

- Removing the ovens from the aft galley of one single-aisle aircraft fleet as well as infrequently used trash compactors from one wide-body aircraft fleet.
- Initiating a project to study replacing existing galley carts with new lighter-weight units.
- Conducting periodic audits to monitor the usage of all catering items and make adjustments to avoid carrying excess quantities.

NACC's Overall Performance from 2005 to 2011

The 2011 data and the historical data for the years 2005 through 2011 inclusive demonstrate the commitment of NACC members to achieving the targets of the June 29, 2005 MOU. For the period 2005 through 2011, the carriers achieved an efficiency improvement in Litres/100 RTK of 6.9 percent or an average of 1.15 percent per year. In 2011 they achieved a 31.3 percent improvement compared to the 1990 baseline, for an average improvement of 1.5 percent per year, and they exceeded the MOU target for 2012 by 9.7 percent. Over the period 2005 through 2011, the RTK for the carriers grew by 30.6 percent while their total fuel consumption rose by only 21.6 percent. The efficiency gains over the period 2005 through 2011 resulted in a saving of 1.34 billion litres of fuel or a reduction of 3.42 megatonnes of CO_2e.

5. Conclusions

The expressed goal of the MOU was to:

> "… reduce collective ATAC member fleet greenhouse gas emissions on a per unit basis (through fuel efficiency improvements, e.g. reduction in litres of fuel/Revenue Tonne Kilometre) by an average of 1.1 percent per annum, reaching a cumulative improvement of 24 percent in 2012 compared to the 1990 base case scenario."

Statistics of passenger and cargo operations and associated fuel use provided by ATAC and NACC for 2011 show that the combined performance of their reporting members continues to exceed that goal.

In 2011 industry activity continued to rebound after the worldwide downturn in economic activity in 2008 and 2009: reported RPK rose by another 9.7 percent, following the increase of 9.5 percent in the previous year.

This is reflected in an increase of 7.6 percent in total fuel consumption by the reporting air carriers from the 5.66 billion litres reported for 2010 to 6.09 billion litres in 2011. Consequently, the total GHG emissions in 2011 were also 7.6 percent greater than in 2010, at 15.6 Mt, compared to the total of 14.5 Mt reported for 2010. The fuel consumption rate reported for 2011 was 0.378 litres per RTK (combining both passenger and cargo traffic), and the emissions rate was 966 grams CO_2e per RTK.

From 1990 to 2011, an average annual reduction in fuel consumption and GHG emissions per RTK of 1.8 percent was achieved, compared to the target of 1.1 percent per year under the MOU. To 2011, the industry had achieved a 31.6 percent cumulative reduction between 1990 and 2011, compared to the target of 24 percent in 2012. Without having taken action, total GHG emissions in 2011 would have reached 22.7 Mt at the 1990 fuel efficiency rate, whereas actual 2011 emissions were significantly lower, at 15.6 Mt.

NACC and ATAC members have demonstrated their commitment to ensuring the continuous improvement of their operating efficiency in order to reduce the emissions of GHG from their flights worldwide. The fuel efficiency improvements have come through investment in fleet renewal programs and the institution of policies and procedures that impact operations, improving efficiency and reducing fuel burn.

Both NACC and ATAC fully support and are proud signatories to Canada's Action Plan to Reduce Greenhouse Gas Emissions from Aviation, which was developed with the Government of Canada and the Canadian aviation industry. Canada's Action Plan sets an ambitious goal to reduce GHG emissions from both domestic and international operations, which is expected to contribute to global efforts to minimize aviation's carbon footprint.

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Glossary of Acronyms

APU:	Auxiliary Power Unit
ASK:	Available Seat Kilometres
ASM:	Available Seat Miles
ATAC:	Air Transport Association of Canada
ATK:	Available Tonne Kilometres
ATM:	Available Ton Miles
CH_4:	Methane
CAEP:	Committee on Aviation Environmental Protection
CG:	Center of Gravity
CO_2:	Carbon Dioxide
CO_2e:	Carbon Dioxide equivalent, which for aviation jet fuel includes CO_2, CH_4, and N_2O
Fuel Used:	Aviation Jet Fuel measured in litres
GHG:	Greenhouse Gases
IATA:	International Air Transport Association
ICAO:	International Civil Aviation Organization
IFR:	Instrument Flight Rules
MOU:	Memorandum of Understanding
NACC:	National Airlines Council of Canada
NADP2:	Noise Abatement Departure Procedure 2
N_2O:	Nitrous Oxide
RNP:	Required Navigation Performance
RPK:	Revenue Passenger Kilometres
RPM:	Revenue Passenger Miles
RTK:	Revenue Tonne Kilometres
SI:	Système international d'unités – International System of Units
TC:	Transport Canada

ANNEX

Table 3: Absolute and proportional changes over time

	Change 2010-2011		Change 2001-2011			Change 1990-2011		
	Absolute	**Proportional**	**Absolute**	**Proportional**	**Annual rate**	**Absolute**	**Proportional**	**Annual rate**
Fuel use (million litres)	430	7.6%	1,260	26.1%	2.3%	1,473	31.9%	1.3%
GHG emissions (millions of tonnes of CO_2-equivalent)	1.099	7.6%	3.220	26.1%	2.3%	3.765	31.9%	1.3%
Traffic (billions)								
Available seat-kilometres (ASK)	13.97	8.9%	54.56	46.7%	3.9%	96.17	127.9%	4.0%
Revenue passenger-kilometres (RPK)	12.50	9.7%	54.52	62.9%	5.0%	74.90	112.9%	3.7%
Passenger revenue-tonne-kilometres (pass. RTK))	1.25	9.7%	5.45	62.9%	5.0%	7.49	112.9%	3.7%
Cargo available tonne-kilometres (cargo ATK)	0.29	4.0%	-0.40	-4.9%	-0.5%	3.17	71.3%	2.6%
Cargo revenue-tonne-kilometres (cargo RTK)	-0.02	-1.2%	0.27	15.7%	1.5%	0.26	15.3%	0.7%
Total available tonne-kilometres (ATK)	1.69	7.3%	5.06	25.7%	2.3%	12.79	106.8%	3.5%
Total revenue-tonne-kilometres (RTK)	1.23	8.2%	5.72	55.1%	4.5%	7.75	92.8%	3.2%
Fuel consumption rates								
Litres/ASK	-0.0004	-1.1%	-0.0067	-16.1%	-1.7%	-0.0267	-43.5%	-2.7%
Litres/RPK	-0.0004	-1.0%	-0.0136	-24.4%	-2.8%	-0.0275	-39.5%	-2.4%
Litres/Total ATK	0.0009	0.3%	0.0058	2.3%	0.2%	-0.1347	-34.9%	-2.0%
Litres/Total RTK	-0.0022	-0.6%	-0.0869	-18.7%	-2.0%	-0.1744	-31.6%	-1.8%
Emission rates:								
CO_2e grams/ASK	-1	-1.1%	-17	-16.1%	-1.7%	-68	-43.5%	-2.7%
CO_2e grams/RPK	-1	-1.0%	-35	-24.4%	-2.8%	-70	-39.5%	-2.4%
CO_2e grams/Total ATK	2	0.3%	15	2.3%	0.2%	-344	-34.9%	-2.0%
CO_2e grams/Total RTK	-6	-0.6%	-222	-18.7%	-2.0%	-446	-31.6%	-1.8%

ENDNOTES

1. Memorandum of Understanding Between Transport Canada and the Air Transport Association of Canada, signed June 29, 2005, available from Transport Canada Environmental Policy Directorate.

2. Air Transport Association of Canada: "Voluntary Agreement on the Reduction of Greenhouse Gas Emissions 2006 Annual Report," February 2008.

3. "Voluntary Agreement of the Reduction of Greenhouse Gas Emissions, 2007 Annual Report".

4. National Airlines Council of Canada: "Voluntary Agreement for the Reduction of Greenhouse Gas Emissions Annual Report 2008".

5. "2008 Canadian Aviation Industry Report on Emissions Reductions", January 2010.

6. "2009 Canadian Aviation Industry Report on Emissions Reductions", October 2010; "2010 Canadian Aviation Industry Report on Emissions Reductions", March 2012.

7. ICAO, Committee on Aviation Environmental Protection: "Template and Guidance on Voluntary Measures", available at http://legacy.icao.int/env/measures/Caep_Template.pdf.

8. "Template and Guidance…", p.1.

9. See IATA statement at http://www.iata.org/SiteCollectionDocuments/Documents/Global_Approach_Reducing_Emissions_251109web.pdf.

10. "2008 Canadian Aviation Industry Report on Emissions Reductions", January 2010.

11. The emission factors remain the same in the latest version of the Inventory, for 2010, available from Environment Canada through: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1.

12. Statistics Canada: *Aviation in Canada*, Catalogue no. 51-206.