Customer Fuel And Emissions Savings

Fuel savings

1997-2015 = 5.1 B litres + 2016-2020* = 3.3 B litres = 8.4 B litres

GHG emissions savings

1997-2015 = 13 M tonnes
2016-2020* = 8 M tonnes
1997-2020 = 21 M tonnes

* forecasted achievable

In 2015 NAV CANADA initiatives saved enough jet fuel to fill 3.6 million barrels of oil

3.6 million barrels
A Boeing 767 aircraft burns 5,800 litres of fuel per hour at level cruise.

Over 3.5 billion passengers were carried by the world’s airlines in 2015.

Aviation is responsible for approximately 2 per cent of human induced CO₂ emissions annually.

Canadian air carriers improved fuel efficiency by 3 per cent in 2014.
Foreword from the President and CEO

NAV CANADA began the Collaborative Initiatives for Emissions Reductions (CIFER) report in 2009 as a way to represent the results of efforts by NAV CANADA employees working with our customers and industry partners, to implement strategies that help reduce the aviation industry’s environmental footprint. Since that time this effort has become a key overarching objective of the company.

As the demand for air travel in our modern world continues to grow, so too, do the demands on the industry to improve technologies and processes to reduce emissions and other environmental impacts. NAV CANADA employees continue to rise to this challenge, finding better ways of managing air traffic safely and efficiently. From modernizing our airspace design to implementing new technologies, this report highlights some of the initiatives undertaken by our employees to optimize air traffic services, all while improving efficiencies for our customers and reducing emissions.

We are proud of these achievements, and we are proud of our employees’ commitment to continually improve how we do things, a commitment that has translated into the technologies we have available to us today, and a continued focus on those of tomorrow. It is that commitment that continues to position us amongst the leaders in our industry.

In 2015, these initiatives resulted in fuel savings of over 570 million litres and reductions in greenhouse gas emissions totalling 1.4 million tonnes.

Neil R. Wilson
President and CEO
NAV CANADA
Spotlight

NAV CANADA has undertaken numerous initiatives designed to reduce fuel burn from aviation activity and as a result, lessen greenhouse gas emissions.

Each year we like to put a spotlight on those innovative initiatives that have made a significant impact and that represent a significant departure from traditional methods.

Oceanic Airspace

The airspace over the northern part of the Atlantic Ocean is the busiest oceanic corridor in the world, with over 400,000 flights per year. Over the past several years, NAV CANADA has collaborated with NATS, the air navigation service provider in the UK, on a number of initiatives to increase Oceanic airspace capacity, cut fuel burn and reduce carbon emissions.

In 2011, reduced longitudinal separation minima (RLongSM) were introduced. RLongSM allows air traffic controllers to enable properly equipped aircraft to fly with a longitudinal separation of five minutes versus the usual ten minutes, which increases capacity and also enables aircraft to use tracks that have optimal altitudes, reducing fuel burn.

Air traffic controllers have also undertaken an initiative called GOFLI, in which they identify and proactively offer opportunities for aircraft to climb to more fuel efficient flight levels. Since implementation, RLongSM and GOFLI have enabled reductions of 14,000 tonnes of greenhouse gas emissions, and 6 million litres of fuel.

Reduced lateral separation minima (RLatSM) were introduced as part of a trial in 2015. Most aircraft transiting the North Atlantic are separated laterally by one degree of latitude, approximately 60 nautical miles, on tracks that are set daily based on the traffic demand and prevailing weather conditions, such as the jet stream.

RLatSM can save the equivalent GHG emissions of over 200 flights a year from Toronto Pearson to London Heathrow.
RLatSM involves the addition of a new track in the core of the NAT tracks that is separated laterally by a half a degree of latitude, or approximately 25 nautical miles from the neighbouring tracks. This allows more aircraft to achieve their optimum route and flight level, helping to cut flying times and reduce fuel burn and emissions. Each full year of RLatSM operation is expected to enable an annual reduction of greenhouse gas emission totalling over 10,000 tonnes.

**Polar Routes**

For air travel between many city pairs, particularly between North America and parts of Asia, Polar Routes provide more efficient routing, resulting in reduced flight times, fuel burn and emissions.

Late in 2011, lateral separation between qualified aircraft flying in the polar region was reduced from 60 nm to 50 nm. This improves NAV CANADA’s ability to optimise routings for aircraft prior to entering Russian airspace.

The addition of new Russian Airspace entry points has also improved capacity and flight profiles. Two new entry points were added in late 2014, and another two were added in 2015, further adding capacity.

Air traffic operating on polar routes has shown a marked increase over the years, increasing 15-fold between 2003 and 2015. In 2015, over 14,000 flights used the polar routes and it is estimated that polar routes now enable over 600,000 tonnes of greenhouse gas emission reductions annually.
Spotlight

PBN

Performance Based Navigation (PBN) is the key to modernizing how air traffic is managed in our airspace. It is helping improve efficiency, providing enhanced capacity and reducing reliance on ground based navigational aids.

Shifting from sensor-based to performance-based navigation will enable more efficient en route and airport operations for equipped aircraft, reducing fuel burn and associated GHG emissions through the design of shorter flight paths and constant descent operations.

NAV CANADA is working towards the implementation of PBN by collaborating with customers and other stakeholders to implement the most appropriate navigation specification for each airspace. NAV CANADA has implemented PBN procedures both in busy terminal and en route environments and will continue to pursue opportunities.

As more customers upgrade their avionics, even greater opportunities will arise with an eventual transition towards 4D operations (Lateral, Longitudinal, Vertical and Time) from gate-to-gate, producing greater efficiencies.

NAV CANADA estimates that PBN is currently saving customers 90 million litres of fuel and reducing GHG emissions by 230,000 tonnes annually.
# CIFER Status Update

<table>
<thead>
<tr>
<th>Initiatives</th>
<th>Results</th>
<th>Total Achievable Customer Benefits: Program Start to 2020</th>
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</thead>
<tbody>
<tr>
<td>ADS-B</td>
<td>Ground-based ADS-B was first implemented in Canada to provide coverage of airspace over Hudson Bay in 2009. Coverage was then expanded to cover areas in northeastern Canada and southern Greenland. This added surveillance allowed for the Gander Oceanic Transition Area to be implemented in 2014, pushing oceanic entry/exit points 185 nautical miles east over the North Atlantic.</td>
<td>991,000 mt CO$_2$e 387 million litres</td>
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<tr>
<td>Space-based ADS-B</td>
<td>The availability of space-based ADS-B surveillance from Aireon will enable significant efficiency and capacity improvements in oceanic and remote areas where ground based surveillance is not available. NAV CANADA will use this service to further improve operational benefits for its customers, beginning in 2018 in the busy airspace of the North Atlantic.</td>
<td>567,000 mt CO$_2$e 222 million litres</td>
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<td>Alberta Airspace and Services Project</td>
<td>Arrival and departure routings in the Calgary area were redesigned to accommodate the new parallel runway at Calgary International Airport which opened in June 2014. En route airways north of Calgary were also adjusted to improve overall operational efficiency in the area.</td>
<td>45,000 mt CO$_2$e 18 million litres</td>
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- **Emerging**
- **In progress**
- **Mature**
- **Complete**
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<td><strong>Area Navigation (RNAV)</strong></td>
<td>RNAV enables equipped aircraft to fly on any flight path within coverage of ground- or GPS-based navigational aids within the limits of their system. Benefits include better access to point-to-point operations and increased opportunity for more efficient en route and airport operations, reducing fuel burn. There are currently over 1200 RNAV instrument procedures in Canada. Approximately 200 additional procedures are in development.</td>
<td><img src="#" alt="Emerging" /></td>
<td>2,087,000 mt CO$_2$e 816 million litres</td>
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<td><strong>Edmonton Route Optimization</strong></td>
<td>Operational staff in the Edmonton Area Control Centre worked proactively with their customers to help build User Preferred Routes which are optimized to reduce flight distances and times in large areas of northern Canadian airspace that remain without surveillance. Customers report reductions of over 20 minutes flying time for some Asian-Americas routes.</td>
<td><img src="#" alt="Emerging" /></td>
<td>126,000 mt CO$_2$e 49 million litres</td>
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<td><strong>Bagotville Military Airspace</strong></td>
<td>Cooperation with the Royal Canadian Air Force has resulted in more flexible use of what was previously a restricted military flying area during periods when the airspace is not required for military operations. This has reduced the need to route around military airspace blocks in busy en route areas.</td>
<td><img src="#" alt="Emerging" /></td>
<td>53,000 mt CO$_2$e 21 million litres</td>
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<tr>
<td>North Atlantic Routes</td>
<td>North Atlantic Routes allow aircraft arriving westbound from Europe to transit to North American destinations using more efficient routes.</td>
<td>Complete</td>
<td>384,000 mt CO$_2$e 150 million litres</td>
</tr>
<tr>
<td>North Warning System Surveillance</td>
<td>Access to data from a portion of the Department of National Defence North Warning System provides an additional 40 minutes of surveillance for aircraft not equipped for ADS-B, flying westbound over the Atlantic Ocean. Preferred altitudes and routing reduce fuel consumption and facilitate efficient loading of North Atlantic tracks.</td>
<td>Emerging</td>
<td>141,000 mt CO$_2$e 55 million litres</td>
</tr>
<tr>
<td>Polar Routes</td>
<td>The implementation of RVSM in Russian airspace, the addition of new entry points, and changes to lateral separation requirements in the polar region have further improved both capacity and flight profiles between cities in North America and Asia, substantially reducing flight times and emissions. In the future, the implementation of space based ADS-B in areas of the north will bring further improvements for air traffic.</td>
<td>In progress</td>
<td>7,841,000 mt CO$_2$e 3,067 million litres</td>
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<td>Reduced Longitudinal Separation Minimum (RLongSM) and Gander Oceanic Flight Level Initiative (GOFLI)</td>
<td>Beginning in 2011, RLongSM implementation in oceanic airspace enabled properly equipped aircraft to fly on tracks across the Atlantic with a separation of five minutes, versus the traditional 10 minutes for non-surveillance airspace. Air traffic controllers have recently undertaken the task of identifying and proactively offering opportunities to climb to more fuel efficient flight levels to pilots flying across the North Atlantic tracks.</td>
<td><img src="emerging.png" alt="Emerging" /></td>
<td>26,000 mt CO₂e</td>
<td>10 million litres</td>
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<td>Reduced Lateral Separation Minimum (RLatSM)</td>
<td>In 2015, NAV CANADA and UK NATS implemented a trial of RLatSM in North Atlantic oceanic airspace. RLatSM reduces lateral separation between appropriately equipped aircraft to a half degree of latitude from a full degree (approximately 60 nautical miles) providing more aircraft the ability to access preferred routings in the jet stream.</td>
<td><img src="in-progress.png" alt="In progress" /></td>
<td>35,000 mt CO₂e</td>
<td>14 million litres</td>
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<td><strong>Required Navigation Performance (RNP)</strong></td>
<td>RNP adds onboard performance monitoring and alerting to RNAV, which is particularly useful in permitting “short-turn” approaches and significantly improves descent profiles, even with parallel operations. In the fall of 2013, new regulatory criteria became available that enable expanded application and use of RNP by Canadian operators. NAV CANADA is working with customers and airports to develop additional RNP procedures in Canada.</td>
<td><img src="./images/complete.png" alt="Complete" /></td>
<td>367,000 mt CO$_2$e 144 million litres</td>
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<td><strong>Windsor-Toronto-Montreal Airspace and Services Review</strong></td>
<td>Changes to preferred routings in the Toronto-Ottawa-Montreal corridor and to STARs at key airports were implemented in February 2012. In the fall of 2014, changes to the en route structure north and west of Toronto were implemented, followed by the adjustment to departure routes to the south in the spring of 2015.</td>
<td><img src="./images/complete.png" alt="Complete" /></td>
<td>226,000 mt CO$_2$e 88 million litres</td>
<td></td>
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Cumulative Tonnes (000) of CO₂ Equivalent Avoided Since 1997 and Cumulative Millions of Litres of Fuel Saved
Annual Tonnes of CO$_2$ Equivalent Emissions Avoided (000) and Annual Litres of Fuel Saved

Projected 2016-2020
NAV CANADA Facilities

While the purpose of the CIFER report is to report on initiatives we have undertaken to reduce emissions from aircraft operations, NAV CANADA is committed to reducing the impact of our own operations on the environment. We are transitioning towards ISO 14001:2015, the international standard helping organizations to improve environmental, sustainability, and operational performance. The following are some initiatives we have undertaken:

- A plug-in hybrid electric car was purchased for use at our Head Office location in 2012. We estimate that use of this vehicle reduces greenhouse gas emissions by 60 per cent compared to a gas-powered vehicle of comparable size.

- We have installed 30 electric vehicle charging stations at facilities across the country and continue to add additional charging stations as the need arises.

- The NAV CENTRE has obtained a Gold Tier rating through the IACC Green Star certification program.
A flight from JFK to Hong Kong can save up to 2 hours flying time, or 16,000 litres of fuel, by using polar routes.

- The near-completion of the ILS replacement program, paired with changes to aircraft technology and modifications to procedures, has enabled us to reduce the flying time for ILS inspections resulting in fuel savings of approximately 560,000 litres annually over 2005 values.

- For visibility reasons when operating on airfields, the majority of our fleet of vehicles are painted bright yellow. We recently worked with our supplier to avoid extra VOCs by having our vehicles painted directly at the factory instead of having to repaint them after market.

- Building automation control systems have been upgraded at various sites across the country to allow water, lighting, and temperature systems to be automatically set back during off-peak times. We have also replaced several chiller systems with more energy efficient models.

- Lighting in our facilities is being upgraded to LED based energy efficient lighting. At the Vancouver ACC and the Toronto ACC, as well as at the NAV CENTRE, we have achieved estimated energy savings from lighting of 65-75 per cent.
Looking ahead with CIFER

NAV CANADA continuously strives to improve the efficiency of the air navigation system in collaboration with our customers and other industry partners. We have worked closely with customers to better understand how aircraft fly most efficiently and what changes we can make to reduce fuel burn, while ensuring the safety of the system.

This collaborative approach is essential to achieving our joint goal of reducing the environmental footprint of aviation and has served as the basis for our future initiatives.

Our collaboration with other air navigation service providers is central to Aireon, a space-based ADS-B initiative that will provide global aircraft surveillance by 2018. The Aireon project has seen major milestones in 2016. All of the ADS-B payloads have been built and tested. They have been integrated into the first group of Iridium NEXT satellites, which are scheduled to be launched shortly. In total, seven launches will help position all the satellites in preparation for the introduction of the service in 2018.

In addition to the safety benefits Aireon will provide, there will be tangible environmental benefits, as enhanced flight tracking will enable improvements in flight efficiency in many parts of the world. As we implement satellite ADS-B, estimates indicate a savings of 300,000 tonnes of greenhouse gases in the North Atlantic alone. But the benefits will extend far beyond the North Atlantic as air navigation service providers around the globe are examining the application of space-based ADS-B in their own airspace; a true global collaboration that will be sure to realize safety and environmental benefits around the world.
Notes and Background Information

- NAV CANADA has made every effort to be as specific as possible with respect to estimating the achievable benefits. NAV CANADA has used, among others, the following resources:
  - Percentage changes in traffic movements: NAV CANADA Service Delivery Reporting Systems
  - Average aircraft fuel consumption per minute: EUROCONTROL BADA Project – EEC Technical/Scientific Report No. 13/04/16-03

- Greenhouse Gas (GHG) refers to those gases in an atmosphere that absorb and emit radiation within the thermal infrared range. In the Earth’s atmosphere, these gases are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

In aviation, one litre of aviation fuel produces the following types of GHG emissions:

- **CO₂** → **CH₄** → **N₂O** → **CO₂e**

  - Carbon Dioxide: 2.5340 kg
  - Methane: 0.0007 kg
  - Nitrous Oxide: 0.0007 kg
  - Total CO₂e: 2.5567 kg*

- Some of the assumptions and formulae used for this report include:
  - Projected air traffic volumes from 2016 forward are NAV CANADA estimates.

- NAV CANADA estimates are predicated upon customers taking advantage of the new services and procedures in a systematic manner when they become available. Actual uptake will be affected by the availability of equipment, government certifications, training and other drivers which NAV CANADA estimates in our analysis. The Company is confident that the report reasonably reflects achievable reductions in GHG emissions and the overall impact of our activities on our customers’ costs.

CIFER 2016
Collaborative Initiatives For Emissions Reductions

www.navcanada.ca