Green Aviation Research & Development Network

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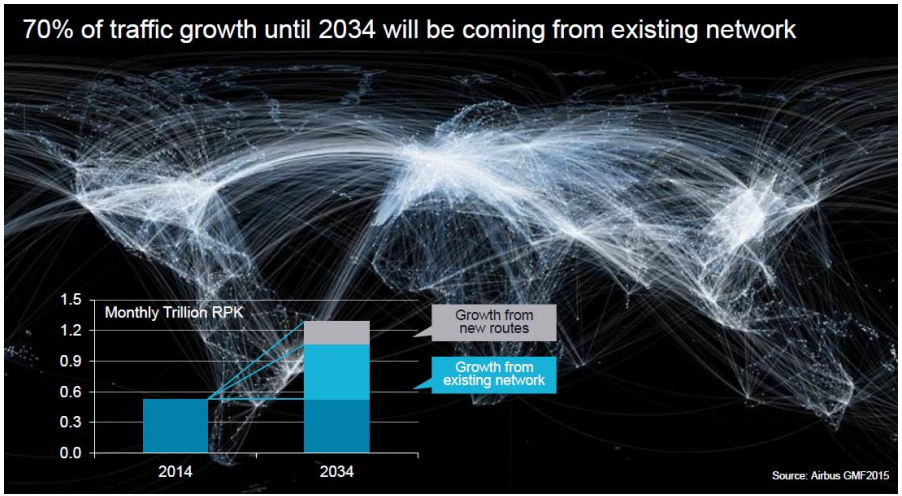
May 31st, 2016

GARDN

Global Context of Aerospace Industry: Constantly growing demand



In 2015, over **3.5 billion passengers** were carried by the world's airlines.

- In 2030, over 6 billion passengers

Canadian Context of Aerospace Industry

* General Aviation: Includes all aircraft not used in either commuter services or airline service (excluding business jets and rotorcraft)

Sources: Flight Simulation: Frost & Sullivan, Commercial Flight Training and Simulation Market, December 17, 2014
Aircraft production: Average of Forecast International and Teal Group forecasts, 2014
Engine Production: Forecast by Forecast International, 2014

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This Success has an Environmental Impact

CSeries: 2,1 l/100 km!

New aircraft such as the CSeries use **less than 3 litres of fuel per 100 passengers kilometres**. This matches the efficiency of most modern compact cars.

But it is still that the aviation industry consumes around **1.5 billion barrels** of Jet A-1 fuel annually **producing 770 million tonnes of CO2 in 2015**.

2% of global human emissions.

Source : http://www.atag.org/facts-and-figures.html (consulted September 29, 2015)

Aerospace Industry environmental Targets

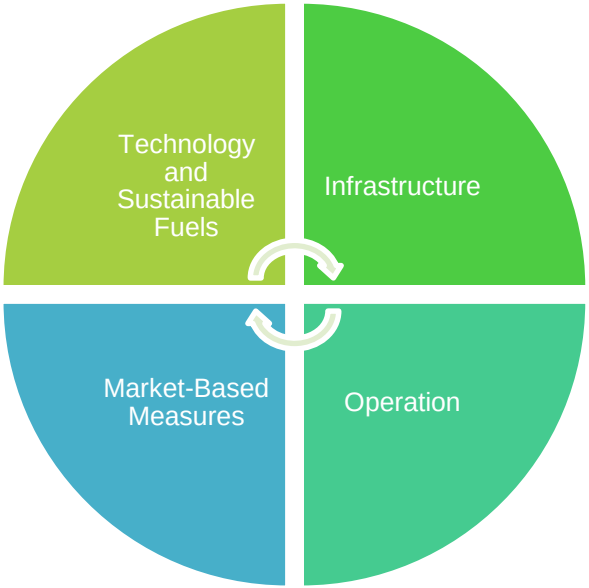
- Improvement of fleet fuel efficiency by **1.5%** per annum between now and 2020.
- From 2020, net carbon emissions from aviation will be capped through **carbon neutral growth**.
- By 2050, **net aviation carbon emissions** will be half of what they were in 2005.
- By 2020, reducing the noise by 50%.

Source : http://www.atag.org/facts-and-figures.html (consulted September 29, 2015)

Aerospace Industry Environmental Track Record

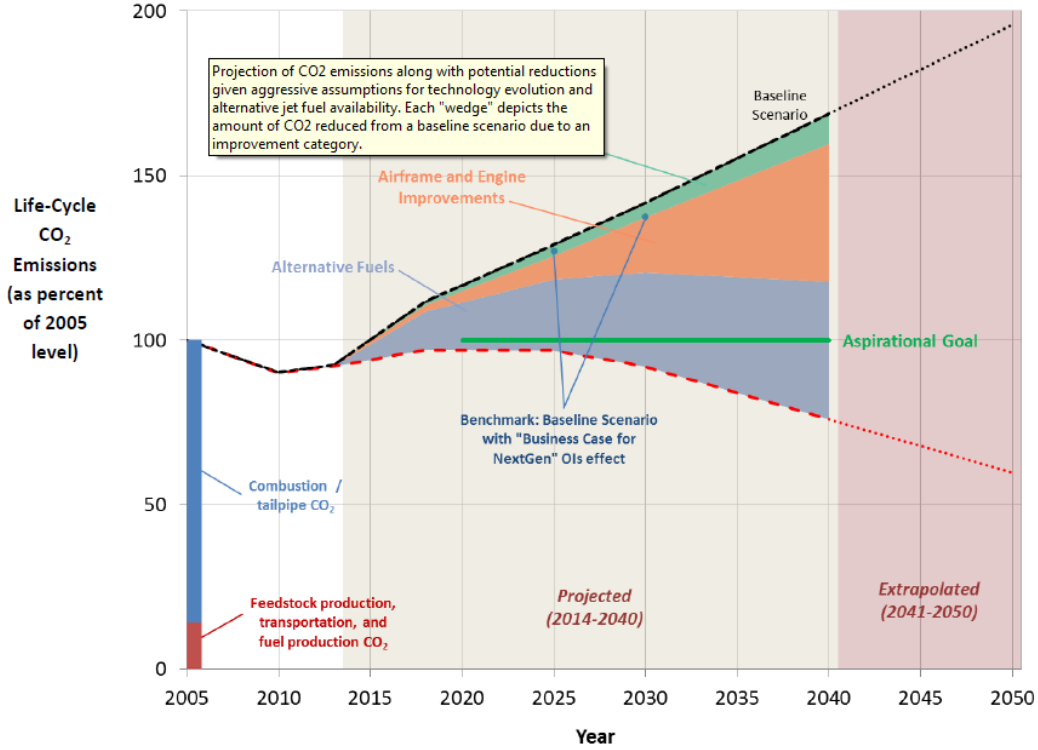
- CO_2 emissions per seat kilometre
  - 80% since first jet aircraft (1960s)
- Perceived noise
  - 75% since first jets (1960s)

4 pillars of Climate Action



Aviation CO_2 Reduction Plan

Projected life-cycle CO2 emissions impacts – Aggressive system improvement scenario



Green Aviation Research & Development Network (GARDN)

WHAT

We promote the development of green technologies on **Clean**, **Quiet** and **Sustainable** Air Transport Systems by encouraging:

- **Creativity**
- **Collaboration**
- **Investment**

WHY

To **increase competitiveness** of Canada's Aerospace Industry as the environmental performance of aerospace products becomes a key differentiator

HOW

By **funding and supporting** precompetitive collaborative industrial R&D projects

GARDN Members

Bell Helicopter – A Textron Company
BOEING
BOMBARDIER
Pratt & Whitney Canada – Une société de United Technologies / A United Technologies Company
AIR CANADA
AIR GEORGIAN
WESTJET
Esterline CMC Electronics
HEROUX DEVTEK
amrikart ultraprecision
BURLOAK Technologies
GROUPE AGECO
HARWOOD
LTA AEROSTRUCTURES
Mecanum
NEBULA Unmanned Aerial Systems
NORAM
PAVAC INDUSTRIES INC.
SRS
waterfall group
ASCENT
RÉSEAU BIOFUELNET CANADA
CAMOSUN
Quebec Metallurgy Center – CMQ – Centre de métallurgie du Québec
Fraunhofer
SkyNRG
CTA
CIRAIG – Interuniversity Research Centre for the Life Cycle of Products, Processes and Services
ÉTS
Carleton UNIVERSITY
Queen's UNIVERSITY
UBC – a place of mind
McGill
UNIVERSITÉ LAVAL
UNIVERSITÉ DE SHERBROOKE
UNIVERSITY OF TORONTO
University of Victoria
CRIAQ
Canadian Manufacturers & Exporters – Canada's Leading Business Network
Manufacturers et Exportateurs du Canada – Le réseau d'affaires par excellence du Canada
CAAFI – COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE
Environment Canada
Environnement Canada
AIAC
CARIC
IATA
NRC·CNRC
Transports Canada
Transport Canada

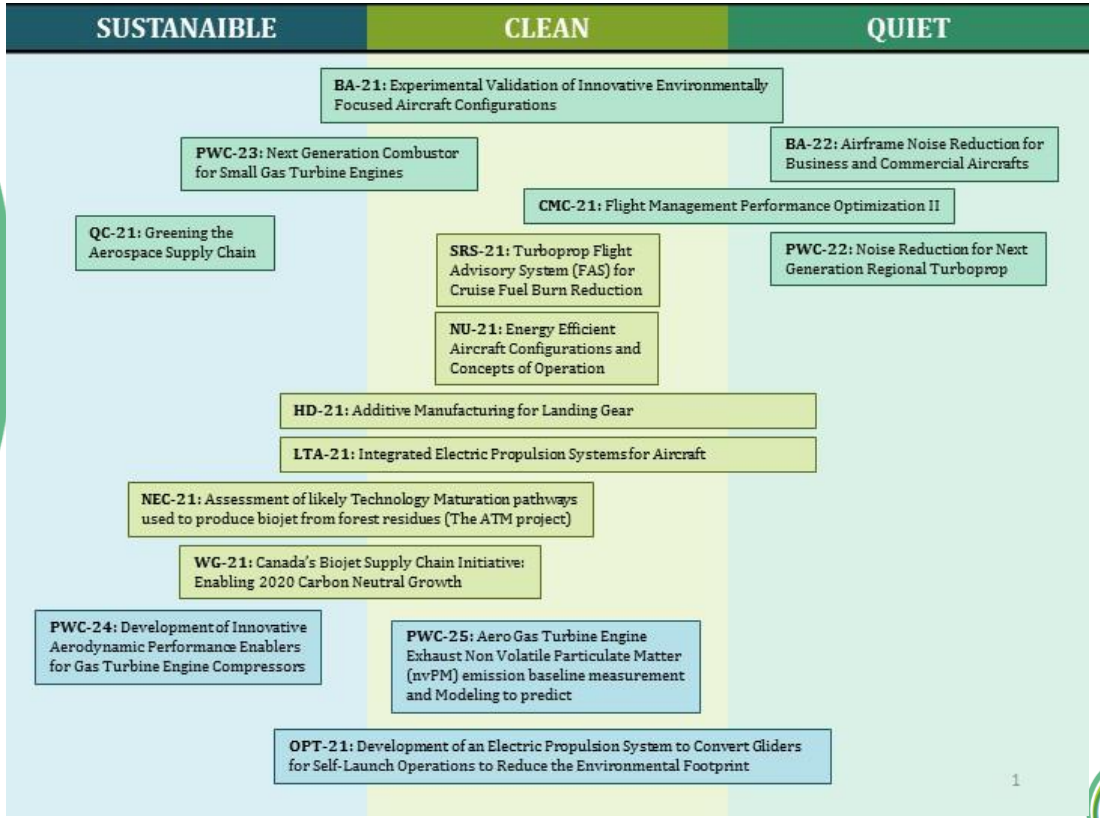
GARDN II : Research Themes

- Aircraft noise
- Engine noise
- Community Noise

- Aircraft design and optimization to reduce fuel burn and climate change
- Advanced engine and combustor concepts to reduce fuel burn, NOx and particulate matter
- Alternative fuels
- Optimized navigation and avionics

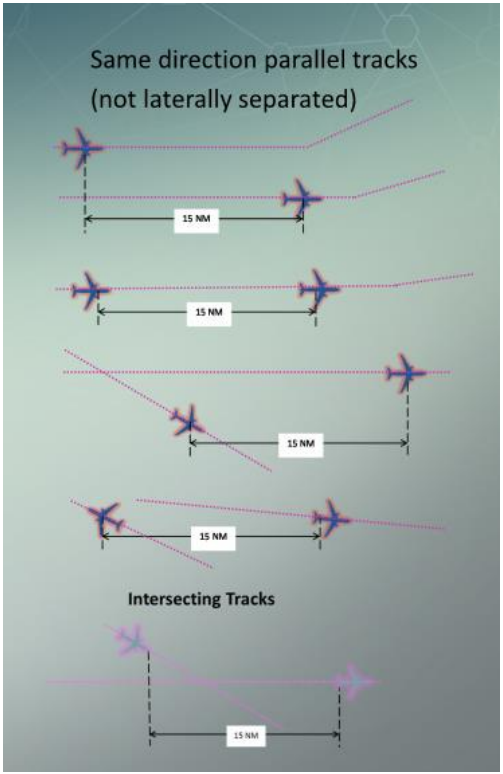
- Product end-of-life
- Green manufacturing and MRO
- Materials of concern
- Recycling

GARDN II Research Portfolio: Mindful of Environmental Interdependencies



Airspace and Avionics Modernization Future

- **Space based ADS-B**
- Allows reduced separation in remote areas, meaning more aircraft using optimum altitude
- **Improved RTA**
- Allows more aircraft to use the most efficient approaches
- **ADS-B In**
- Allows ATC to maintain VFR throughput in IFR weather



More Electric Aircraft / Engines

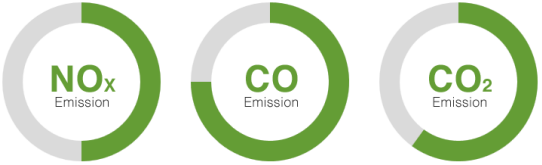
System Features

Using the Auxiliary Power Unit (APU) generator to power motors on the main wheels, the EGTS taxiing system allows aircraft to push back without a tug and then taxi without requiring the use of the main aircraft engines. One wheel on each main gear is equipped with an electric motor to drive the aircraft, while unique power electronics and system controllers give pilots total control of the aircraft's speed and direction during taxi operations.

In collaboration with airports worldwide EGTS is being designed to integrate seamlessly into existing surface traffic flow irrespective of weather conditions.

EGTS can deliver up to 4% savings of total block fuel consumption

Optimized Electric Aircraft: Industry continues its research into more electric aircraft power systems, generators and electric starters along with high power conditioning and power distribution and control. Electric aircraft research can improve fuel burn and reduce emissions.



Up to 50% Total | **Up to 75% Total** | **Up to 60% Total**

When compared to Dual Engine Taxi (DET) Operations
For further information on the environmental benefits of EGTS click here

Electric Engines

The **E-Fan** is a prototype two-seater electric aircraft being developed by Airbus Group. The target market is pilot training.

Solar Impulse 2 completed the Pacific Ocean crossing leg of its round-the-world flight.

End-of-Life / Materials of Concern

Replacement of **Materials of Concern / Additive Manufacturing**

Aircraft Recycling

Airship / UAV

Innovative new flying machines that will go into service within this decade. The airships are expressly designed for the North, where infrastructure is limited or non-existent and where climactic conditions can be challenging.

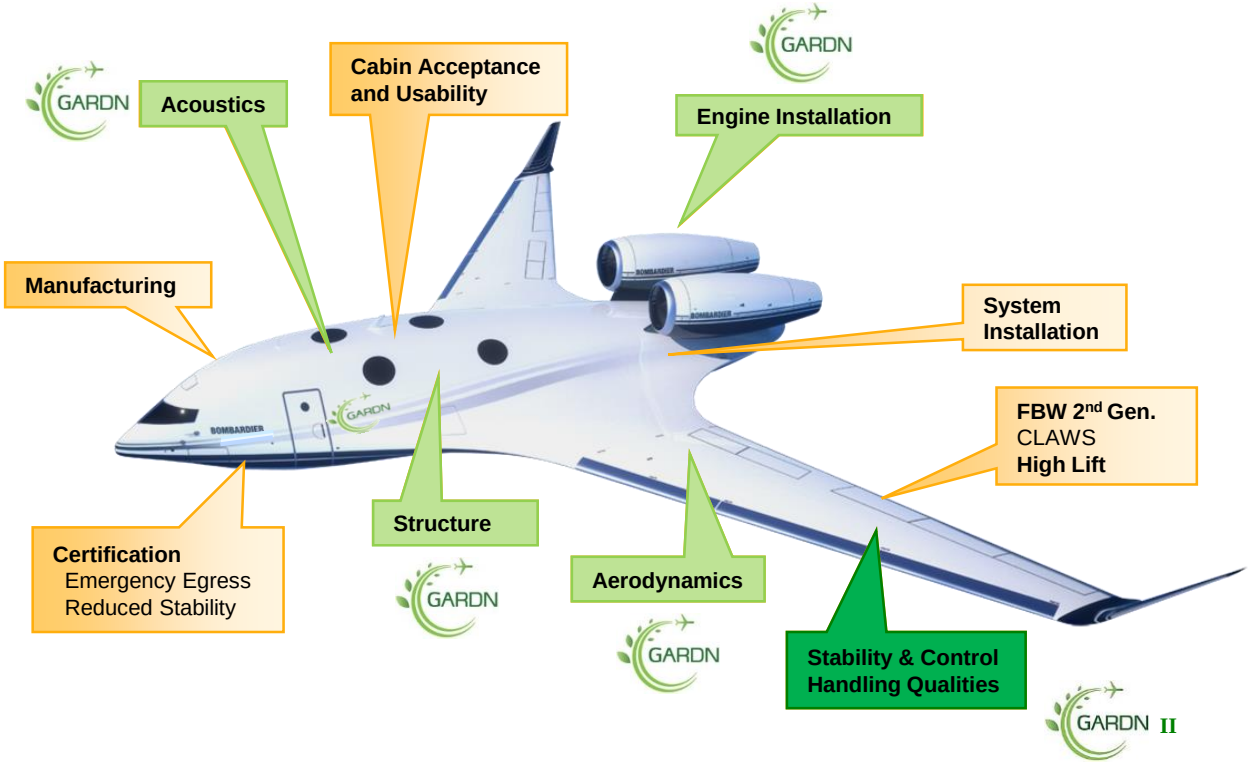
UAV Types

	Multicopter	Small Fixed Wing	Traditional Helicopter	Mid Sized Fixed Wing
Cost	$100-$5000	$100-$5000	$5k+	$10k-$100k+
Flight time	10-30 min	20min– 4hr	15min-2hr	1-16hr
Payload	1-2kg	1-4kg	1-20kg	5-50 kg
Complexity	Vey low	Moderate	High	Very High
Training Req.	Minimal	Some	Very High	High
Takeoff	Vertical	Hand/Launcher	Vertical	Launcher/Runway

Comprehensive Review of UAVs http://uaviators.org/docs

An unmanned aerial vehicle may operate with various degrees of autonomy: either under remote control by a human operator, or fully or intermittently autonomously, by onboard computers. Their use is expanding in commercial, scientific, environmental and other applications, such as policing and surveillance, aerial photography, agriculture...

New Configurations



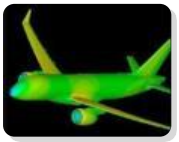
New Aircraft Design

The CSeries

Optimal Aircraft Integration

Lighter Aircraft

State-of-the-Art Aerodynamics



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Game Changing Engine

PurePower® PW1500G

20% Fuel Burn Advantage

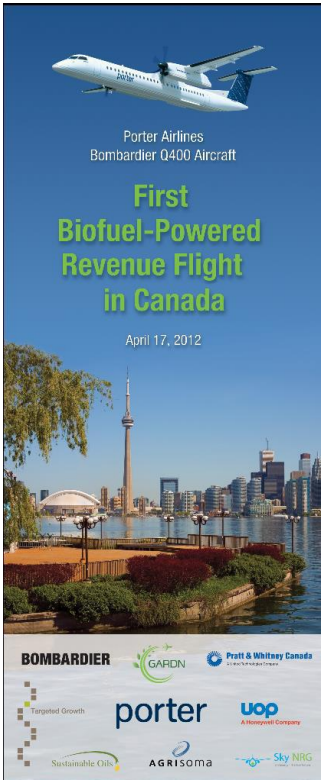
~120,000 metric tons of CO_2 savings over aircraft life*

- *CO_2 saving assumes an operation over 60,000 cycles and typical mission and is compared to in-production aircraft. CO_2 number will be lower if assuming a 500 nm mission average but higher for a 1,000 nm mission average. Numbers will also be significantly higher when compared to older generation aircraft. For illustration only,

Alternative Fuel

The National Research Council of Canada's Falcon 20 will be the World's first civil aircraft to fly with 100% biojet fuel.

Brassica carinata



GARDN II Current Projects:

NEC-21

Biojet production from Woody Biomass.

WG-21

Demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system using existing delivery infrastructure to directly support carbon neutral growth of the CND aviation sector beyond 2020.

Recommendations

- To include aviation sector as one of the sector targeted by the Canada Sustainable Development Strategy and the upcoming Innovation Agenda
- To use GARDN as one of the mechanism for supporting green aviation research and development acitivities in order to keep Canada's competitive advantage.
- To recognize the role of ICAO to implement Market-Based Measures at the international level.
- To facilitate and de-risk the introduction of biofuels.

In Conclusion

The Canadian aviation sector (including government, industry, and academia) did a lot since 2009 through GARDN. But its action must by amplified to address its impact on climate change, while responsibly meeting the growing demands for air transport and, in turn, improving the quality of life of all Canadians for the foreseeable future.

Thank you! | Merci!

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