Green Aviation Research & Development Network

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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

Canadian aerospace manufacturing ranks 5th in OECD countries in terms of GDP (2011)

#1 in civil flight simulation (2014)

#3 in civil aircraft production (2014)
- #2 in business aircraft production
- #2 in regional aircraft production
- #3 in general aviation* production
- #5 in helicopter production

#3 in civil engine production (2014)
- #1 in turboprop engine production
- #1 in helicopter engine production

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

Sources:
- Aircraft production: Average of Forecast International and Teal Group forecasts, 2014
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.

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%.

Aerospace Industry
Environmental Track Record

• $\text{CO}_2$ emissions per seat kilometre
  – 80% since first jet aircraft (1960s)

• Perceived noise
  – 75% since first jets (1960s)
4 pillars of Climate Action

- Technology and Sustainable Fuels
- Infrastructure
- Market-Based Measures
- Operation
Aviation CO₂ 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
## GARDN II: Research Themes

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<tr>
<th>QUIET</th>
<th>CLEAN</th>
<th>SUSTAINABLE</th>
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<tbody>
<tr>
<td>• Aircraft noise</td>
<td>• Aircraft design and optimization to reduce fuel burn and climate change</td>
<td>• Product end-of-life</td>
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<td>• Engine noise</td>
<td>• Advanced engine and combustor concepts to reduce fuel burn, NOx and particulate matter</td>
<td>• Green manufacturing and MRO</td>
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<td>• Community Noise</td>
<td>• Alternative fuels</td>
<td>• Materials of concern</td>
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<td>• Optimized navigation and avionics</td>
<td>• Recycling</td>
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GARDN II Research Portfolio: Mindful of Environmental Interdependencies

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<th>SUSTAINABLE</th>
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<td>PWC-23: Next Generation Combustor for Small Gas Turbine Engines</td>
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<td>QC-21: Greening the Aerospace Supply Chain</td>
<td>SRS-21: Turboprop Flight Advisory System (FAS) for Cruise Fuel Burn Reduction</td>
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<td>NU-21: Energy Efficient Aircraft Configurations and Concepts of Operation</td>
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<td>LTA-21: Integrated Electric Propulsion Systems for Aircraft</td>
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<td>NEC-21: Assessment of likely Technology Maturation pathways used to produce biojet from forest residues (The ATM project)</td>
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<td>WGC-21: Canada’s Biojet Supply Chain Initiative: Enabling 2020 Carbon Neutral Growth</td>
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<td>OPT-21: Development of an Electric Propulsion System to Convert Gliders for Self-Launch Operations to Reduce the Environmental Footprint</td>
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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

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.
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.

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

- Acoustics and Usability
- Engine Installation
- System Installation
- FBW 2nd Gen.
  CLAWS
  High Lift
- Structure
- Aerodynamics
- Stability & Control
  Handling Qualities
- Manufacturing
- Certification
  Emergency Egress
  Reduced Stability
New Aircraft Design
The CSeries

Optimal Aircraft Integration
Lighter Aircraft
State-of-the-Art Aerodynamics

Fuel Burn Advantage
20%

Game Changing Engine
PurePower® PW1500G

~120,000 metric tons of CO₂ savings over aircraft life

*CO₂ saving assumes an operation over 60,000 cycles and typical mission and is compared to in-production aircraft. CO₂ 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.
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 activities 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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