Transport Canada – Clean Transportation Initiative
Viability of an Aviation Biofuel Supply Chain In Canada

Executive Summary

June, 2015

RÉSEAU BIOFUELNET CANADA

SkyNRG

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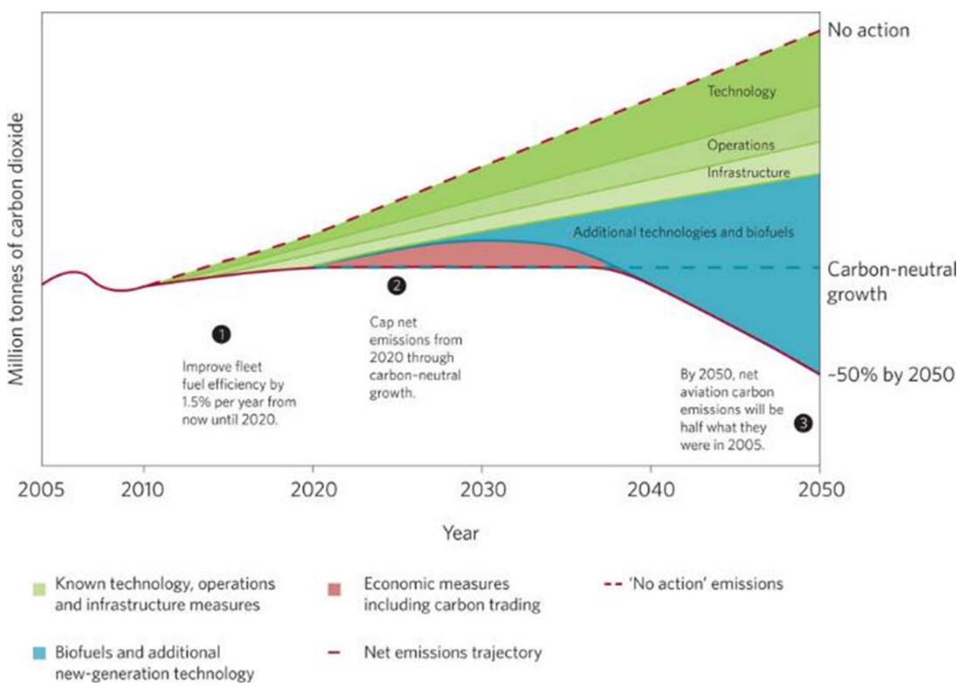
Project overview

Scope

Assess the feasibility, cost, and environmental impact of establishing aviation biofuel supply chains at key locations in Canada – project duration May 2014 to Jun 2015

Aviation sector imperative

Biojet fuel is a major component of the aviation industry's plan to achieve carbon neutral growth by 2020, and a 50% reduction in 2005 GHG emissions levels by 2050



External advisors to the project

AIR CANADA IATA Pierre Poitras et Associés

Our external advisors provided comprehensive aviation sector perspective and guidance throughout the project

Why in Canada

Canada has the natural resources and supporting environment to be a leader in biojet production**:**

- Commercial quantities of feedstock available
- Demonstrated ability to implement policy for renewables
- R&D expertise and technical leadership
- Interested airline community

Benefits include: increased economic development, ability to position Canada as world leader in sustainable fuel, energy security. Government can create the enabling conditions for biojet technologies, both domestic and developed internationally, to take root.

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Results Summary

Technology and feedstock platforms were evaluated and prioritized for two time horizons and locations in Canada

Through a multi-step evaluative process, the project team created 2 interdependent biojet development streams:

2020 HEFA: Hydroprocessed esters and fatty acids, currently approved by ASTM for biojet. Uses oleochemical feedstock such as oilseed crops, animal fats, used cooking oil, and other sources. Noted that a future ASTM approval for hydrodgenation derived renewable diesel (HDRD) could reduce the cost of biojet from oleochemical feedstocks.

2025 HDCJ: Hydrotreated depolymerized cellulosic jet, expected approved by ASTM for biojet in 2017. Uses cellulosic agricultural residues, roundwood, forest harvest residues, and pellets.

Locations

2020 HEFA: Edmonton and Sarnia regions are the most promising due to availability of feedstock, hydrogen for processing, existing refining capacity, and proximity to airports.

2025 HDCJ: Edmonton, Prince George, Sarnia, and Montreal/Quebec City are most promising due to availability of feedstock, hydrogen for processing, existing processing capability, and proximity to airports.

Emissions performance

The Lifecycle Analysis (LCA) considers complete life cycle emissions, using the GHGenius model. Compared to fossil jet, GHG reductions for biojet were calculated to be:

2020 HEFA: 73-89%

2025 HDCJ: 46-64%

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Results Summary

Techno-economic performance

Fossil Jet Reference Price: The price of jet fuel is variable.

The reference price used in the analysis is: $965/tonne ($0.782/litre)

The jet price at airports (delivered into the aircraft) would include transportation and other added costs and is likely at a premium over the above price.

Minimum biojet selling price where biofuel can be sold while still achieving basic profitability thresholds is estimated at:

HEFA 2020: $1725/tonne ($1.40/litre)

HDCJ 2025: $1020/tonne ($0.83/litre)

For the 2020 – 2030 time period, we assume progressively increasing blend rates. The table shows that the estimated price premium for biojet blends up to 10% can be marginal, relative to the estimated price of fossil jet fuel over the 2020-2030 time period:

Biojet Blend Rate (%)	Fossil Jet Reference Price ($/L)	HEFA Biojet		HDCJ Biojet	
		Blended Selling Price ($/L)	Premium ($/L)	Blended Selling Price ($/L)	Premium ($/L)
0%	$ 0.782	$ 0.782	$ -	$ 0.782	$ -
1%	$ 0.782	$ 0.789	$ 0.008	$ 0.782	$ 0.000
2%	$ 0.782	$ 0.797	$ 0.016	$ 0.782	$ 0.001
3%	$ 0.782	$ 0.805	$ 0.023	$ 0.783	$ 0.001
4%	$ 0.782	$ 0.813	$ 0.031	$ 0.783	$ 0.001
5%	$ 0.782	$ 0.821	$ 0.039	$ 0.783	$ 0.001
6%	$ 0.782	$ 0.828	$ 0.047	$ 0.783	$ 0.002
7%	$ 0.782	$ 0.836	$ 0.054	$ 0.784	$ 0.002
8%	$ 0.782	$ 0.844	$ 0.062	$ 0.784	$ 0.002
9%	$ 0.782	$ 0.852	$ 0.070	$ 0.784	$ 0.003
10%	$ 0.782	$ 0.859	$ 0.078	$ 0.785	$ 0.003

Sustainability performance

The prevalence of multiple sustainability schemes used within and external to regulations, the nascent state of biojet production, the sensitivity of biojet consumers to sustainability criticism, and the recognized need to decarbonizse aviation fuels all combine to make predictions difficult on the preferred approach to sustainability for a future Canadian biojet industry.

Emerging approaches that incorporate a meta standard structure to enable the use of multiple schemes, and a potential tiered approach to sustainability performance, hold potential benefit for the emerging biojet supply chain.

Based on current sustainability schemes used under existing renewable fuels policies for ground transport, it is likely that Canadian biojet (and its component feedstocks) would be certified as meeting sustainability requirements.

The global nature of the aviation sector requires that emerging standards and approaches to sustainability are internationally aligned to help enable the tracking of sustainability attributes and GHG reductions among multiple airlines for both domestic, transborder, and international aviation.

Policy Options

The project identified a selection of policy tools that can create enabling conditions for a domestic biojet industry. The policy tools are useful to achieve the following:

- create market access for biojet that is not exclusively dependent on it being cheaper than fossil aviation fuels;
- reduce project risk by creating financial instruments to incentivize capital formation, facility operation, fuel blending and airline uptake; and
- monetize value of GHG reductions from displacing fossil jet fuel

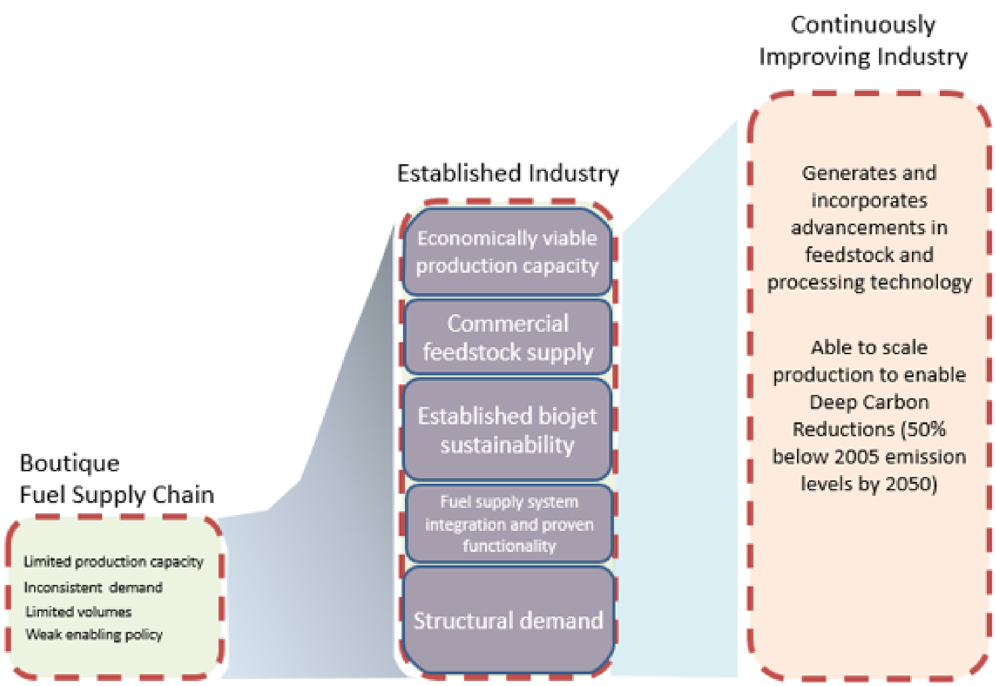
This project proposes that elements from the below can be used to create the enabling conditions for a domestic biojet industry.

- Market Access Policies:
  - Renewable Fuel Standard - obligates inclusion of renewable content in a fuel sector
  - Low Carbon Fuel Standard - requires the reduction of carbon intensity of a fuel type
  - Nested Mandates/Carve-outs - Mandates for specific fuel types that exist within renewable fuel standards
- Fiscal Measures:
  - Capital Incentives - used to reduce a project's capital cost, reduce payback risk and enhance project return profile
  - Operating Incentives - can bridge the production cost of a renewable fuel and the fossil fuel substitute
  - Consumption Incentives - used to stimulate market use by reducing cost of low carbon fuel
  - Investment Incentives - specific investment structures can help balance project risk and reward. Can improve project cash flows in early, payback period.
  - Innovation - Public investment funds used to advance a strategic sector by stimulating innovation research, reducing the cost of research and development, leveraging private sector investment & knowledge, and continuous improvement of production assets.

Recommendations and next steps

Scaling the industry

The components below represent some of the required elements to progress from a 'boutique' to an 'established' to a 'continuously improving' industry:



Select Next Steps

- Canada should actively participate in the creation of sustainability criteria for biojet being developed under the global Market Based Measures by ICAO. Canada's informed participation can ensure that future sustainability systems work for domestic agriculture and forestry that will be the main biojet feedstocks.
- Barriers to the wider use of biojet at domestic airports (via the co-mingled hydrant fuel system) should be examined and addressed, potentially through pilot blending projects and the documentation & dissemination of best practices.
- Canada's domestic aviation sector and government stakeholders should explore options to reduce emissions prior to the publication of the global Market Based Measures by ICAO.

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Glossary and Select Figures

Fuel volumetrics (indicative)

- Canada jet production (2013): 4.2 billion litres (BL)
- Canada jet consumption (2013): 6.8 BL
- Canada gasoline consumption (2013): 36 BL
- Canada jet consumption 2050: 12 BL
- Biojet to meet industry target 2020: 54 ML
- Biojet to meet industry target 2035: 1 BL
- Biojet to meet industry target 2050: 6.1 BL

Biojet

- Most common technology today: HEFA
- Number of technologies certified by ASTM: 3

Glossary

- HEFA - hydroprocessed esters and fatty acids, a technology platform to produce biofuel, currently approved by ASTM for biojet
- HDCJ - hydrotreated depolymerized cellulosic jet, a technology platform to produce biofuel, expected approved by ASTM for biojet in 2017
- HDRD - hydrogenation derived renewable diesel, also called green diesel, has been trialed by Boeing in blends up to 15%
- Oleochemical – oil containing feedstocks used in HEFA process, such as oilseeds, waste cooking oil, fats
- LCA - lifecycle emissions analysis, a model to estimate emissions performance
- TEA – techno-economic analysis, to model the technical and economic aspects of a supply chain
- MBM – Market based measure, ICAO led initiative to price carbon from aviation