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ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS

Canada’s Biojet Supply Chain Initiative and Domestic SAF Progress (Clean Fuel Standard)

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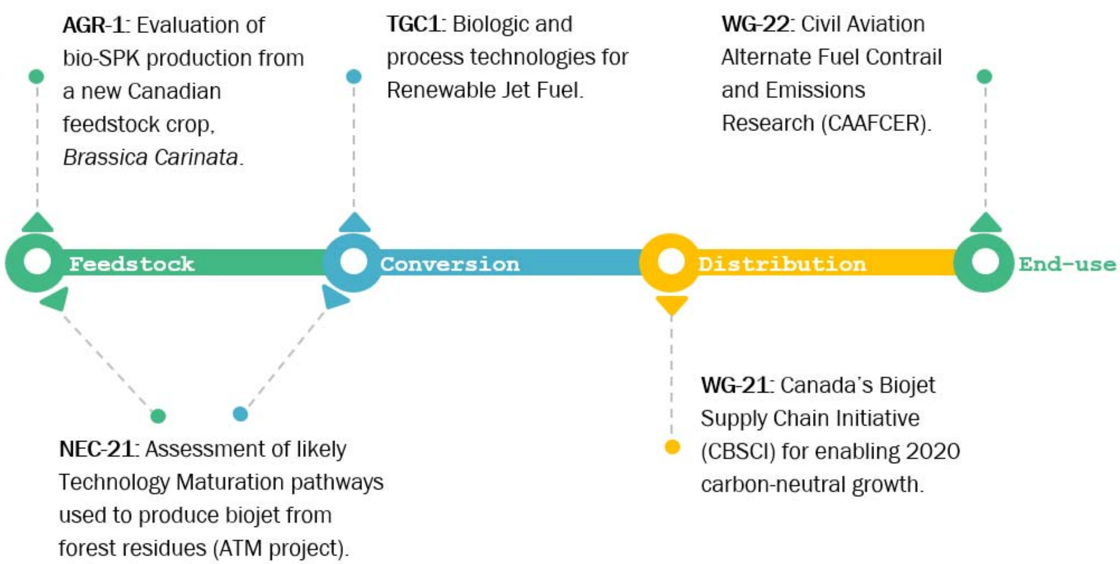
Partner, Waterfall Group

CBSCI is a GARDN – enaled project

GARDN is the first green aviation initiative in Canada and a catalyst for SAF development



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AIR CANADA

CBSCI
Canada's Biojet
Supply Chain Initiative

GARDN
Green Aviation
Research & Development
Network

ASCENT
AVIATION SUSTAINABILITY CENTER

RÉSEAU
BIOFUELNET
CANADA

BOEING

CAAFI
COMMERCIAL AVIATION
ALTERNATIVE FUELS INITIATIVE

IATA

McGill

Canada
NRC·CNRC

Queen's
UNIVERSITY

SkyNRG

Transport
Canada
Canada

UNIVERSITY OF
TORONTO

waterfall
group

1

Demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system using existing delivery infrastructure (e.g., co-mingled airport fuel system).

2

Validate Canadian biojet supply chain elements (e.g., quantitative feedstock availability, sustainability certification, biojet integration in the jet fuel supply system, quantify regulatory/fiscal options).

3

Generate hands-on experience with biojet integration to develop best practices in a Canadian context.

4

Catalyze the development of the domestic biojet sector by using HEFA biojet as an enabling mechanism to create market access, drive research, development, and commercialization of advanced biofuel feedstocks and conversion technologies beyond the 2020 timeframe.

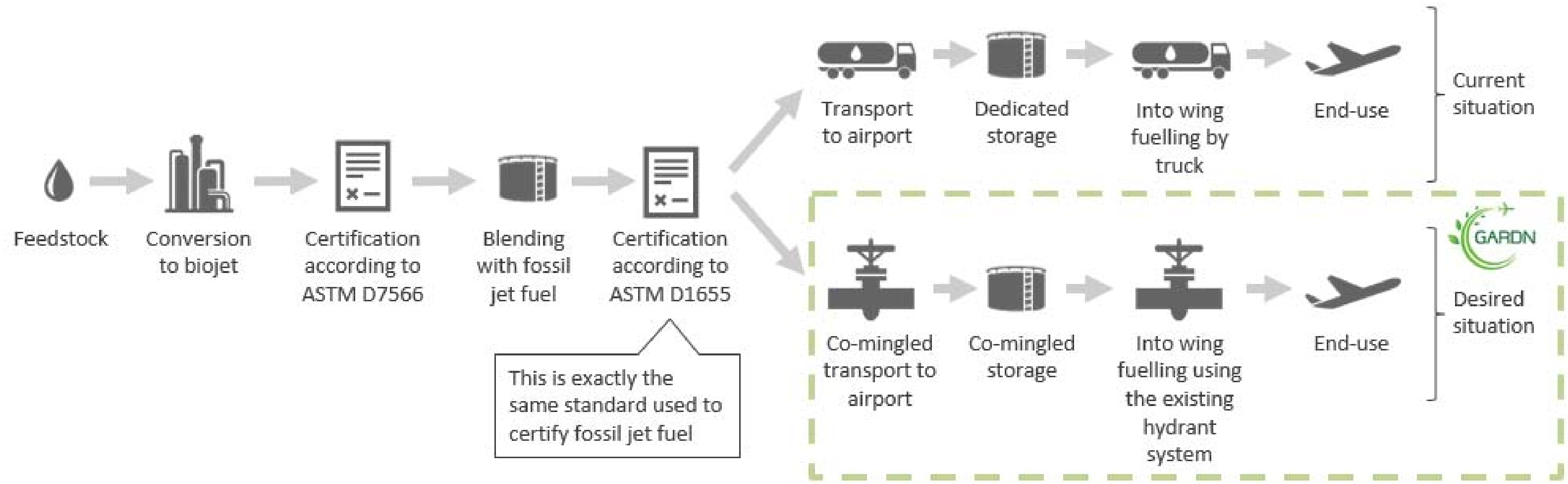
Significance *of the* supply chain

Efficiency is key to the biojet supply chain.

Delivering fuel via the multi-user hydrant fuel system enables it to be blended upstream of the aircraft, for seamless delivery.

The CBSCI is removing barriers, and delivering hands-on experience so that biojet can become a permanent part of the supply chain in the Canadian aviation fuel supply.

Enabling an efficient fuel supply system



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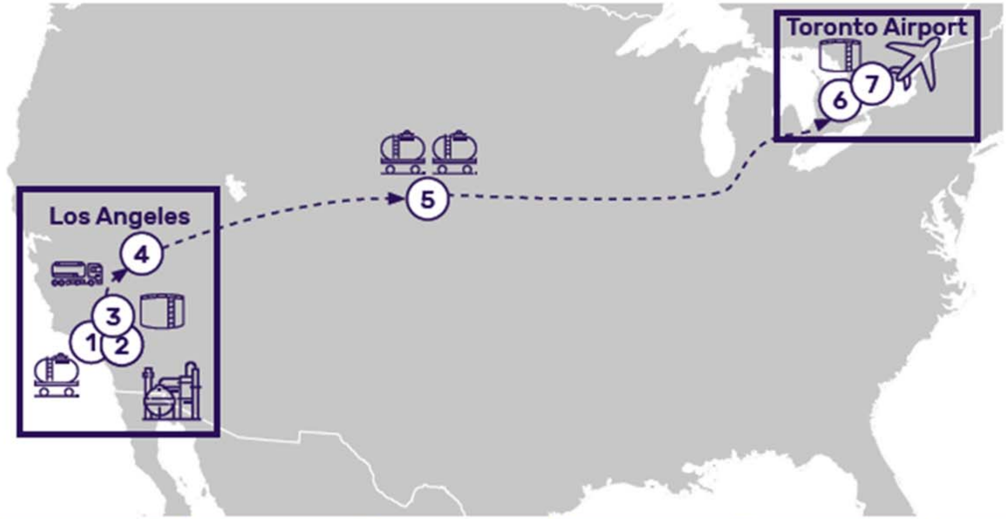

SkyNRG
AltAir Fuels
ventura TRANSFER COMPANY
EPIC FUELS
AIR CANADA
Toronto Pearson
BUREAU VERITAS
ASIG BY MENZIES AVIATION

COUNT	FLIGHT #	DEP	ARR	LITERS	TOTAL	BLEND RATIO
1	AC480	YYZ	YUL	7,600	7,600	30%
2	AC133	YYZ	YYC	16,000	23,600	30%
3	AC400	YYZ	YUL	7,600	31,200	30%
4	AC259	YYZ	YWG	9,000	40,200	30%
5	AC402	YYZ	YUL	9,400	49,600	30%
6	AC137	YYZ	YYC	16,000	65,600	30%
7	AC442	YYZ	YOW	4,625	70,225	30%
8	AC404	YYZ	YUL	7,600	77,825	30%
9	AC139	YYZ	YYC	16,000	93,825	30%
10	AC406	YYZ	YUL	7,600	101,425	30%
11	AC261	YYZ	YWG	11,875	113,300	30%
12	AC446	YYZ	YOW	4,625	117,925	30%
13	AC107	YYZ	YVR	20,750	138,675	30%
14	AC408	YYZ	YUL	7,600	146,275	30%
15	AC410	YYZ	YUL	7,600	153,875	30%
16	AC450	YYZ	YOW	4,625	158,500	30%
17	AC143	YYZ	YYC	16,000	174,500	30%
18	AC111	YYZ	YVR	20,375	194,875	30%
19	AC263	YYZ	YWG	9,000	203,875	30%
20	AC452	YYZ	YOW	6,625	210,500	30%
21	AC145	YYZ	YYC	16,000	226,500	30%
23	AC271	YYZ	YWG	8,574	235,074	29%

1 Feedstock Sourcing
- UCO sourced domestically by and railed to AltAir
- Tested on AltAir's feedstock specification compliance

2 Biojet Production
- AltAir Fuels produced HEFA biojet fuel
- The biojet fuel is certified to ASTM D7566 Annex 2 by Bureau Veritas

3 Blending with fossil jet fuels
- Fossil jet fuel is sourced locally and trucked to AltAir
- AltAir made a 30% biojet fuel blend, certified to ASTM D1655 by Bureau Veritas

4 Loading in railcars
- The blended biojet fuel is trucked to the railyard by EPIC Fuels
- The fuel is transferred into railcars by Ventura Transfer Company

5 Transport to airport
- SkyNRG and EPIC Fuels arranged the railcar transport to Toronto Airport's fuel farm

6 Supply into fuel farm (storage)
- The biojet railcars were connected to the regular fossil jet fuel train to YYZ
- The biojet railcars were unloaded into the airport's commingled fuel farm

7 Fueling flights
- The biojet is part of the airport's fuel system and potentially ends up in any aircraft fueling at YYZ
- Air Canada administratively claims the biojet and its benefits

Earth Day 2018

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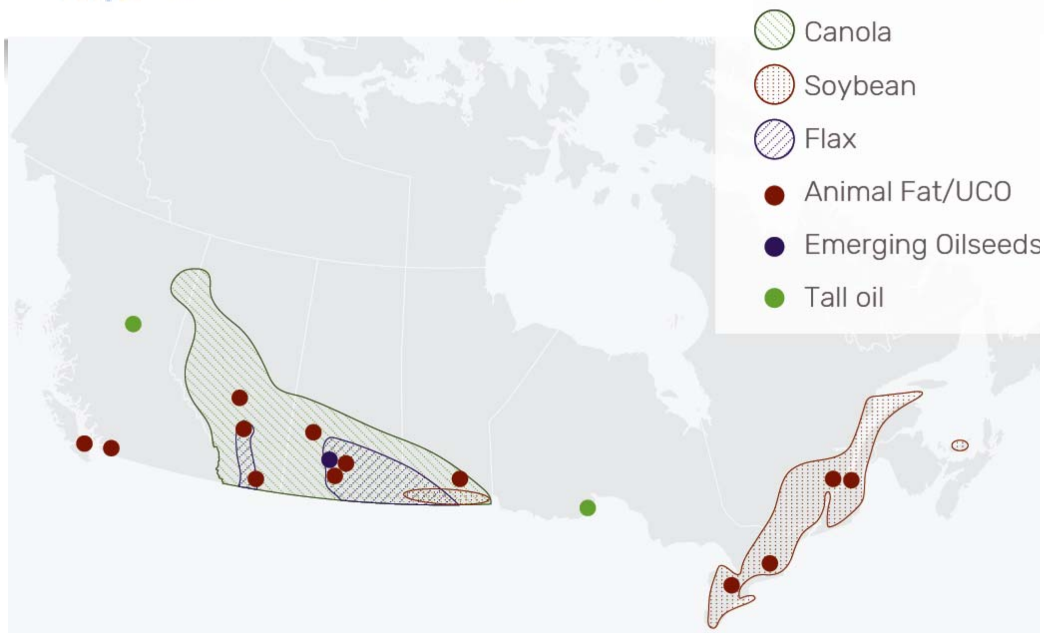
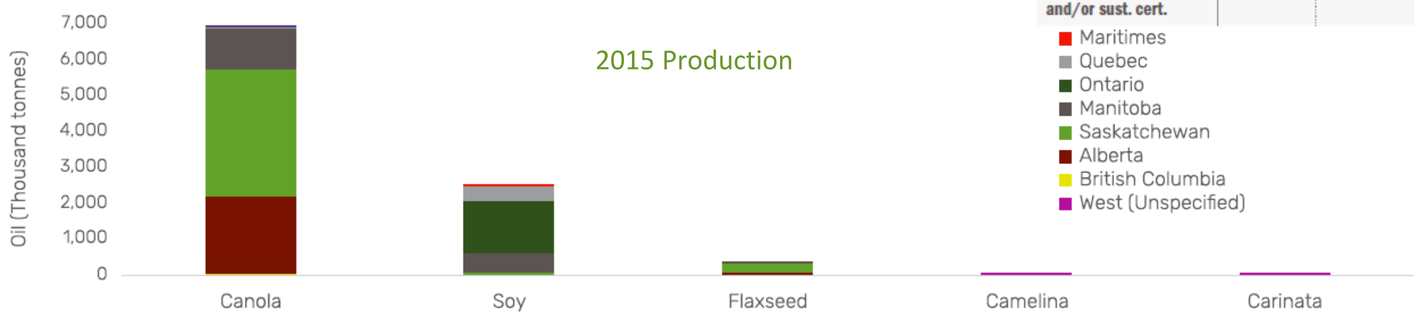
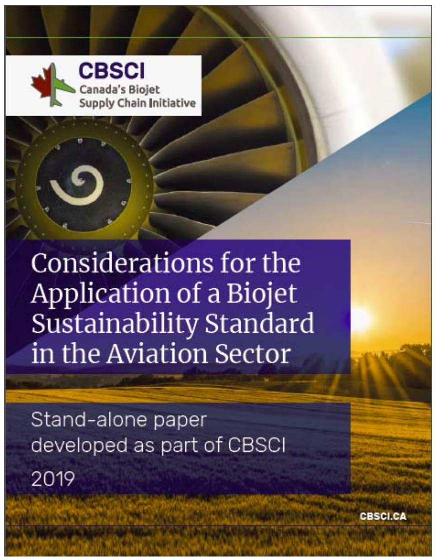
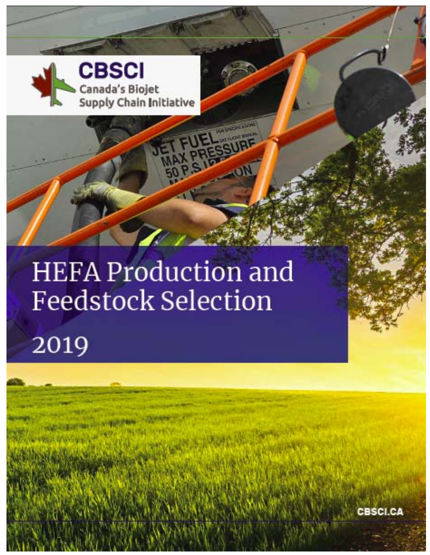


	CANOLA	SOY	ANIMAL FATS/UCO	FLAX	CAMELINA	CARINATA	ALGAE
Oil production (2015 est)	<7 MMT	>1 MMT	<1 MMT	<.5 MMT	<.005 MMT	<.005 MMT	<.005 MMT
Established annual production	✓	✓	✓	✓	X	X	X
Feedstock currently exported	✓	✓	✓	✓	X	X	X
Commercial contracting available within Canada	✓	✓	✓	✓	X	X	X
Commercial contracting for future seed delivery possible	✓	✓	✓	✓	✓	✓	X
Crop insurance availability	✓	✓	N/A	✓	✓	✓	X
Ability to meet HEFA producer specifications9	Yes, with processing	Yes, with processing	Yes, with processing	Yes, with processing	Yes, with processing	Yes, with processing	Yes, with processing
Eligibility as renewable biomass (per US EPA) and/or sust. cert.	✓	✓	✓	✓	✓	✓	✓

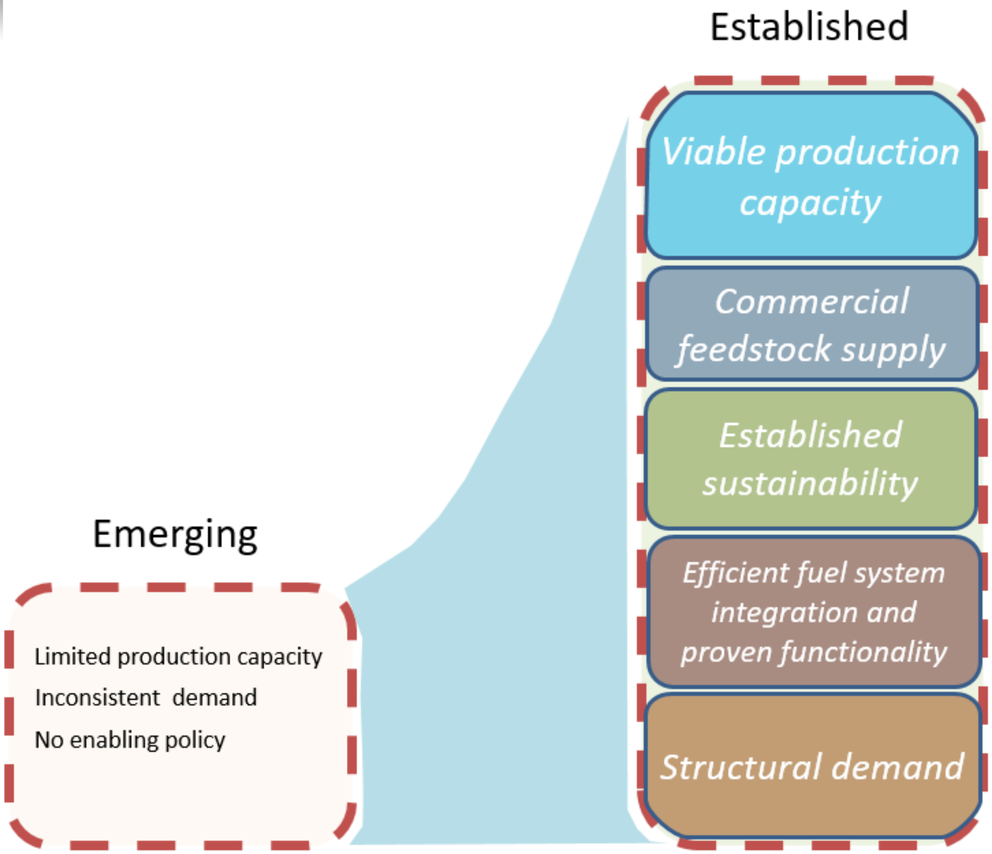






Available at biojet.ca

CBSCI makes concrete steps towards creating an established biojet sector in Canada by enabling fuel supply system integration and establishing functionality in the hydrant fuel system.

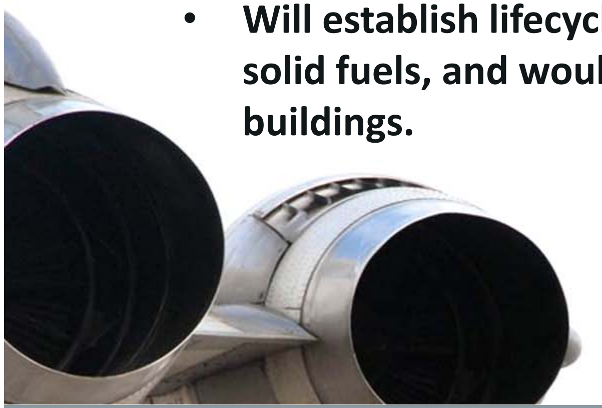


Clean Fuel Standard

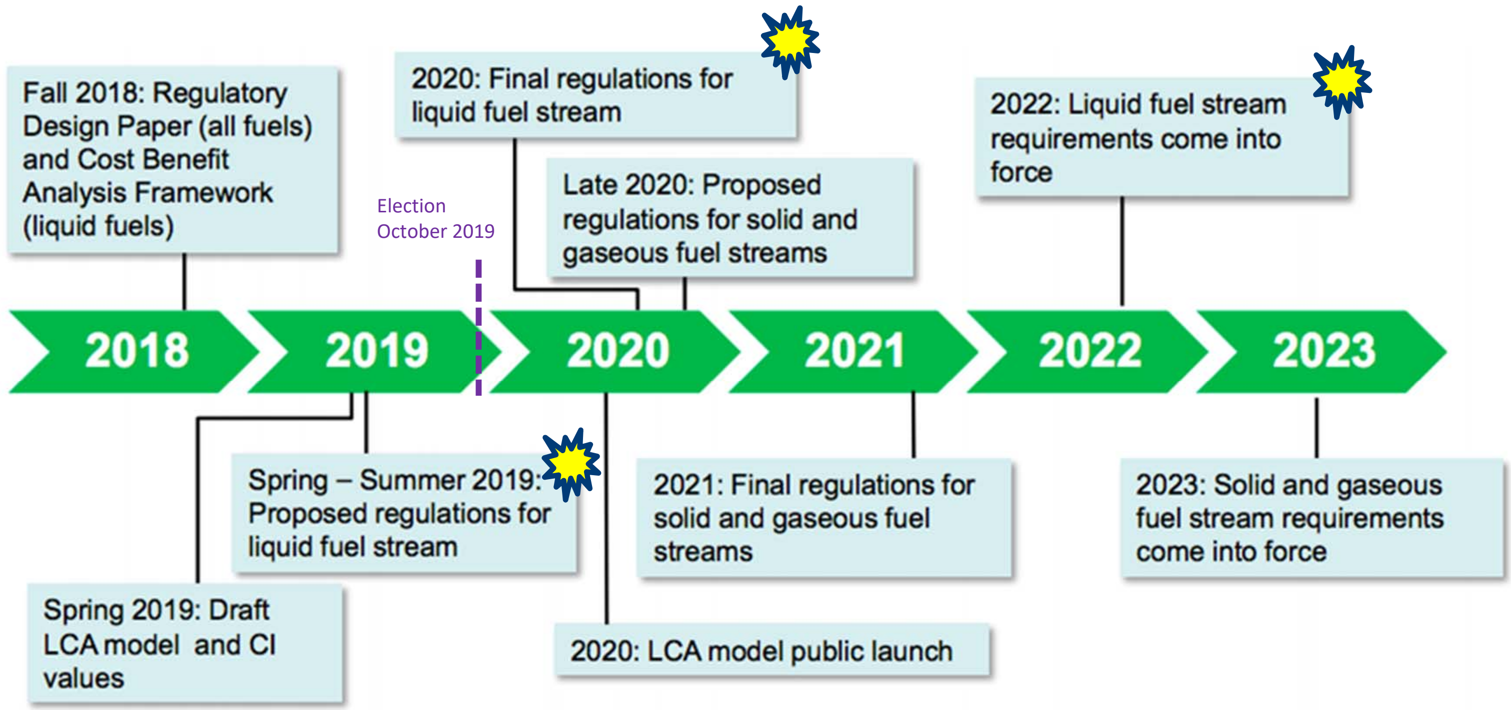
- **Performance-based approach to incent a broad range of low carbon fuels, energy sources and technologies, such as electricity, hydrogen, and renewable fuels, including renewable natural gas.**

- **The objective of the Clean Fuel Standard is to achieve 30 megatonnes of annual reductions in GHG emissions by 2030, with 23 MT from liquid fuels.**

- **Will establish lifecycle carbon intensity requirements separately for liquid, gaseous and solid fuels, and would go beyond transportation fuels to include those used in industry and buildings.**



Clean Fuel Standard: Current Timeline



Source: ECCC – July 19, 2018

Clean Fuel Standard: Aviation Fuels

Provisional approach to aviation fuels released October 2018

Environment and Climate Change Canada (ECCC) clarified that:

- Domestically used jet fuel would be included as part of the obligation for fossil fuel producers and importers
- International flights would be excluded, Avgas excluded

Compliance with CFS obtainable via:

- Low CI fuel blending in Gasoline/Diesel/Jet/HFO/LFO
- Through fuel switching (e.g., EV's, natural gas displacing a liquid fuel)
- Through use of emission reductions achieved in the fossil fuel supply chain

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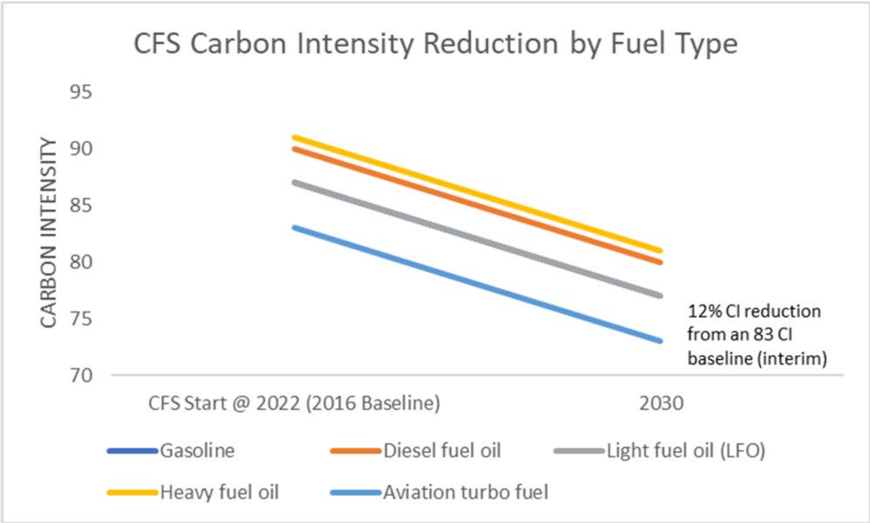
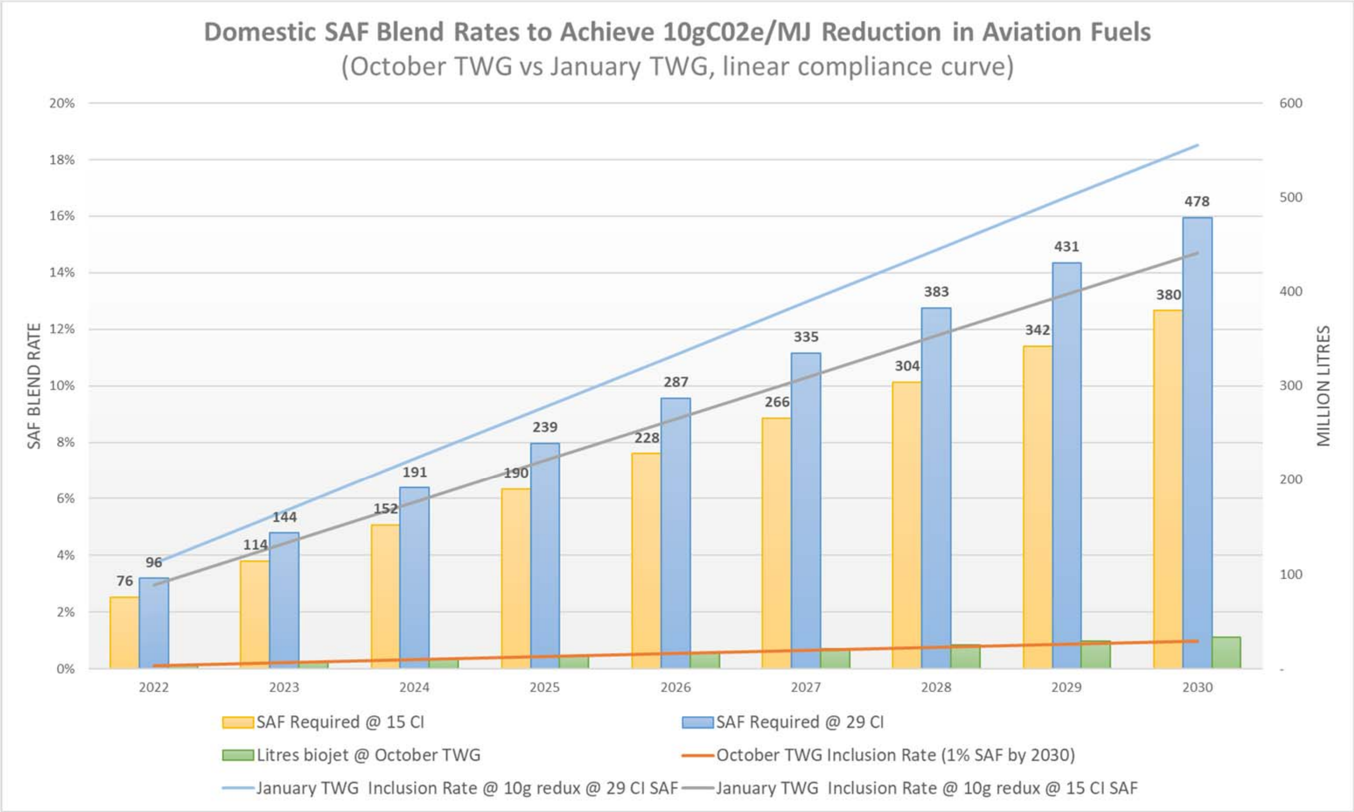
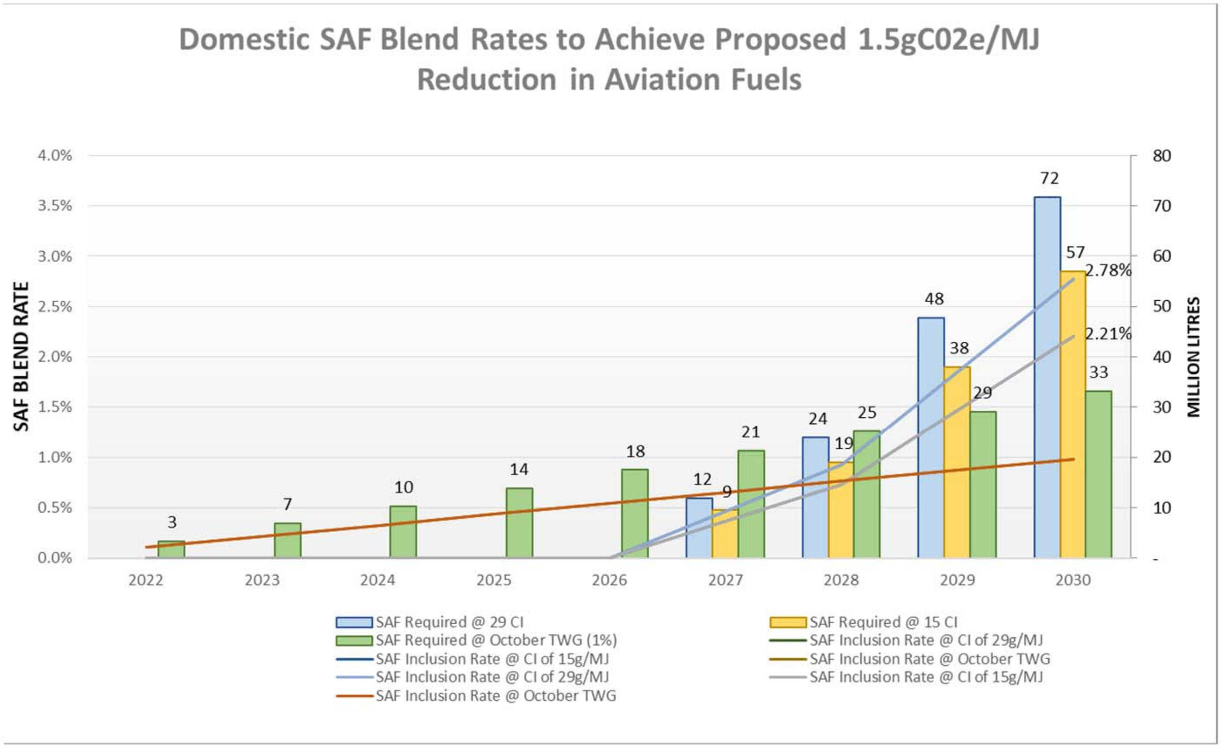
Clean Fuel Standard: Aviation Fuels

- January 2019 included significant update on CFS design thinking
- Jet fuel potentially same CI reduction obligation as all liquid fuels (~10g by 2030)
  - CFS structure does not require that jet CI reductions be achieved within jet fuel pool
- A multiplier approach being considered to incent SAF use, production
- Active engagement by industry:
  - Design that results in domestic SAF production and use, preserves competitiveness
  - Enables consistency with ICAO, SAF developments globally




Domestic SAF Blend Rates to Achieve 10gC02e/MJ Reduction in Aviation Fuels
(October TWG vs January TWG, linear compliance curve)
SAF BLEND RATE
MILLION LITRES
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
600
500
400
300
200
100
-
2022
2023
2024
2025
2026
2027
2028
2029
2030
76
96
114
144
152
191
190
239
228
287
266
335
304
383
342
431
380
478
SAF Required @ 15 CI
SAF Required @ 29 CI
Litres biojet @ October TWG
October TWG Inclusion Rate (1% SAF by 2030)
January TWG Inclusion Rate @ 10g redux @ 29 CI SAF
January TWG Inclusion Rate @ 10g redux @ 15 CI SAF



April 2019 Industry (National Airlines Council of Canada) proposed CI reduction target and resulting SAF blend rates.

CBSCI's Policy Report contains 27 specific recommendations for enabling SAF in Canada, among them:

ENABLING BIOJET VIA THE CLEAN FUEL STANDARD:

- Design the CFS so that biojet use creates compliance credits to positively enable blending economics.

- Allow a multiplier or 'factor' approach to CFS credit generation for biojet used in domestic aviation to address the higher production cost of biojet vs other renewable fuels and the nascent state of commercial biojet production.

- Align the fossil jet fuel carbon intensity value used in the CFS with ICAO's global value.

- Ensure Canadian feedstocks and production pathways will be recognized under CORSIA.

- Design the CFS to discourage fuels derived from feedstocks that negatively impact biodiversity, critical species habitats, and cause the conversion of land with high carbon stocks.

CARBON PRICING ON AVIATION FUELS:

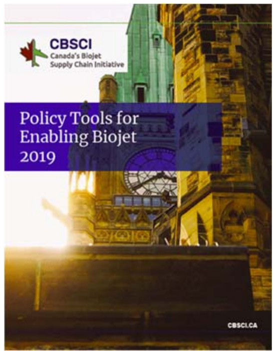
- Exempt biojet from the carbon charge under federal and provincial carbon pricing policies. *(Currently would pay as if fossil jet 5 cpl in federal system, 8 cpl in Alberta, 10 cpl in British Columbia)*

- Reassess the current patchwork approach to carbon pricing of aviation fuels.

- 'Recycle' (re-invest) any carbon charge revenues to support aviation sector decarbonization, including the use of biojet.

$$x_{hcs} = \frac{x_f + 2.6x_p}{PF}$$

x_{hcs} = share of expansion into land with high-carbon stock;
x_f = share of expansion into forest;
x_p = share of expansion into wetland, including peatland;
PF = productivity factor.



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