Sustainable Aviation Fuels: A Market Opportunity

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First flight from continuous commercial production of SAF, 10 March 2016

Fuel from World Energy - Paramount (HEFA-SPK 30/70 Blend).

Only facility offering continuous production of SAF at present.
Other batch production is occurring due to extreme customer interest.

CAAFI - Public/Private Partnership

A reflection of the 26+B usg U.S. Jet "market pull"

An aviation industry coalition established to facilitate and promote the introduction of alternative aviation fuel

Goal is development of non-petroleum, drop-in, jet fuel production with:

- *Equivalent safety & performance*
- *Comparable cost*
- *Environmental improvement*
- *Security of energy supply for aviation*

Synthetic jet fuels, primarily from renewable sources

Enables its diverse stakeholders to build relationships, share and collect data, identify resources, and direct research, development and deployment of alternative jet fuels

www.caafi.org

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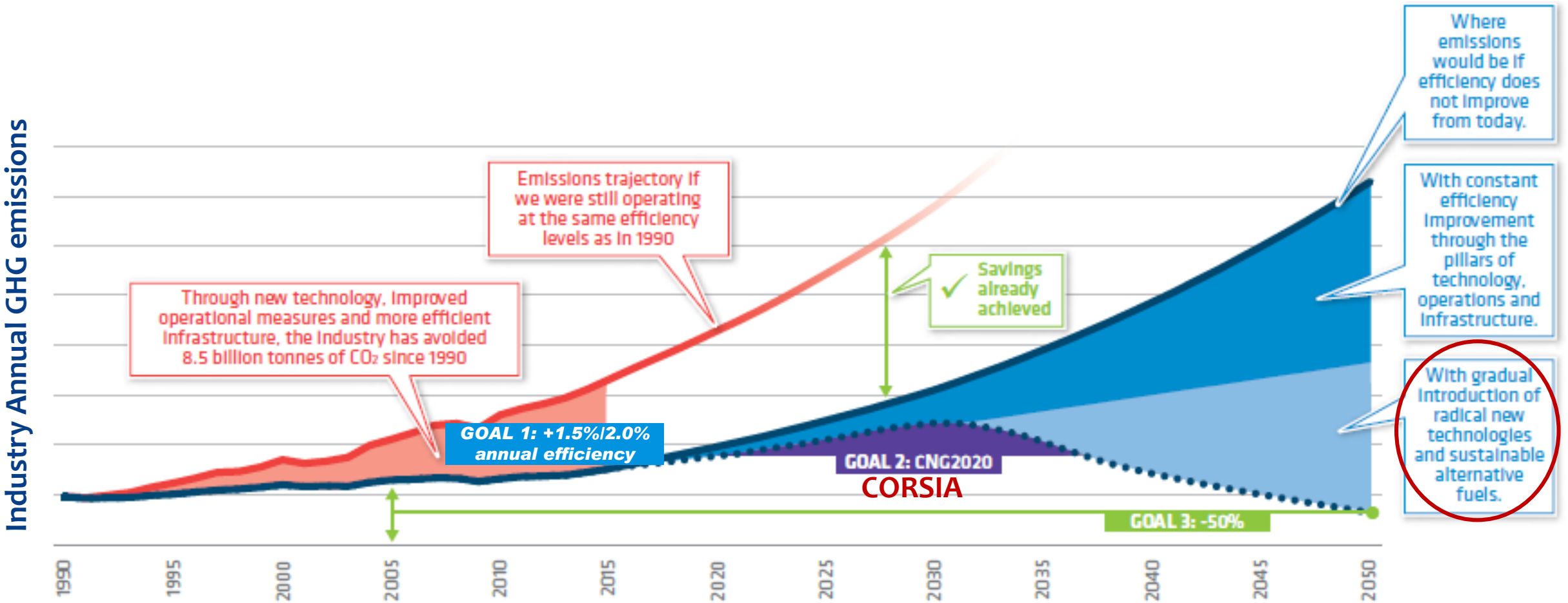
SAF a key component of the Technology Pillar; enabler for GHG containment strategy



Courtesy of ATAG: www.atag.org/our-publications/latest-publications.html
Beginner's Guide to Sustainable Aviation Fuel
Business Aviation made similar commitments

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SAF (Sustainable Aviation Fuel)
a.k.a. aviation biofuel, biojet, alternative aviation fuel

Aviation Fuel: Maintains the certification basis of today's aircraft and jet (gas turbine) engines by delivering the properties of ASTM D1655 – Aviation Turbine Fuel – enables drop-in approach – no changes to infrastructure or equipment, obviating incremental billions of dollars of investment

Sustainable: Doing so while taking Social, Economic, and Environmental progress into account, especially addressing GHG reduction

How: Creating synthetic jet fuel with biochemical and thermochemical processes by starting with a different set of carbon molecules than petroleum … a synthetic comprised of molecules essentially identical to petroleum-based jet (in whole or in part)

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SAF Progress - Technical

* SAF are becoming increasingly technically viable
  * Aviation now knows we can utilize numerous production pathways
    (7 approved, 6 in-process, >15 in pipeline)
  * Enabling use of all major sustainable feedstocks
    (lipids, sugars, lignocellulose, hydrogen & carbon sources, circular-economy byproduct streams)
  * Utilizing thermo-chemical and bio-chemical conversion processes to produce pure hydrocarbons, followed by standard refinery processes
  * Following blending with petro-jet, SAF is drop-in, indistinguishable from petro-jet
  * Some future pathways expected to produce SAF blending components that will need less, or zero, blending
  * Expanding exploration of renewable crude co-processing with refineries
  * Continuing streamlining of qualification – time, $, methods

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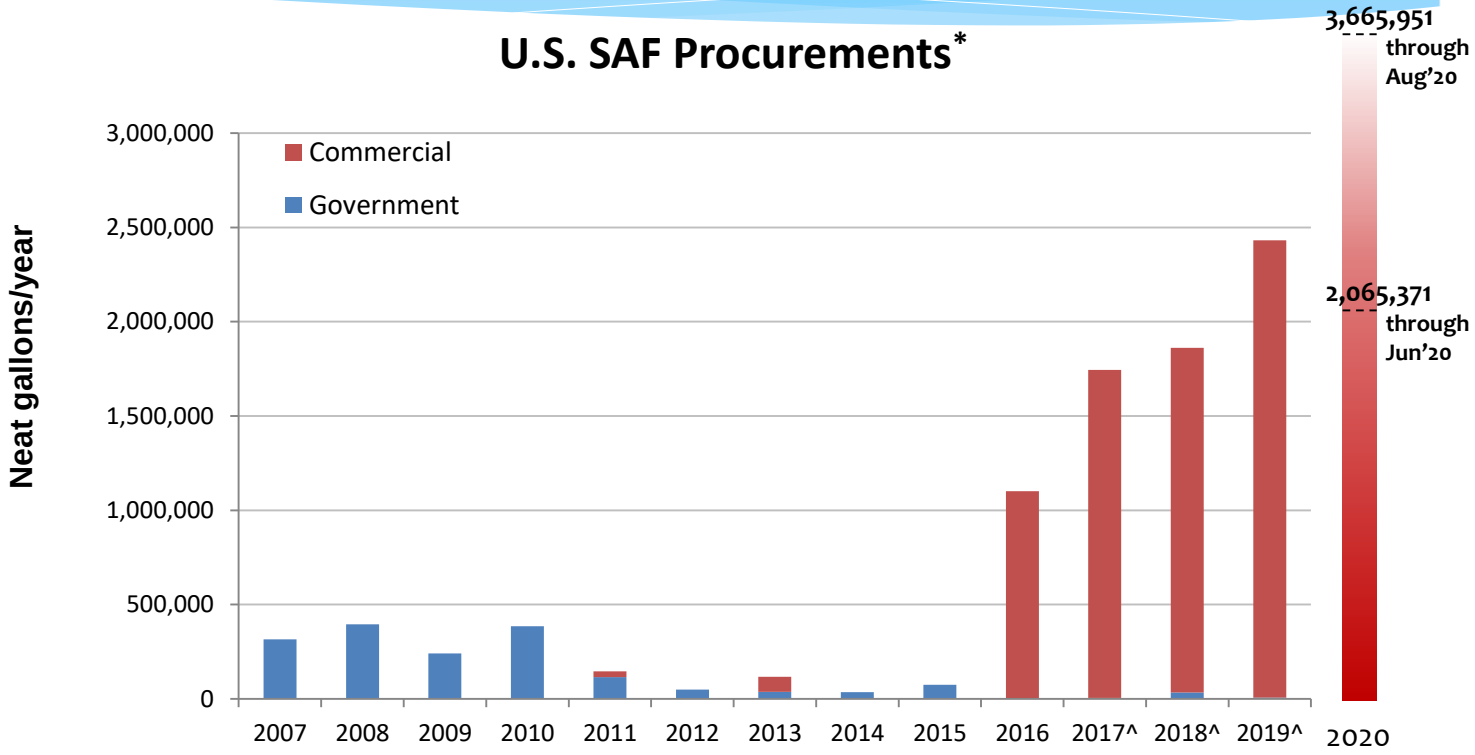
Where we stand on U.S. SAF consumption
Initiation under way, still early

- Four years of sustained commercial use
- Commercial & General Aviation engaged
- Two facilities in operation
- Two facilities under construction, others in development
- Cost delta still a challenge, with policies favoring renewable diesel
- In spite of that … we still have $6.5 B in airline offtake commitments for >350M gpy … with more in development



Credit: FAA

*Reflects voluntarily reported data on use by U.S. airlines, U.S. government, manufacturers, other fuel users, and foreign carriers uplifting at U.S. airports.
^2017-2019 calculation includes reported EPA RFS2 RINs for jet fuel.

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Worldwide SAF production capacity forecast

Announced intentions*

* Not comprehensive; CAAFI estimates (based on technology used & public reports) where production slates are not specified

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SAF offtake agreements
Beyond numerous demonstration programs

world energy
Paramount *

- Initial 40M gpy nameplate facility
  With 25M gpy SAF capacity

neat quantities

UNITED → Up to 5 M gpy from 2016 (LAX)

World Fuel Services + Gulfstream → Second 5-year agreement from 2020, 30/70 blend

Shell + amazon Prime Air → 1.8M g over 12 months

SkyNRG NORDIC + AIRFRANCE + FINNAIR + KLM → Misc Flights, e.g. SFO

air bp + SAS + OSLO AIRPORT + Shell + Lufthansa Group → Bioports on demand, et al.

- Halmstad
- Arlanda
- Bromma
- Goteborg
- Leeuwarden

VISTAJET

* 24Oct'18: Moving forward with $350M Paramount expansion to enable 306M gpy total capacity & jet capacity of 150M gpy; Fuel production expected by YE'22

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SAF offtake agreements – pg 2

Beyond numerous demonstration programs

NESTE

Porvoo *

- Initial 34M gpy capacity

+ air bp =

SAS AIRBUS

Lufthansa

KLM

ZURICH AIRPORT

FINNAIR

Emirates

Alaska

jetBlue American Airlines

+ Signature FLIGHT SUPPORT NETJETS® =

Neat quantities not announced

Porvoo SAF Q4'18 restart supplied to:

Swedish Airports - SAS;

Mobile, Hamburg – Airbus;

Frankfort – Lufthansa;

Amsterdam – KLM;

Zurich – WEF;

Helsinki – Finnair;

Stockholm – Emirates, Swedavia;

SFO - American, Alaska, and JetBlue

SFO, London – Signature FBO

* Moving forward with significant expansion at Singapore and feasibility study at Rotterdam to enable ~480M gpy by 2023

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SAF offtake agreements – pg 3

Beyond numerous demonstration programs

gevo *

* 3-4 facilities, utilizing ethanol conversion bolt-on approach

neat quantities

+ AVFUEL / AIR TOTAL = Up to 1M gpy, 5 yrs+ / France & EU supply;

+ AVFUEL ATLANTIC ACIJET = Various Business Aviation airports FBOs

+ SAS VIVA Energy Australia Queensland Government =

+ DELTA =

+ TRAFIGURA = Unspecified SAF distribution rights

10M gpy, from 2022/2023 term/blend unspecified

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SAF offtake agreements – pg 4

Beyond numerous demonstration programs

* Per statements made at ABLC 2020
  - #2 Gary, IN @ 3x capacity
  - Then replication in Houston, UK, WA state, CA state, Australia
- Additional sites aligned with investor airlines' US focal cities previously discussed

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SAF offtake agreements – pg 5

Beyond numerous demonstration programs

RED ROCK BIOFUELS + Southwest = 3 M gpy each, 7 yrs (Bay Area, CA)

RED ROCK BIOFUELS + FedEx =

SG Preston + jetBlue = 10M gpy, 10 yrs (JFK)

SG Preston + QANTAS = 4M gpy, 10 yrs (LAX)

SkyNRG NORDIC + KLM = 24M gpy, 10 yrs

SkyNRG NORDIC + Shell = SAF Supply collaboration

LanzaTech * + ANA + Suncor + Mitsui & Co. = Freedom Pines, supply from 2022, 10M gpy nameplate

LANZAJET + virgin atlantic = UK DfT F4C Funding: ATJ Development

neat quantities

* 100M gpy by 2024 from 4 facilities

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SAF offtake agreements – pg 6

Beyond numerous demonstration programs

neat quantities

preem	Gothenburg Refinery	+ SAS	=	Long-term supply negotiation (from 2023). Fueling all domestic flights by 2030.
SAF+ CONSORTIUM		+ Air transat	=	Detail tbd; Montreal East pilot facility approaching completion

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Airline commitments of greater ambition

FedEx

Obtain 30% of jet fuel from alternative sources by 2030; 06Nov'17

UNITED

First U.S. Airline to Pledge to Reduce Own Emissions by 50% (vs. 2005) by 2050; 13Sep'18. $40M SAF Investment Fund; 27Oct'19

SpiceJet

Commits to flying 100 M passengers on SAF by 2030; 23Sep'19

AIRFRANCE

Horizon 2030: offset 100% of domestic CO2 from 2020; reduce 2030's CO2/pax-km by 50% from 2005; R&D for French SAF industry; 01Oct'19

IAG INTERNATIONAL AIRLINES GROUP

Net-zero carbon by 2050, offsetting all domestic emissions by 2020; 10Oct'19

oneworld

NZC'50

QANTAS

Net-zero carbon by 2050, CNG from 2020 on all emissions, $33M investment in SAF by 2030, matching of customer offsets; 25Nov'19

FINNAIR

Reduce its net emissions by 50% from 2019 by the end of 2025, and achieve carbon neutrality by 2045 at the latest; 09Mar'20

SAS

SAF corresponding to the total jet consumption used in all SAS domestic flights, by the year 2030; 14Nov'19

amazon Prime Air

Net Zero by 2040, and 100% renewable operations by 2025

norwegian

Improve carbon efficiency by 45% by 2030 (16-28% SAF usage, or up to 500M liters)

Multiple airlines now committing to net zero carbon by 2050 (NZC'50).
Pressure to look at more progress by 2035.

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Commitments of Greater Ambition

Airlines using passenger booking options to offset cost

BRA BRAATHENS REGIONAL AIRLINES

Customer option to pay for incremental price of SAF of €29.50 on any flight

SAS

Customer option to pay for incremental price of SAF in 20-min blocks of flight time for €10 / block (up to 80% CO_2 reductions); fuel being allocated to future flights

Lufthansa

SWISS

Compensaid – calculates specific cost of SAF for specific flights and enables customer to pay for incremental price
On select flights, CHF80 to offset carbon, 5% of which goes to SAF via Compensaid

FINNAIR

Customer option to pay for incremental price of SAF for 3 categories of flight: intra-Finland (€10), intra-EU (€20), International (€65); fuel being allocated to future flights

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Other commitments of greater ambition

Norway's government introduces 0.5 % blending mandate for advanced aviation biofuels from 2020; 04Oct'18

Netherlands committed to transition all military aircraft to 20/80 AJF blend by 2030 and 70% by 2050; 23Jan'19

France, in alignment with EU Green Deal goals, announces SAF targets: 2% of SAF from 2025, 5% in 2030 and 50% in 2050; 27Jan'20

DG Move have now put together a comprehensive "roadmap" as a potential way forward for an integrated approach for policy intending to foster SAF commercialization in the European Union - ReFuelEU

Sweden's government introduces GHG reduction mandate for jet fuel, from -0.8% in 2021 to -27% in 2030; Fossil free by 2045; 11Sep'20

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SAF progress – Significant commercial pull !

* First facilities on-line, producing SAF at various run-rates
* Commercial agreements being pursued, fostered by policy and other unique approaches
* Line of sight to first billion gallons, but reflecting only 1% of market need
* Making progress, but still significant challenges – only modest production: focus on enabling commercial viability
* Potential for acceleration a function of engagement, offtakes, first facilities' success replication, policy, …
* … and additional technologies that lower production cost, lower capital, enable byproduct revenue

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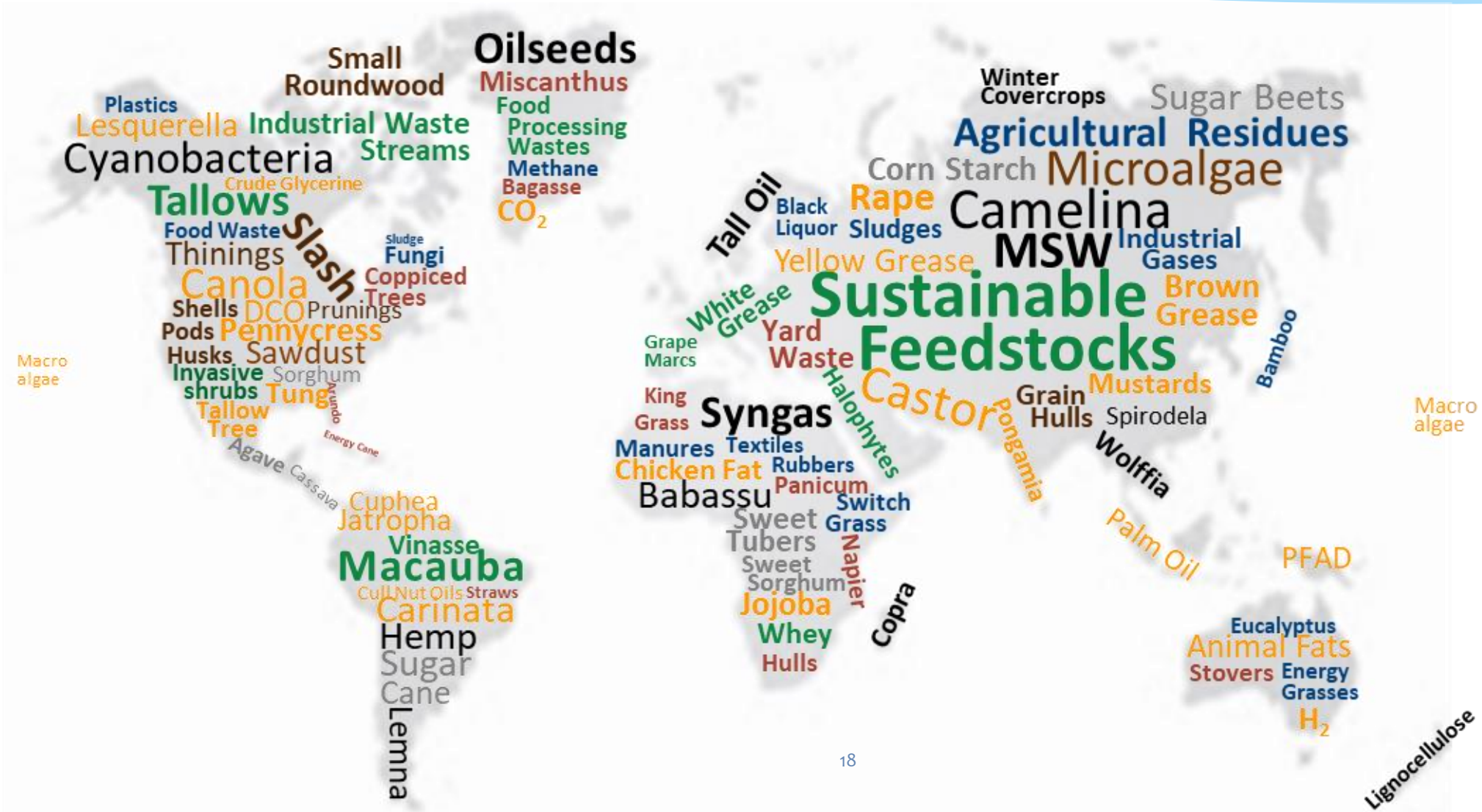
SAF: from a diverse set of world-wide feedstocks

Wastes, residues, purpose grown, circular-economy byproducts



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Thank You

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