

SAJF Commercialization Progress Overview

MN Working Lands Meeting

Discussion Session:

Markets for innovative oil seed crops

- Overview of perspectives from CAAFI and Aviation

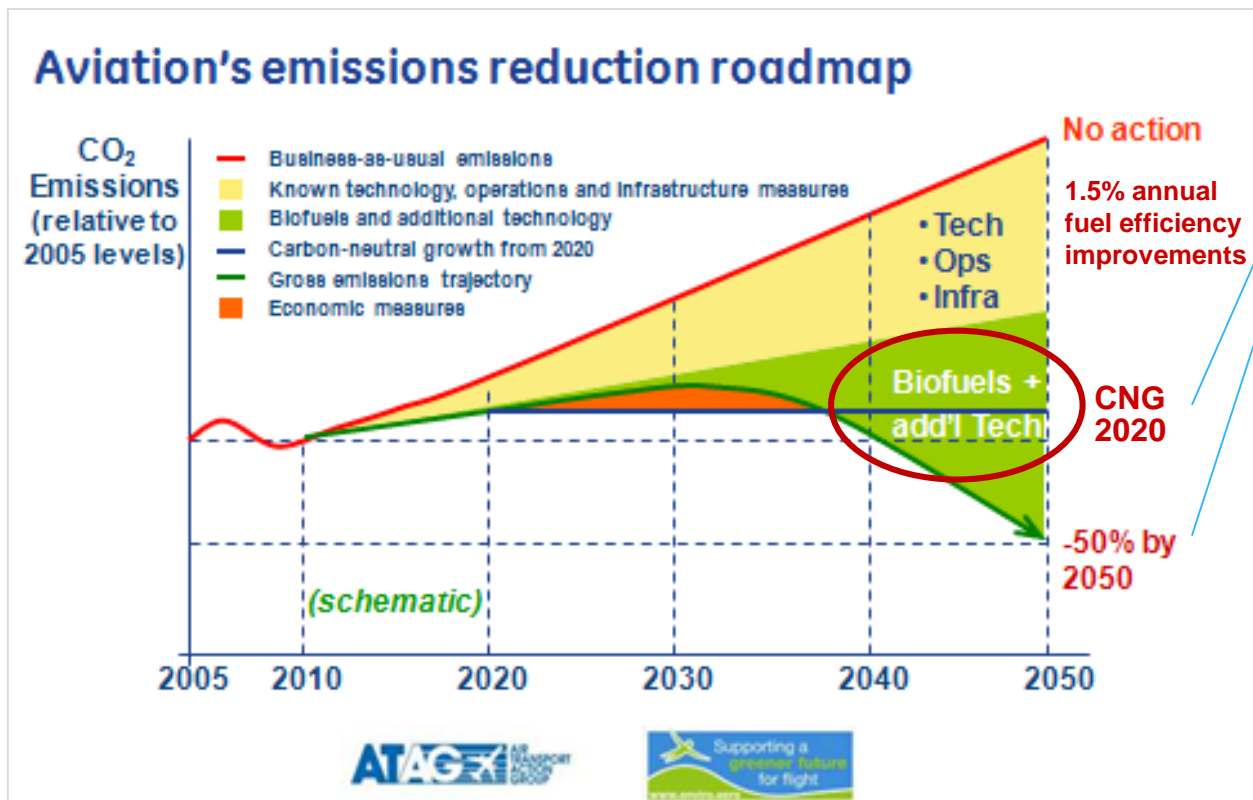
Steve Csonka, Executive Director, CAAFI



Commercial Aviation's CO₂ commitments

To decouple carbon growth from demand growth

Biofuels a key component of GHG containment strategy



These 3 industry commitments are currently being converted into regulation through an ICAO/CAEP “basket of measures”:

- * CO₂ Standards
 - * MBMs – will monetize carbon
- Similar commitment from BizAv & DOD

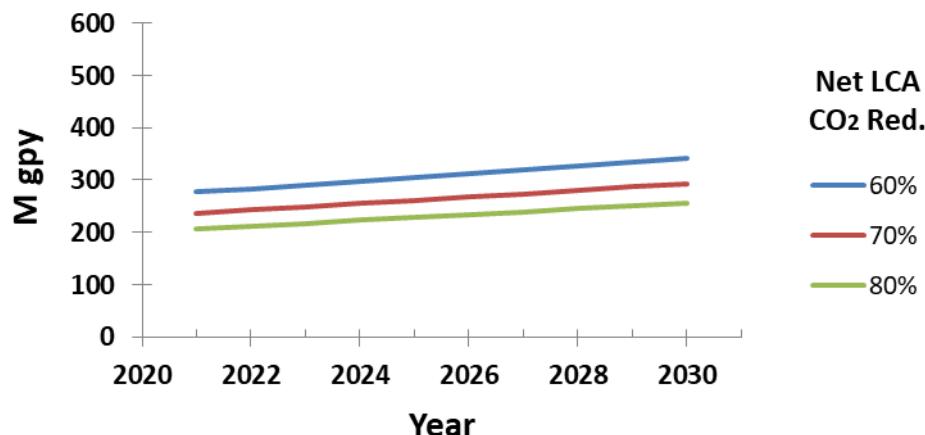
How much SAJF is needed (USA)?

Total US jet fuel supply (satisfying all uses: Com'l, DoD, BizAv, GA):

- * 2016: 1.61 M bpd = 24.814 B gpy (Worldwide >87 B gpy)
- * 2017: trending at 1.65 M bpd (+2.5%)

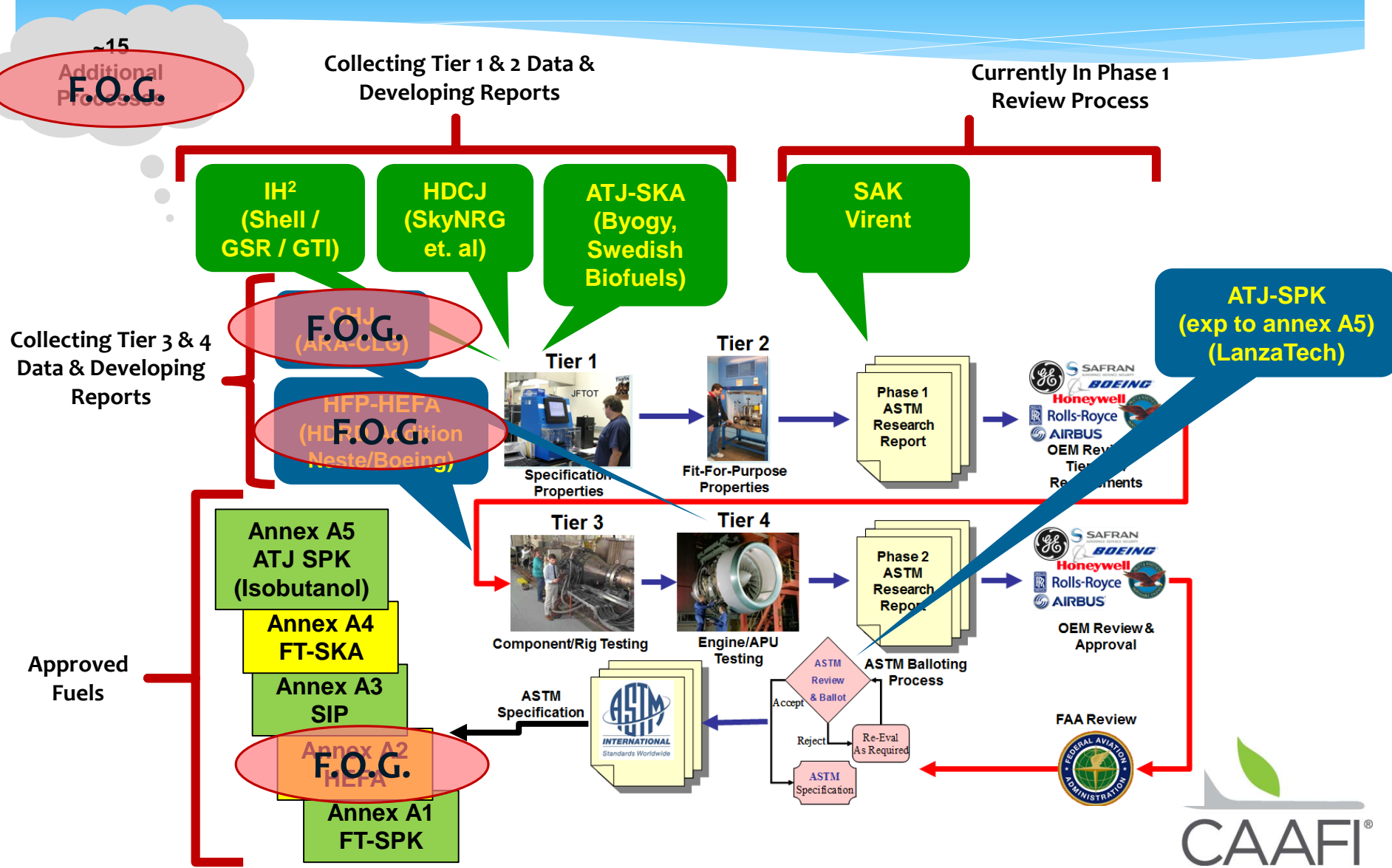
CAAFI Bogey set by implementation targets of CNG2020 (CORSA)

CAAFI SAJF Production Bogeys
Potential Offset Obligation



- * The offsetting of growth in International operations could result in targeting **annual, incremental production of 200-400 M gpy of neat SAJF**
- * Volume can change significantly with assumptions, as well as demand from International carriers for US uplift

SAJF qualification status



Select “additional processes”

Targeted for additional cost reductions

Approach	Feedstock	Notes
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- | | | | |
|-------|---------------------------|---------------------------|-----------------------------------|
| D7566 | 1) IHI: HD HCs | HC from other bio-sources | |
| | 2) SBI: CGC PICFTR | F.O.G. - biodiesel | Shell partnership ¹ |
| | 3) Forge: Thermal Deoxyg. | F.O.G. | Demo plant being built in Ontario |
| | 4) Tyton: CCL | F.O.G. | |

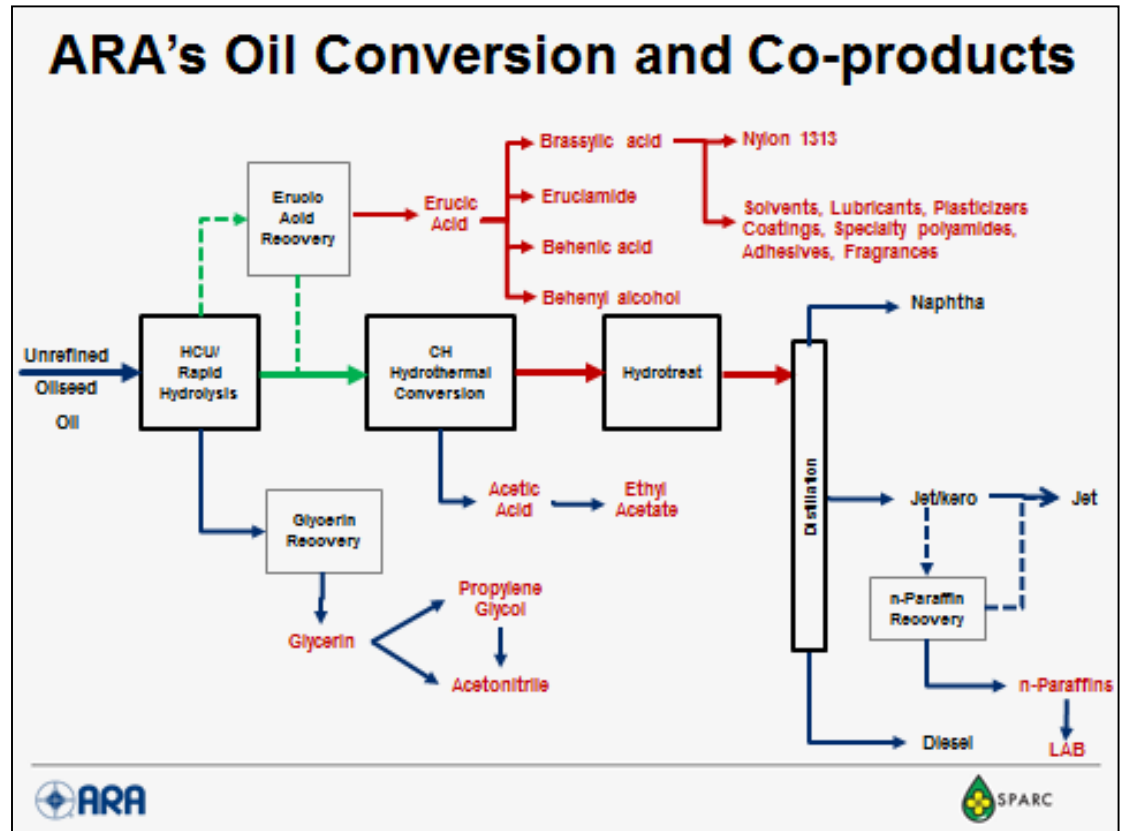
... 11+ more using various other feedstocks and conversion processes

- | | | | |
|-------|--|-----------------|-------------------------|
| D1655 | 1) Co-processing | F.O.G. | Chevron, BP, Phillips66 |
| | * Successfully balloted. Sets the stage for other entities to follow, by sending biocrude to the refineries for finishing, e.g.: | | |
| | 2) Co-processing | Biocrude | Fulcrum |

1 This now gives Shell a footprint with cellulose (IH2), sugars (Virent), and F.O.G.

Conversion-cost-focus is only part of need

- * Techno-economic assessments don't address total value
- * Expectation that viability will be enabled via other revenue (feed / proteins), other services, and integration with existing facilities and industries



SAJF offtake agreements

Beyond numerous demonstration programs

neat quantities



SAJF offtake agreements

Beyond numerous demonstration programs

neat quantities



Southwest



3 M gpy each, 7 yrs
(Bay Area, CA)



FedEx



CATHAY PACIFIC



A350 deliveries
10% blend (ex-TLS)



10M gpy, 10 yrs (JFK)



4M gpy, 10 yrs (LAX)

DG Energy



0.5M gpy, 10 yrs

*These offtakes/efforts represent >250 M gpy,
and account for the total production slate of
the first several commercialization efforts*

Other recent announcements

effort



MOU



Brisbane Supply Demonstration



MSW-based FT-SPK evaluations



In negotiation



BTL #1, Natchez, MS
1,400 bpd



HFP-HEFA collaboration



Carinata supply development

Multiple Producers
TBA (1/1/4+)



Full production slate
offtakes

Commercialization in-development

Renewable Diesel & Jet **from F.O.G.**

- * Emerald (DPA recipient, HDRD focus)
- * AltAir build-out (3-5X)
- * Diamond Green (expansion underway)
- * SG Preston (duplicate facility plan)
- * ARA licensing build-out (multiple efforts)
- * UOP licensing - new / refinery retrofit
- * Neste, REG, UPM, ... potential pivots to HDRD / HEFA
- * Unlocking of renewable diesel and refinery co-processing

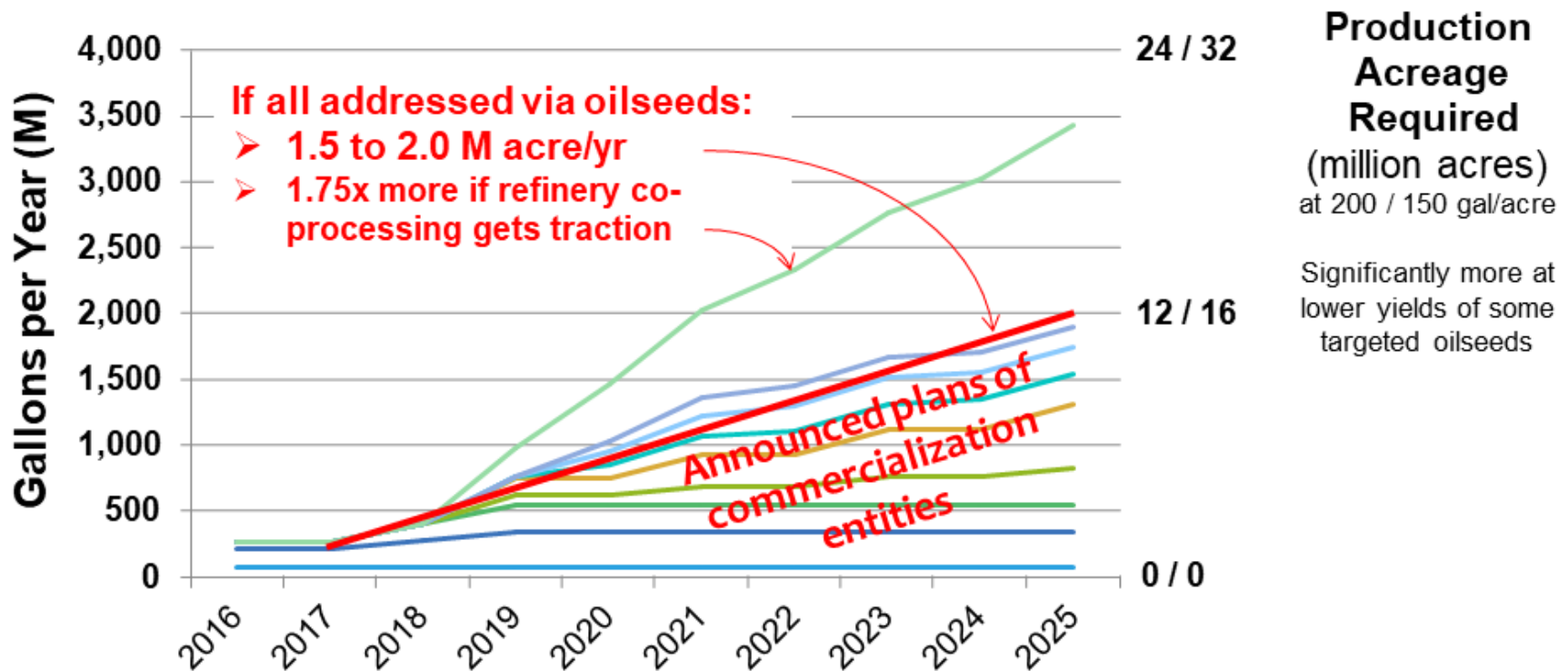
**Greater than 1B
GPY capacity by
2021 !?!**

**... necessitates
serious engagement
with purpose grown
oilseed & FOG
development /
expansion**

Commercialization intent - F.O.G.

“Declared” nameplate capacities: significant opp’ty

HDRD and SAJF Capacity Outlook



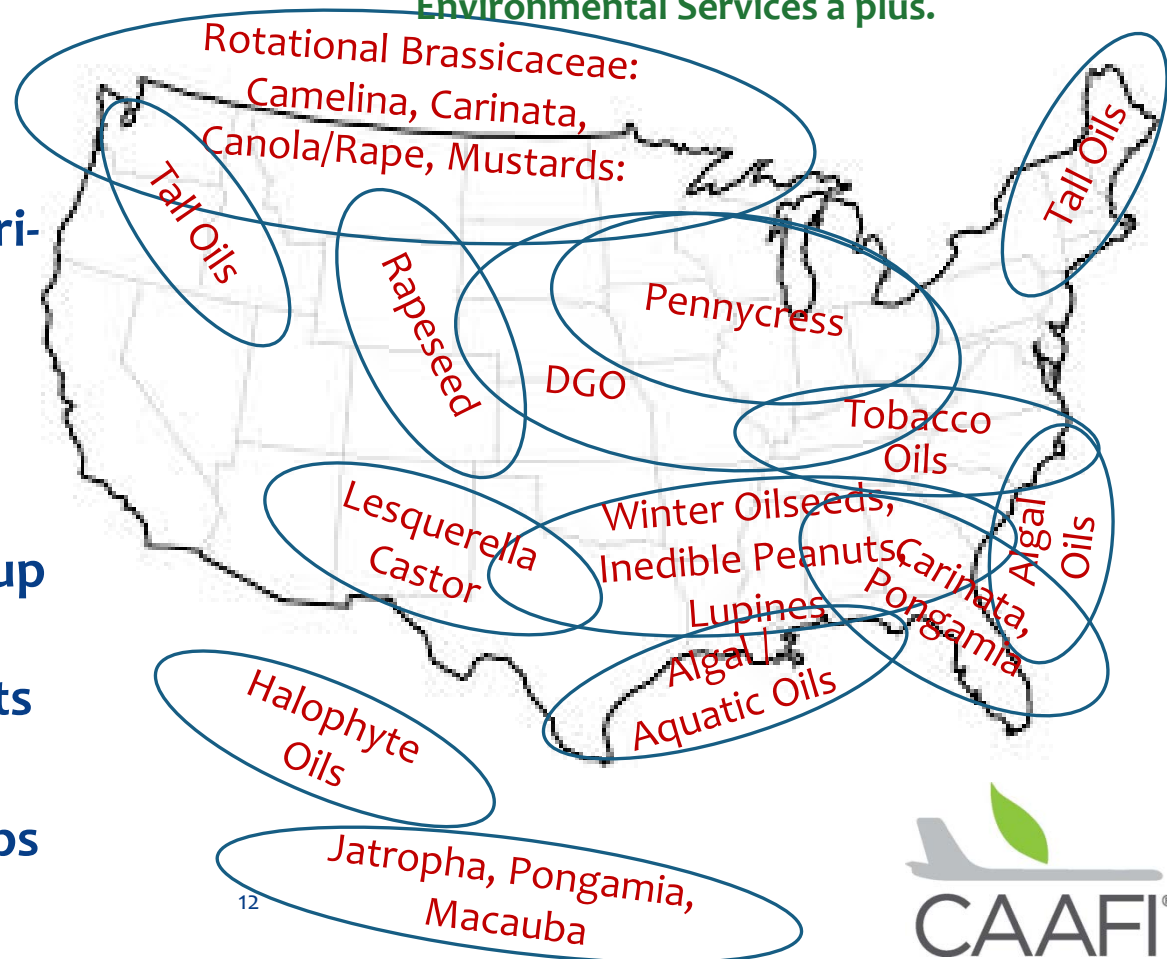
Ignores 0.5B gpy additional expected biodiesel production!

Lipid feedstocks

Potentially enabling of significant production ...

- * Multiple conversion processes (3+ 3 additional)
- * Multiple feedstock developers
- * Multiple producers
- * Multiple low LUC/ILUC agri-based feedstocks, **plus:**
 - * White Grease, Poultry Fat, Tallow
 - * UCO / Yellow Grease
 - * Brown Grease, Biosolids
- * Easier supply chain scale-up leveraging biodiesel and HDRD production concepts
- * Lowered H₂ cost & availability (from NG) helps

Targeting most sustainable solutions:
Low, or Zero, impact LUC/ILUC & F-v-F solutions;
Environmental Services a plus.

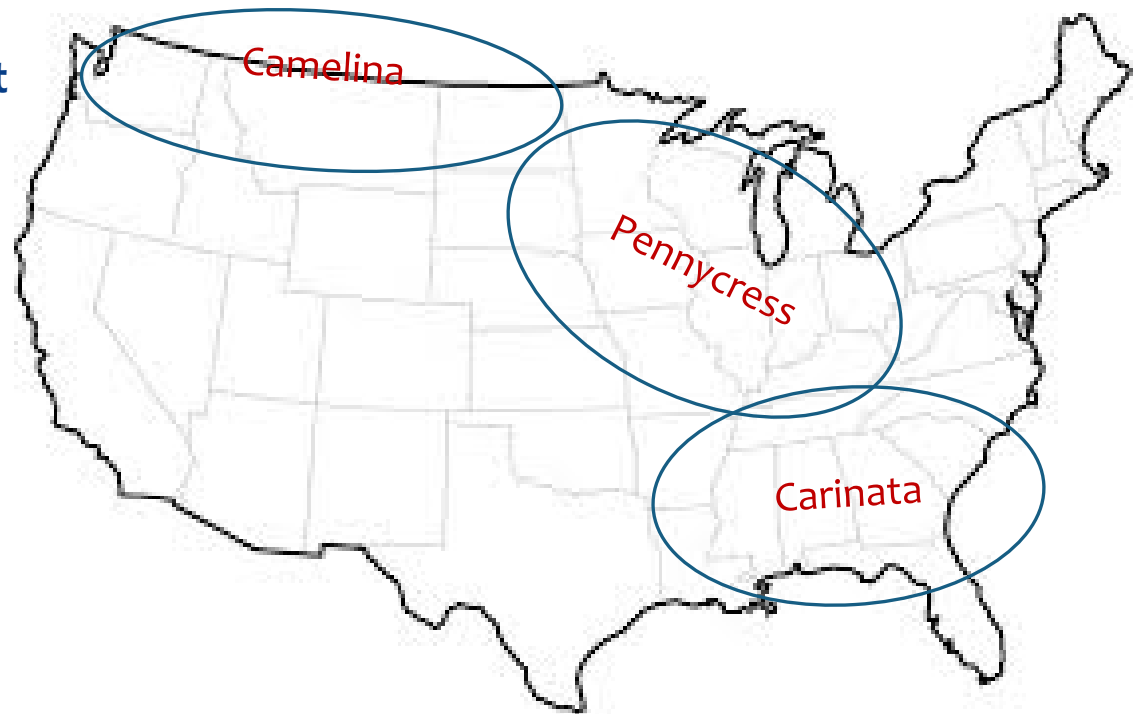


Winter “cover” oilseeds

Huge production potential without ILUC...

- * Carinata below freeze line
 - * 12-20 M acres
- * Pennycress above freeze line, in regions with sufficient precipitation
 - * 40+ M acres
- * Camelina above freeze line, perhaps targeted at lower precip regions
- * **All need further varietal and agronomic development**

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2018 CBGM, Washington DC, 04-06Dec

In conjunction with:

ASCENT Yr 5 Symposium

NJFCP YE meeting

State Initiative Stakeholders Forum



FUELING SOLUTIONS FOR
SECURE & SUSTAINABLE AVIATION

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