SAJF Marketplace Observations
Capitalizing on carinata opportunities and overcoming hurdles

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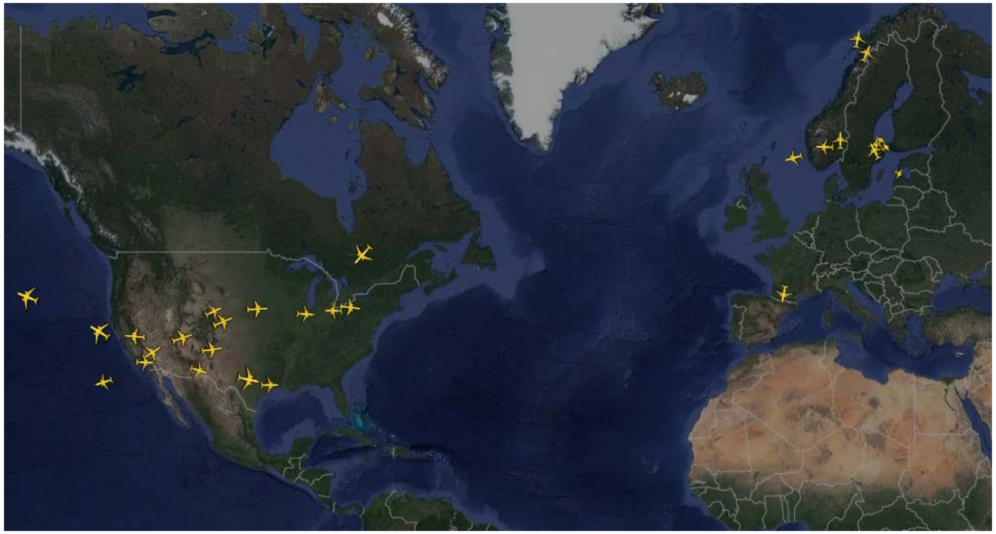

At any given moment, SAJF is being uploaded from 4 airports worldwide, being supplied on a regular basis by AltAir and others. See: https://www.icao.int/environmental-protection/GFAAF/Pages/default.aspx

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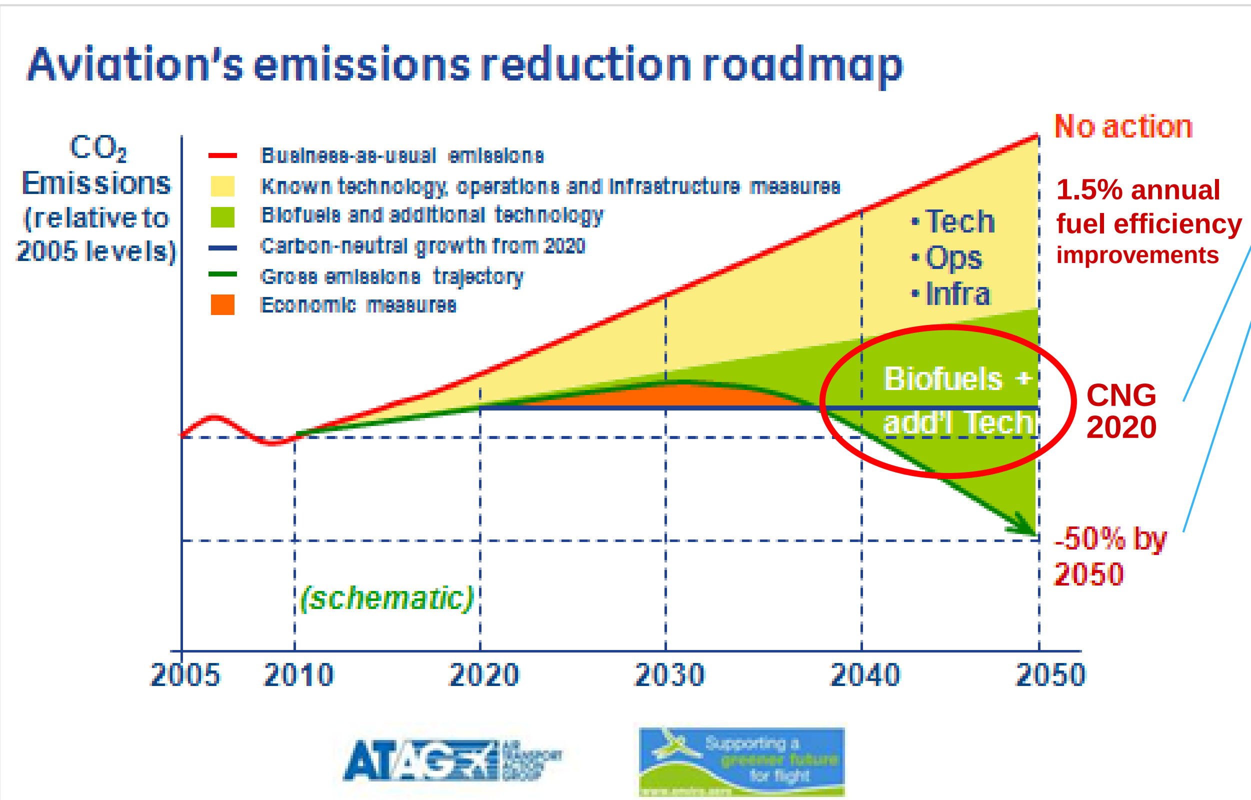
COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE

29Mar'17

Commercial Aviation's CO2 commitments
To decouple carbon growth from demand growth

Biofuels a key component of GHG containment strategy



These 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

Aviation still a committed offtaker

- Greater than 250M gpy already committed!
  - Several initial SAJF facilities “sold-out”
  - Commercial aviation willing to offer long-term contracting for SAJF supply
- More agreements to be announced by YE
- Interest in more - Additional new efforts initiating
- Foreign carriers also now looking for US supply
- CNG 2020 codified in international agreement, ICAO (CORSIA)
  - SAJF usage will reduce an airline’s CNG2020 obligation

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SAJF offtake agreements

Beyond numerous demonstration programs

neat quantities

Up to 5 M gpy
from 2016 (LAX)

3 yr agreement
30/70 blend

3 yr agreement
Enabling LAX flts

Bioports
on demand

Halmstad
Arlanda
Bromma
Goteborg

1% of GVA supply

37.5M gpy

90-180 M gpy

50 M gpy

10 yr
agreements

* AltAir also continues supplying fuel for multiple trial and research activities

SAJF offtake agreements

Beyond numerous demonstration programs

				neat quantities
RED ROCK BIOFUELS	+	Southwest	=	3 M gpy each, 7 yrs (Bay Area, CA)
	+	FedEx	=	
TOTAL | AMYRIS	+	CATHAY PACIFIC / CHINA AIRLINES	=	A350 deliveries 10% blend (ex-TLS)
SG Preston	+	jetBlue	=	10M gpy, 10 yrs (JFK)
	+	QANTAS	=	4M gpy, 10 yrs (LAX)
DG Energy	+	GE Aviation	=	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

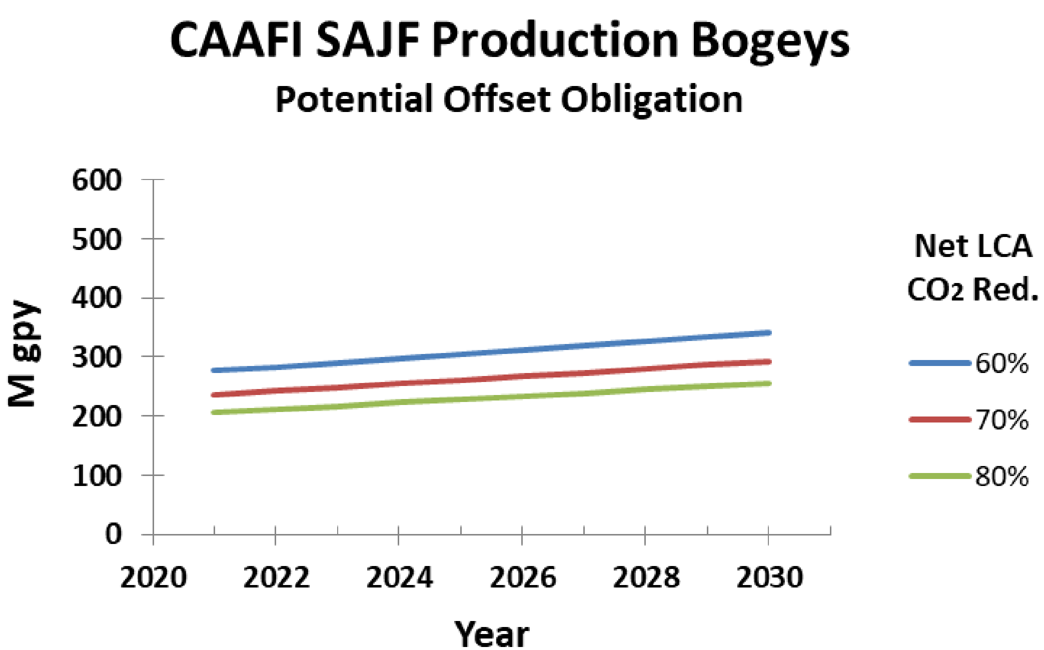
				effort
gevo	+	Lufthansa	=	MOU
	+	Virgin australia	=	Brisbane Supply Demonstration
VELOCYS	+	BRITISH AIRWAYS	=	MSW-based FT-SPK evaluations
	+	In negotiation	=	BTL #1, Natchez, MS 1,400 bpd
neste	+	American Airlines	=	HFP-HEFA collaboration
AGRISOMA	+	QANTAS	=	Carinata supply development
Multiple Producers TBA (1/1/4+)	+	World Fuel Services	=	Full production slate offtakes

How much SAJF is needed (USA)?

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

* 2017: 1.65 M bpd (+2.5%) (Worldwide >87 B gpy)

CAAFI Bogey set by implementation targets of CNG2020 (CORSIA)



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

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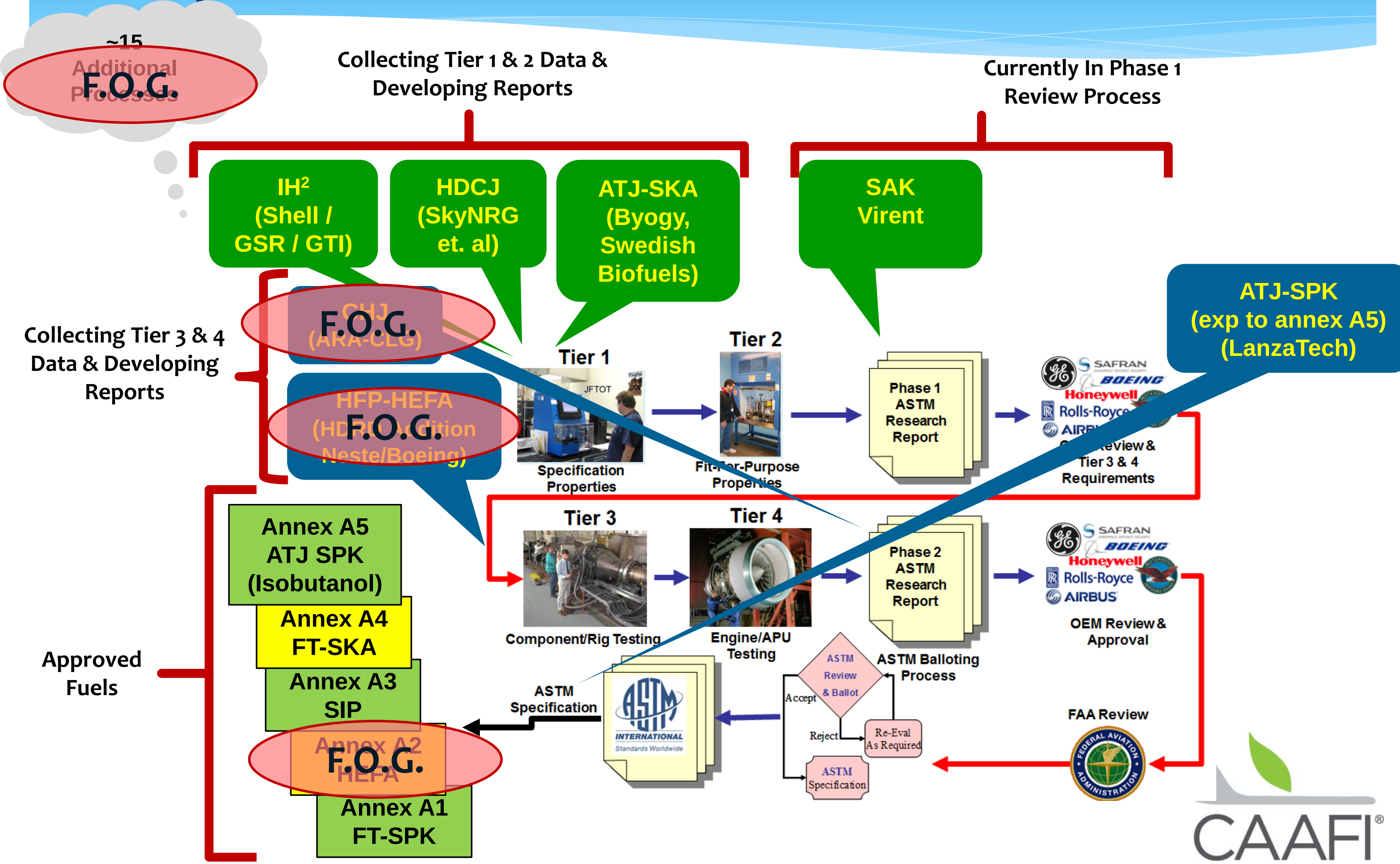
We know how to make SAJF

SAJF qualification status



Select "additional processes"

Targeted for additional cost reductions

	Approach	Feedstock	Notes
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.

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

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Challenge: Achieving price point

- Not a trivial challenge with:
  - Competitive crude at <$60/bbl = $1.80/gal Jet Fuel
  - Benchmark soy oil at >$0.30/lb = $2.19/gal as feedstock
- However, policy support may still be enabling
  - RFS2 RINS
  - LCFS (to include SAJF from start of 2019)
  - Federal Tax Policy
  - CORSIA monetization
  - State Incentives

  Can result in incentives of $2-$3 / usg
- CNG 2020 codified in international agreement at ICAO (CORSIA)
  - SAJF usage will reduce any airlines CNG2020 obligation
  - Otherwise, they need to offset any usage above baseline level

Challenge: Oilseed sustainability

* NGO's / EU pushing back on purpose-grown feedstocks generally, and oilseeds specifically. Issues include:
  * Concerns over land-use-change (LUC/ILUC)
    * Deforestation – blocking consideration of palm oil
    * Food versus Fuel
  * Uninformed views: of use of marginal soils and concepts of dual cropping or winter covers
* Carinata development may address these challenges!

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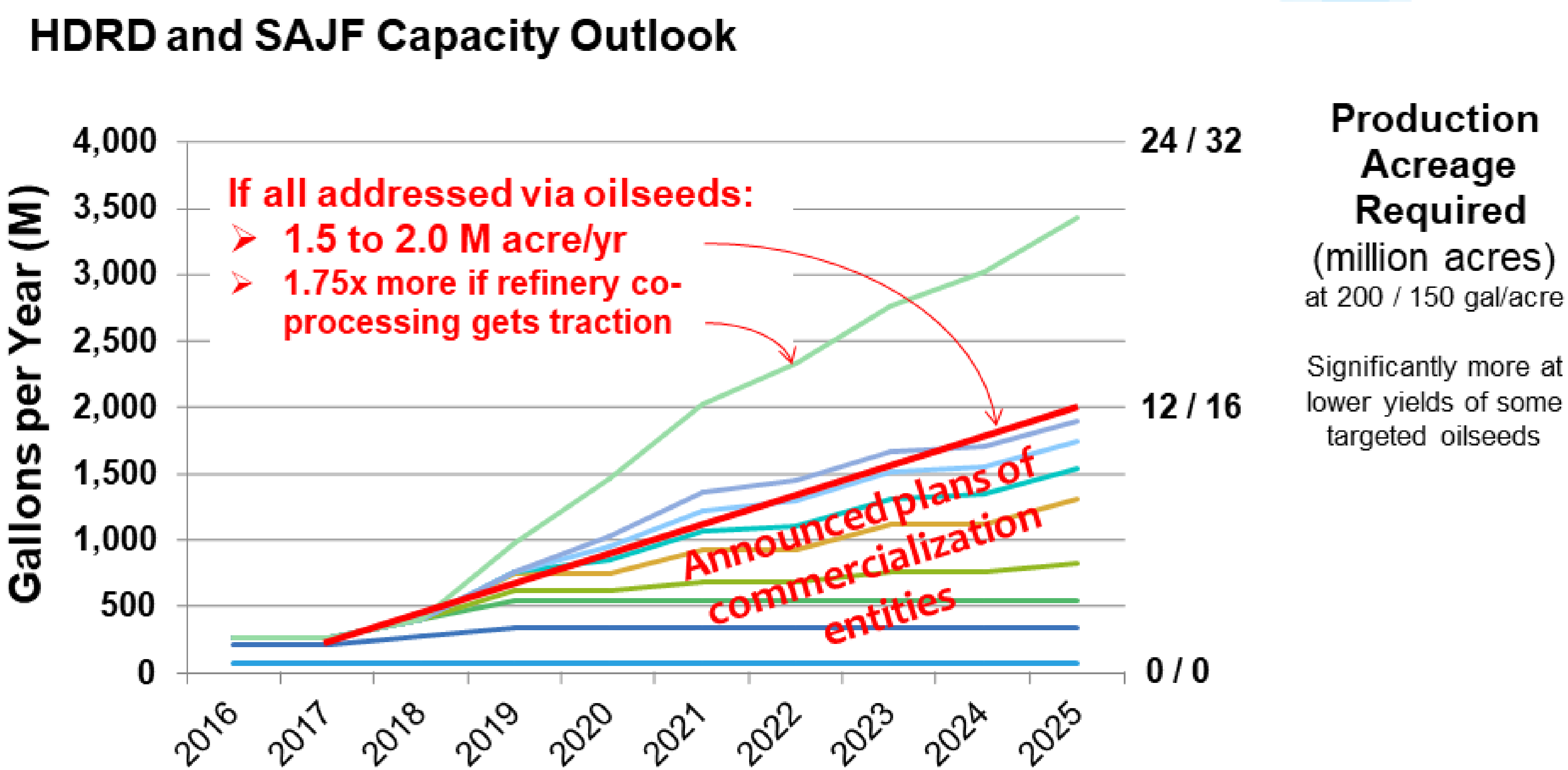
Challenge: Oilseed volumes

"Declared" nameplate capacities: significant opp'ty



Ignores 0.5B gpy additional expected biodiesel production!

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Opport'y: Dynamic Jet fuel market

* Gasoline: growth declining from 1.5% to flat
  * Big changes expected over next decade as autos move to batteries
* Diesel: flat (FAME and HDRD displacing petroleum ?)
  * Already turn down in EU
* Jet Fuel
  * Surpassed 25.3B gpy US production, 87B gpy world-wide in 2017
  * 3.5+% continued traffic growth rate in US, greater abroad
  * No viable alternatives to turbine-based primary power using jet fuel
  * First electric application may enter market by 2035, but will be extremely limited in application (small, short-range aircraft), while hybrid approaches (if any) will still use turbines
  * Jet fuel will remain primary energy source through 2050, barring any absolute technology breakthroughs

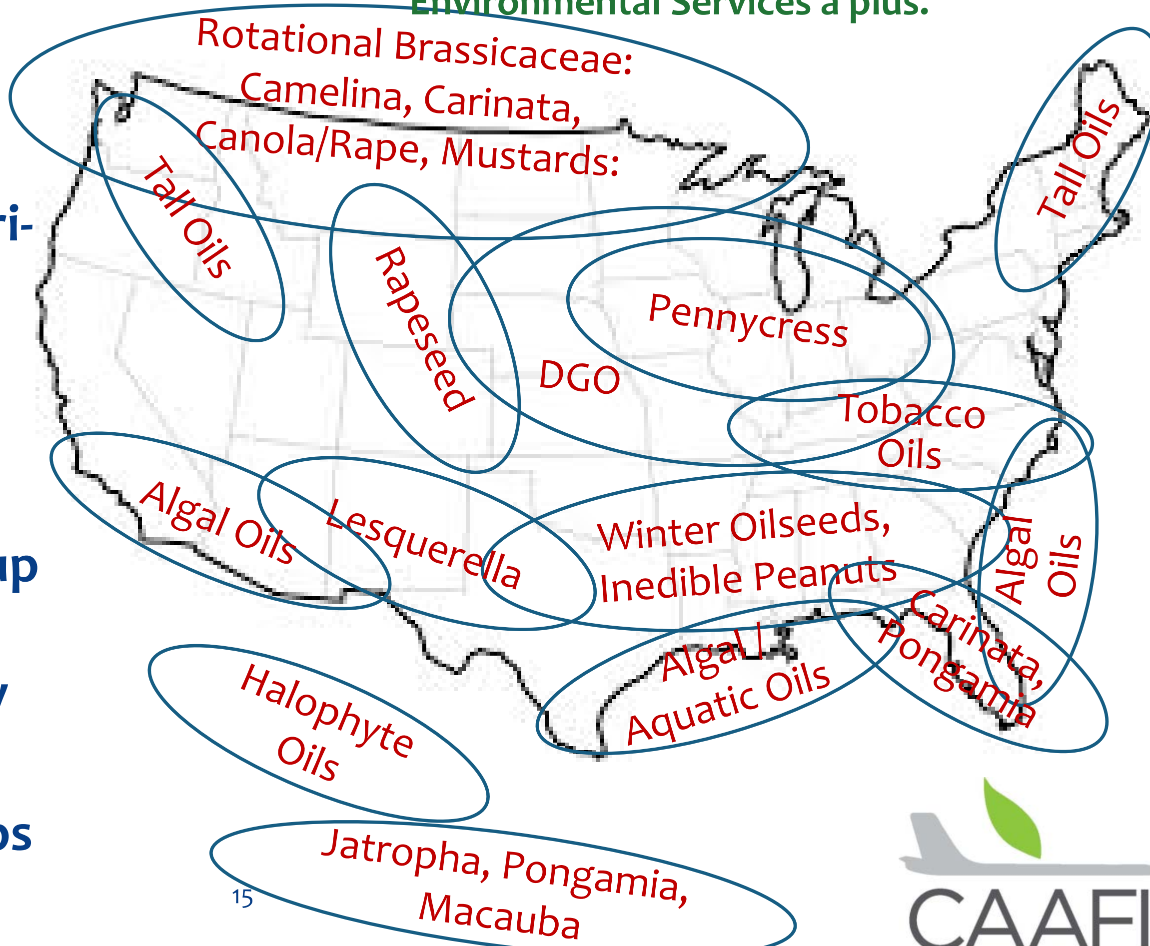
Opport'y: Lipid feedstocks

Potentially enabling of significant production …

* **Multiple conversion processes**
* **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 capacity**
* **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.



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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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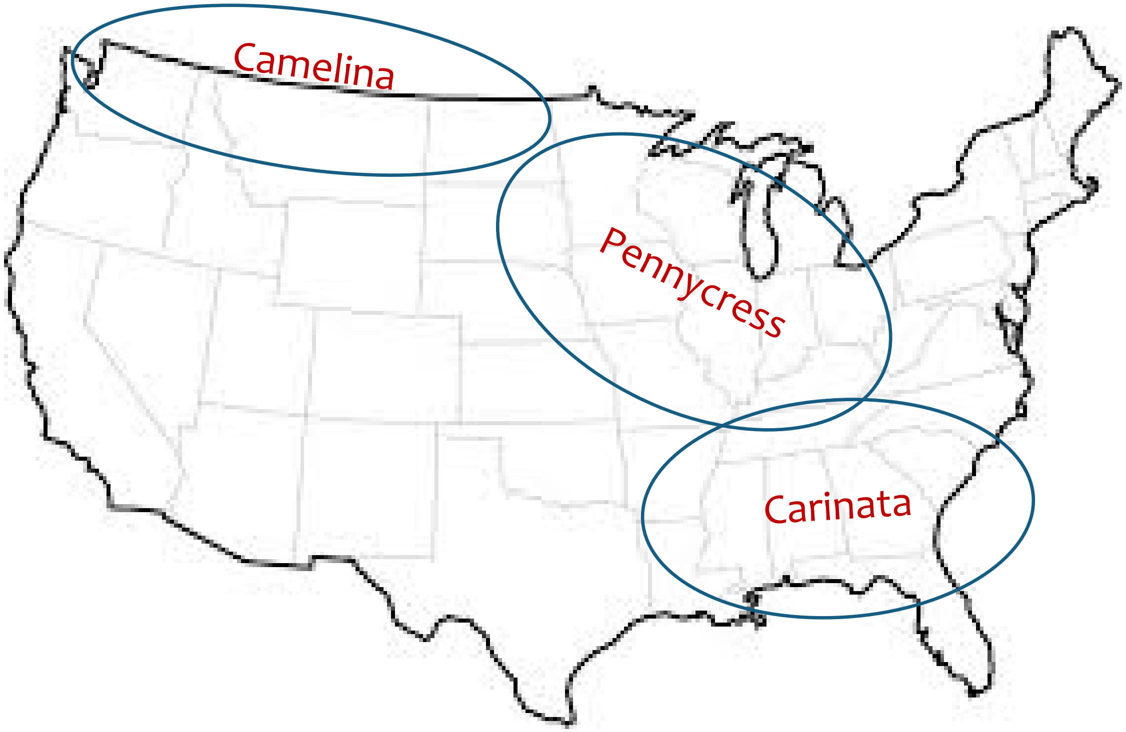

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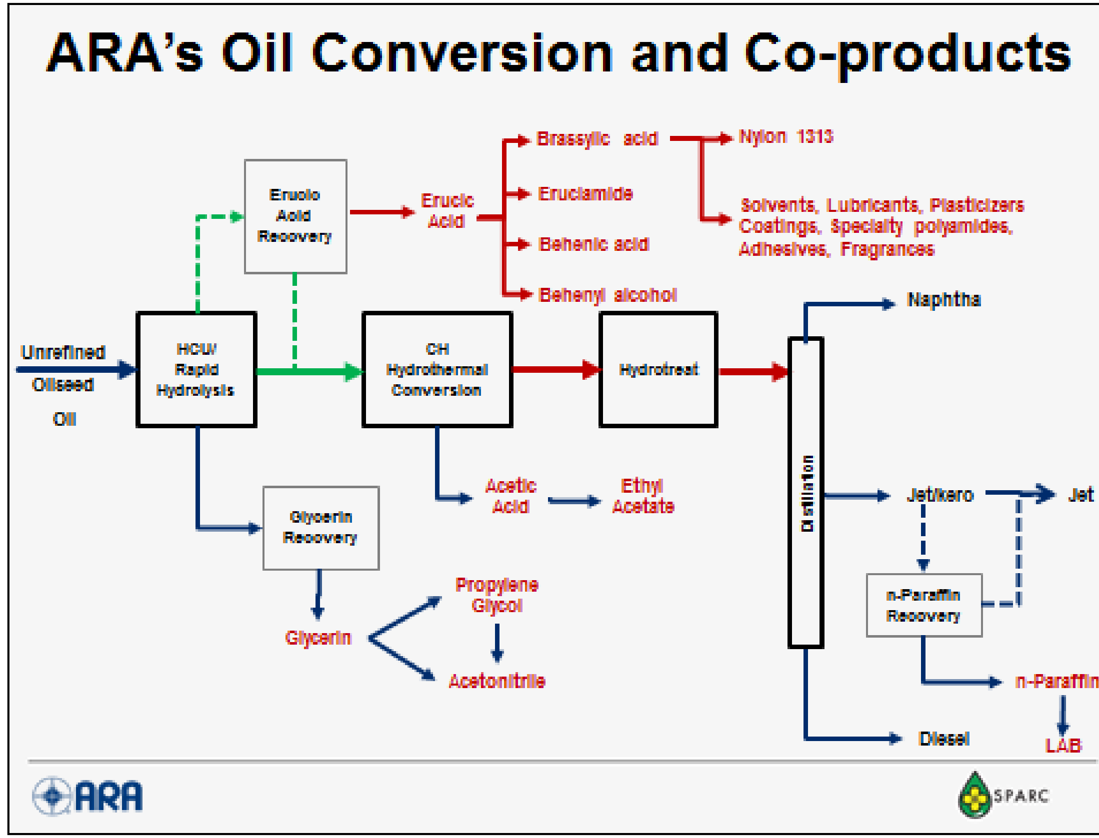
Opport'y: Integrated business
Cost-focus is only part of the need

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



Summary

* SAJF a large, stable, and growing market (25B+ gpy US, 87B+ worldwide)
* Offtake / commercialization impeded by:
  * Risk, lack of supply chain maturity & poor capital availability
  * Desire for price parity, with depressed price of oil
  * Uncertain, unstable, inequitable policy
* Still … potentially enabled by today's/tomorrow's policy and migrating societal values
* Commercial aviation can offer long term contracts of significant volume, enabling financeability
  * Potential for supply chain investment, with upside/downside sharing
* Aviation acknowledges that we may need to settle for having SAJF as a biorefinery "byproduct," until such time as oil price, policy, other fuel markets, and technology mature
  * Allows for very robust business-growth models for some scenarios
* Production from purpose grown, inedible, sustainable oilseeds (e.g. Carinata) viewed as being a big, high-potential part of the solution

2018 CBGM, Washington DC, 04-06Dec

In conjunction with:

- ASCENT Yr 5 Symposium
- NJFCP YE meeting
- State Initiative Stakeholders Forum

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FUELING SOLUTIONS FOR
SECURE & SUSTAINABLE AVIATION

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