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Los esfuerzos de EE. UU. para implementar combustibles de aviación alternativos.

Steven John Csonka
Director Ejecutivo, CAAFI

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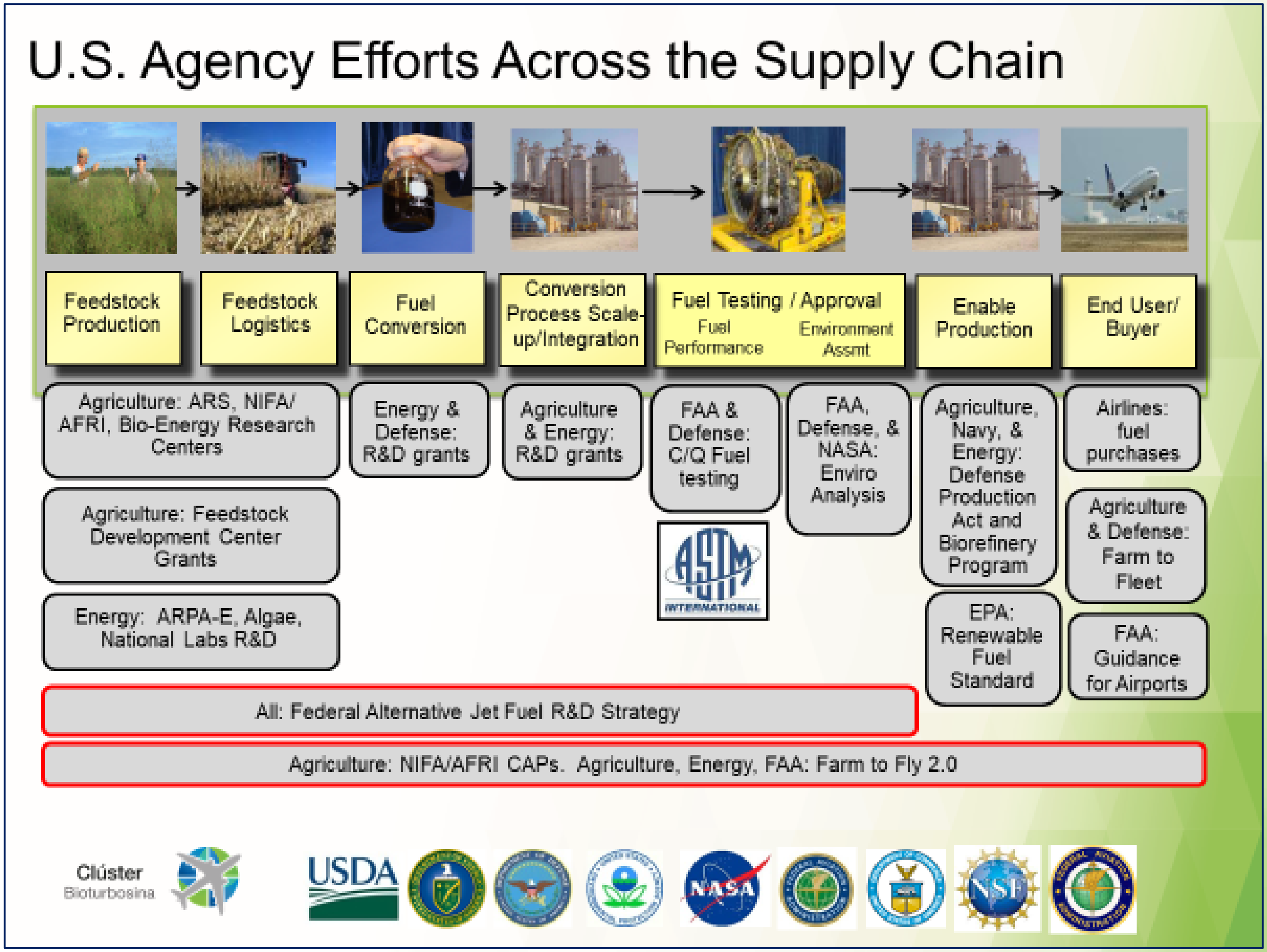
Efforts to Implement Alternative Aviation Fuels: USA Examples

Speaker: Steve Csonka, Executive Director CAAFI
(Commercial Aviation Alternative Fuels Initiative)

Date: 04Sep'18

Overview

- For the past 2 decades, the U.S. has expended significant efforts to commercialize Alternative Aviation Fuels



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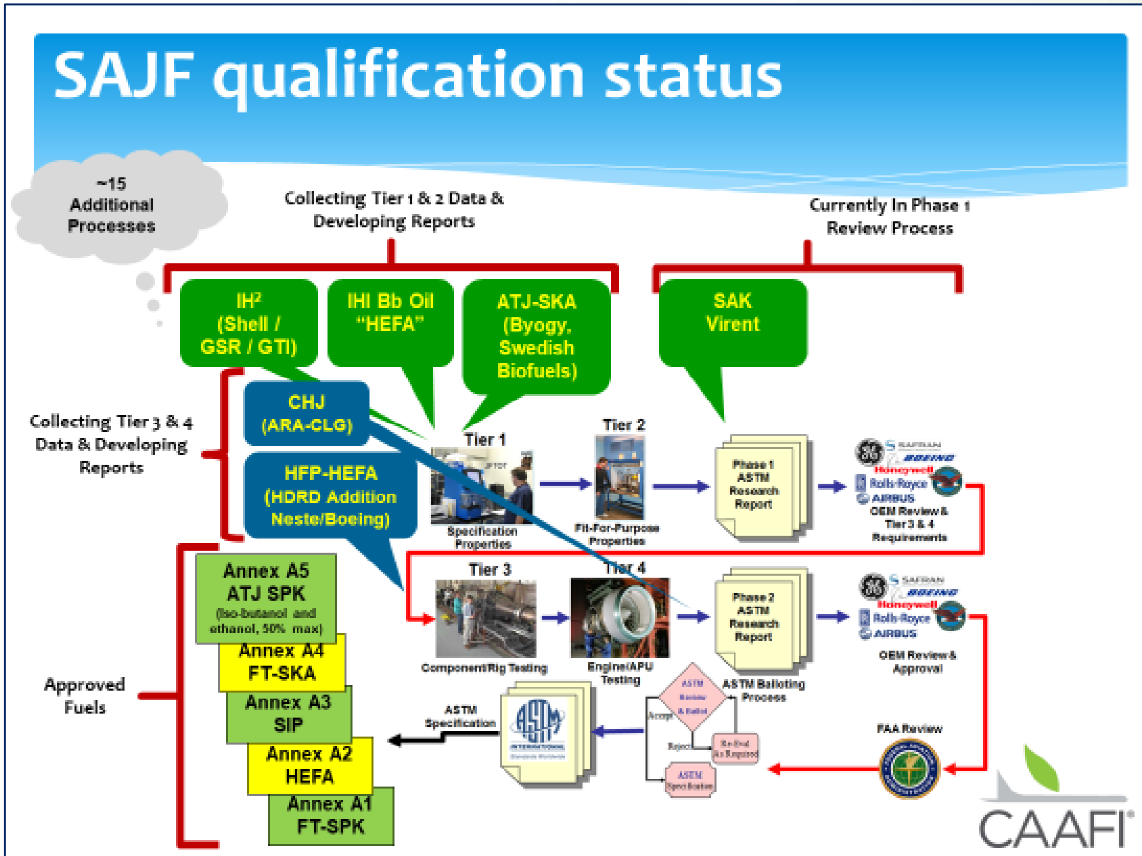
Overview (continued)

- Aviation now knows we can now utilize numerous production pathways (5 approved, others pending)
    - Enabling use of all major feedstocks (lipids, sugars, lignocellulose, H&C slipstreams)



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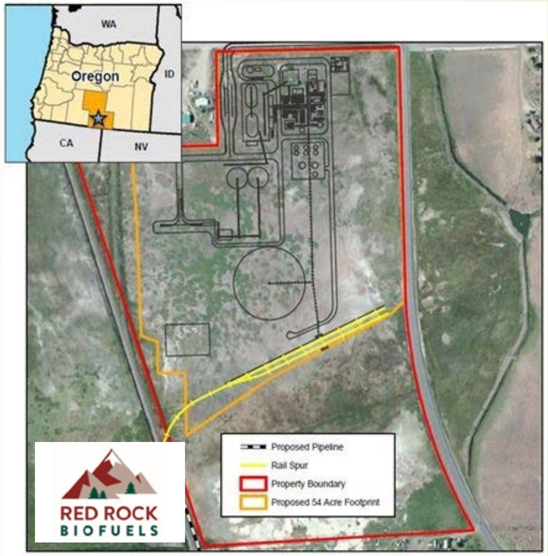
Overview (continued)

- Those efforts have resulted in one continuous-production facility, while several others are in commercial development



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Overview

- While work is expected to continue, there has been a shift in U.S. focus that will likely lessen development in the near term:
  - General reduction in funding due fiscal conservatism (DoD, USDA, DoT)
  - Move to earlier technolopgy-readiness-level development, and away from Demonstration & Deployment (DoE)
- … However, this may be offset by policy maturation (CORSIA, LCFS expansión) or escalating influence (CSR, airports, suppliers)
- Near term focus is on delivering cost effective AAF solutions

Commercial viability challenges:

- SAJF Production price not competitive with petro-based fuels and chemicals, due in part to “low-priced” petroleum
- Having to stand-up new industrial sector
- Capital’s aversion to risk and low reward (w/ commodities in general)
  - Uncertainties due changing state of technology, in some cases rapid
- Current policy approaches are fragmented: in impact, duration, and regionality, and create non-level playing fields
  - Odd alliances of factions, for and against, influencing policy

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Commercial viability opportunities:

- Challenges could be closed with:
  - Policy: Consistent, long-term, level playing field
    - Reward for other provided services: environmental challenges in agriculture, air quality
    - Address impact of carbon from (or incentives to) petroleum
  - Cost Reductions (investment in R&D)
    - CapEx: Duplication, Learning Curve, Incentives (lower cost of capital, taxation), Oil Refinery Integration, …
    - OpEx: Feedstock maturity, Tech (catalysts), Hydrogen, …

- Recommendation:
  - Consider aggressiveness in using “waste streams”, co-products, and other “low-cost” purpose-grown agriculture, silviculture, …

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Questions

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THANK YOU
FOR YOUR ATTENTION

Appendix

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Beyond numerous demonstration programs

neat quantities

AltAir Fuels *	+	UNITED	=	Up to 5 M gpy from 2016 (LAX)
	+	World Fuel Services, Gulfstream	=	3 yr agreement 30/70 blend
		KLM	=	3 yr agreement Enabling LAX flts
	+	SkyNRG NORDIC, air bp, OSLO AIRPORT, SAS, Lufthansa Group	=	Bioports on demand, et al. (Halmstad, Arlanda, Bromma, Goteborg, Leeuwarden)
Fulcrum BIOENERGY	+	CATHAY PACIFIC	=	37.5M gpy
	+	UNITED	=	90-180 M gpy
	+	air bp	=	50 M gpy
NESTE	+	GENÈVE AÉROPORT	=	1% of GVA supply

10 yr agreements

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

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Beyond numerous demonstration programs

neat quantities

Red Rock Biofuels + Southwest = 3 M gpy each, 7 yrs (Bay Area, CA)

Red Rock Biofuels + FedEx =

Total | Amyris + Cathay Pacific, China Airlines = A350 deliveries 10% blend (ex-TLS)

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

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

gevo + AVFUEL = Up to 1M gpy, 5 yrs+

gevo + Virgin australia = Brisbane Supply Demonstration

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

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effort

VELOCYS	+	BRITISH AIRWAYS, Shell	=	MSW-based FT-SPK evaluations
	+	In negotiation	=	BTL #1, Natchez, MS 1,400 bpd
NESTE	+	American Airlines, DFW Dallas Fort Worth International Airport	=	SAJF Supply exploration
AGRISOMA	+	QANTAS	=	Carinata supply development
SkyNRG NORDIC	+	Shell	=	SAJF Supply collaboration
DG Energy	+	GE Aviation	=	0.5M gpy, 10 yrs
Multiple Producers TBA (1/1/4+)	+	World Fuel Services	=	Full production slate offtakes

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				effort
preem Gothenburg Refinery	+	SAS	=	**Long-term supply negotiation** (from 2022)
LanzaTech capturing carbon fueling growth	+	virgin atlantic	=	**UK DfT F4C Funding: ATJ Development** **Demo flight pending**
TBA	+	FINNAIR	=	**Customer funding of SAJF purchase from 2019**
	+		=	
	+		=	
	+		=	

U.S. Commercialization activity

HDRD & SAJF from lipids/F.O.G.

- Diamond Green: Norco, LA
- REG: Geismar, LA
- AltAir/World Energy: Paramount, CA
- Diamond Green expansion (160->275->550M gpy)
- AltAir Build out (3-5X)
- SG Preston (duplicate 240M gpy facilities)
- ARA licensing build-out (4+ activities)
- UOP licensing for refinery retrofit(s)
- Refinery co-processing Andeavor Dickinson conversion (180+M gpy)
- Unlocking of renewable diesel? Or Neste, REG, UPM, … potential US pivots

In Production
390 M gpy by YE

In Development: Greater than 1B GPY capacity by 2021 !?!

… necessitates serious engagement with purpose grown oilseed & F.O.G. development / expansion

R.o.W. Commercialization activity

HDRD & SAJF from lipids/F.O.G.

HDRD & SAJF from lipids/F.O.G.

- Neste (3 facilities)
- Eni, Italy
- SinoPec, China
- UPM, Finland
- Total, La Mede, France
- Neste, Singapore expansion
- Petrixo, Fujairah

In Production
700+ M gpy

In Development
~700 M gpy

Other

-

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Commercialization in-development

Renewable Diesel & Jet from FT

Each with a portfolio vision

- **Fulcrum #1 Sierra - 11 M gpy; #2 Chicagoland - 30 M gpy; …**
- **Red Rock Forestry residues, initiating in OR**
- **Velocys First site announced – developing offtake**
- **D'Arcinoff Varied lignocellulosic approach, starting in TX**
- **NuFuels Initial site now targeting CA**
- **Several incognito**
  - **With a group of gasification approaches/providers, FT providers, EPCs, commercialization partners, and financial providers, might expect significant near term progress and announcements**