

Bioenergy and Biorefineries: Innovations and Futures

Workshop Impulse Presentation

An aviation perspective



GLOBAL
BIOECONOMY
SUMMIT 2018

Parallel Workshops II, 19th April,
16:45 – 18:45 / Track: "Industry"
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First flight from continuous commercial production of SAJF, 10Mar'16
Fuel from AltAir Fuels, Paramount, CA (HEFA-SPK 30/70 Blend).
Since, being delivered to LAX fuel farm for everyone's upload

19Apr'18

Overall industry summary:

Sustainable Alternative Jet Fuel (SAJF) activity

- * **SAJF are key for meeting industry's commitments**
 - * Aviation enterprise aligned; 25B gpy US & 87B GPY worldwide opt'y
 - * Delivers net GHG reductions of 65%+, delivers other enviro services
 - * Aviation industry working to foster, catalyze, enable, facilitate, participate (CAAFI, AIREG, BBP, mfrs, airlines, airports, govt agencies)
 - * Segment knows how to make it; Activities from FRL 1 to 9
 - * First facilities on-line, producing modest quantities
 - * Commercial agreements in-place and others in-development
 - * Pathways identified for significant penetration (i.e. fully synthetic, while at 50% max blend today)
- * **Making progress, but still significant challenges – only modest production – focus on enabling commercial viability**

Commercial viability challenges:

- * Production price not competitive with petro-based fuels and chemicals, due 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 fragmented: in impact, duration, and regionality, and create non-level playing fields
 - * Odd alliances of factions, for and against, influencing policy

Commercial viability challenges:

- * **Could be closed with:**
 - * **Policy: Consistent, long-term, level playing field**
 - * **Reward for other provided services: environmental challenges in agriculture, air quality**
 - * **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, ...**
 - * **Leveraging agriculture, silviculture, and additional aggressiveness in using “waste streams”**
 - * **Escalating price of petroleum, or universally agreed price for carbon (policy issues ?)**

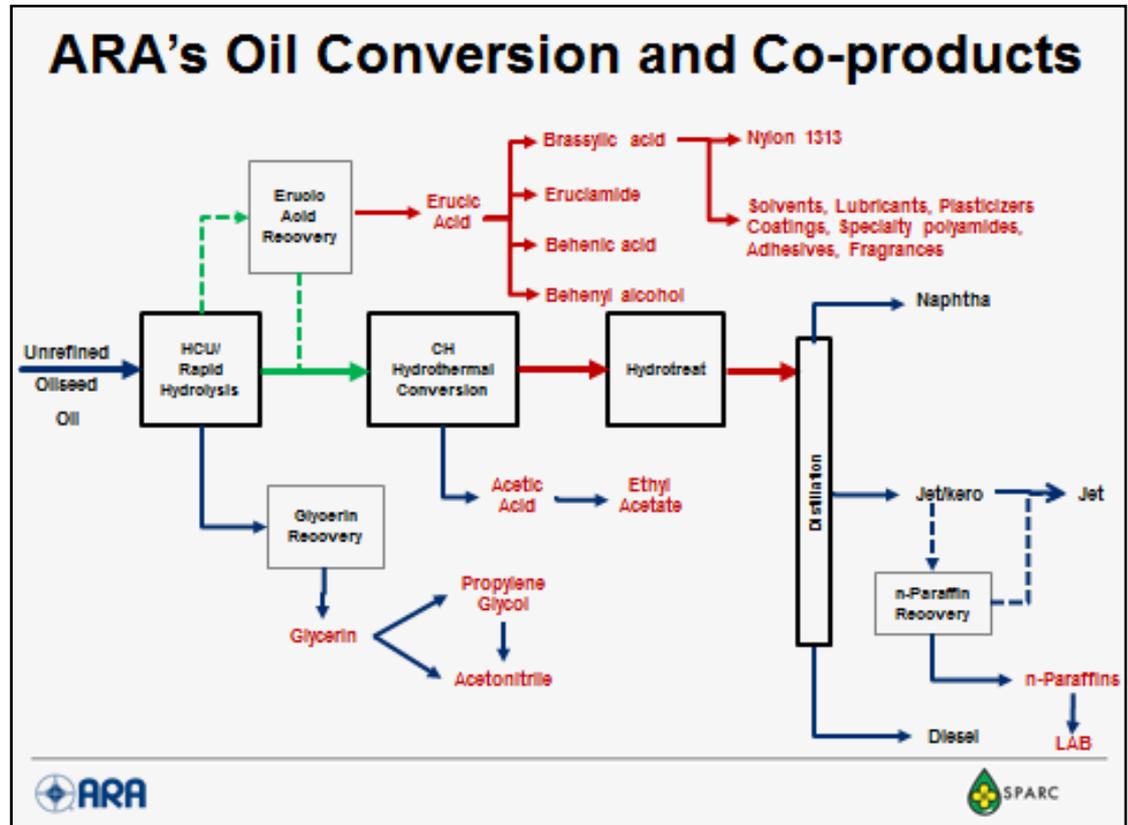
Environmental services...

* Via feedstock scenarios

- * Improved water quality, from erosion control, reduced nutrient leaching
- * Improved soil retention, from extended ground cover
- * Improved soil carbon uptake, from additional biomass residues, or use of biochar, compost, new fertilizer concepts
- * Reduce pesticides and herbicides, via improved rotational strategies
- * Improve biodiversity and pollinator health
- * Reduce wildfire risk
- * Create new biomes for food, fiber, materials, and revenue
- * Reutilize marginal lands, winter fallow, chem fallow, ...

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
- * But which comes first?



Purpose-grown feedstocks have a place: e.g. lipids

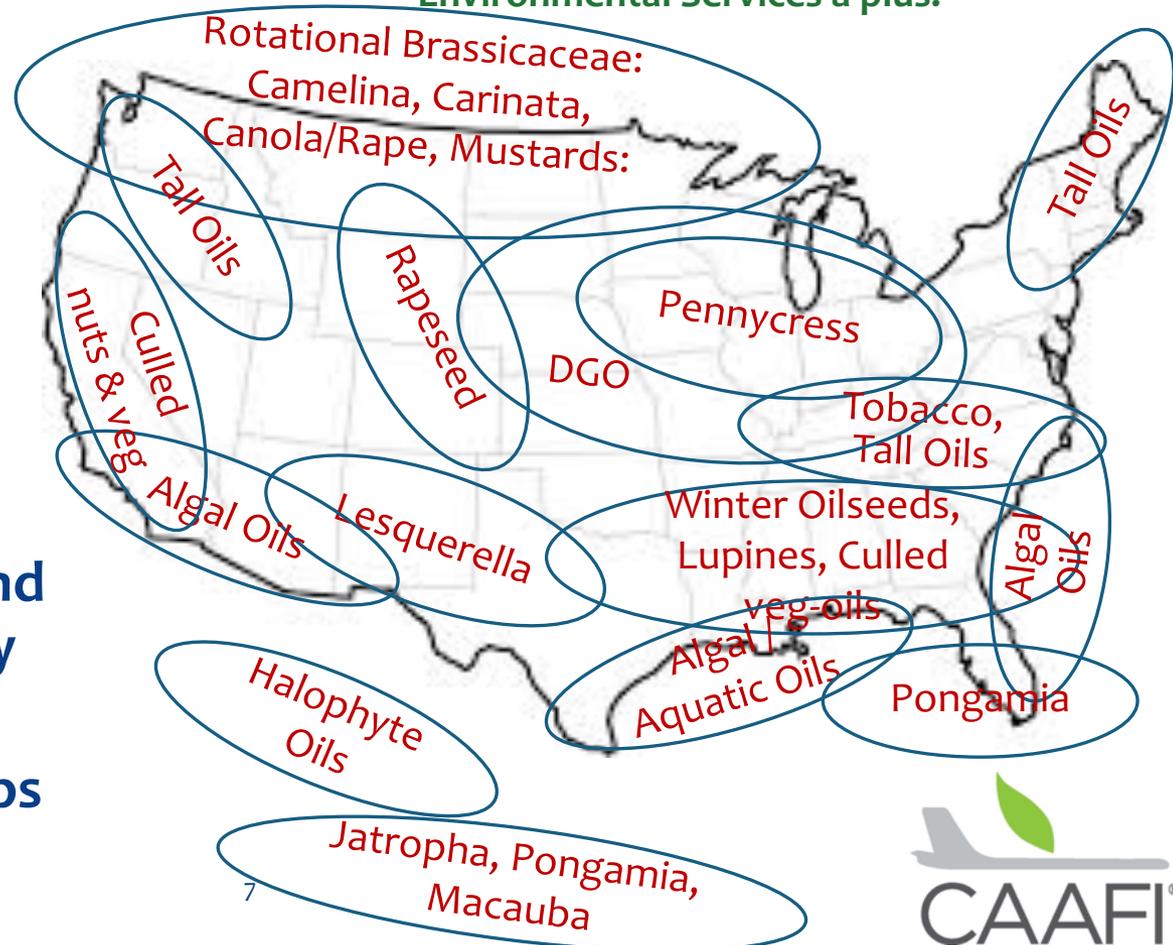
Multiple:

- * Conversion processes
- * Feedstock developers
- * Producers
- * Low LUC/ILUC agri-based feedstocks
- * Waste F.O.G.
 - * 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.



Other aviation draws

- * Considerable market size, with stable expected growth through 2040's
 - * Long-term prospects for ground transport less certain
- * Policy continuing to develop – enabling economics?
 - * LCFS applicability from start of 2019
 - * CORSIA from 2020 (further monetizes carbon for aviation via market mechanisms which are expected to be tighter)
 - * Still not a full level playing field in policy with HRRD
- * B-to-B engagement, consumer vagaries moot
- * Supply chain straight-forward – interest in facilitating distributed supply
- * Ability to directly negotiate long-term (10-20 year) agreements
- * Clear interest in additional, sustainable feedstock solutions
- * Multiple fuel conversion technologies – offering cost reduction promise

Summary:

- * **SAJF & co-products technically viable – slowly being commercially developed**
 - * Opportunities actually continuing to expand
 - * Industry still counting on execution of SAJF, commensurate with progress on other pillars
- * **Challenge is achieving price-point equivalency to petro-jet**
 - * Policy support has been shown to close some business cases
 - * Some producers remain bullish on their costs without policy
- * **Feedstock availability might be pacing for some pathway families, but not envisioned to be an ultimate constraint**
- * **Full range of activities ongoing to try to bring down cost, reduce risk, incentivize production, develop feedstocks, ...**
 - * Crude oil price and policy mechanisms will be key determinants