DOD Alternative Fuel Programs

Air Force Research Laboratory
Propulsion Directorate

Approved for public release; distribution unlimited.
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Whole-Government Approach to Aviation Biofuel

Feedstocks | Feedstock Logistics | Conversion | Fuel Testing & Approval | Jet Fuel

A Complete Supply Chain Approach

USDA & DOE research & grant programs	*USDA conservation programs*	*USDA biomass & risk assistance programs*	*DoD & DOE research programs*	*FAA & DoD Q/C programs*	*USDA & DOE commercial programs*	*Fuel purchase guarantees*

DOD focus (except for DPA)

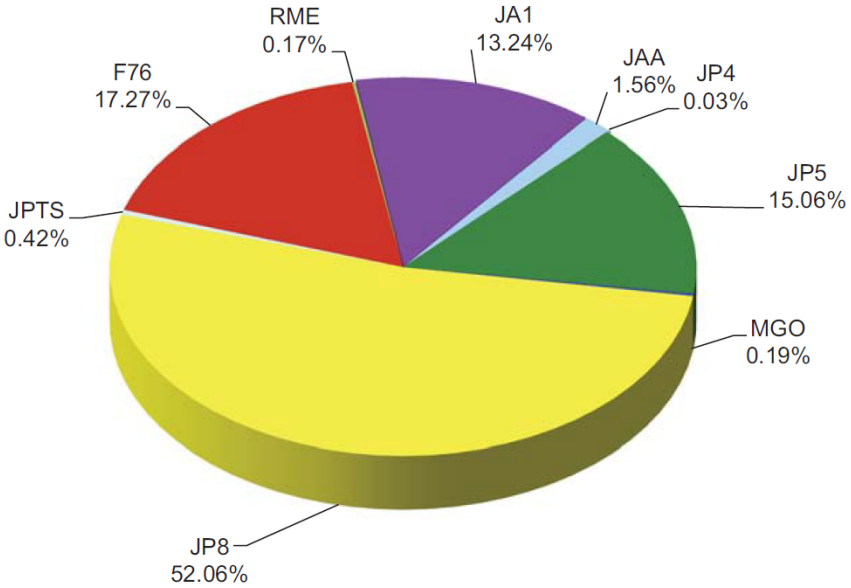
It Isn't Just About the Fuel….

FAA CLEEN Program Goals

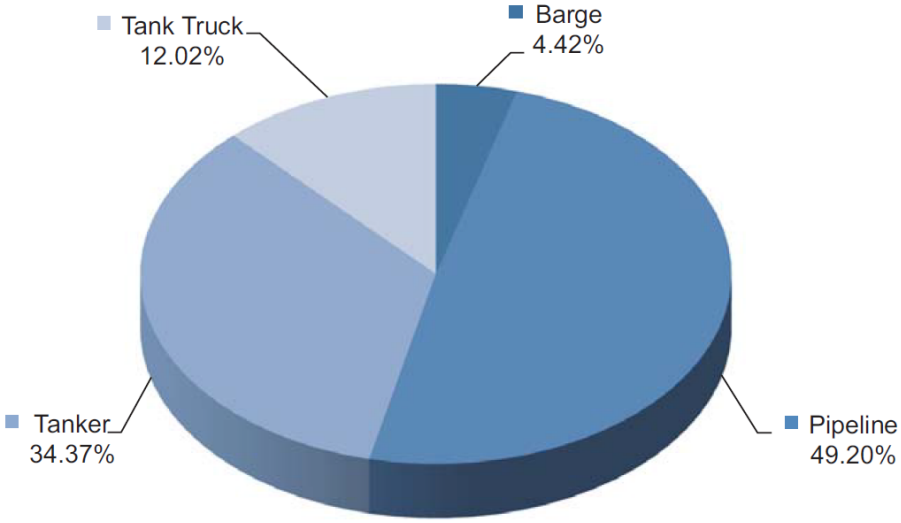
	N+1 (2015) CONVENTIONAL CONFIGURATION RELATIVE TO 1998	N+2 (2020-25) UNCONVENTIONAL CONFIGURATION RELATIVE TO 1998	N+3 (2030-35) ADVANCED CONCEPTS RELATIVE TO 2005
NOISE	-32 dB cum below Stage 4	-42 dB cum below Stage 4	-71 dB cum below Stage 4
LTO NOX EMISSIONS (BELOW CAEP 6)	-60%	-75%	better than -75%
AIRCRAFT FUEL BURN	-33%	-50%	better than -70%

- Petroleum Quality Information System – 2011 report
- DOD buys mostly jet fuel (and marine diesel)

Bulk Products Represented by Percent Volume
Total 2011 U.S. Gallons—3,533,013,357

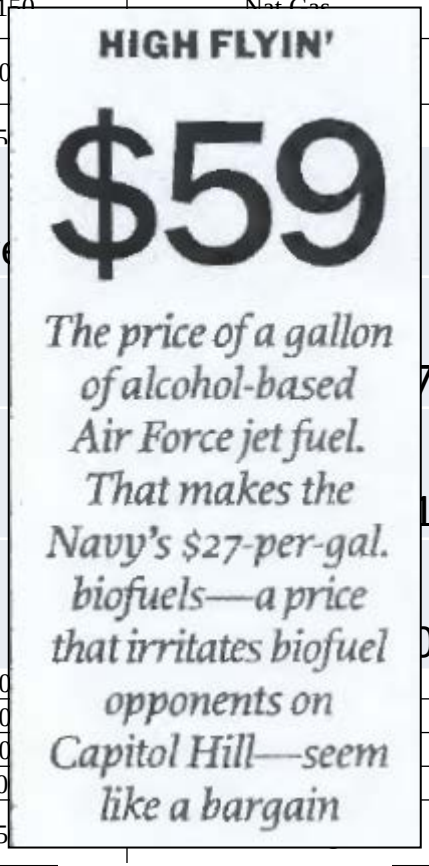


2011—Transportation Method by Percent Volume
Total 3,526,301,297 U.S. Gallons



Contract #	Contract Number	Company	Product	Award Date	Quantity	Cost per Gallon	Total	Feedstock	Service
1	07-D-0486	Shell	FT Iso Paraffinic Kero	6-Jun-07	315,000	$3.41	$1,074,15	Nat Gas	AF
2	08-D-0496	SASOL	FT Iso Paraffinic Kero	26-Jun-08	60,000	$3.75	$225,00		AF
3	08-D-0497	SASOL	FT Iso Paraffinic	3-Jul-08	335,000	$3.90	$1,306,5		AF
4	09-D-								Navy
5	09-D-								Navy
6	09-D-								AF
7	09-D-								AF
8	09-D-							76	Navy
9	10-D-								Army
	Opt							14	Navy
	Opt								AF
	Opt							00	AF
10	11-D-0526	Gevo	ATJ8	23-Sep-11	7,000	$59.00	$413,00		AF
	Option	Gevo	ATJ8	28-Sep-11	4,000	$59.00	$236,00		AF
11	11-D-0530	UOP	HRJ8	30-Sep-11	4,500	$33.00	$148,50		Army
12	12-D-0549	Dynamic	HRJ5	30-Nov-11	100,000	$26.75	$2,675,0		Navy
	CLIN 0201	Dynamic	HRD76	30-Nov-11	350,000	$26.75	$9,362,5		Navy
13			HRJ8		4,500				Army

	Total Gallons	Total Cost	Ave
Fischer Tropsch	730,000	$2,745,650	
Hydrotreated Renewable	1,085,450	$41,400,070	
Alcohol to Jet	11,000	$649,000	



Time, 7/30/12

	Total Gallons	Total Cost	Average Cost per Gallon
Fischer Tropsch	730,000	$2,745,650	$3.76
Hydrotreated Renewable	1,085,450	$41,400,070	$38.14
Alcohol to Jet	11,000	$649,000	$59.00

Alternative Fuel Evaluation (ASTM D4054, MIL-HDBK-510)

Specification Properties

Fit-For-Purpose Properties

Component/Rig Testing – operability, durability

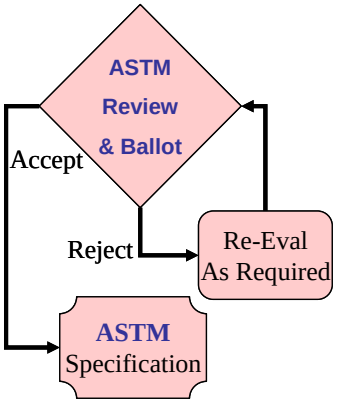
Engine/APU Testing

"R&D"

"Certification"

ASTM Research Report

FAA & OEM Review & Approval



ASTM Balloting Process

ASTM D7566 Revision

DOD Certification Status (11/2012)

- **SPK (Fischer-Tropsch synthetic paraffinic kerosene) – complete**
- **HEFA (aka HRJ) – essentially complete (AF: F119 test remains). Great Green Fleet sailed.**
- **ATJ (alcohol-to-jet) – AF program through Phase I (A-10); Navy procurement in progress; Tri-Service Working Group established**
- **Now what?**
  - DOD looking at HDCJ, DSHC, HSK etc fuels

Tri-Service Alternative Fuels Team Organization

Chemistry Team

Executive Committee

Secretariat

Aviation:
ulsionTeam

Materials Te

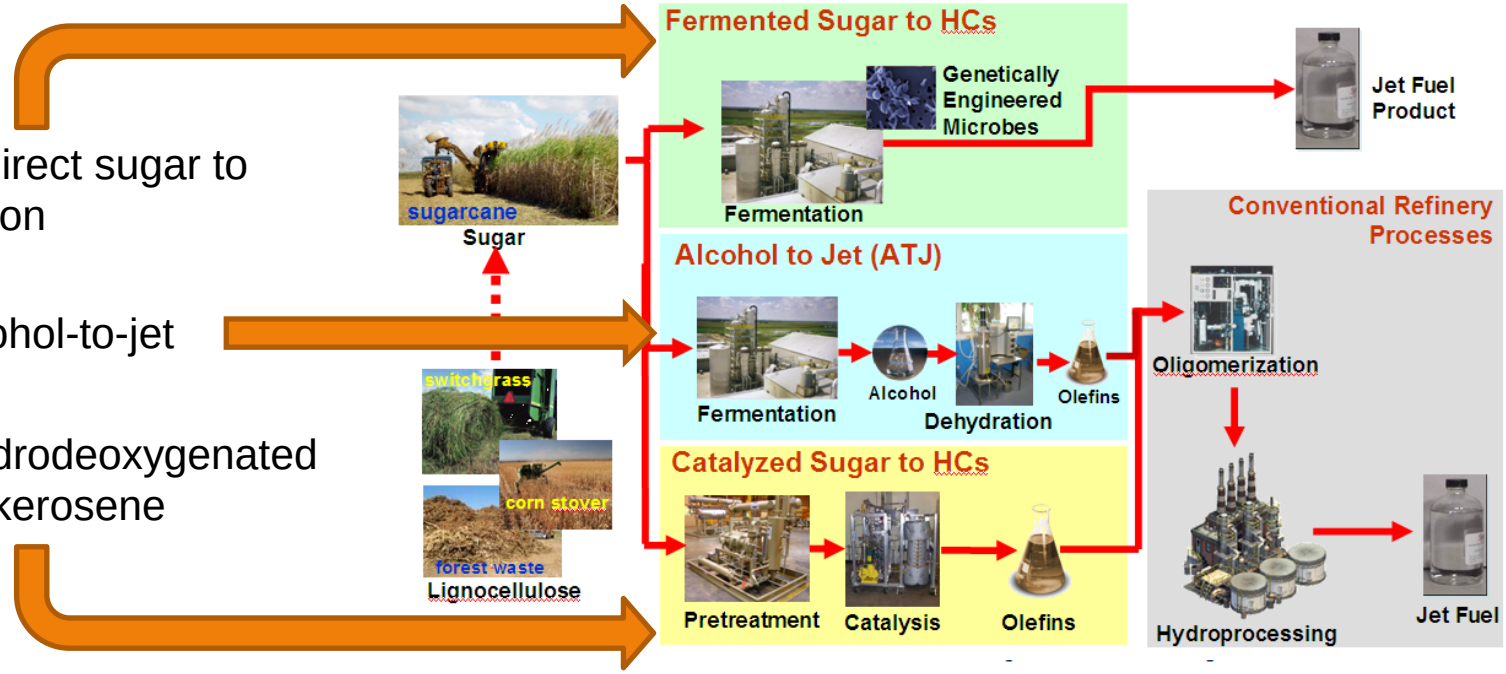
n:
pment Team

Toxicology

DSHC – direct sugar to hydrocarbon

ATJ – alcohol-to-jet

HSK – hydrodeoxygenated synthetic kerosene



SKA (vs SPK) – synthetic kerosene w/ aromatics (F-T and ATJ variants)

HDCJ – hydroprocessed depolymerized cellulosic jet

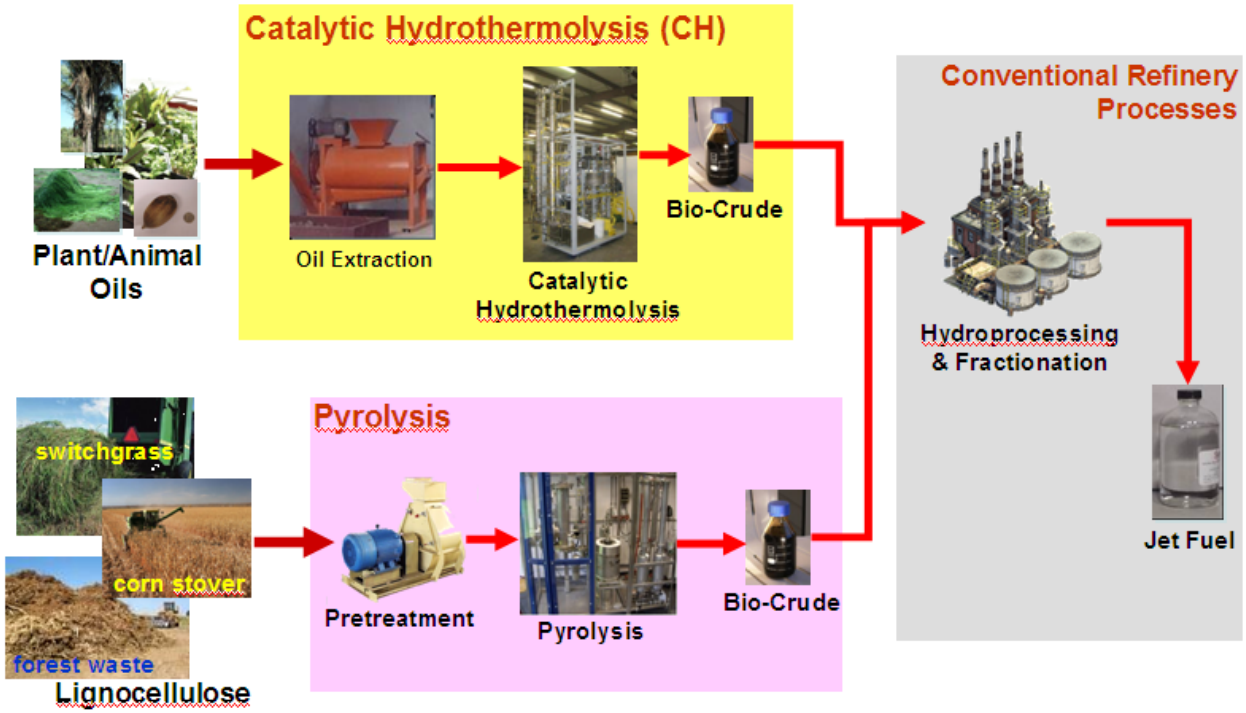


Figure (modified) from Mark Rumizen/FAA

Fuels from Operational Facilities

Gevo, Luverne MN, 18 M gal/yr isobutanol

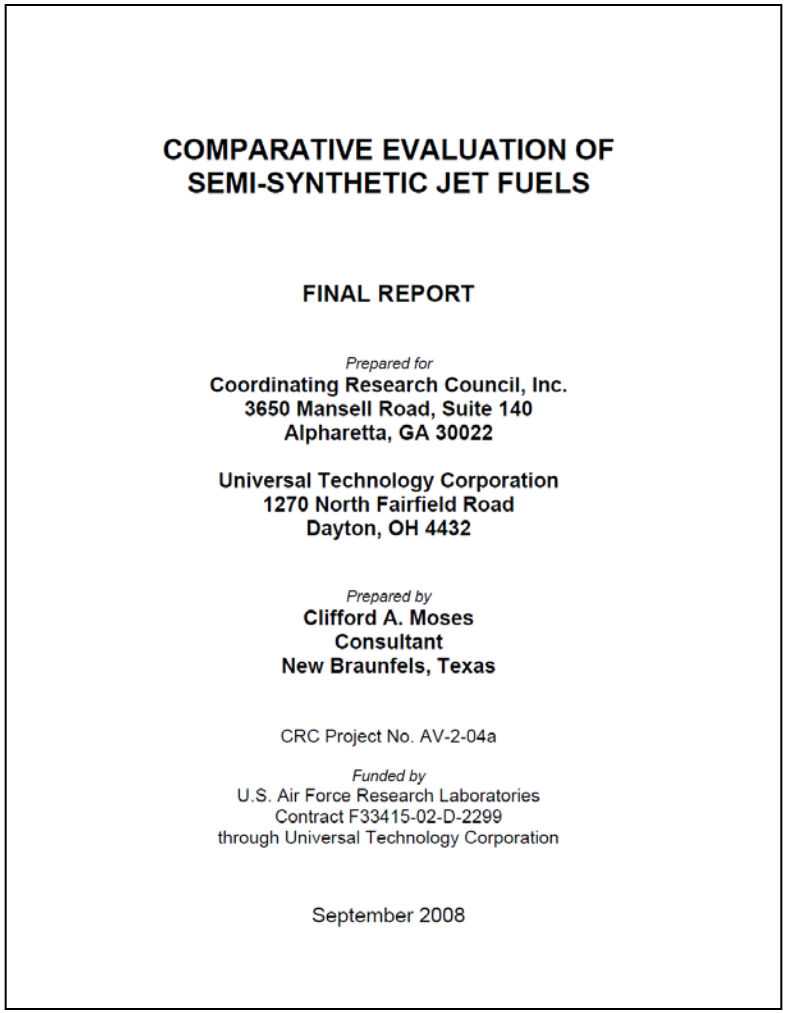
Dynamic Fuels, Geismar LA, 75 M gal/yr

KiOR, Columbus MS, 11 M gal/yr

Amyris, Brazil, 17 M L/yr hydrocarbon

Data Collected in Research Reports

- Used to support commercial specifications (data also used for military certification)
  - Some DOD-unique: diesel engines, afterburners…
- Addresses whether "drop-in" fuels fall within experience base
- Coordinated with Commercial Aviation Alternative Fuel Initiative (CAAFI)
- Over next two years, expect:
  - ATJ (SPK+SKA)
  - HDCJ
  - DSHC



COMPARATIVE EVALUATION OF
SEMI-SYNTHETIC JET FUELS

FINAL REPORT

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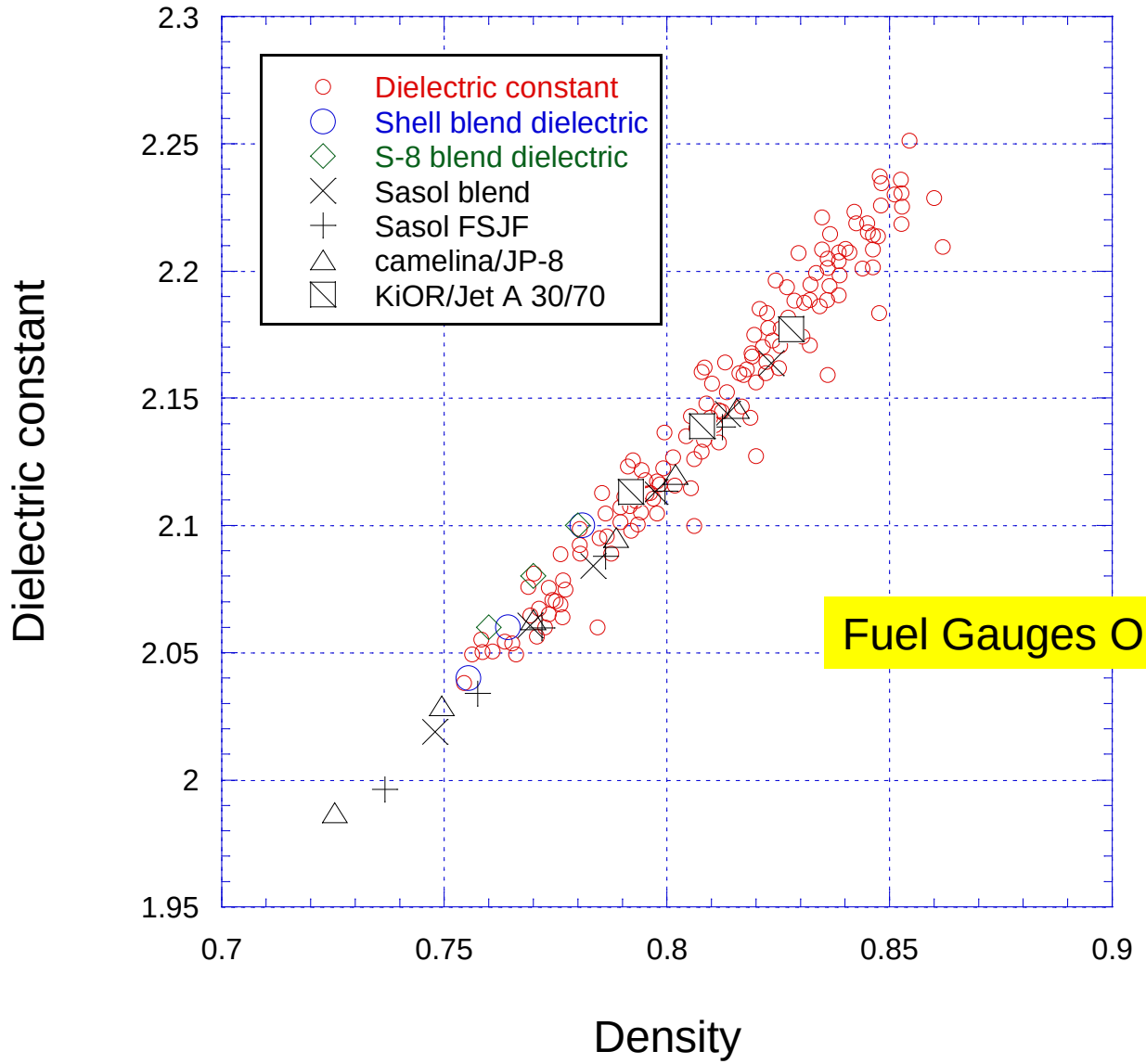
September 2008

Data Enables Certification



Fuel Gauges Operate Correctly!

DOD Alternative Fuel Evaluation

- **Challenges**
  - Gas turbine combustor operability (blowout, relight)
  - Diesel engine performance
  - Lubricity
  - Material compatibility (non-metallics)
  - Infrastructure/handling/additives

- **Needed – link between composition and performance to create compositional limits in specifications**

Summary

- **International collaborative effort has been enabling alternative aviation fuel development**
  - Partnering over entire fuel life cycle required (production to deployment/use)
- **U.S. Government interagency collaboration also key enabler**
- **Funding challenges will limit pace of program**
- **Fuels available for collaborations**
  - Sasol IPK
  - HEFA (various)
  - ATJ SPK (maybe)