Overview of FAA Alternative Jet Fuel Activities

By: Dr. Jim Hileman
Chief Scientist and Technical Advisor for Environment and Energy
Office of Environment and Energy
Federal Aviation Administration

To: Biomass R&D Technical Advisory Committee, Washington D.C.

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Aviation Environmental Challenges

- Aviation impacts community noise, air quality, water quality, energy usage, and climate change
- Environmental impacts from aviation could pose a critical constraint on capacity growth
- Alternative jet fuels could reduce the environmental impact of aviation:
  - Carbon neutral growth by 2020 compared to 2005
  - 1 billion gallons of renewable jet fuel in use by aviation by 2018
  - Absolute reduction of significant air quality impacts, notwithstanding aviation growth

United States Climate Action Plan for Aviation

The U.S. is pursuing a multi-pronged approach to address greenhouse gas emissions from aviation

- Aircraft and Engine Technology Improvement
- Operational Improvements
- Alternative Fuels Development and Deployment
- Policies, Environmental Standards, and Market Based Measures
- Scientific Understanding Through Research, Modeling and Analysis

U.S. Climate Action Plan for Aviation is available at:
http://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/policy/media/Aviation_Greenhouse_Gas_Emissions_Reduction_Plan.pdf

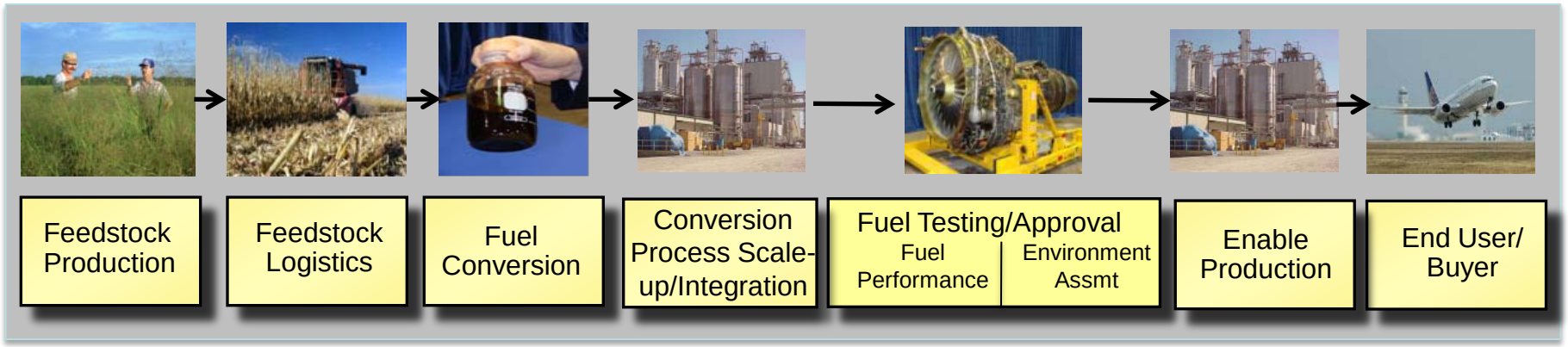
Challenges for Alternative Jet Fuels

- Feedstock Availability
- Competitive cost for alternative fuel
- Approved for performance/safety
- Environmentally sustainable
- Commercially produced

Coordinating USG Efforts across Supply Chain

CAAFI

Facilitating Deployment and Investment



Agriculture: Biomass Crop Assistance Program & Crop Insurance Program

Agriculture: Feedstock Development Center Grants

Energy & Defense: R&D grants

Agriculture & Energy: R&D grants

FAA & Defense: C/Q Fuel testing

FAA, Defense, & NASA: Enviro Analysis

Agriculture, Navy, & Energy: Defense Production Act and Biorefinery Program

EPA: Renewable Fuel Standard

Defense & Airlines: fuel purchase

FAA: Guidance for Airports

ASTM INTERNATIONAL

PARTNER Partnership for Air Transportation Noise and Emissions Reduction

USDA · Department of Energy · Department of Defense · EPA · NASA · FAA

FAA Areas of Focus in Alternative Fuels







Feedstock Development & Production	Feedstock Logistics	Fuel Conversion	Conversion Process Scale-up/Integration	Fuel Testing/Approval: Fuel Performance	Fuel Testing/Approval: Environment Assmt	Enable Production	End User/ Buyer
FAA	✓		✓	✓	✓		✓

High level description of agency effort:

- Fund Certification/Qualification testing to inform ASTM approval
- Environmental & cost analysis
- Government & Industry coordination & cooperation
- Additional support and studies

CLEEN — Continuous Lower Energy, Emissions & Noise — Federal Aviation Administration

CAAFI®

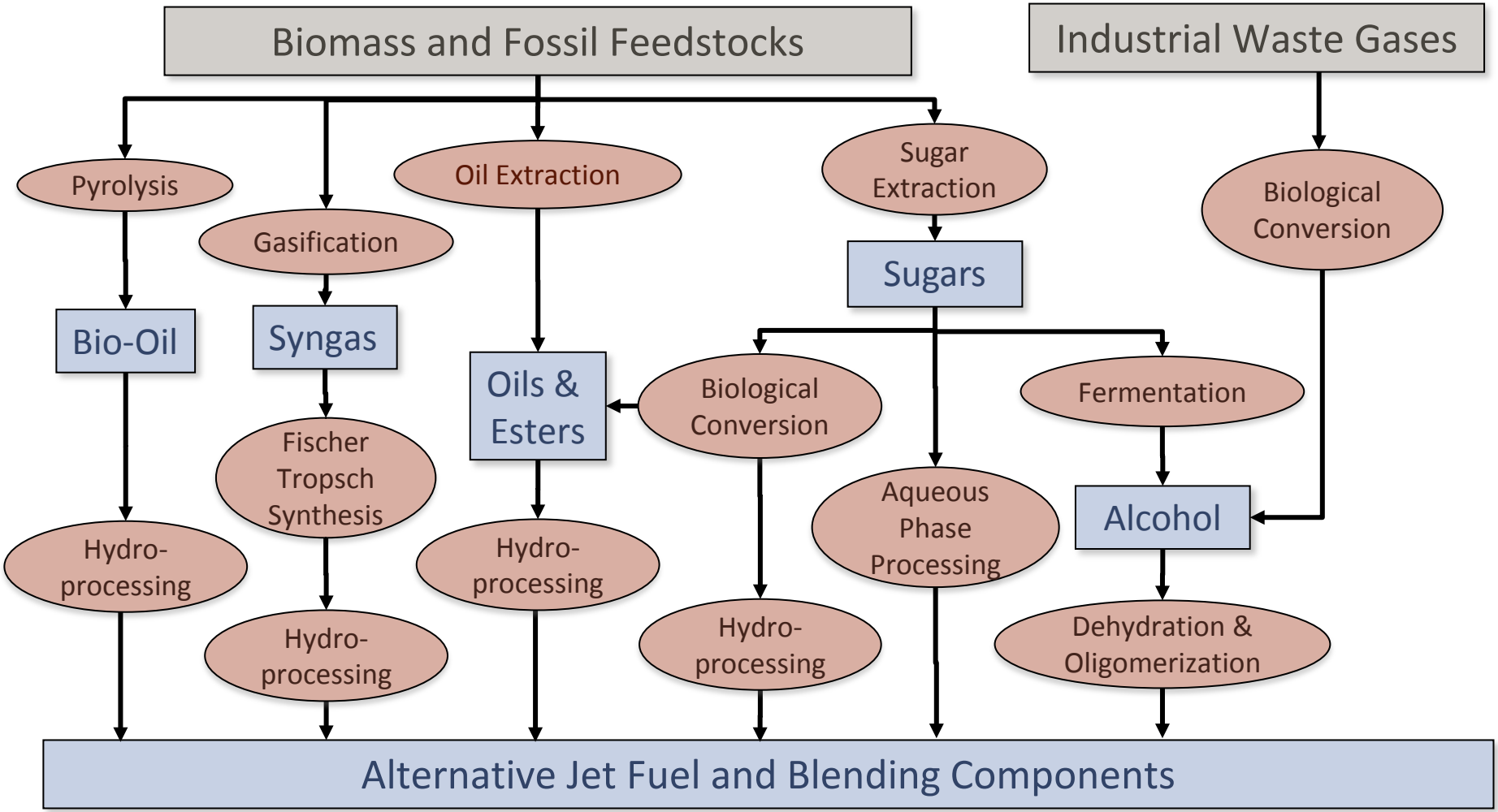
the VOLPE center

BAA for alternative jet fuel

PARTNER — Partnership for Air Transportation Noise and Emissions Reduction

✓	**Primary Activity**
✓	**Secondary Activity**

Alternative Jet Fuel Pathways



Current FAA Alternative Jet Fuel Activities

- **Testing**
  - Material compatibility
  - Certification / Qualification
  - Emissions measurements
- **Analysis**
  - Environmental sustainability
  - Techno-economic analysis
  - Future scenarios
- **Coordination**
  - Interagency
  - State & Regional
  - International

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How a Fuel Gets Approved (ASTM D4054)

Specification Properties

Fit-For-Purpose Properties

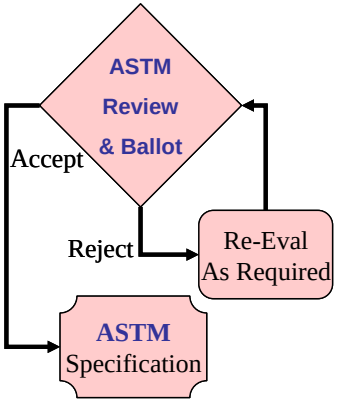
Component/Rig Testing

Engine/APU Testing

ASTM Research Report

FAA & OEM Review & Approval

ASTM Balloting Process



ASTM D7566 Revision

Alternative Jet Fuels Test Matrix

		Genre	Synthetic Paraffinic Kerosene		Synthetic Kerosene w/ Aromatics			Alchol-to-Jet		Cellulose to Hydrocarbon	Direct Sugar to Hydrocarbon	Synthetic Kerosene
		Acronym	FT-SPK	HEFA	FT-SKA	HEFA-SKA	CH	ATJ-SKA	ATJ-SPK	HDCJ	DSHC	SK
		ASTM Status	Annex A1	Annex A2	Research Report		-	-	Research Report	Research Report	-	Research Report
		Process	Gasification/FT Hydroprocessing	Deoxygenation / Hydroprocessing	Gasification/FT & Hydroprocessing	HEFA w/ Renewable Aromatics	Catalytic Hydrothermolysis	Fermentation Olig/hydro/Catal	Fermentation Olig/hydro	Hydrotreated Depolymerized Cellulosic Jet	Fermentation	Catalysis of Sugars
FRL Level	Total Fuel Quantity Required for Evaluation	Example Producers → / Test ↓	Sasol, Syntroleum, Shell	UOP, Dynamic Fuels, Neste, EERC	Sasol, Shell / Virent	Algeon / Swift, UOP	ARA-Readijet	Byogy, LanzaTech / Swedish Biofuels, Logos	Gevo, UOP, Cobalt / US Navy, LanzaTech / Swedish Biofuels	KiOR, UOP	Amyris / Total	Virent
5	100 gallon	Fuel Production						FAA (LT/Swed Bio)	FAA (UOP)			FAA (Virent)
4 / 6.1	1-gallon	Lab Testing	USAF	USAF	USAF FAA	FAA	USAF	USAF	USAF	USAF	USAF	USAF
	10-gallons	Lab Testing	USAF	USAF	USAF FAA	FAA	USAF FAA	USAF FAA	USAF	USAF	USAF	USAF
6.3	20-gallons	Cold Fuel Atomizer Plugging		FAA Honeywell		FAA Honeywell	FAA Honeywell		FAA USAF Honeywell	FAA Honeywell	FAA Honeywell	FAA Honeywell
	40-gallons	Atomizer Spray & Check Valve	USAF Honeywell	USAF Navy Honeywell		FAA Honeywell	FAA Honeywell		FAA USAF Honeywell	FAA Honeywell	FAA Honeywell	FAA Honeywell
6.3 / 6.4	50-gallons	APU Cold and Altitude Starting	USAF Honeywell	USAF Navy Honeywell	FAA	FAA Honeywell	FAA Honeywell	FAA USAF	FAA USAF Honeywell	FAA Honeywell	FAA Honeywell	FAA Honeywell
	100-gallons	Combustor Rig				FAA Honeywell	FAA Honeywell	FAA USAF	USAF Honeywell	FAA Honeywell	FAA Honeywell	FAA Honeywell
	6,500-gallons 131-9[B]	Endurance		USAF Honeywell		FAA Honeywell						
6.3 / 6.4	400-gallons e.g. TPE331-10	Engine Perf/Oper/Emiss	USAF Honeywell	USAF Boeing Honeywell			FAA	FAA	USAF Honeywell	FAA		
	150-gallons	Combustor Rig	USAF Honeywell	USAF Honeywell			FAA Honeywell	FAA	USAF	FAA		
	5000 gallons e.g. HTF 7000	Engine Perf/Oper/Emiss				FAA Honeywell						
	120,000-gallons	Endurance		FAA Honeywell								
6.3 / 6.4	T63 engine	Engine Prop &/or Dyno	USAF	USAF						USAF		
	1000-gallons T55 engine	Combustor Rig	US Army Honeywell	US Army Honeywell					U.S. Army Honeywell			

Legend

- Test Complete
- Funded
- Planned or completed testing by GE
- Planned or completed testing by PW
- Planned or completed testing by RR/LW
- Honeywell Planned or completed testing by Honeywell
- Planned or completed testing by AFRL

- Matrix is under development (subject to revision)
- Need to add ongoing US Navy testing
- Focusing on near-term candidates
- Working to streamline process

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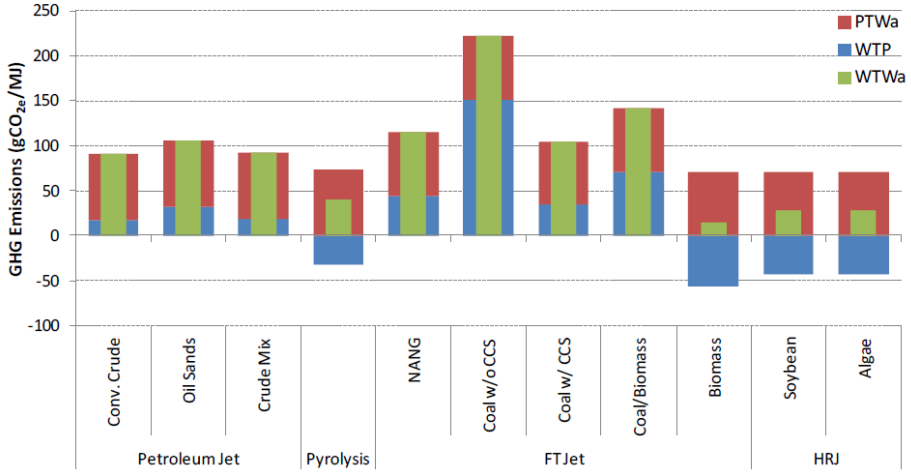
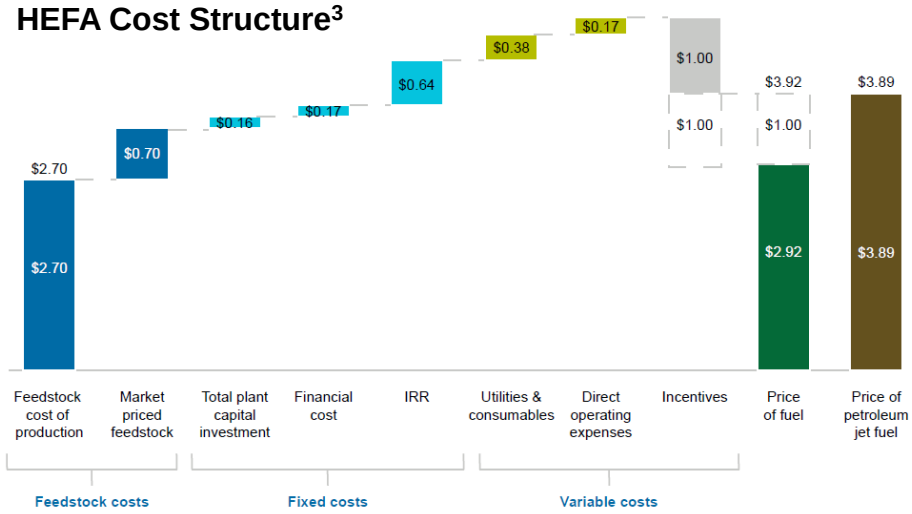
Environmental and Economic Analyses

- Environmental analyses
  - Focus on well-to-wake GHG, including climate impacts of combustion emissions
  - Results incorporated into ANL GREET model and EPA analysis
- Economic analyses
  - Techno economic analysis that are coordinated with DoE efforts
  - Identifying opportunities for cost reduction
  - Examining production scenarios
- Research being conducted by PARTNER Center of Excellence[1]

Life Cycle GHG Emissions[2]



HEFA Cost Structure[3]



1. http://partner.mit.edu/projects/environmental-cost-benefit-analysis-alternative-jet-fuels
2. http://greet.es.anl.gov/files/aviation-lca
3. http://www.masbi.org/content/assets/MASBI_Report.pdf

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Commercial Aviation Alternative Fuels Initiative

- Public-Private coalition for commercial aviation to engage the emerging alternative fuels industry
- Goal is development of non-petroleum jet fuel production with:
  - Equivalent safety & performance (drop-in)
  - Comparable cost
  - Environmental improvement
  - Security of energy supply for aviation

CAAFI®
COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE

- Enables diverse stakeholders to build relationships, share and collect data, identify resources, and direct research, development and deployment of alt jet fuels

CAAFI Comprehensive Approach

- **Addressing challenges to adoption**
- **Engaging at state/regional & international level**

Environmental Team

Life Cycle GHG, Particulate Matter, Sustainability

Certification-Qualification Team

ASTM D7566

R&D Team

Multiple "Drop-in" Solutions

Business & Economics Team

Facilitate Deployment, Investment

Future FAA Alternative Jet Fuel Activities

FAA CoE program (University Research)

Center of Excellence for Alternative Jet Fuel & Environment

- Continues research carried out by PARTNER CoE
- Ten technical areas – include feedstock, infrastructure
- Address strategic needs and gaps
- Solicitation closed and evaluations are complete
- On schedule to have center operational in 2013

Continuous Lower Energy, Emissions and Noise (CLEEN) II

- CLEEN I: 2010-2015 effort
- CLEEN II: solicitation 2014; start May 2015-2020.
- Reduce aircraft fuel burn, emissions and noise & advance Alternative Jet Fuels

Observations

- Government & Industry leadership has led to significant successes
  - Drawing focus to aviation
  - Aerospace manufacturers acceptance of alt fuels
  - ASTM approvals of two alt jet fuels
  - Inclusion of alt jet fuels in life-cycle models (GREET)
  - Increased interagency coordination & collaboration
- Near term next steps
  - Continued Testing & Analysis
  - Coordinate Domestic and International Stakeholders
  - Facilitate State & Regional Deployment

Closing Thoughts:

- Alternative jet fuels are a key component of FAA strategy in meeting environmental goals
- FAA efforts are directed to overcoming key challenges via testing, analysis and coordination
- CAAFI, a public-private partnership, helping to catalyze promising, renewable jet fuel technologies

Thank you

Dr. Jim Hileman

Chief Scientific and Technical Advisor for Environment and Energy

Office of Environment and Energy, Federal Aviation Administration

Email: james.hileman@faa.gov