Sustainable Alternative Jet Fuels

FAA Overview: R&D Activities and Coordination Efforts

Presented to: ACCESS-2, Public Data Workshop
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Outline

• Vision & Approach
• FAA Activities
  – Testing
  – Analysis
  – Coordination
• Summary
Aviation Environmental Challenges

- Aviation impacts community noise, air quality, water quality, energy usage, and climate change
- Environmental impacts from aviation emissions 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
  - Absolute reduction of significant air quality impacts, notwithstanding aviation growth
  - 1 billion gallons of renewable jet fuel in use by aviation by 2018
U.S. Climate Action Plan for Aviation

The U.S. is pursing a multipronged 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
Alternative Fuels Principles – U.S. Vision

• Alternative Jet Fuels must be drop in, have equivalent safety and better environmental performance than petroleum Jet fuel
• Enable all possible fuels that meet criteria
• Government role to address key barriers
• Work through Public-Private Partnerships
• Address the whole supply chain
• Leverage expertise and resources of other government agencies and other countries
• Aviation should be a lead user of alternative fuels
FAA Programs supporting Alternative Jet Fuels

Aviation Sustainability Center (ASCENT)
- Center of Excellence for Alternative Jet Fuels and Environment

Continuous Lower Energy, Emissions and Noise (CLEEN)
- Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels

Commercial Aviation Alternative Fuels Initiative (CAAFI)
- Public-Private coalition for commercial aviation to engage the emerging alternative fuels industry
Continuous Lower Energy, Emissions and Noise (CLEEN) Program

• FAA R&D Program:
  – Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels
  – 1:1 minimum cost share requirement

• CLEEN I: 2010-2015 ($125M FAA Funding)
  – Alternative Jet Fuel Projects with Boeing, Rolls Royce, Pratt & Whitney, and Honeywell

• CLEEN II: 2015-2020 ($100M FAA Funding)
  – Industry Day - December 3, 2013 in Washington DC
  – Solicitation open until February 2, 2015
  – More information available at: https://faaco.faa.gov/index.cfm/announcement/view/18077
Lead Universities:
• Washington State University (WSU)*
• Massachusetts Institute of Technology (MIT)

Core Universities:
• Boston University (BU)
• Georgia Institute of Technology (Ga Tech)
• Missouri University of Science and Technology (MS&T)
• Oregon State University (OSU)*
• Pennsylvania State University (PSU)*
• Purdue University (PU)*
• Stanford University (SU)
• University of Dayton (UD)
• University of Hawaii (UH)*
• University of Illinois at Urbana-Champaign (UIUC)*
• University of North Carolina at Chapel Hill (UNC)
• University of Pennsylvania (UPenn)
• University of Tennessee (UT)*
• University of Washington (UW)*

* Denotes USDA NIFA AFRI-CAP Leads and Participants & Sun Grant Schools
FAA Alternative Jet Fuel Activities

• Testing
  ▪ Support Cert/Qual testing
  ▪ Improve Cert/Qual process
  ▪ Emissions measurements

• Analysis
  ▪ Environmental sustainability
  ▪ Techno-economic analysis
  ▪ Future scenarios

• Coordination
  ▪ Interagency
  ▪ Public-Private
  ▪ State & Regional
  ▪ International
FAA Alternative Jet Fuel Activities

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Fuel Qualification Support

Support ASTM Intl evaluation of alternative jet fuels

- Support ASTM D4054 testing activities to enable development of data for fuel approval
- ASTM Research Report Review
- Streamline ASTM Intl jet fuel approval process via the National Jet Fuel Combustion Program
Emissions Measurements

- Supporting teams at Stanford and ARI to examine ACCESS results as well as MIT and PSU to examine test data to understand how fuel composition effects emissions.

- PARTNER developing relationship for black carbon emissions based on engine thrust and fuel aromatic content \(^1\).

- Expanding knowledge to include alternate jet fuels that have aromatic content (e.g., HDCJ).

Preliminary PARTNER Project 47 research results (http://partner.aero) – DO NOT CITE OR QUOTE
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Environmental Analyses

• Environmental analyses
  – Focus on well-to-wake (WTW) life cycle GHG emissions
  – Results incorporated into ANL GREET model\(^1\) and EPA analysis
  – Examining climate impacts from change in combustion emissions

• Recent life cycle GHG work\(^2\)
  – Tallow and waste oils for HEFA
  – Advanced fermentation of sugars, starches, and switchgrass

• Water footprint analysis\(^3\)
  – Examined water footprint of all fuels considered for LC GHG emissions
  – Fuel use on same order of magnitude as conventional jet fuel unless irrigation is used

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1. ANL GREET model available at http://greet.es.anl.gov/files/aviation-lca
3. PARTNER Project 47 (partner.aero): Staples et al. 2013
Economic Analyses

- **Techno-Economic Analysis**
  - Computing minimum selling price (MSP) for n\(^{th}\) plant
  - Using discounted cash flow rate of return method

- **Effort is focused on identifying ways to reduce production costs**

- **Lower feedstock costs**
  - HEFA production from rotation crop such as pennycress\(^1\)
  - Advanced fermentation using sugar cane\(^2\)

- **Modify product slate**
  - For HEFA, maximizing jet fuel production requires $0.25 to $0.30 per gallon more than maximizing diesel fuel to break even\(^3\)
  - Maximizing biochemicals makes certain jet fuel production pathways economical\(^4\)

- **Utilizing brownfield facilities reduces production costs\(^2,3\)**

Research results can be found at [http://partner.aero/](http://partner.aero/):

1. Project 31 – Winchester et al. 2013
2. Project 47 – Staples et al. 2014
3. Project 28 – Pearlson et al. 2013
4. Project 47 – Bond et al. 2014
ASCENT Alternative Jet Fuel Supply Chain Project

• Examine the barriers to the large scale production of alternative jet fuels via the full range of pathways being considered for ASTM approval

• Considering the entire supply chain:
  – feedstock production, transportation, and conversion
  – jet fuel and co-products,
  – blending and jet fuel use by aviation
  – quantify competition for resources along the supply-chain by other sectors

• Considering Project Contributions
  – Aimed at a holistic evaluation of pathways and resources
  – Incorporate social, economic, and environmental considerations
  – In context of current policy environment
Research Team

• ASCENT Universities:
  – Washington State (M. Wolcott)
  – Penn State (P. Smith)
  – U. Illinois (J. Endres)
  – U. Tennessee (T. Rials)
  – Penn State (T. Richard)
  – MIT (R. Malina)
  – Purdue (W. Tyner)

• National Labs:
  – DOT Volpe Center
  – Argonne National Lab

• Cost share support:
  – Biojet Canada (TC funded effort)
  – ITAKA (CLH Aviation, EC funded effort)
  – Delta Airlines
  – Byogy
  – Monsanto

• Universities represented:
  – USDA AFRI Coordinated Agricultural Projects
    – Northwest Advanced Renewables Alliance (NARA via WSU)
    – Northeast Woody/Warm-season Biomass Consortium (NEWBio via PSU)
  – Sun Grant Partnership
  – Bioenergy Science Center (via U. Illinois)
Objectives

1. **Develop information on regional supply chains**
   – Scenarios of future alternative jet fuel production
   – Outputs will be used as inputs to a regional supply chain analysis tool (AFTOT) being developed by the Volpe Center

2. **Identify the key barriers in regional supply chains that must be overcome**
   – to produce 1 billion gallons of alternative jet fuel by 2018 and
   – an order of magnitude larger production in the longer term

3. **Support International Civil Aviation Organization (ICAO Committee on Aviation Environmental Protection (CAEP) Alternative Fuel Task Force (AFTF)**
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  ▪ State & Regional
  ▪ International
Commercial Aviation Alternative Fuels Initiative (CAAFI)

• Public-Private coalition for commercial aviation to engage the emerging alternative fuels industry

• Enable development of alt jet fuels:
  – Equivalent safety/performance (drop-in)
  – Comparable cost
  – Environmental improvement
  – Security of Energy supply

• Four teams for key issues:
  – Environment Team
  – Certification-Qualification Team
  – R&D Team
  – Business Team

• State and Regional Support

• International Cooperation
Coordinate USG Efforts Across the Supply Chain

- **Feedstock Production**
- **Feedstock Logistics**
- **Fuel Conversion**
- **Conversion Process Scale-up/Integration**
- **Fuel Testing / Approval**
  - Fuel Performance | Environment Assessment
- **Enable Production**
- **End User/Buyer**

**Agriculture:** Biomass Crop Assistance Program & Crop Insurance Program

**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

**Defense & Airlines:** fuel purchase

**FAA:** Guidance for Airports

**Energy:** R&D

**USDA**

**Energy:** R&D

**EPA:** Renewable Fuel Standard

**FAA, Defense, & NASA:** Enviro Analysis

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**EPA:** Renewable Fuel Standard
National Alternative Jet Fuels (AJF) R&D Strategy (in development)

**Intended Purpose**
Identify opportunities and strategically address challenges associated with Research, Development, Demonstration, and Deployment (RD3) along the development path of alternative jet fuels.

**R&D Goals & Objectives**
- Feedstock Development, Production, and Logistics
- Fuel Conversion and Scale-Up
- Fuel Testing and Evaluation
- Integrated Challenges

An undertaking by Aeronautical Science and Technology Subcommittee of the OSTP/NSTC with input from stakeholder community.

8 participating Departments & Agencies: USDA, DOC, DOD, NASA, FAA, DOE, EPA, NSF, DOS
Farm to Fly 2.0

... “THEREFORE, AS OUR GOAL, we the undersigned, jointly signify our intent to continue working together over the next five years in an expanded collaboration entitled “Farm to Fly 2.0”, to enable commercially viable, sustainable bio-Jet Fuel supply chains in the U.S. that are able to support the goal of one billion gallons of bio-Jet Fuel production capacity and use for the Aviation Enterprise by 2018”
CAAFI State & Regional Deployment

- Working with local lead organizations/POCs
- Provide context, advice, strategy, benchmarking
- Facilitate networks & links between stakeholders
- Link to Farm to Fly 2.0

* Does not include Dept. of Energy Pilot Projects, Defense Production Act Projects, map credit to diymaps.net.
International Engagement

• Bilateral Cooperation Agreements
• Informal coordination with counterpart organizations
• International Civil Aviation Organization
Summary

• Alternative jet fuels are a key component of U.S. strategy for meeting aviation environmental goals

• FAA efforts are directed to overcoming key challenges via testing, analysis and coordination

• Multiple programs and activities focus on different aspects of the challenge

• Partnerships across technical areas are a key focus

• Strong domestic and international coordination necessary for success
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