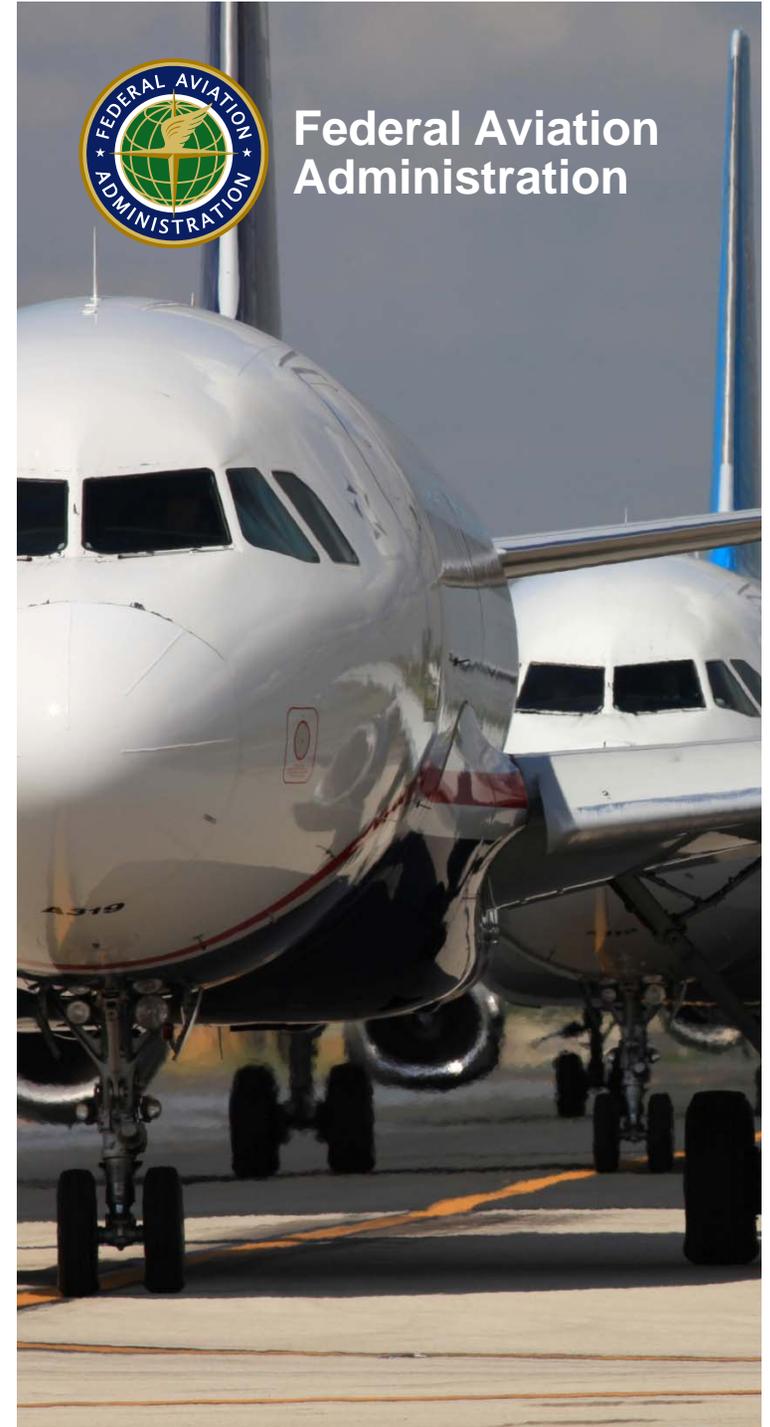


FAA Alternative Jet Fuels R&D Update

To: CLEEN Consortium Meeting

By: Nate Brown
Alternative Jet Fuel Project
Manager, FAA Office of
Environment and Energy

Date: November 19, 2014



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 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

- **Testing**

- Support Cert/Qual testing
- Improve Cert/Qual process
- Emissions measurements

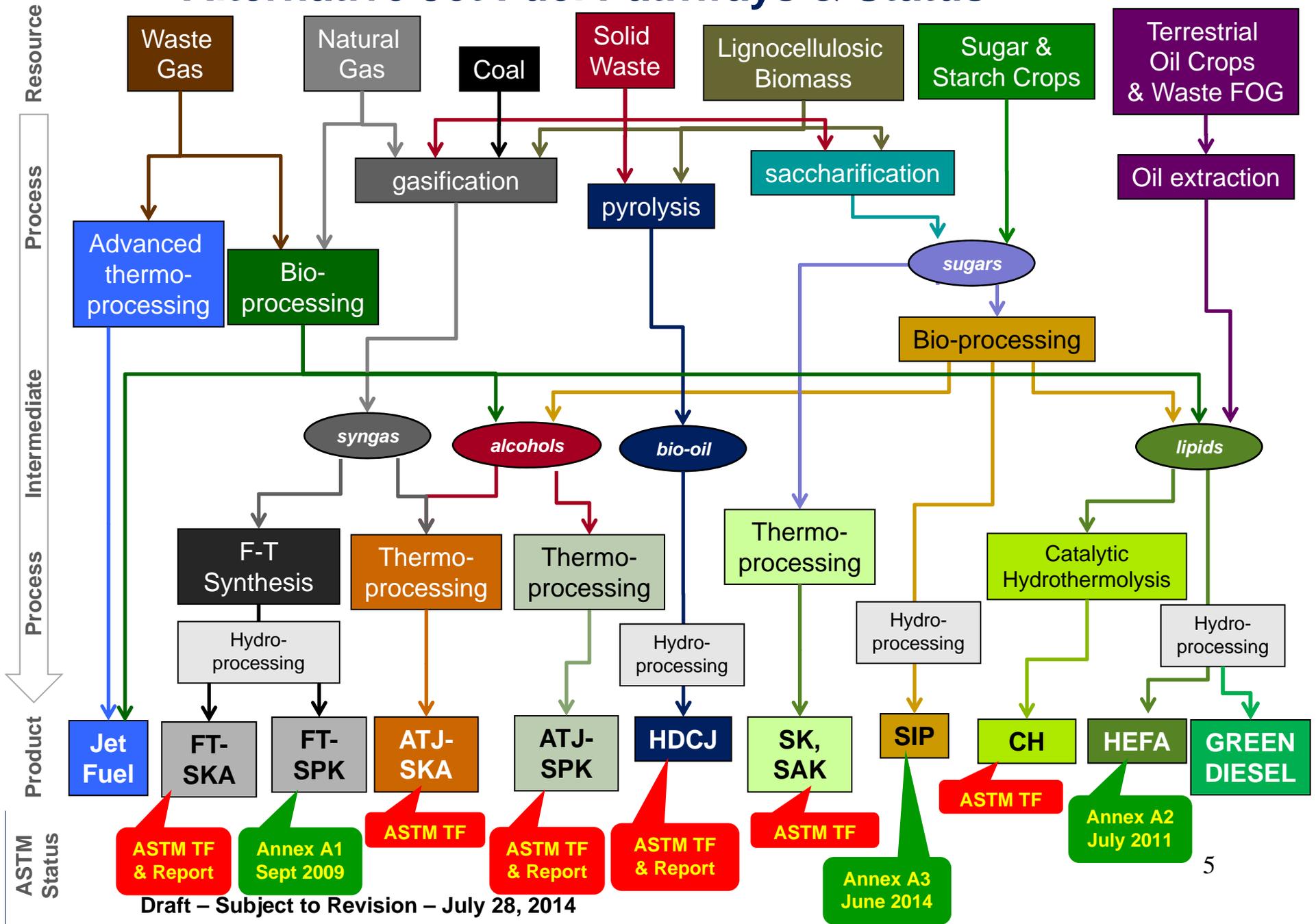
- Support evaluation of fuels for ASTM approval
- Reduce test cost and time for qualification

- **Coordination**

- Interagency
- Public-Private
- State & Regional
- International



Alternative Jet Fuel Pathways & Status



Fuel Qualification Support

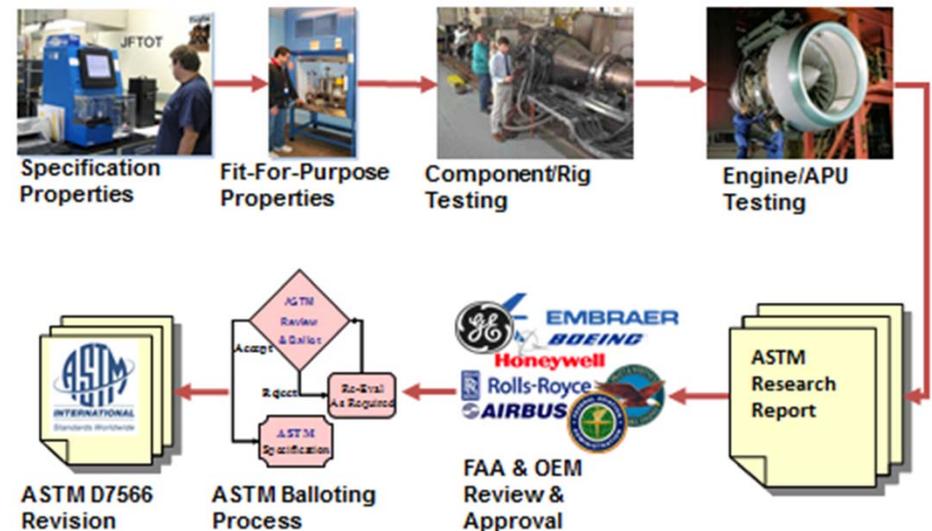


Support ASTM Intl evaluation of alternative jet fuels



- Support ASTM D4054 testing activities to enable development of data for approvals
 - CLEEN
 - BAA
 - ASCENT Project 31
- Research Report Review
 - CLEEN

Aviation Fuel Qualification (ASTM D4054 Process)



CLEEN has been instrumental



Federal Aviation
Administration

National Jet Fuels Combustion Program

Streamline ASTM International jet fuels approval process

- **Challenges to Alternative Fuel Approval Process**
 - Cost/duration of fuel approval process
 - Fuel quantities for rig/engine tests
 - OEMs uncertainty over effects of novel fuel composition and chemistry on combustor operability
- **Proposed Solution**
 - Develop generic fuel composition/chemistry evaluation methodology
 - Standardized rig/lab tests
 - Chemical kinetic/combustion modeling
 - Collaborative OEM/university/federal effort



NIST



Honeywell

Rolls-Royce

Williams International



Federal Aviation
Administration



ASCENT C/Q Projects (FY14)

- **P25 NPCJF Area 1- Chemical Kinetic Combustion**
- **P26 NPCJF Area2 -Chemical Kinetic Modeling**
- **P27 NPCJF Area 3 - Advanced Combustion Test**
- **P28 NPCJF Area 4 - Combustion Modeling**
- **P29 NPCJF Area 5 - Atomization Testing**
- **P30 NPCJF Area 6 - Referee Swirl Stabilized Combustor Evaluation**
- **P31 Alternative Jet Fuel Test and Evaluation**
- **P34 NJFCP Area 7 - Overall Program Integration and Analysis**



FAA Alternative Jet Fuel Activities

- **Testing**

- Support Cert/Qual testing
- Improve Cert/Qual process
- Emissions measurements

- **Analysis**

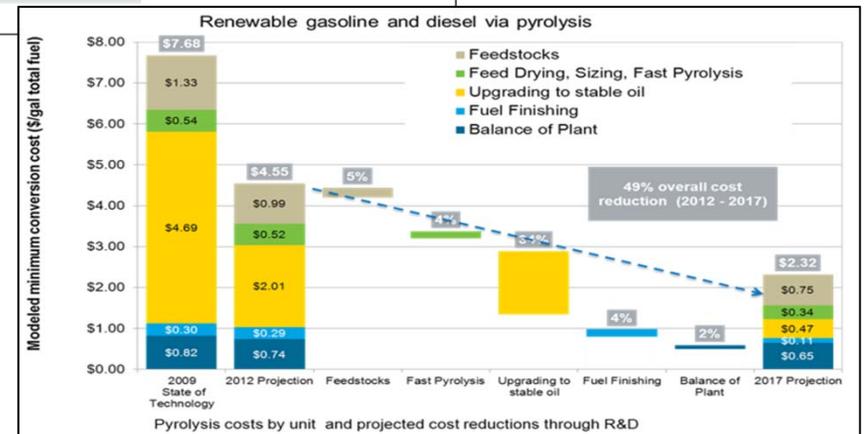
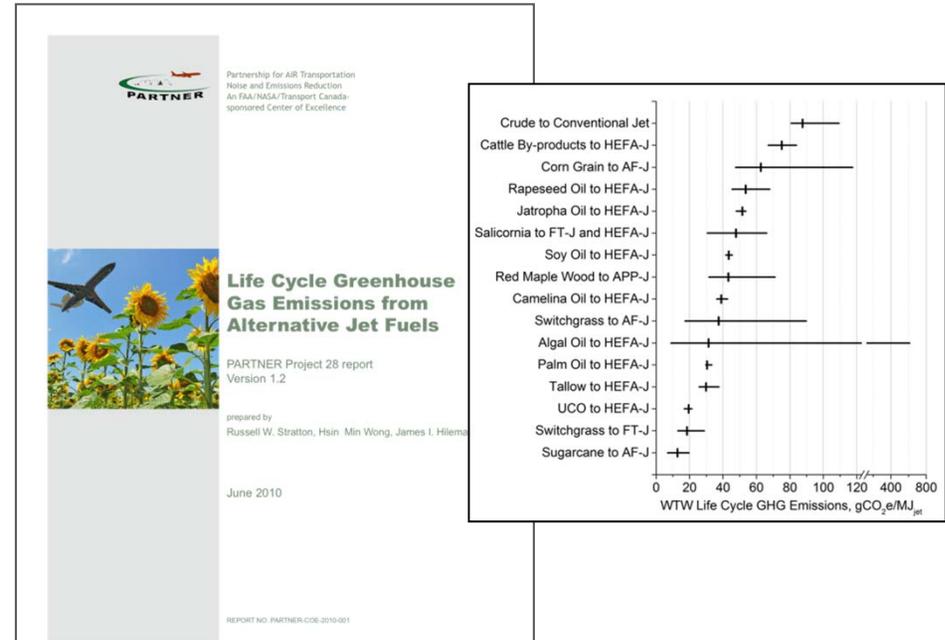
- Environmental sustainability
- Techno-economic analysis
- Future scenarios

- Improve understanding of environmental and economic sustainability of alternative jet fuel pathways
- Improve understanding of the potential availability of alternative jet fuels



Alt Jet Fuel Emissions & Cost studies

- PARTNER Jet Fuel LCA Studies*
 - Focus on well-to-tank GHG and combustion CO₂
 - Emphasize influential aspects of fuel production on GHG emissions
 - Results are component of models and EPA analysis
- Alternative Fuel PM emissions
 - Coordinated with NASA, DOD
- Alt Jet fuel cost estimation
 - Multiple pathways
 - Identify opportunities for cost reduction
 - Coordinated with DOE studies



From DOE EERE Office of the Biomass Program

*<http://web.mit.edu/aeroastro/partner/reports/proj28/partner-proj28-2010-001.pdf>



Federal Aviation Administration

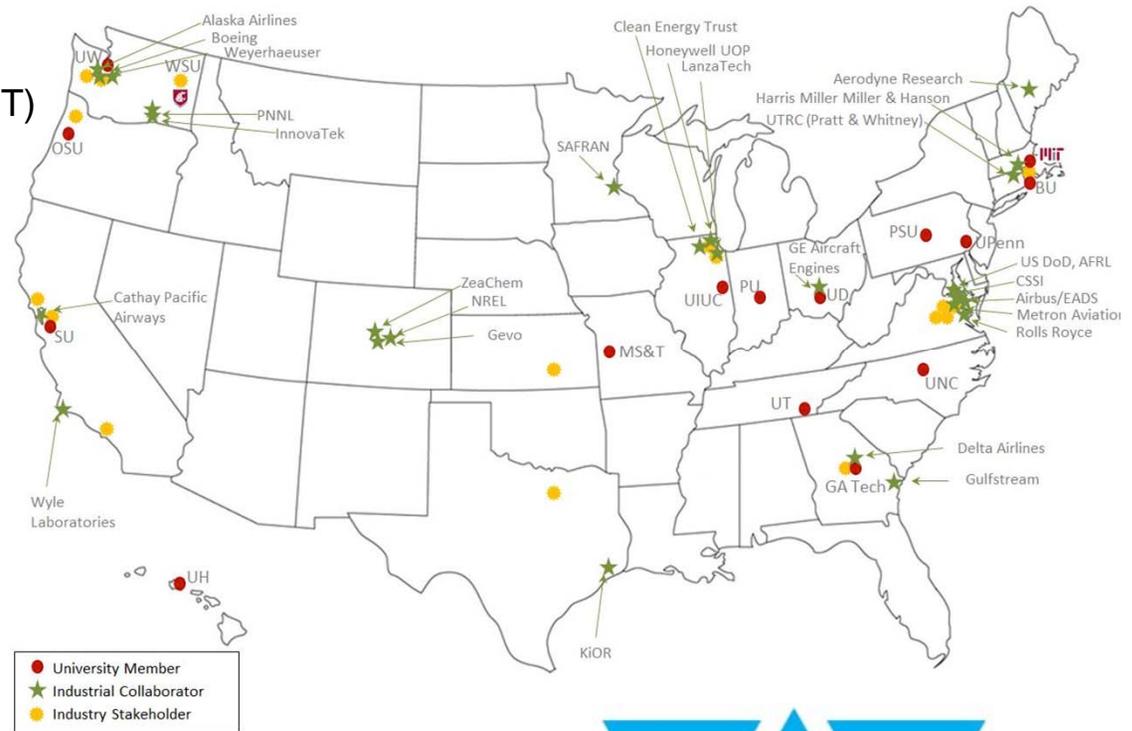
FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT

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

ASCENT P1 Alternative Jet Fuel Supply Chain Analysis

Objectives

- Develop information on regional supply chains for use in scenarios of future alternative jet fuel production
- Identify the key barriers in regional supply chains that must be overcome to produce 1 billion gallons of alternative jet fuel by 2018
- Support the Alternative Fuel Task Force (AFTF) of the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP)



ASCENT Alternative Jet Fuel Supply Chain Analysis

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)
- **Universities represented:**
 - Sun Grant Partnership
 - USDA AFRI Coordinated Agricultural Projects
 - Northwest Advanced Renewables Alliance (NARA via WSU)
 - Southeast Partnership for Integrated Biomass Supply Systems (IBSS via U. Tennessee)
 - Northeast Woody/Warm-season Biomass Consortium (NEWBio via PSU)
 - Bioenergy Science Center (via U. Illinois)
- **Kick-off Meeting – held in October:**
 - Team, CAAFI, Airlines 4 America, USDA, DOE, DLA-Energy, US Navy, and AFRL
- **National Labs:**
 - Volpe, ANL (already onboard)
 - *INL, NREL, ORNL, PNNL (as possible)*
- **Cost share support:**
 - Biojet Canada (TC funded effort)
 - ITAKA (CLH Aviation, EC funded effort)
 - Delta Airlines
 - Byogy
 - Monsanto



ASCENT Alternative Jet Fuel Supply Chain Analysis Project Layout

AJF Supply Chain Assessment





ASCENT Analysis Projects (FY14)

- **P1 Alternative Jet Fuel Supply Chain Analysis**
- **P13 ACCESS 2 Micro Physical Modeling with NASA**
- **P24 Emissions Data Analysis for CLEEN, ACCESS, and Other Recent Tests**
- **P32 Worldwide Life Cycle Analysis (LCA) of Greenhouse Gas (GHG) Emissions from Petroleum Jet Fuel**
- **P33 Alt jet fuel test data library**



FAA Alternative Jet Fuel Activities

- Complement and leverage work of other U.S. agencies
- Complement and leverage work of private sector
- Support state/regional supply chain development and deployment
- Complement and leverage work of international partners

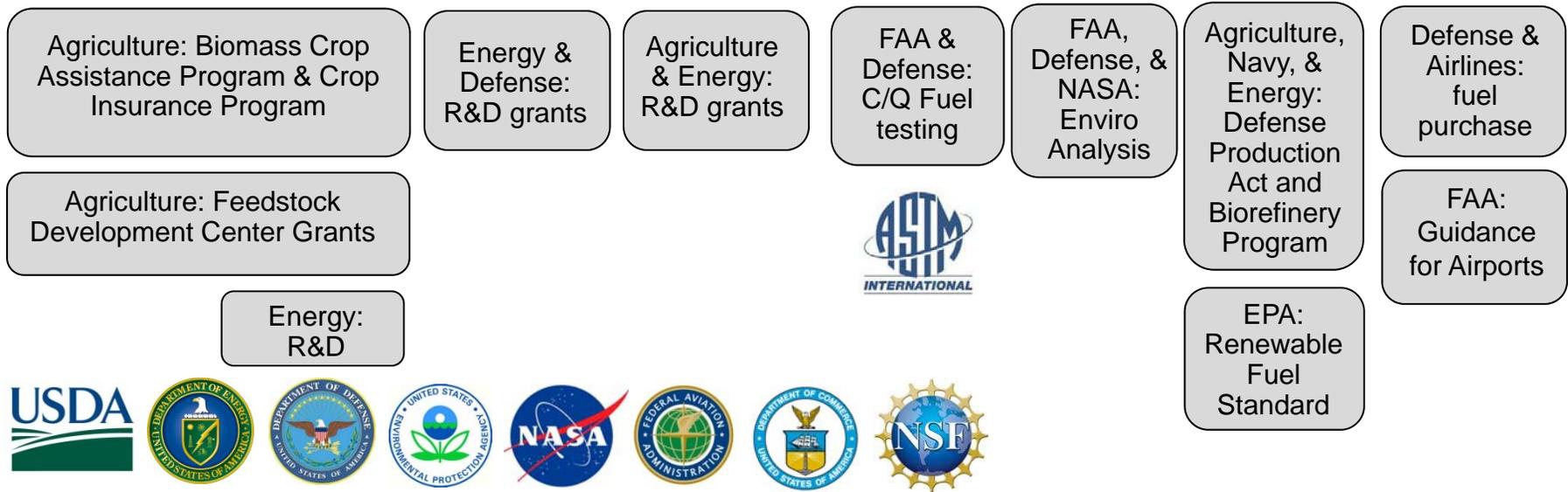
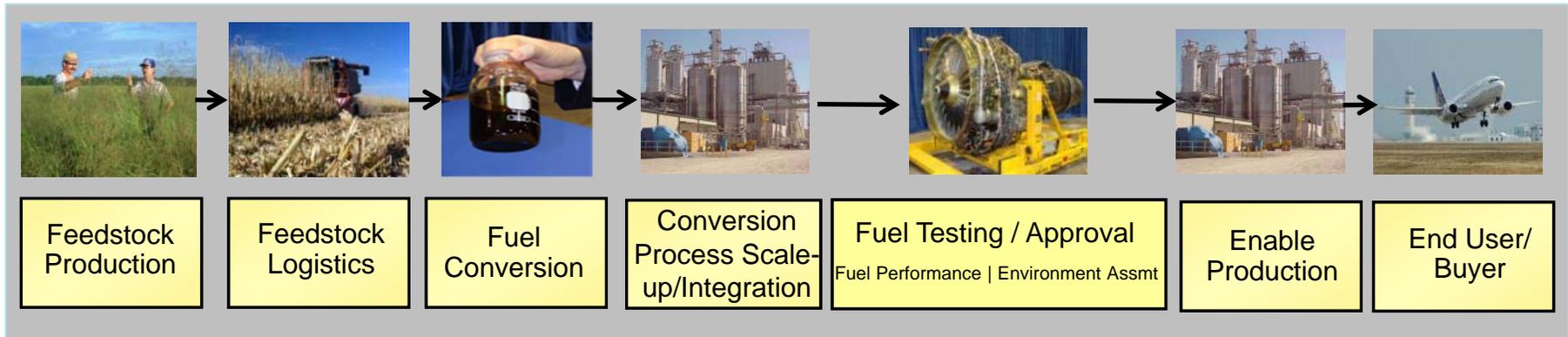
- Future scenarios

• Coordination

- Interagency
- Public-Private
- State & Regional
- International



U.S. Government Efforts Across the Supply Chain



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



Federal Aviation
Administration

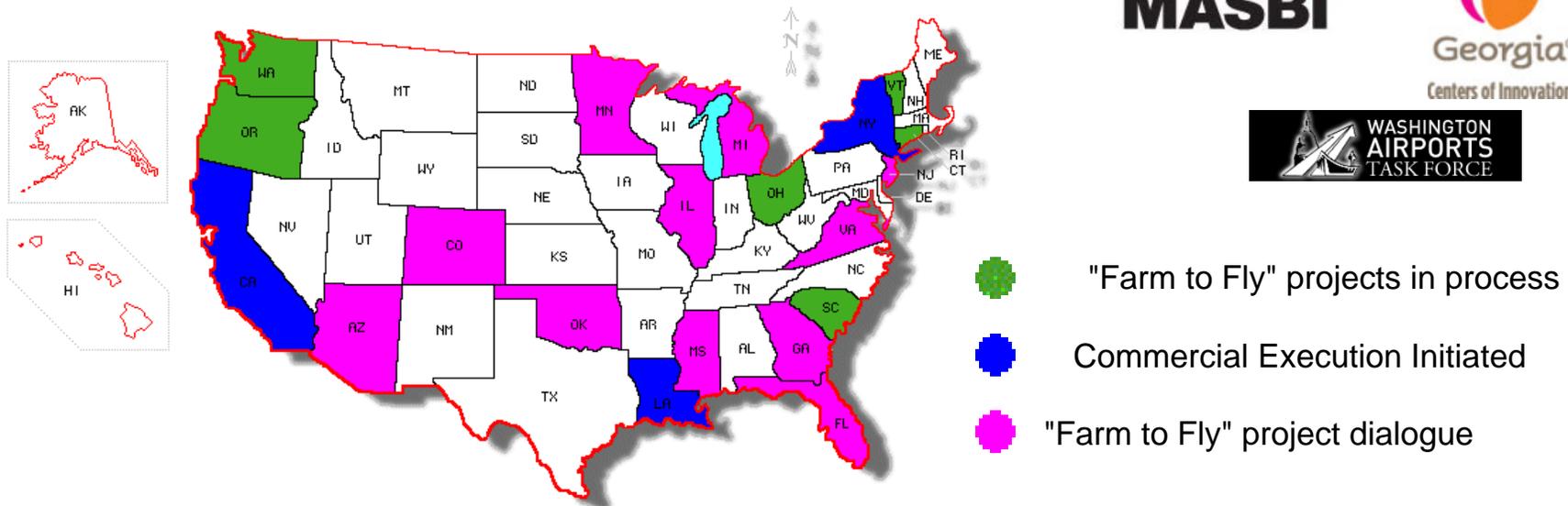
Farm to Fly 2.0

... “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.



Coordinating with International Efforts



CAAFI



ABRABA/SABB



SWAFEA/Alfabird



Australia / AISAF



ICAO



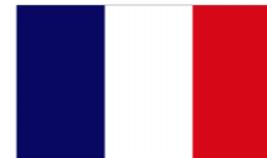
Aireg



SENASA/ITAKA



Sky NRG



IFP Energy Nouvelle



- **Formal and informal coordination**
 - International Airshows
 - Workplans - Bilateral Cooperation Agreements
 - Coordination with R&D organizations
 - Global Exchange meeting
- ICAO as forum for exchange



Alt Fuels Development Progress 2014

- **ASTM approval of SIP fuels (June 2014), additional ballots under preparation**
- **Engine tests of novel fuels completed**
- **ASCENT analysis projects established**
- **Continued domestic and international engagement**



Defense Production Act Update

- **\$510 million commitment by USDA, DOE and U.S. Navy**
- **In 2013 4 Phase 1 awards made to Emerald Biofuels; Nature's Bioreserve; Fulcrum Bioenergy; Red Rock Biofuels**
- **In September 2014 Phase 2 awards made to Emerald Biofuels; Fulcrum Bioenergy and Red Rock Biofuels**
- **100 million gallons of drop-in diesel and jet fuel to start production by 2016**
- **Cost competitive -- weighted average price in 2013 dollars <<\$4/gal**



Airline offtake agreements...announced thus far



**5 M gpy
from 2014**



**Supply
in 2018**



370M usg



**180M usg
over 11 years**



RED ROCK BIOFUELS



3 M gpy

Alt Fuels Progress Anticipated in 2015

- **Continue support to ASTM approval of additional fuel pathways**
- **Work to improve testing methods to reduce cost and time of Certification / Qualification over longer term**
- **Continue Analysis in support of deployment**
- **Continue domestic and international engagement**
- **CLEEN II**



Summary

- Alternative jet fuels are a key component of FAA strategy in meeting environmental goals
- R&D efforts making progress on overcoming key challenges via testing, analysis and coordination
- Multiple programs and activities:
 - Commercial Aviation Alternative Fuels Initiative (CAAIFI)
 - Continuous Lower Energy, Emissions and Noise (CLEEN) Program
 - Aviation Sustainability Center (ASCENT)
 - Farm to Fly 2.0
- Strong domestic and international coordination





Nate Brown

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Federal Aviation Administration

Office of Environment and Energy

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CLEEN 2 Alt fuels proposal areas

- A) Alternative Jet Fuel Test and Evaluation – Proposed Capabilities, To-Be-Determined Fuels
- B) Alternative Jet Fuel Test and Evaluation – Proposed Capabilities and Fuel(s)
- C) Alternative Fuels Analytical Method Development and Specification Research
- D) Support for the Alternative Jet Fuel Evaluation and Specification Development Process

