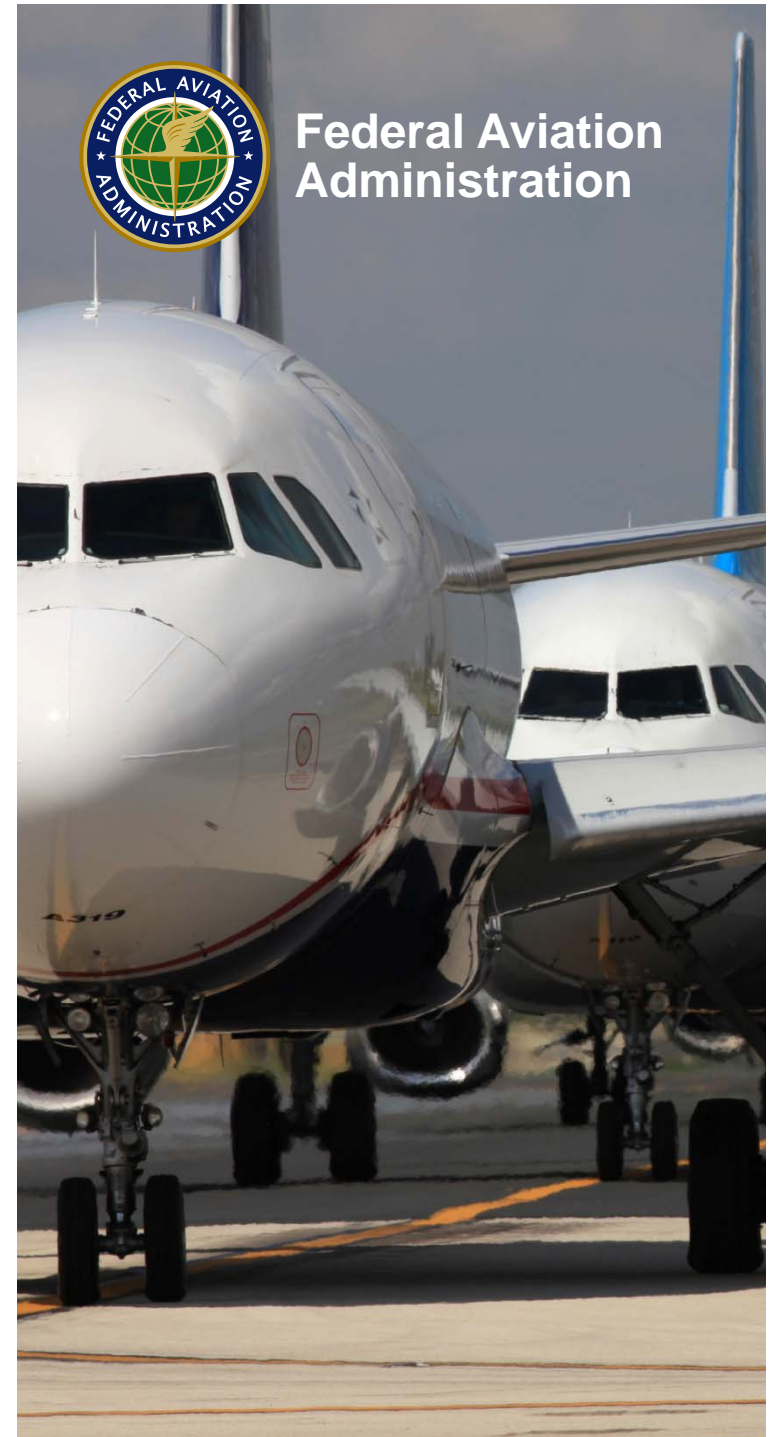


Alternative Jet Fuels Research Overview

Presented to: REDAC

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CLEEN Program
Environment and Energy
Federal Aviation Administration

Date: March 26, 2014



Challenges for Alternative Jet Fuels

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



Alt Fuels Development Progress

- Boeing completed study on seal swell from cycloparaffins
- Engine tests of novel fuels
 - PW615F turbofan testing of 3 fuels completed
 - Honeywell APU testing of 7 fuels underway
 - Cooperative testing of Alcohol-to-Jet fuel with USAF
- One ballot at ASTM, additional ballots under preparation
- Analyses continue on sustainability and techno-economics
- Continued domestic and international engagement
 - CAAFI Biennial General Meeting
 - Farm to Fly 2.0 signed and working group established
 - National Alternative Jet Fuel Strategy under development
 - First alternative jet fuel Global Exchange meeting held
 - ICAO Alternative Fuels Task Force (AFTF)
- Established a system for voluntary reporting of alt fuel use



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
- **Tracking use**



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FAA Alternative Jet Fuel Activities

- **Testing**

- Material compatibility
- Certification / Qualification
- Emissions measurements

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

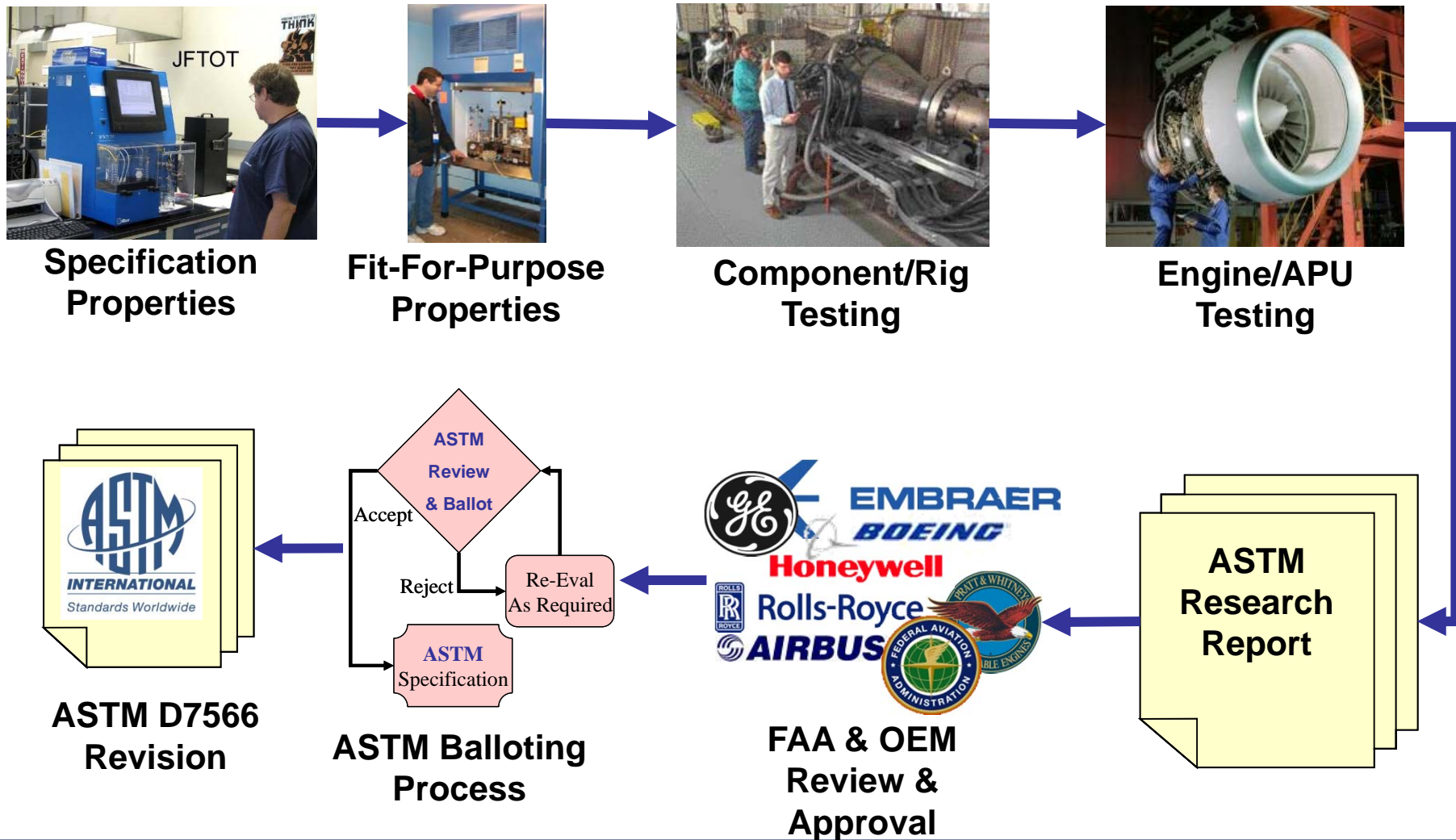
- **Coordination**

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

- **Tracking use**

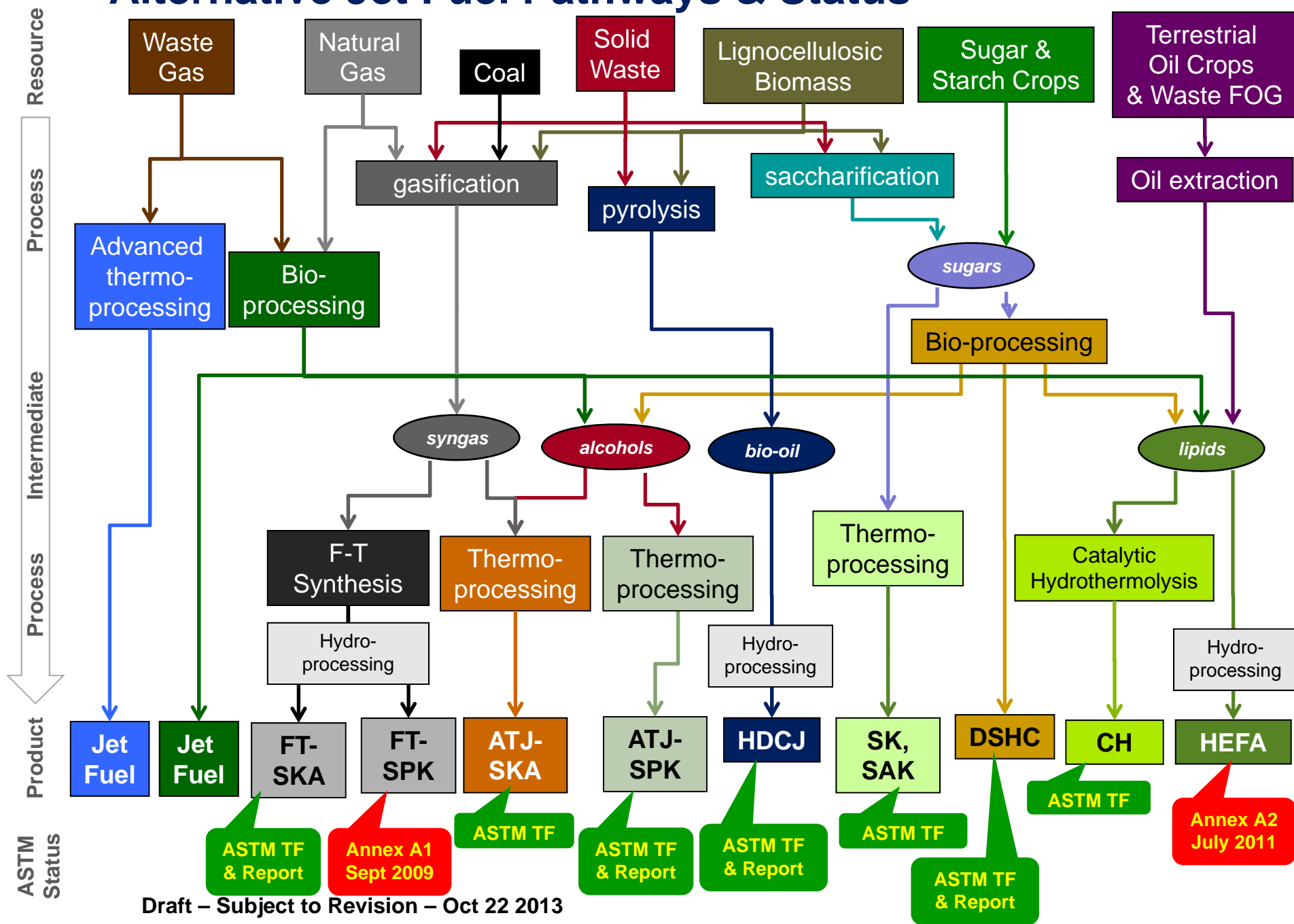


Aviation Fuel Qualification (ASTM D4054 Process)

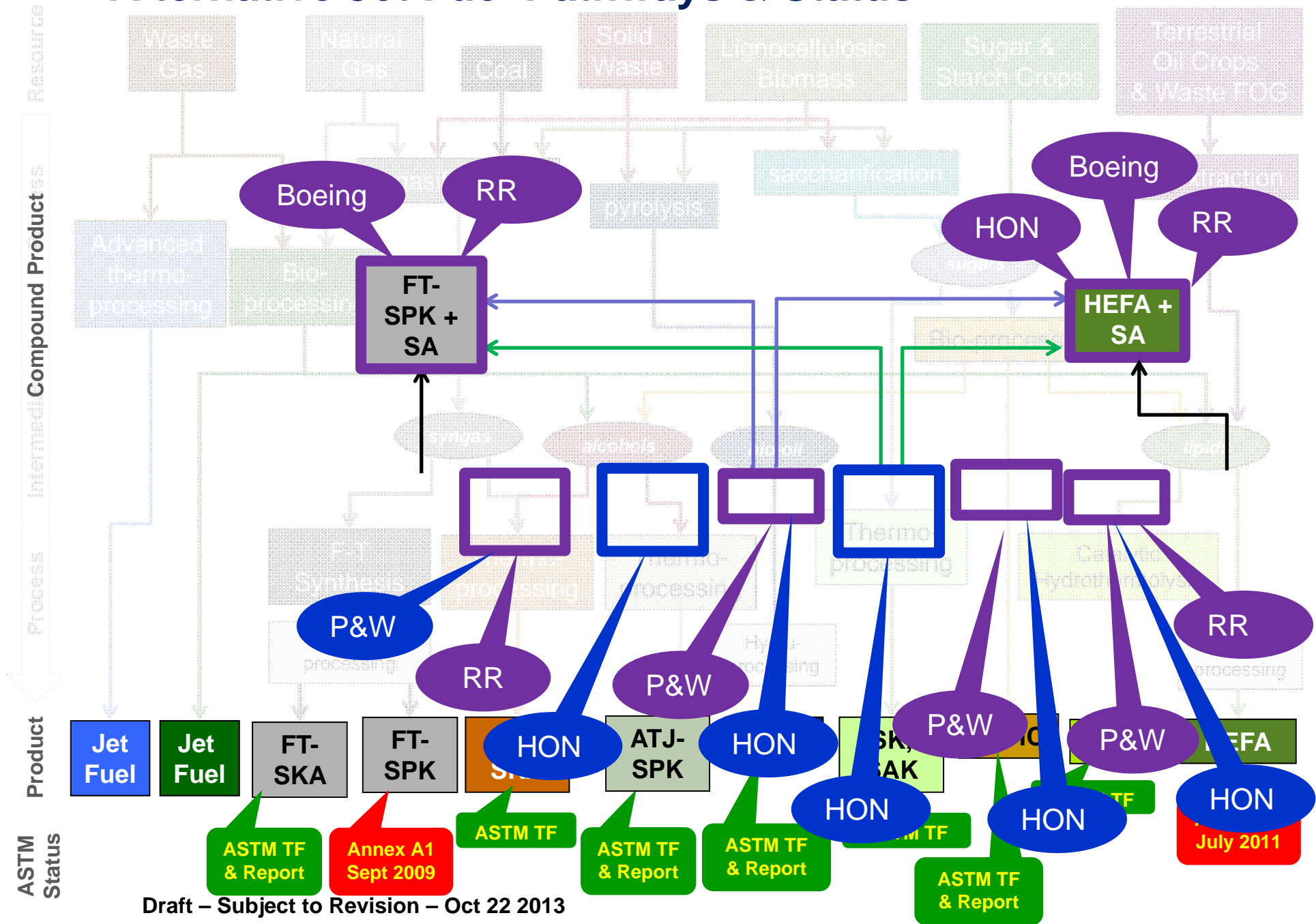


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Alternative Jet Fuel Pathways & Status

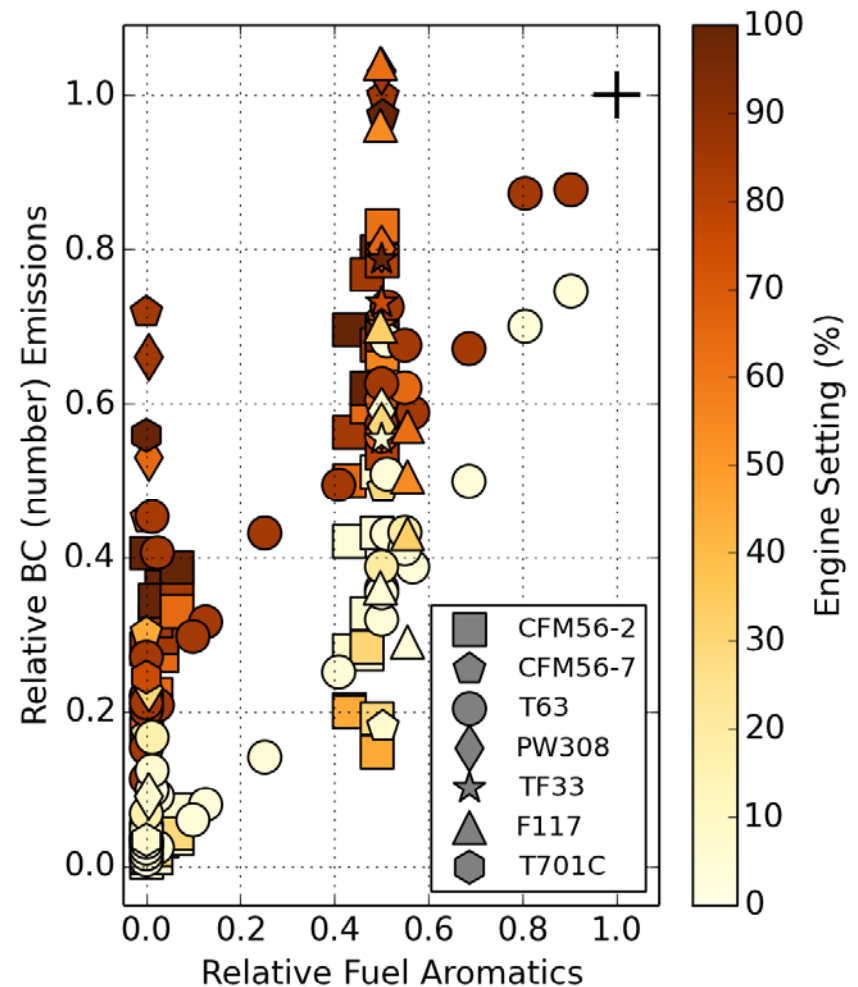


Alternative Jet Fuel Pathways & Status



Emissions Measurements

- PARTNER developing relationship for black carbon emissions based on engine thrust and fuel aromatic content
- Intend to further expand alt jet fuels emissions knowledge using measurements from CLEEN Program and NASA tests
- Expanding knowledge to include alt jet fuels that have aromatic content (e.g., HDCJ)



FAA Alternative Jet Fuel Activities

- **Testing**

- Material compatibility
- Certification / Qualification
- Emissions measurements

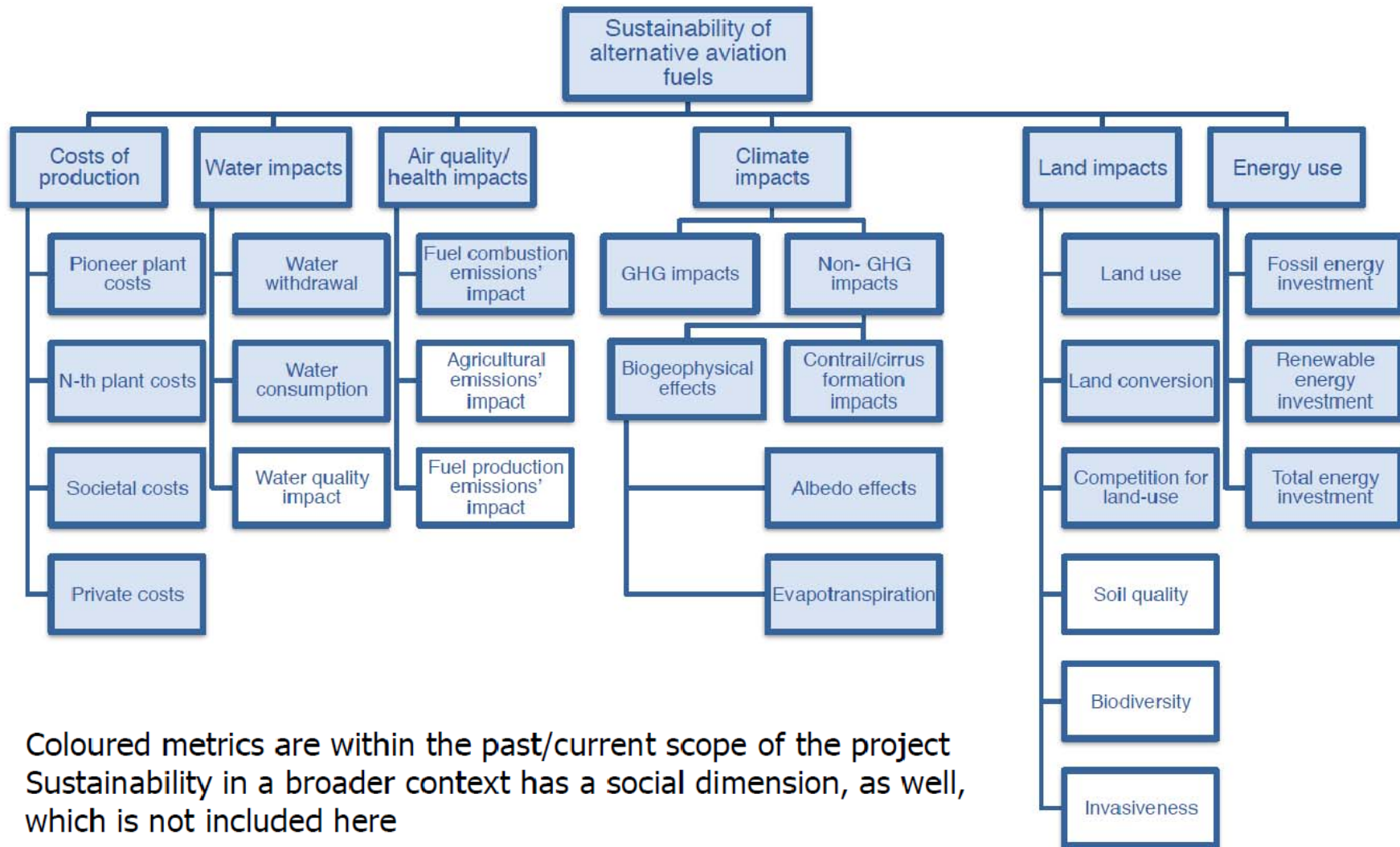
- **Analysis**

- 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 fuel



Alternative Jet Fuel Sustainability

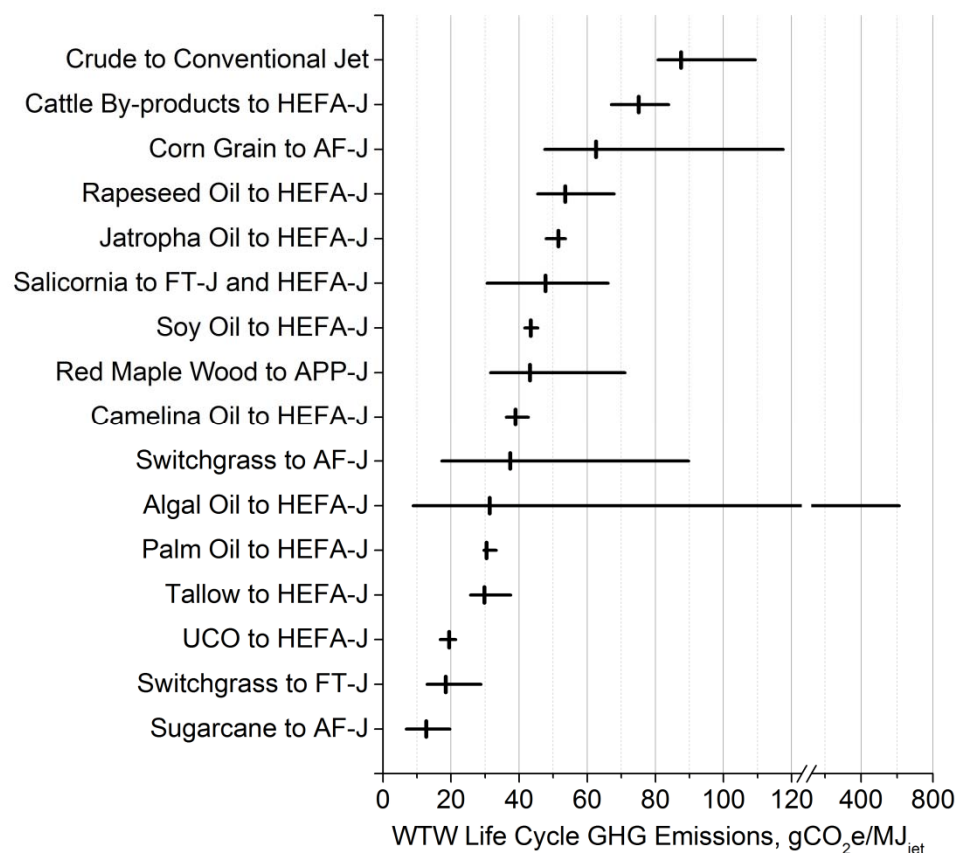


- Coloured metrics are within the past/current scope of the project
- Sustainability in a broader context has a social dimension, as well, which is not included here



Environmental Analyses

- Environmental analyses
 - Focus on life cycle (aka well-to-wake, WTW) GHG emissions
 - Results incorporated into ANL GREET model and EPA analysis
 - Examining climate impacts from change in combustion emissions
- Recent life cycle GHG work:
 - Tallow and waste oils for HEFA
 - Advanced fermentation of sugars, starches, and switchgrass
- Water footprint analysis
 - 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



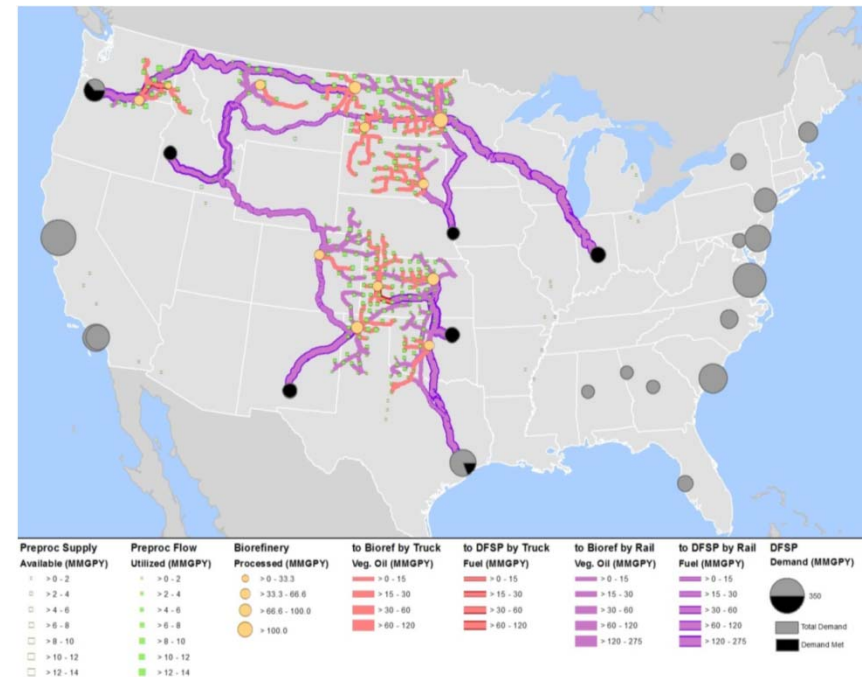
Economic Analyses

- Techno-Economic Analysis (TEA)
 - 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
 - Advanced fermentation using sugar cane
- 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
 - Maximizing biochemicals makes certain jet fuel production pathways economical
- Utilizing brownfield facilities reduces production costs



Estimating Future Alternative Jet Fuel Production

- Volpe Alternative Fuel Transportation Analysis Tool (AFTOT) - co-funded by ONR and FAA
- Ongoing COE work to look at long-term technical potential
- ASCENT Project to evaluate regional supply chain potential
- Work is being leverage for both CAEP Alternative Fuel Task Force (AFTF) and Farm to Fly 2 effort



FAA Alternative Jet Fuel Activities

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

- **Coordination**

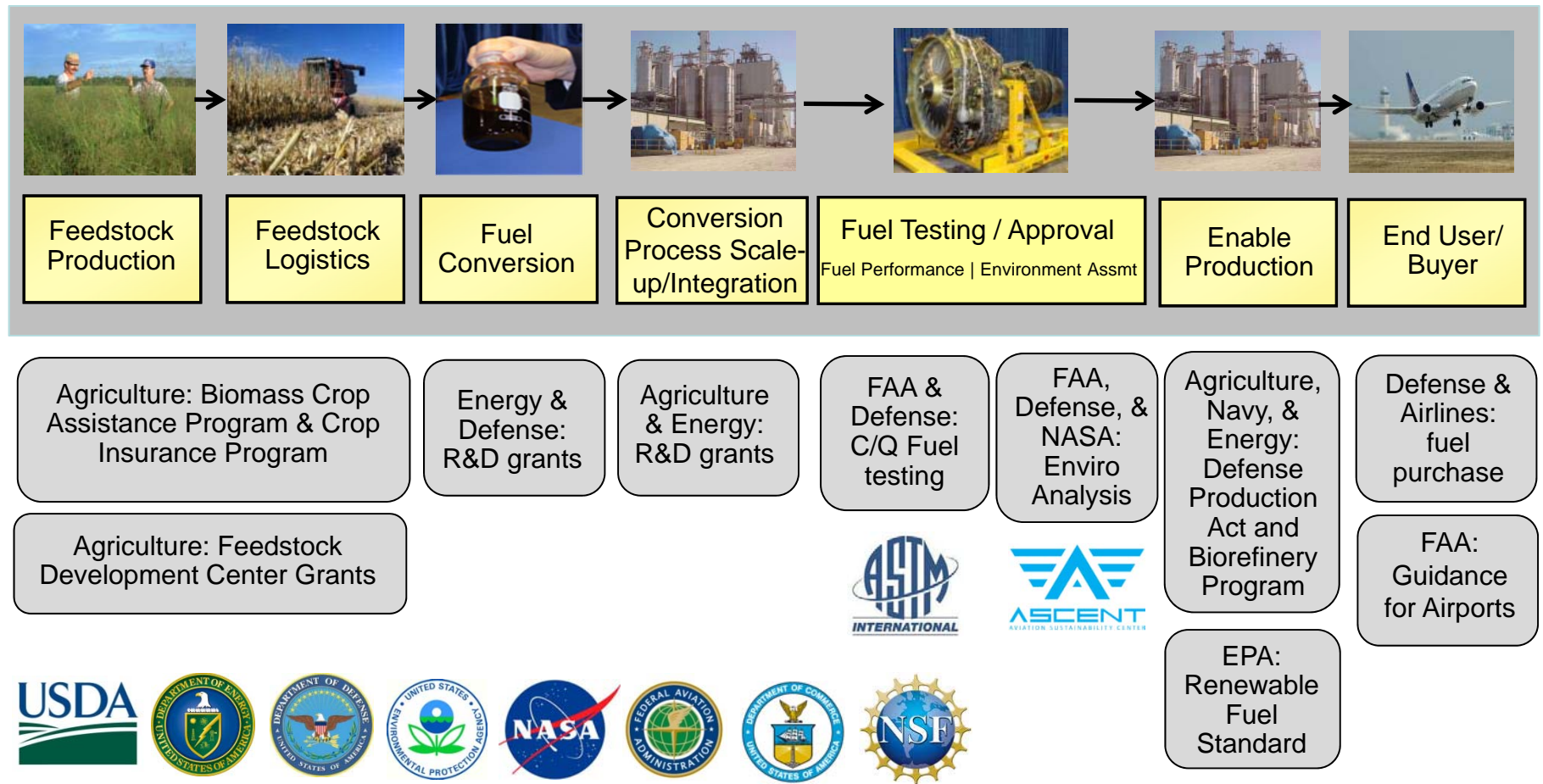
- Interagency
- Public-Private
- State & Regional
- International

- Tracking use



Coordinating Agency Efforts across Supply Chain

Facilitating Deployment and Investment



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Commercial Aviation Alternative Fuels Initiative

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



CAAFI Biennial Meeting – January 2014



- Very successful two day meeting
- Keynote addresses:
 - USDA Secretary Tom Vilsack
 - FAA Administrator Michael Huerta
 - Alaska Airlines CEO Brad Tilden
- Breakout sessions for all four CAAFI teams



CAAFL Environment Team Workshop

- Meeting of experts before CAAFL Biennial Meeting
- Examined variations in life cycle greenhouse gas (GHG) emissions due to:
 - Using different Life Cycle Analysis (LCA) methods, tools, and data
 - Meeting varied purposes and regulatory regimes
- Process:
 - Briefings explored how life cycle GHG emissions varied with different tools and purposes
 - Group discussion led to creation of a GHG LCA Issue Matrix spreadsheet (that is still under development)
 - Identify elements that lead to variations in LC GHG emissions results
- Outputs being fed to CAEP AFTF and other forums where harmonization of LC GHG results is being sought



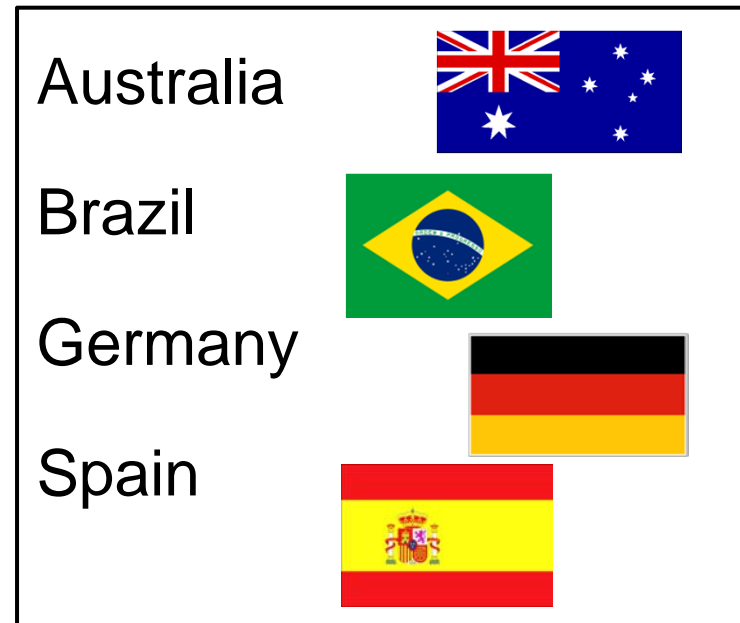
Farm to Fly 2.0

... “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”**



International Engagement

- Bilateral Cooperation Agreements
- Coordination with counterparts, and R&D organizations
- U.N. International Civil Aviation Organization



FAA Alternative Jet Fuel Activities

- **Testing**

- Material compatibility
- Certification / Qualification
- Emissions measurements

- **Analysis**

- Environmental sustainability
- Techno-economic analysis
- Future scenarios

- **Coordination**

- Interagency
- Public-Private

- Understand progress to meeting FAA's goal

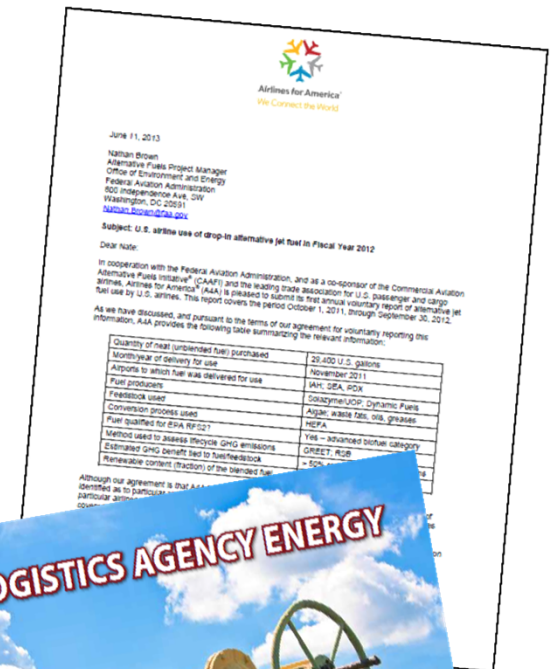
- **Tracking use**



Tracking Alternative Jet Fuel Use

- Measuring progress to 1B gallon Goal
- In FY13 established annual reporting of all U.S. jet operations
 - Voluntary Reporting by A4A
 - DoD fuel purchase data

Performance Indicator (CY)	2012	2013	2014	2015
Renewable Jet Fuel <i>Gallons of renewable jet fuel for the NAS.</i> Defined as renewable jet fuel used by U.S. aviation per calendar year.	49,600	TBD	TBD	TBD



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FY14 Efforts

- Certification / Qualification testing of fuels with current methods (D4054) to support ASTM approval
- Improved testing methods to reduce cost and time of Certification / Qualification over longer term
 - Follow on to USAF “Rules and Tools”
 - Coordinating with USAF, NASA, NIST, Navy
- NASA ACCESS test support via ASCENT Projects
- Relate measured changes in emissions and fuel performance to fuel composition
- Supply chain analysis
- Environmental and economic sustainability analyses
- Continued coordination



Summary

- 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
- Multiple programs and activities:
 - Commercial Aviation Alternative Fuels Initiative (CAAIFI)
 - Continuous Lower Energy, Emissions and Noise (CLEEN) Program
 - Aviation Sustainability Center (ASCENT)
 - National Alternative Jet Fuel Strategy development
- Strong domestic and international coordination

