

2016 Biennial General Meeting



Welcome to the 5th General Meeting of CAAFI

October 2016

Welcome our emcee – John Gardner

Vice President for Advancement, WSU
Chief Executive Officer, WSU Foundation
ASCENT Industry Stakeholder Liaison
PhD Plant Science, UofNE



CAAFI's Functional Sponsors



Airlines for America™
We Connect the World



CAAFI - Public/Private Partnership

Enabling and facilitating commercial progression

An aviation industry coalition established in 2006 to facilitate and promote the introduction of sustainable alternative jet fuel

Goal is development of sustainable, drop-in, jet fuel production:

- * Equivalent safety & performance*
- * Comparable cost*
- * Environmental improvement*
- * Security of energy supply for aviation*

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

How CAAFI works

Bringing interested parties together ...

Aircraft,
Engine, Subsystem
OEM's



Airlines,
Military,
Airport orgs.



Academia,
Gov't Labs

>1000 Global Practitioners

Supply
Chain
Partners



CAAFI®



Fed & State
Government
Offices

Fuel Producers,
Suppliers,
Handlers

... to collaboratively stand-up a new industrial segment

How CAAFI works

Bringing interested parties together ...

Aircraft,
Engine, Subsystem
OEM's

Airlines,
Military,
Airport orgs.

Academia,
Gov't Labs

***Using multiple Work Teams
and PPP projects***

Supply
Chain
Partners

Fed & State
Government
Offices

Fuel Producers,
Suppliers,
Handlers

... to collaboratively stand-up a new industrial segment

Where we're working

CAAFI facilitation – compiling the pieces

Feedstock Development

Pathway Development

Sustainability

Price Point

Risk Reduction

Institutional Alignment

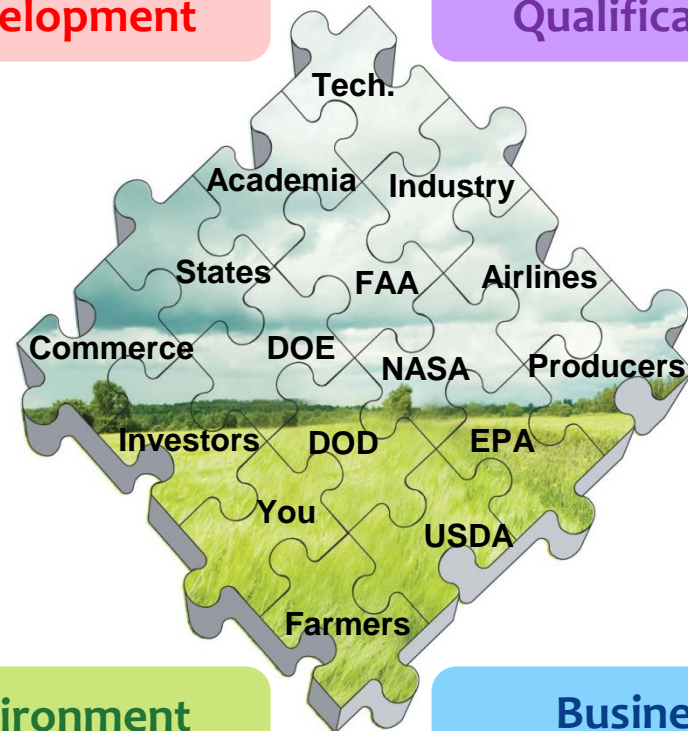
Analysis / Tools

Regional Engagement

Int'l Engagement

Research & Development

Certification & Qualification



Environment

Business

Our gracious CBGM financial sponsors

Champions Level



Airlines for America®
We Connect the World



Advocates Level



Allies Level



Supporters Level



CAAFI Biennial General Meeting – 2016

CAAFI: Ten Years and Growing!

Steve Csonka
Executive Director, CAAFI



**Readying for pushback:
First flight fueled from continuous commercial
production of SAJF, LAX-SFO, 10Mar'16**



Scene Setting

10 Years of Progress

Priorities Going Forward

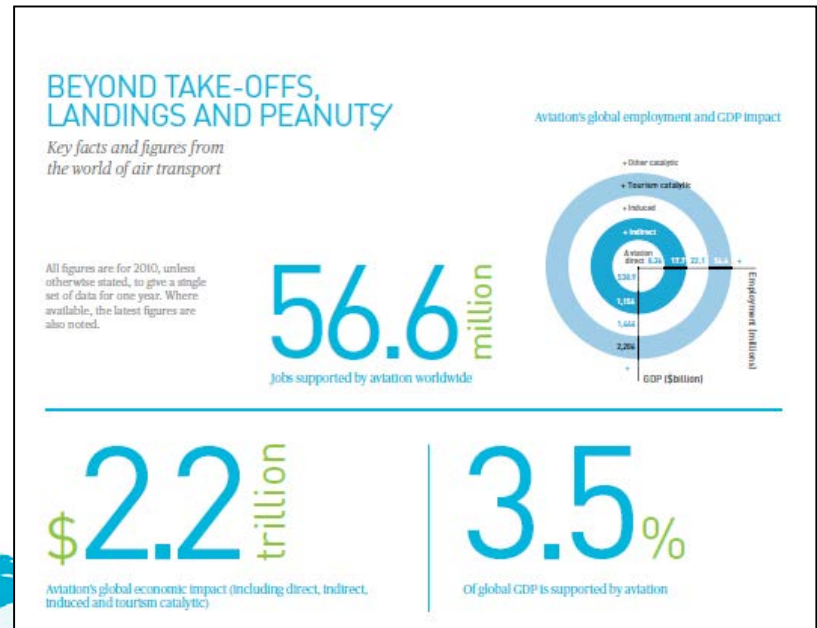
This CBGM

Aviation's successes ...

Unprecedented Value!

- * Safe, High-Speed, Efficient Transport
- * Full range of transport products
- * Connectivity & Trade lifelines
- * Jobs, Development & GDP

Resulting in significant social value, and robust demand!



www.atag.org

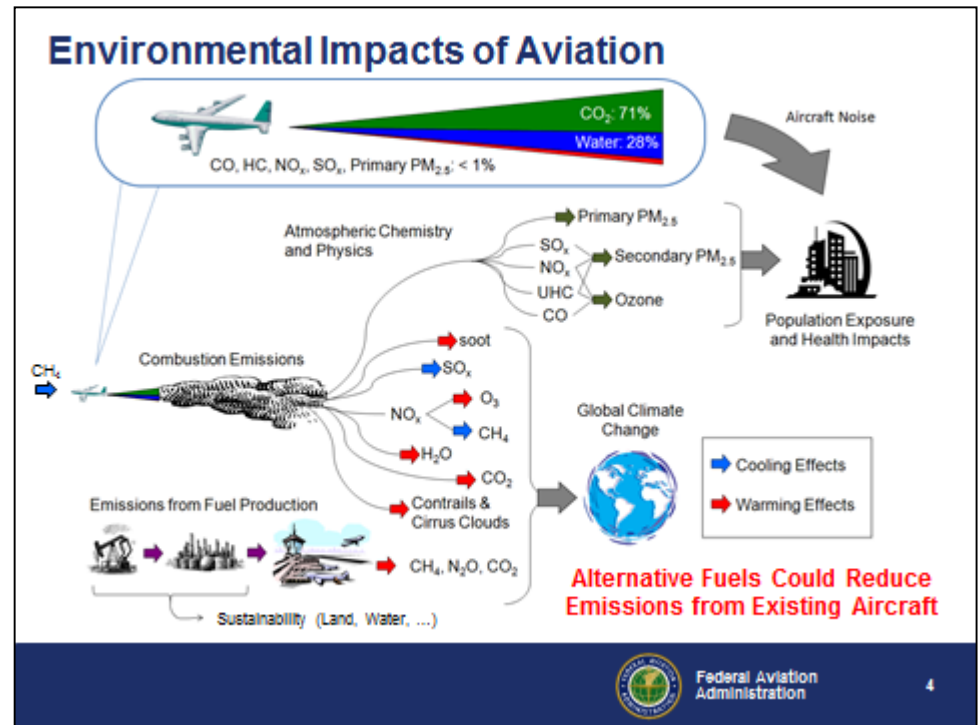
... drive aviation's challenges

Unprecedented pressures to address growth

- * **Environmental impacts of noise & emissions (both GHGs and criteria pollutants)**
- * **Heightened focus on overall sustainability**

Continued efficiency improvements alone have difficulty keeping pace ...

Jet Fuel price volatility: increasing trend, wild swings, future refinery imbalances



Aviation takes its environmental responsibility seriously ...



Industry commitments in 2009, 2012, 2015



Aviation Industry Commitment to Action on Climate Change

As leaders of the aviation industry, we recognise our environmental responsibilities and agree on the need to:

- build on the strong track record of technological progress and innovation that has made our industry the safest and most efficient transport mode; and
- accelerate action to mitigate our environmental impact, especially in respect to climate change while preserving our driving role in the sustainable development of our global society.

Therefore, we, the undersigned aviation industry companies and organisations declare that we are committed to a pathway to carbon-neutral growth and aspire to a carbon-free future.

To this end, in line with the four-pillar strategy unanimously endorsed at the 2007 ICAO Assembly, we will:

1. push forward the development and implementation of new technologies, including cleaner fuels;
2. further optimise the fuel efficiency of our fleet and the way we fly aircraft and manage ground operations;
3. improve air routes, air traffic management and airport infrastructure; and
4. implement positive economic instruments to achieve greenhouse gas reductions wherever they are cost-effective.

We urge all governments to participate in these efforts by:

1. supporting and co-financing appropriate research and development in the pursuit of greener technological breakthroughs;
2. taking urgent measures to improve airspace design including civil/military allocation, air traffic management infrastructure and procedures for approving needed airport development; and
3. developing and implementing a global, equitable and stable emissions management framework for aviation through ICAO, in line with the United Nations roadmap agreed in Bali in December 2007.

Our efforts and commitment to work in partnership with governments, other industries and representatives of civil society will provide meaningful benefits on tackling climate change and other environmental challenges.

We strongly encourage others to join us in this endeavour.



Robert J. Aprahamian
Robert J. Aprahamian
Director General



Giovanni Bisogni
Giovanni Bisogni
Director General & CEO



Thomas Enders
Thomas Enders
President & CEO



Eric Bachard
Eric Bachard
CEO



Stephen Finger
Stephen Finger
President



Alexander von Kalle
Alexander von Kalle
Secretary General



Fernando Pinto
Fernando Pinto
Chairman



Scott Carson
Scott Carson
President & CEO



Federico Freyre Curato
Federico Freyre Curato
President & CEO



Mark King
Mark King
President
Civil Aerospace

Ashley Smout
Ashley Smout
Chairman



Steve Ridolfi
Steve Ridolfi
President
Regional Aircraft



Scott C. Donnelly
Scott C. Donnelly
President & CEO
GE Aviation



Philippe Rochat
Philippe Rochat
Executive Director

Marion C. Blakey
Marion C. Blakey
Chair



Tasleem Hossain
Tasleem Hossain
Vice-Chair

3rd Aviation & Environment Summit, 22nd April 2008, Geneva, Switzerland

... and is committed to action on four pillars for GHGs:

- Technology
 - Including SAJF
- Operations
- Infrastructure
- Basket of Measures

efficient transport modes, and
▪ accelerate action to mitigate our environmental impact, especially in respect to climate change while preserving our driving role in the sustainable development of our global society.

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Robert J. Aaronson
Robert J. Aaronson
Director General

James C. Cherry
James C. Cherry
Chairman



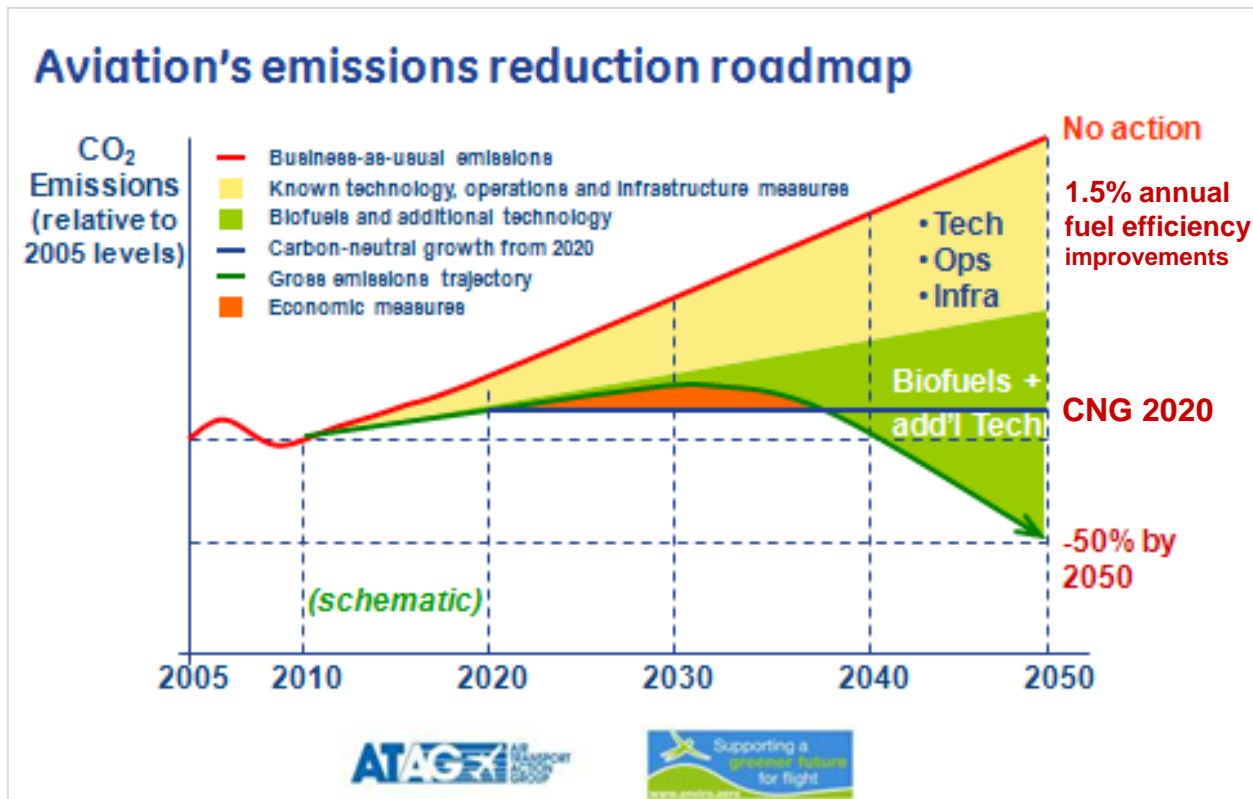
Giovanni Bisignani
Giovanni Bisignani
Director General & CEO

Fernando Pinto
Fernando Pinto
Chairman

Commercial Aviation's CO₂ commitments

To decouple carbon growth from demand growth

Biofuels a key component of GHG containment strategy



These industry commitments are currently being converted into regulation through an ICAO/CAEP “basket of measures”:

- * CO₂ Standards
- * GMBMs

Similar commitments from BizAv & DOD

SAJF Sustainable Alternative Jet Fuel

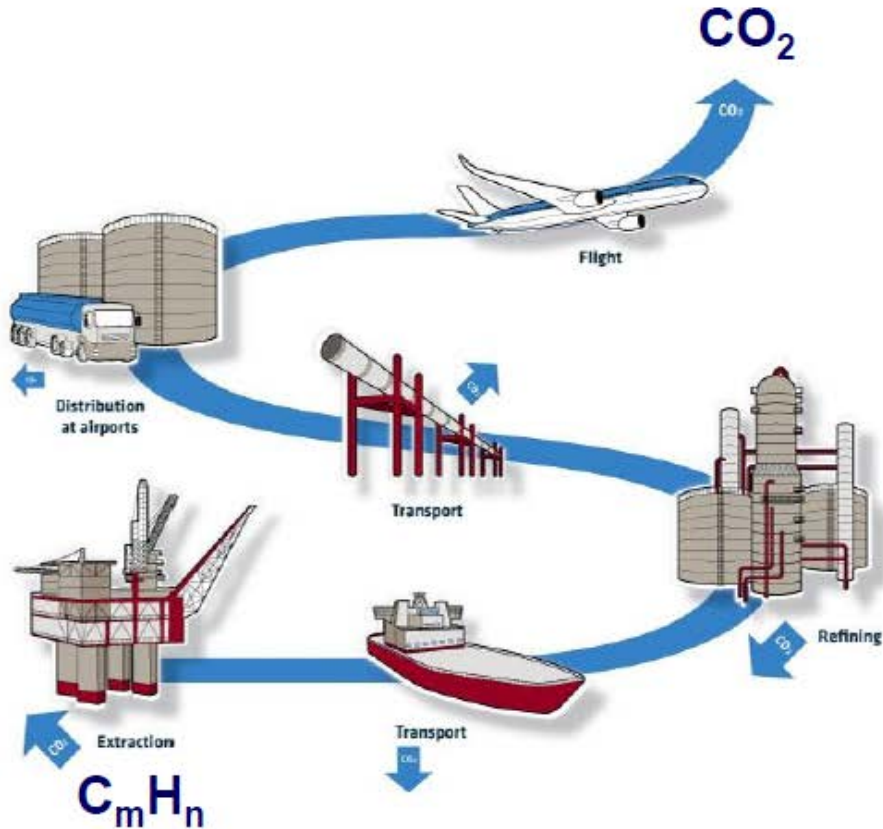
a.k.a. aviation biofuel, biojet, alternative aviation fuel

Alternative: Creating a synthetic jet fuel by starting with a different set of hydrocarbons than petroleum ... a synthetic comprised of molecules essentially identical to petroleum-based jet (in whole or in part) – **enables drop-in approach – no changes to infrastructure or equipment**

Sustainable: Doing so while taking Social, Economic, and Environmental progress into account

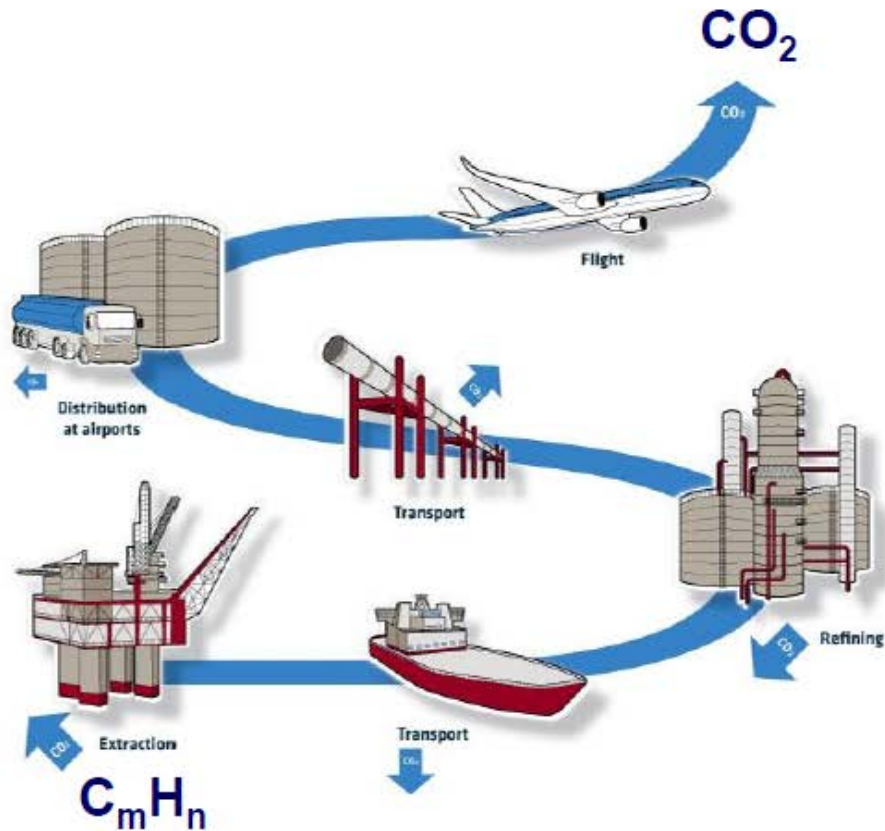
Jet Fuel: Delivering the properties of ASTM D1655

Achieving net LCA GHG reduction

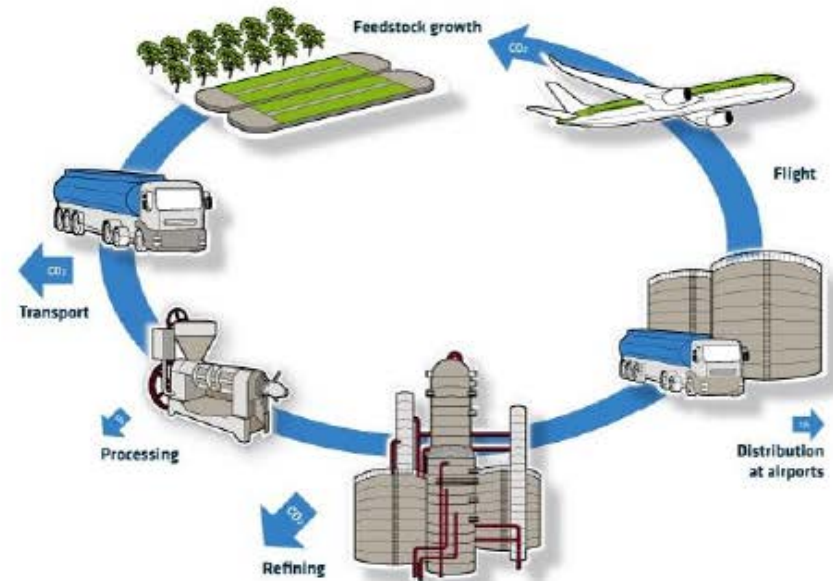


Petroleum based Jet

Achieving net LCA GHG reduction



Petroleum based Jet

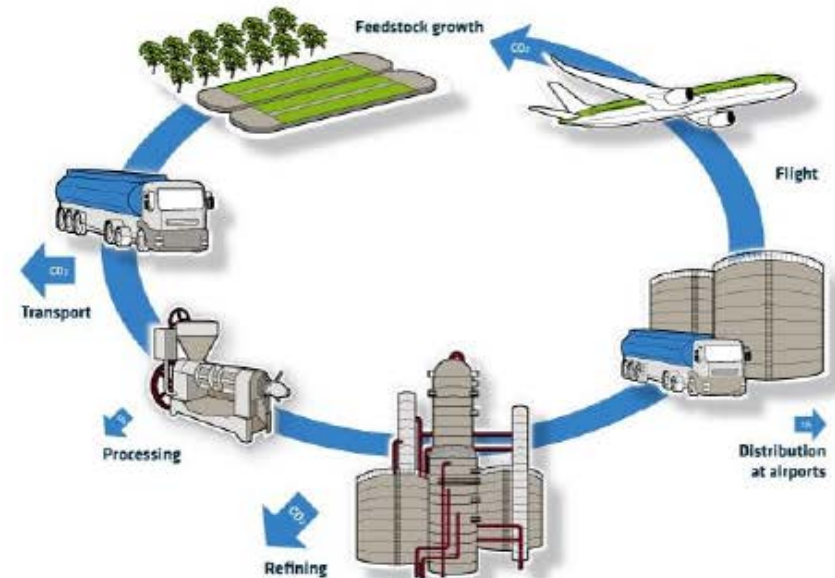


Sustainable Alternative Jet Fuel

Achieving net LCA GHG reduction

Reduction in carbon being introduced into biosphere

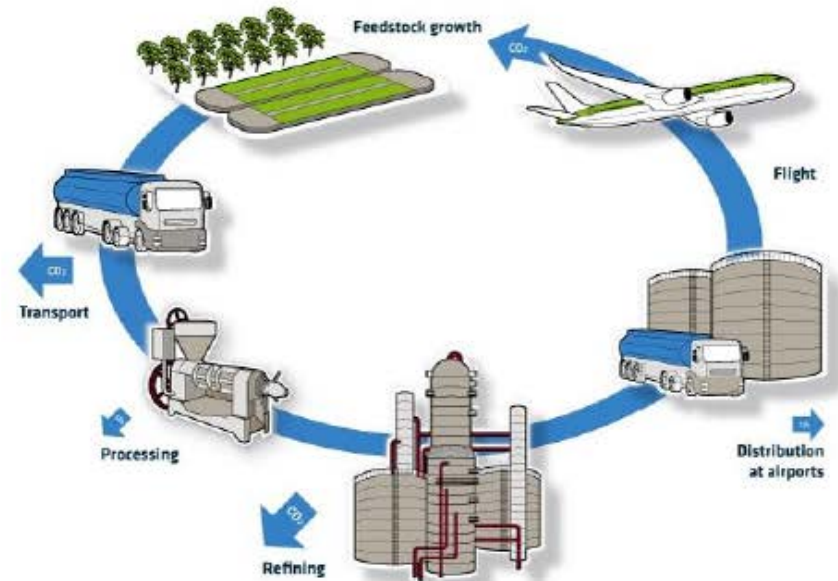
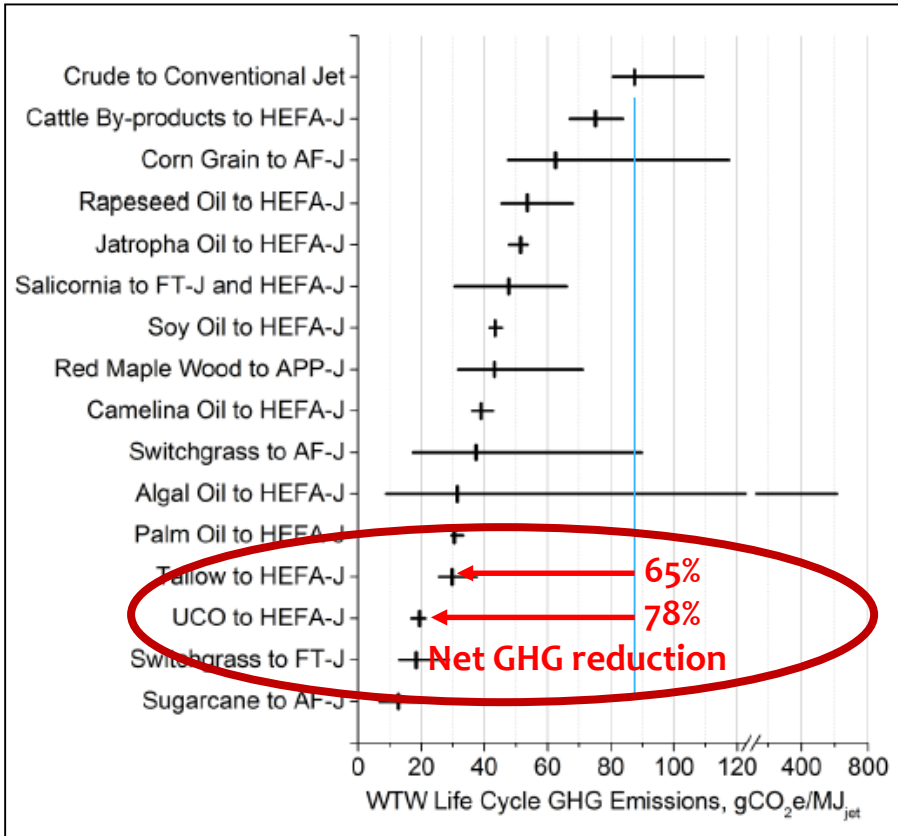
Net LCA GHG reduction:
Benefit comes from leaving carbon molecules in the ground; Instead, utilizing the carbon already in the biosphere via recycling or dual use (e.g. biomass, waste streams)



**Sustainable Alternative
Jet Fuel**

Achieving net LCA GHG reduction

How much? Determined by detailed LCA.



Sustainable Alternative Jet Fuel

Why Aviation cares about SAJF

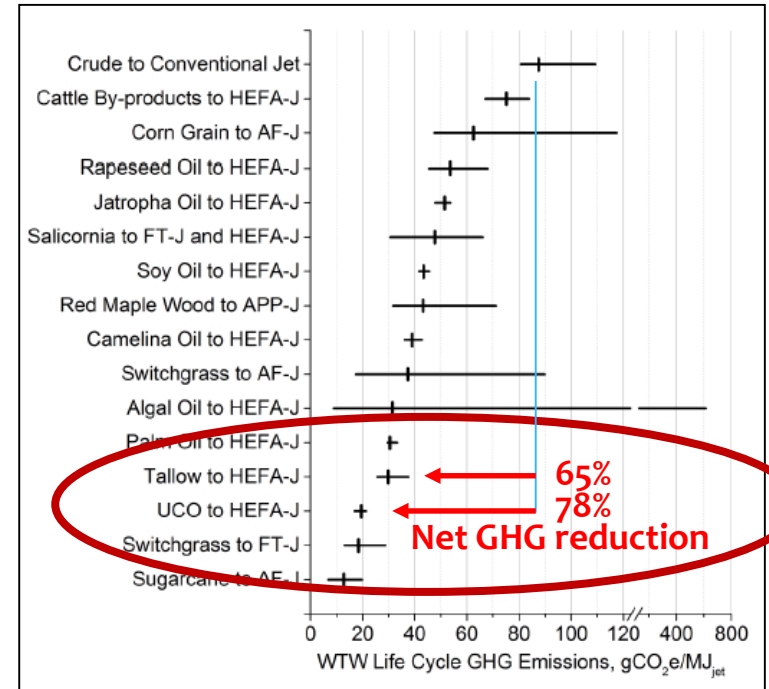
Sustainable Alternative Jet Fuel, a.k.a. biofuel, biojet

Aviation commitments

- * **Decouple carbon growth**
- * **No other viable options !**

Industry alignment on SAJF value proposition

- * **Net carbon relief !**
- * **Supply surety, Price stability**
- * **Energy security**
- * **Lower “criteria pollutants”**
- * **Improved energy mass density**
- * **Minimal infrastructure impact**
- * **Economic development**



SAJF works! Challenges, yes ... but abundant options!

- * **Multiple feedstocks, conversion technologies, entrepreneurs**

Overall industry summary:

- * **Industry aligned on need! Com'l, BizAv, US DOD = 23B gpy in US**
 - * Demand / interest is not the limiting factor
- * **Other challenges we've met:**
 - * Technical viability proven & versatile solutions identified
 - * Feedstock sources / volumes validated
- * **Modest amounts of SAJF coming online**
 - * AltAir from Mar'16, followed by three DPA facilities in '18, ...
 - * Several others in development
- * **Challenges remaining? Sure:**
 - * Risk, **affordability**, financing, execution, more feedstocks and processes
 - * Working a full range of Public-Private-Partnership activities to break down barriers, lower risk, facilitate supply



Scene Setting

10 Years of Progress

Priorities Going Forward

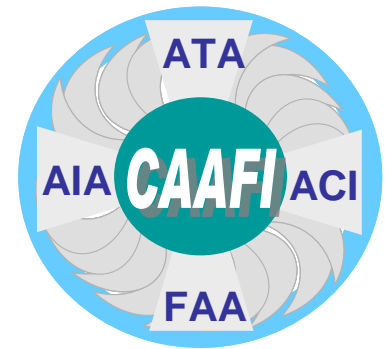
This CBGM

The CAAFI kickoff in 2005-2006

- * A review of technology development roadmaps vis-a-vis market forces (policy, regulation, trends) identifies a need to focus on reductions in GHG pollutants associated with the combustion of fuel, by focusing on the fuel
- * Enough work had been done on synthetic fuel evaluation during the 1980's oil spike to know that such was technically feasible
- * ... But how to do it commercially and at scale, and who can do it with no natural industry lead?
- * Rich Altman gets volunteered (conscripted) to lead an effort
- * ... and here we go!

2006-2007

- * Initial Working Group meeting at Boeing facilities in Seattle, WA, 24May'06
- * The CAAFI concept advanced to affirmation at an Alternative Fuels Workshop at GA Tech in Oct'06
- * A timely development ... For the first time in history, fuels become the single largest component of U.S. airline op-costs, with crude oil ranging between \$60-\$75/bbl through the year



2006-2007: Gearing up

CAAFI overall approach adopted and put into place

- * Convening of first CAAFI General Meeting, Nov'07
- * **Coalition closes 2007 with 40 recommendations and established priorities**
 - * Single market with military, initiate interagency cooperation
 - * Initiate emissions measurements
 - * Establish aviation as a leader
 - * Start looking at technology from a perspective of reducing cost
 - * Explore demand side pull approaches
 - * Engage on airport infrastructure
- * Crude oil ramps 50% in price over the course of 2007, from \$60 to an end of year close of \$96/bbl. The pain has not yet peaked for the airlines, but the pricing draws interest from a lot of potential SAJF producers.

2008-2009: Formative years

- * Business and Economics Team forum: 130 potential producers, buyers meet to spur development of viable SAJF
- * Environment Team forum: Defines approach to SAJF GHG Well to Wake Assessments
- * **Significant Progress Made at ASTM Towards Adoption of Semi-Synthetic Aviation Fuel – Task Force formed,**
- * **D7566 subsequently established, Annex A1 added in Jun'09**
- * **ASTM D4054 Issued**
- * R&D Team forum: Initiate roadmapping activities for processes and feedstocks, evaluate government Initiatives
- * Second CAAFI BGM in Sep'09
- * 15 Airlines take groundbreaking step in SAJF deployment, by signing comprehensive MOUs to negotiate purchase of fuel from AltAir & Rentech
- * Amyris initiates test program
- * Crude oil ramps peaks at \$145/bbl in Jul'08, slips back to \$30 by Dec, then starts a steady march back to \$80/bbl to close 2009.

2010-2011: Foundational work

- * First Air Force demonstration in an A-10, followed by Green Hornet flight on Earth Day '10
- * CAAFI Environment Team advances GHG and sustainability metrics for SAJF deployment
- * **R&D Team creates communication frameworks with introduction/expansion of FRL and FSRL, and incorporation into road-mapping**
- * **Jet fuel pathways added to RFS2**
- * Paris Air Show exposition
- * MOU signing with Brazil
- * D7566 Annex A2 HEFA-SPK added in Jul'11
- * Third CAAFI BGM in Nov'11
- * Farm-to-Fly wrap-up
- * Crude oil stays on relatively stable climb over the period to end 2011 at \$100/bbl.

2012-2014: Enabling success

- * R&D Workshop clarifies stakeholder R&D investment needs and priorities with publication of 8 white papers
- * Addition of resources to CAAFI Leadership Team, new branding
- * Initiation of SOAP-Jet Webinars with CHASE (carbon, hydrogen, and separations efficiencies) series
- * Aviation Day at 2013 ABLC & Signing of Farm-to-Fly 2.0
- * **Focus on regional business development – State Initiatives**
- * **First SAJF cost workshop with DOE**
- * Fourth CAAFI BGM in Jan'14
- * D7566 Annex A3 HFS-SIP added in Jun'14
- * Crude oil floats in \$80-\$110/bbl range for 32 months before starting a slide in Aug. to \$55/bbl at the end of 2014 – creating some SAJF business case pressures

2015-2016: Fostering execution

Five pages of industry headlines on CAAFI.org

- * Additional demonstrations (GGF), offtake agreements, supply activities, including contract for F-76 from DLA
- * AltAir commences production – supply to LAX
- * Announcements of progress on research and funding, expansion of efforts to integrate value from co-products
- * Refiners progress on co-processing – EPA supportive NPRM
- * Bioeconomy focus, with feedstock supply updates
- * Testing validates PM reductions
- * Crude wanders downward in '15 from \$50 to \$26/bbl by Jan'16, dampening SAJF activity (and stimulating the naysayers) but then mounts a steady return to the current \$50/bbl level, and ... RINS stabilization & Tax Policy support approved
- * RFPs on NIFA AFRI CAPS, Foundational Research, and BRCs
- * Agreement at ICAO

We've come a long way in 10 yrs

- * Language, Tools, Frameworks, Communication Events
- * Research efforts – feedstocks and processes
- * Project activity, feasibility assessments, ASCENT work
- * **ASTM qualification**
- * Sustainability evaluations
- * **Flight demonstration work**
- * Policy frameworks
- * **Offtake agreements**
- * International collaboration
- * Poised for the commencement of production

SAJF approved production pathways

Annexes to ASTM D7566: D1655 fuel following blending

→ Syngas FT (FT-SPK)	50% max blend
→ Hydroprocessed lipids (HEFA-SPK)	50% max blend
→ Biochem sugars (HFS-SIP)	10% max blend
→ Syngas FT w/ aromatic alkylation (FT-SPK/A)	50% max blend
→ Isobutanol conversion (ATJ-SPK)	30% max blend

Approved

- * Commercialization for each in development, in some cases by multiple parties who would use licensing
- * Seven others in process, plus co-processing
- * Another 15+ at various levels of lower FRL



Over 2500 demonstration and commercial flights leading to the start of regular commercial usage in 2016



SAJF offtake agreements

Beyond numerous demonstration programs

neat quantities

	+	UNITED 	=	5 M gpy from 2016
	+	 Gulfstream	=	3 yr agreement 30/70 blend
	+	 	=	3 yr agreement Enabling LAX flts
	+		=	375M usg
	+	UNITED 	=	90-180 M gpy Over 10 yrs
	+	Southwest 	=	3 M gpy
	+	FedEx	=	3 M gpy

SAJF offtake agreements

Beyond numerous demonstration programs

neat quantities





Scene Setting

10 Years of Progress

Priorities Going Forward

This CBGM

Facilitate production in development

First refinery online – AltAir – What's next?

- * **DPA Awardees**
 - * Red Rock, Fulcrum, Emerald, and their build-out plans
- * **AltAir Build out (4X)**
- * **SG Preston (5 facilities in first tranche)**
- * **ARA licensing and build-out**
- * **Neste, REG, UPM pivots**
- * **Unlocking of renewable diesel and refinery co-processing**
- * **Initiating activities of Amyris/Total, Gevo, Virent, LanzaTech ...**
- * **Other commercial-scale technology demos to occur in next 12 months that should prove to be enabling**

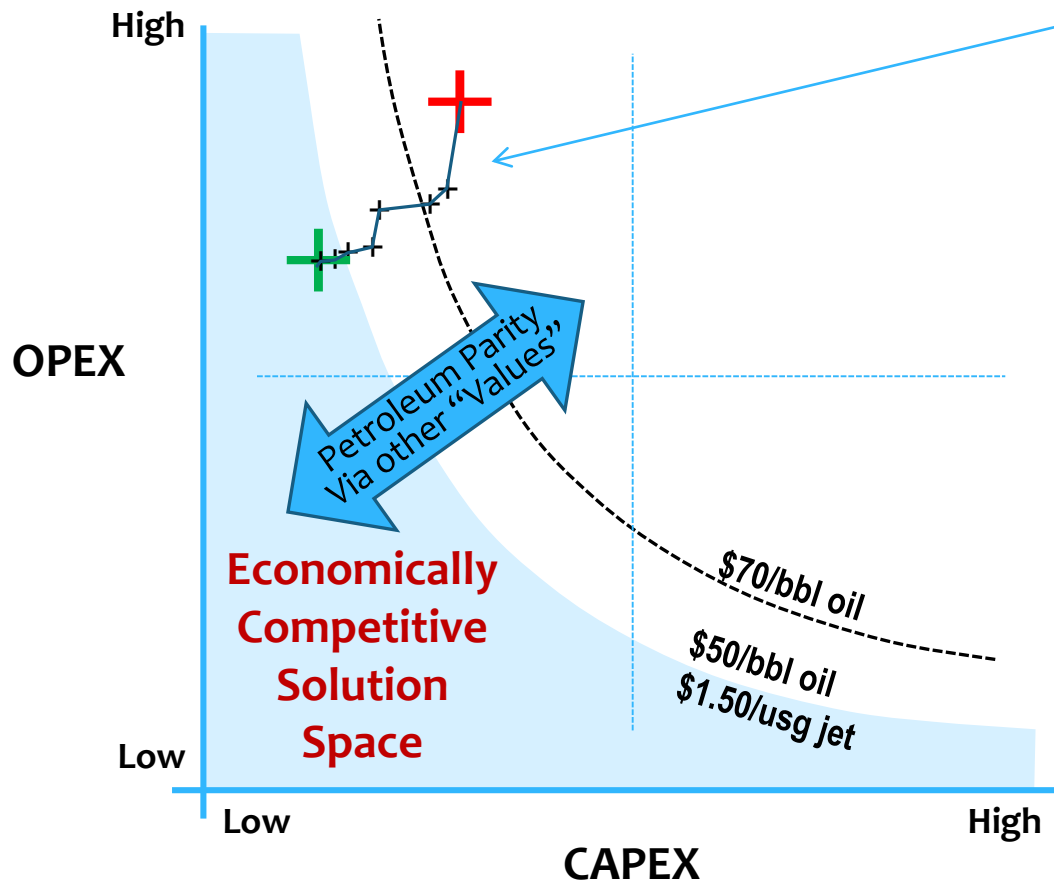
Necessitates serious engagement with purpose grown oilseed & FOG development / expansion

Leverage enterprise adoption

Build on the foundation of fundamentals we have established

- * Continued State Initiative engagement
- * Actualization of Federal AJF R&D Strategy – mirroring findings from NAS/ASEB Low Carbon Aviation Committee
- * Bioeconomy Initiative: Billion Ton Update, FARB, Challenges and Opportunities, ...
- * USDA NIFA/AFRI CAPs & DOE BRC applicants (30+ for each)
- * Progression of ASCENT engagement in Supply Chain development, and NJFCP efforts
- * Progress with ASTM “Quick Entry” qualification concept
- * ICAO Assembly Agreement in Oct’16 – framework for MBM
- * Commercialization progress

Drive toward cost competitiveness



Enabled by:

- * R&D
- * D&D Support
- * Policy
- * Commercialization learning-curve progression
- * Build-out – Scale
- * Competitive uses
- * Valued co-products / services
- * Brownfield / co-location

Enabling approaches informed by analytics

Enable robust fuel qualification

- * **Improve current flow – eliminate choke points**
 - * Consider clearing house, joint funding, CoE, int'l participation
- * **Inform thinking on compositional approaches**
 - * National Jet Fuel Combustion Program execution
 - * Develop / Improve testing methods to improve
 - * Continue monitoring of existing petroleum supply
- * **Move in the direction of a compositional spec**
 - * Enable a Quick Entry approach,
 - * Needs to be able to expand in scope (blend, breadth of molecules) over time to enable 2050 goal achievement
 - * Develop M.o.C., Process Stability, stage-gate control mechanisms



Scene Setting
10 Years of Progress
Priorities Going Forward

This CBGM

CBGM discussions this week

Inform, collaborate, plan, encourage, set expectations

Many success factors – but continued effort required!

- * It's an improving atmosphere of policy certainty
- * It's a collaborative, global effort – broad feedstocks and conversion process opportunities
- * Making progress on framing challenges and solutions
- * Success examples: now and pending
- * Continued integration with interests of others, including multiple U.S. agencies
- * Continue to define and work the “nuts and bolts”

2017-20xx: Focus on key enablers

Additional engagement with resources aligned under FAJFRDS

- * Feedstock research and supply build-out
- * Continued focus on new / additional conversion technologies
- * Process demonstration and scale-up
- * Qualification Streamlining
- * Better framework for communication of FRL advancement, and engagement with buyers
- * Mitigating commercialization buckets of risk
- * Attracting institutional investment
- * Integration with existing refineries
- * Integration with distribution systems / airports

Thanks for being part of this!

Steve Csonka

Executive Director, CAAFI

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Unconference Session Set #1

4:35 – 5:15

Evaluating Sustainability (Environment Team focus) - Room 145A

Explore the sustainability evaluation frameworks that are available and identify roles CAAFI can play to assist with codifying sustainability assessments.

- * Moderator: Jim Hileman, FAA; Nancy Young, A4A
- * Kickoff discussion: Jim Hileman, FAA

Feedstocks and Feedstock Systems (R&D Team focus) - Room 145B

Identify challenges to advancing feedstock readiness level (FSRL), framed by the consideration of multiple feedstock families.

- * Moderator: Todd Campbell, USDA
- * Kickoff discussion: Scott Turn, U of HI

Enhancing Fuel Qualification Process (Cert/Qual & Business Team focus) - Room 146A/B

A discussion of how key stakeholders can enhance the qualification process, including: Producers, OEMs, and Customers. Discuss opportunities for C/Q streamlining, and other issues like the current evaluation of co-processing.

- * Moderator: Mark Rumizen, FAA

Unconference Session Set #2

5:20 – 6:00

Additional Revenue Streams (Environment Team Focus) - Room 145A

Identify opportunities for realizing adjacent benefits (bio-products, environmental-services) as revenue, and discuss ways to approach capturing such value.

- * Moderator & Kickoff: Tom Richard, PSU

Evaluating Techno-Economic Viability (R&D Team Focus) - Room 145B

Identify ways for incorporating “real-world data” into TEA.

- * Moderator: Jim Hileman, FAA
- * Kickoff discussion: Robert Malina, University of Hasselt

Airport Infrastructure Evaluations (Business Team Focus) - Room 147A

Identify systematic approaches to addressing airport-specific challenges.

- * Moderator: Steve Csonka, CAAFI
- * Kickoff discussion: Carol Sim, Alaska Airlines

Key Fuel Qualification Challenges (Cert/Qual Team Focus) - Room 146A/B

Discuss unique challenges associated with a move to more robust qualification approach - exploration of utilizing a quick-entry & composition-based specs.

- * Moderator: Gurhan Andac, GE Aviation
- * Kickoff discussion: Cliff Moses, SWRI, Melanie Thom, Baere Consulting

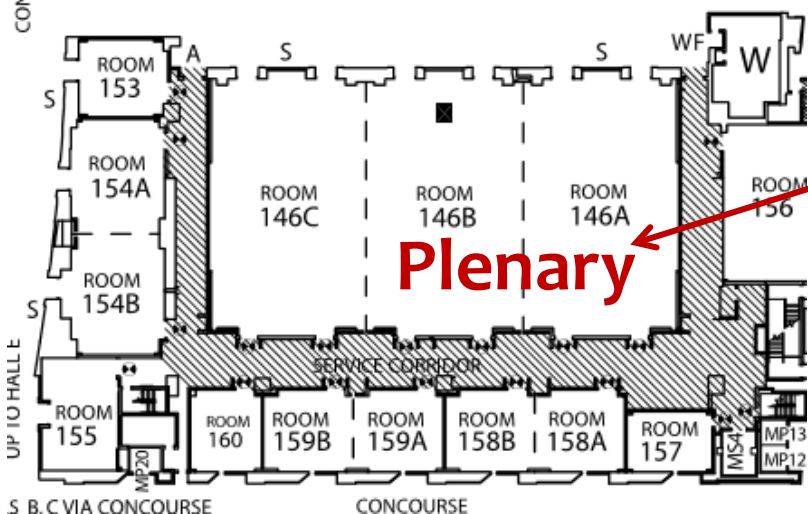
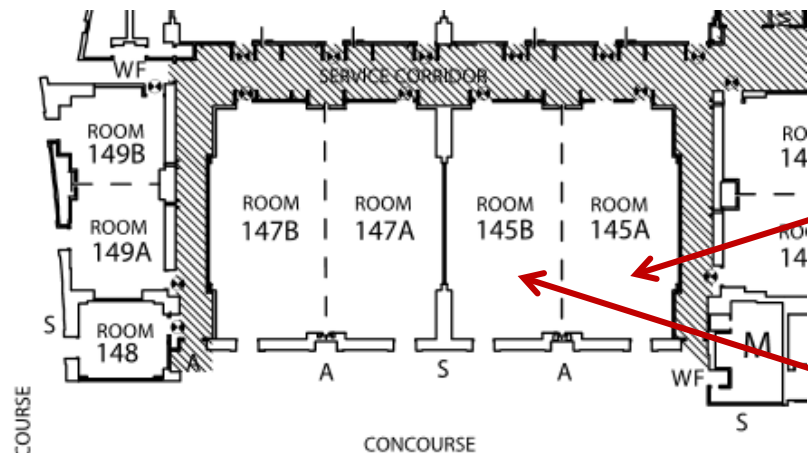
Unconference Sessions

Session Set #1, 4:35 - 5:15

* Evaluating Sustainability:
Environment Team Focus
Room 145A

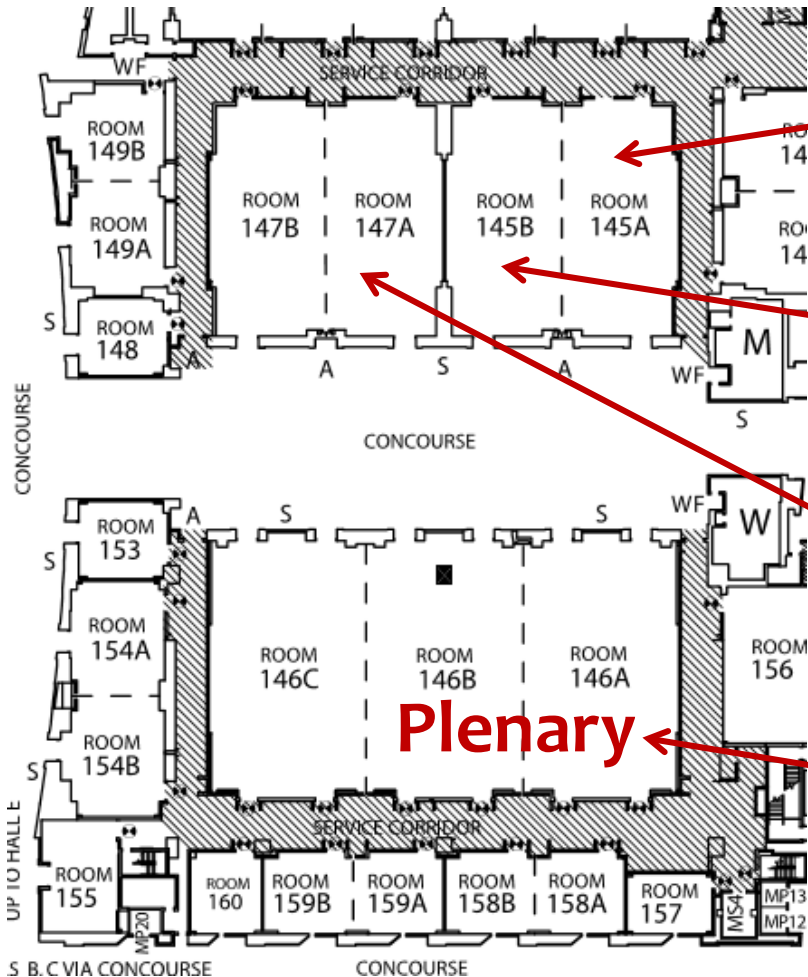
* Feedstocks and Feedstock Systems:
R&D Team Focus
Room 145B

* Enhancing Fuel Qual. Processes:
Cert/Qual & Business Team Focus
Stay in Plenary, Room 146A/B



Unconference Sessions

Session Set #2, 5:20 – 6:00



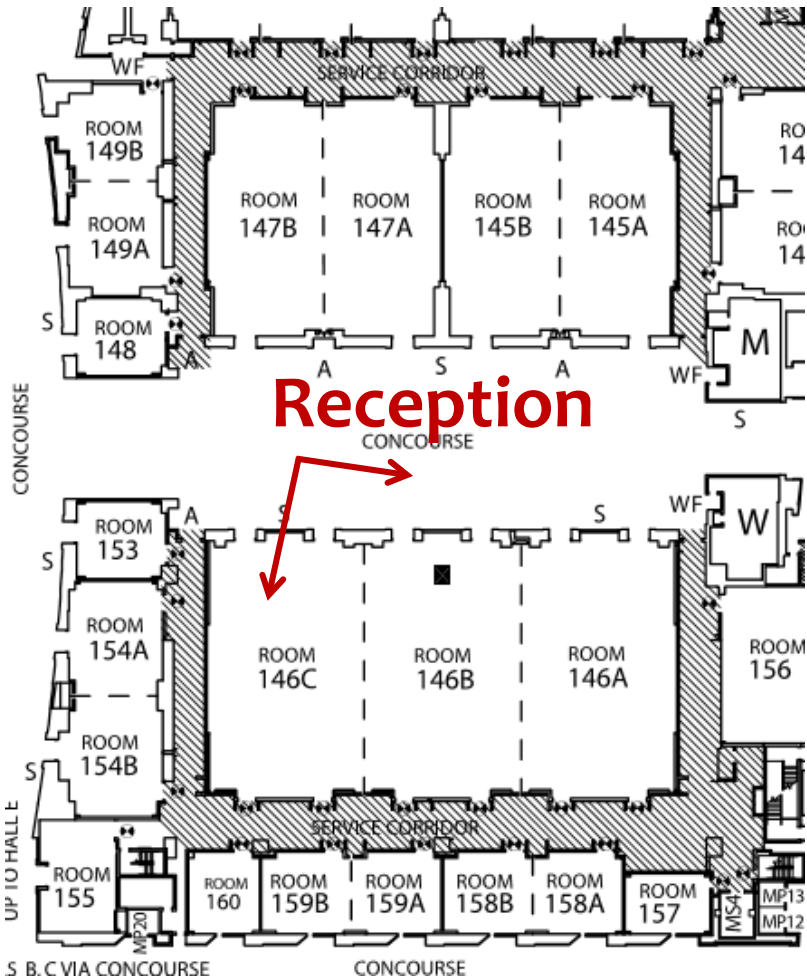
* Additional Revenue Streams:
Environment Team Focus
Room 145A

* Evaluating Techno-Economic Viability:
R&D Team Focus
Room 145B

* Airport Infrastructure Evaluations:
Business Team Focus
Stay in Plenary, Room 147A

* Airport Infrastructure Evaluations:
Cert/Qual Team Focus
Stay in Plenary, Room 146A/B

Reception: 6:05 – 7:30p



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CAAFI Work Team Breakouts

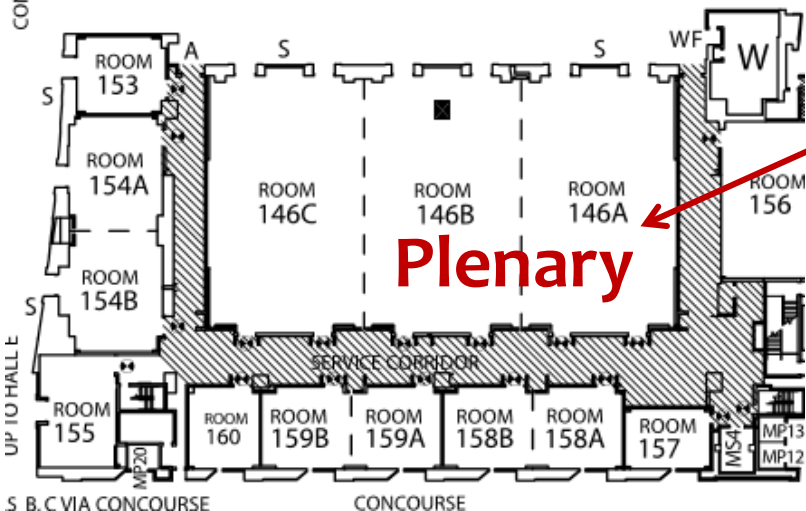
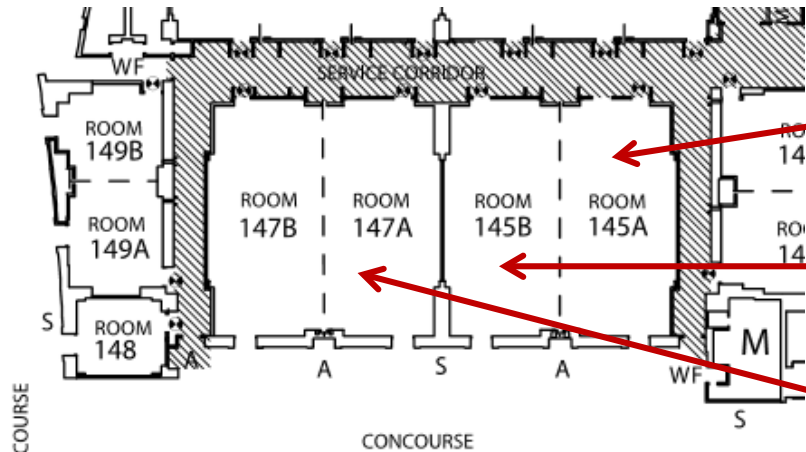
Wedn. 26 Oct, 08:00 – 09:30A

* Environment Team
Room 145A

* R&D Team
Room 145B

* Cert/Qual
Room 147A

* Business Team Focus
Room 146A/B



Areas for side discussions

When not in use by CBGM

- * Room 153 – Private Board Room
Available via reservation only,
schedule control by Sara Forni

- * Breakout Rooms:

Room 145A

Room 145B

Room 147A

Room 146C

Not completely private, but please
respect signs on door:

Private session from xx:yy – xx:zz

